University of Warwick

Economics Department

PhD Thesis

A Mediterranean Region FTA: some economic and environmental effects studied within a dynamic CGE framework

Maurizio Bussolo

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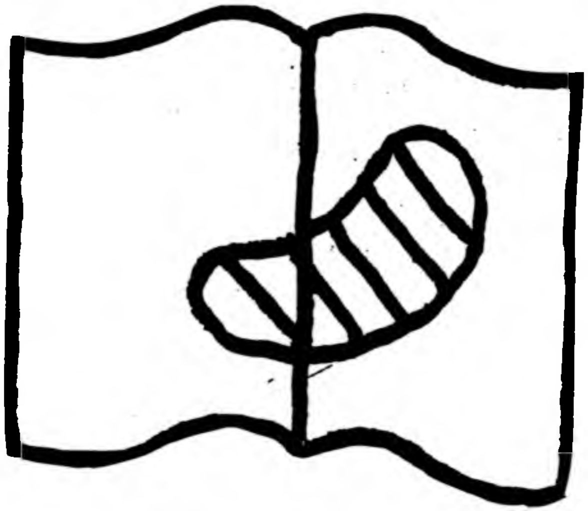

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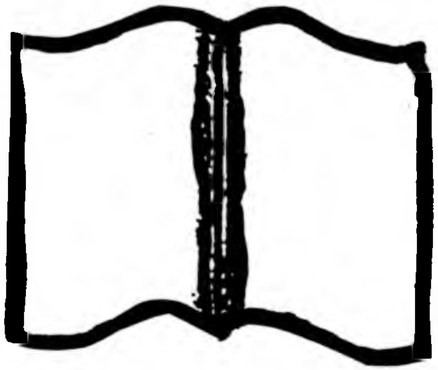

To my grandparents:

Caterina, Emilia, Giacomo e Fedele

Acknowledgements

It goes without saying that most of what is contained here I learned from and with many teachers and other students. Among them, I have to note my obvious debt to Jeffery I Round and thank him for his help, constant support and excellent guidance throughout this enterprise. I also would like to express my sincere gratitude to Dominique Van der Mensbrugghe whose generosity in sharing his expertise had been indispensable for my work. A special thank goes also to David Roland-Holst who provided me with clever inspiration, and to Guillermo Larraín who had always been available to learn with me.

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1 Introduction

The conclusion of the GATT Uruguay Round and the contemporary proliferation of regional trade agreements[1] will probably be remembered among the major economic-related events of the 90's. The concerns that regionalism may undermine the spirit of global free trade, and hence be a stumbling block for a more integrated and successful international economy, really signal how trade is still considered a crucial factor for economic development. Trade policies have been economists' object of study since the beginning of their science and these new events have stimulated further analyses. The view we have of economic development has also been influenced by a third prominent event: the 1992 Global Warming Rio meeting. This international conference registered, for the first time, the formulation of global policies for sustainable growth and environment preservation. It is interesting to note that most of these policies consisted of mutual promises and concessions among developed and developing countries, in a very similar way to that witnessed at the Uruguay Round.

These main events, their interrelation, the original ideas and policies they produced, the new questions they raised, have all motivated this thesis. Its *broad* objective is to contribute to the formulation of new hypotheses on and analyses of North-South relations, particularly in respect of trade policy, regional trade agreements and their effects, trade and environment linkages, and sustainable growth.

Is the formation of a Free Trade Area between developed and developing countries advantageous to all or does it have some conflicting consequences? What is at stake in such an agreement in terms of trade creation, trade diversion, consumers' welfare, structural adjustment, growth effects? Are trade liberalisation and growth objectives conflicting with environment protection? Or, is an environmental policy too costly in terms of growth potential, and does its implementation influence developing countries'

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[1] The most prominent have been NAFTA and Mercosur in the Americas, the EU enlargement to include former EFTA countries in Europe, and the expansion and consolidation of the ASEAN group in the Pacific region. See, for overviews, Landeck M. (1994), Sapir A. (1992), Yamazawa I. (1992), Brown D., A.V. Deardorff, and R. Stern (1992).

comparative advantage in international trade? What are the economists' main analytical instruments used in the analysis of the mentioned issues? What data are available for empirical analyses? These are among the main questions addressed in this thesis.

Clearly, given the breath of these issues, the analysis presented here had to be circumscribed and focused in a number of ways. One restriction has been in terms of the geographic area considered. The thesis does not address global issues: the specific Mediterranean area has been chosen as the object of study. This area has the main advantage of being the point of contact between developed and developing countries, moreover it has not been subject of extensive analyses as, for instance, has North America.

A second restriction has been on the specific economic policies investigated. The thesis thoroughly examines two broad policies: commercial and environmental policies. In particular, it analyses the first in the form of the creation of a regional block including, on one side, the industrialised European Community, and, on the other, the developing countries of North Africa. Additionally, the focus is on the interrelations between trade liberalisation and environment protection.

A third restriction on the thesis has been on its analytical approach. The types of issues of interest as well as the focus on distributional effects of the policies here examined require a system-wide, general equilibrium perspective. Therefore general equilibrium analyses are the main analytical tool used throughout the thesis. By providing benchmarks and counterfactuals, they allow simulating policies not yet implemented, as it is the case in a regional Mediterranean agreement or in a green tax policy. Besides, the complex interrelations among the environment, the production structure and trade, where direct as well as indirect effects are very important, can be fully captured and explained only with a general equilibrium study.

As an introduction to the following chapters and a useful way to outline my analysis and my contributions to the economic literature on the mentioned issues, three main themes developed throughout this thesis are identified and described below. Their coherence results from the desire to tackle the issues of interest using a common database and multi-sectoral, general equilibrium modelling approach. The logical, and practical, link among these three themes is given by the strict connection between data and models (theme 1), as well as by the crucial relationships among trade, growth, environment, and policy sequencing (themes 2 and 3).

1. Data Compilation, Accounting and Multiplier Analysis

The first theme is concerned with data compilation, accounting, and multiplier analysis. Given the geographic and analytical focus of my thesis and the lack of good basic data, the construction of an updated and extensive new Social Accounting Matrix (SAM) for two representative countries of the Mediterranean area, was the necessary first step in my work. This is of fundamental importance: a SAM is the essential database for all my subsequent quantitative analyses and the quality and consistency of the SAM data affect the intrinsic value of all the results presented here. This new Mediterranean SAM is valuable in its own right for providing a "snapshot" of the structure of the subject economies and as such represents a part of my original contribution in this thesis.

A full description of the Mediterranean SAM and its preliminary analytical uses are therefore provided in the first part of the thesis. Initially, the SAM is used to highlight the main characteristics of the relevant economies, and to build a fixed-price model. Then, the lengthy and detailed process of the SAM construction is outlined.

The originality of this first part, beyond the provision of a new, informative database, is mainly ascribable to the use I make of the fixed-price model. The initial simple analytical results granted by this model represent a novel way of describing the basic economic structure of the particular region under study and its structural adjustment process following an exogenous shock. This preliminary examination reveals several important features of the Mediterranean area, for instance its similarities with the NAFTA region. It is also considered a very useful precursor to the more complex Computable General Equilibrium models. In fact, the demand-driven, fixed-price, fixed coefficient (SAM-based[2]) models may exaggerate quantity adjustments to policy changes. However, the market clearing assumptions of CGE models may sometimes result in excessive price responsiveness and dampen quantity responses[3]. It may be that the results of SAM-based and CGE models reflect upper and lower bounds on quantity and price adjustments in the context of the policy experiments here considered. Although the following chapters are not dedicated to a systematic comparison of SAM-based and CGE results, by offering both of them, this thesis fills a sort of gap in the economic literature that does not usually consider the strict links between these two models families.[4]

Once the SAM has been identified as a key input in the analysis and its basic structure as a crucial factor influencing the subsequent results, a natural question arises. How might a change in the accounting structure – for instance in the treatment of imports – affect the size of the (fix-price) model multipliers? This special case of multiplier sensitivity analysis is another contribution of this first part of my thesis. The input-output literature considers three main ways of treating imports: (1) classified by purchasers, (2) classified by goods (competitive or complementary imports), (3) a separate input-output table for imported goods. Clearly, the last, by combining the first two methods, delivers more information but it also has demanding statistical requirements. In this thesis, by experimenting with a regional fixed price model, I offer a practical way to evaluate the information loss of going from the comprehensive accounting structure of (3) to that of

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[2] In the text I use the expression 'SAM-based model' when I refer to multipliers model, which are an evolution of earlier input-output models.

[3] This may occur when countries undertake major economic changes and prices, especially those of factors of production, are not fully flexible.

[4] Usually CGE models are preferred to SAM-based models for the simple reason that the latter do not include important supply constraints. In fact by fixing its prices, it would be perfectly possible to force a CGE model to emulate a SAM-based one. However, this latter kind of model enjoys some practical advantages: they are much simpler to construct and calibrate. Besides, their straightforward structure, by highlighting how the simulations results are affected by sectoral production and demand shares, factors' intensities, trade dependency ratios, income distribution and other ratios, clearly unveils the key role played by these important characteristics of the basic SAM data. In the relevant economic literature, very few studies attempt any careful comparison between SAM and CGE models. For an example refer to McGregor P.G. and J.K. Swales (1993). In another paper, I. Adelman and J.E. Taylor (1991) argue that "optimally, it may be worthwhile to estimate both types of models and test for the robustness of their results." (Page 167).

(2). One important conclusion is that this loss is minor, especially in the case where it is possible to distinguish between intermediate and final imported goods.

The relevance of this conclusion is not limited to fixed price models and can be easily extended to CGE models. In fact, a standard assumption in these models is to have a hypothetical "Armington" agent who minimises the cost of demanding a composite good subject to some aggregation function of imported and domestic goods. The shares of the imported and domestic component of the composite good are calibrated from the base year SAM. The ideal situation would be to have a separate input-output table for the national and foreign goods (as in (3) above). This in turn would entail having multiple "Armington" agents for intermediate and final demands with potentially different elasticities of substitutions. Clearly this complicates the analysis in two ways. Firstly, it is much more data intensive in terms of the accounting structure of the initial SAM, but also in terms of non-SAM parameters, namely the substitution elasticities. Secondly, by considerably increasing the number of equations and variables, it may create computation problems. A straightforward method to obtain structure (3) from (2), with no additional data required, is proposed and tested with the multiplier sensitivity analysis. This method has the advantage of providing the necessary data to calibrate the relevant Armington equations of a CGE model. Furthermore, the minor loss detected in the size of the multipliers – in the specific regional case examined here – may justify its application in a CGE context and the concomitant single "Armington" agent assumption.

The first part of the thesis is concluded with a detailed description of the Mediterranean SAM construction. The general approach to assembling data for the SAM is hierarchical. When direct estimates are available from official sources, these are incorporated first. The second category of estimates are updates of data from previous years. Finally, when data are missing or considered extremely unreliable, indirect estimation methods, such as share imputation and matrix balancing, are used. The use of these conventions is made explicit at each stage below. By making this construction process as transparent as possible, the primary objective of this chapter is to allow an assessment of the strengths (and weaknesses) of the empirical models based on the Mediterranean SAM. A second objective consists in providing some basic criteria for

SAM assembling. Although this process can not yet be entirely standardised, the methods described there are fairly general and can be considered as guidelines in overcoming the most common obstacles.[5]

2. Trade and the Environment: Are There Policy Trade-offs or Is Co-ordination Possible?

The second theme of this thesis is the study, in the specific Mediterranean context, of the interdependencies of environmental and commercial policies. Apart from the obvious central interest in trade policy, various reasons motivate this theme. Firstly, the possible environmental consequences of more liberal trade arrangements have received the growing attention of policy-makers. Two recent prominent trade negotiations, the Uruguay Round of the GATT and the NAFTA agreement, contain various norms and restrictions on the use of environmental policy instruments that may conceal protectionist objectives. Secondly, a concomitant interest in this issue in the academic literature has been reflected in the large number of papers emerged on the subject. Two basic questions on the connections between trade and environmental policy are more often addressed in the literature: (1) for developing countries signing trade agreements with more developed economies, is specialisation in dirty activities the direct result of the realisation of comparative advantage? (2) How do environmental policies, such as abatement taxes, influence international competitiveness? Given the lack of robustness of qualitative results shown in theoretical work concerning these issues, most recent studies have been focused on measuring quantitatively the interconnections between trade and the environment. My contribution is in this line of investigation. By using a CGE model of Morocco I am able to carry out a detailed quantitative analysis of the linkages between economic activity and the environment in this Mediterranean country and to evaluate the joint impact of environmental and commercial policies.

Three main aspects of the CGE model presented in this thesis account for its originality with respect to previous environment and trade analyses. First, it embodies a

[5] This also fills a gap in the literature on applied economics. Basically the only published work I could find on SAM building is that of S. Keuning and W. de Ruijter (1988).

high level of disaggregation for pollutants, products, sectors and types of households. This model can be used to simulate abatement policies targeted to specific air emissions, measuring, at the same time, the effect on related water and soil pollutants. Trade policy reforms, and the related resource reallocation, do not have uniform outcomes across sectors. The expansions or contractions of specific activities have differentiated environmental consequences. The product disaggregation of the model allows highlighting specific environmental outcomes of trade policy. Moreover, income distribution issues arising from environmental and commercial policies, and the question of the redistribution of environmental taxes receipts, are briefly discussed and can be further investigated due to the detailed classification scheme of households. Second, this model explicitly includes dynamic features. Its simulations run to year 2004, allowing the introduction of exogenous factors such as productivity shifts and demographic changes that affect capital accumulation and growth trajectory. Comparing the trends of outputs and emissions derived from different scenarios reveals the dynamic interdependencies of environmental and commercial policies. Third, most economy-wide studies on growth and environment linkages rely on effluent intensities associated with output, and do not allow for substitution between non-polluting and polluting factors. Abating pollution is then achieved principally by reducing output in pollution intensive sectors, with a significant cost in terms of growth. By contrast, in the current model pollution emissions are linked to polluting input use, rather than output. Technical adjustment by substituting non-polluting factors to polluting factors may therefore be assessed.

3. Mediterranean Economic Integration

The third and last main theme developed in this research completes the empirical analysis of the Mediterranean economic integration by offering an assessment of the effects of the trade policy reforms currently discussed for this geographic area. The theme is developed in two parts. In the first, the economic benefits of further integration in terms of increased welfare, trade and growth rates are assessed using a multi-country CGE model. In the second, the recursive dynamic version of the same model is used to extend the discussion of the sequencing issue of trade reforms.

The novelty of this work is not limited to its geographic focus but rests on the model structure, principally its trade equations and its labour market alternative closures, and on the distinct use I made of the model for the sequencing issue. The present model differs from conventional CGE specifications in important ways. First, it is a detailed and complete two-country model, so domestic supply, demand, and bilateral trade for the two Mediterranean countries are fully endogenous at a 24-sector level of aggregation. Moreover, each country's import and export flows with the rest of the world are further spatially disaggregated into flows with the European Union and the other countries. The extent of price adjustments, as well as the volume and pattern of trade creation and trade diversion, are important factors in determining the ultimate welfare and resource allocation effects of multilateral trade policy, and are fully assessed by the present model in the case of a FTA trade liberalisation.

The main results confirm the findings of previous studies concerned with similar set-up of trade integration among partners at different levels of development. The comparative static simulations of the removal of trade barriers show considerable gains whose magnitude is directly linked to the initial level of protection, trade dependency and relative size of the economies participating in the regional agreement. Extended discussions of the implications of different closures for the labour markets and of the possible limitations of the Armington and Constant Elasticity of Transformation (CET) assumptions for the trade equations complete the analysis.

An additional objective of this last part consists of extending the literature on the sequencing issue of trade reforms. The economic literature on this topic is mainly devoted to establishing the correct order of liberalisation between the current and capital account and, surprisingly, it neglects the problem of sequencing among the sectors of the current account. In fact, adjustment costs generated by the non-instantaneous realignment of goods and factor prices represent a major concern of policy makers when implementing more liberal commercial policies. By using a recursive dynamic version of the multi-country CGE model, a comparison of trade reforms, which differ in their liberalisation sequence, is presented with an estimation of their effects in terms of adjustment costs and growth rates.

The thesis is structured into eight additional chapters as follows.

The next chapter presents a brief introduction to the Euro-Mediterranean economic relationship and to some background studies of this geographic area.

Chapter 3, by using a fixed price multiplier model, analyses the original two-country Social Accounting Matrix (SAM) constructed for this research thesis. The multiplier decomposition method is also originally employed to assess the validity of more data intensive formats of the reference SAM.

Chapter 4 should be considered as an extended technical appendix. It describes in detail the methodology and data sources for the construction of the SAM. Although no crucial research results are presented, this chapter has been included to allow an appraisal of the strengths (and weaknesses) of the empirical models built on these data.

Chapter 5 investigates the linkages between trade and environment with a single-country CGE model. A detailed examination of the possible specialisation in dirty industries induced by trade liberalisation, or the loss of competitiveness following the implementation of domestic environmental taxes is carried out, and encouraging conclusions on the co-ordination of trade and environmental policies are reached. Chapter 6 is effectively the technical appendix of the previous chapter. It presents the complete algebraic structure and main assumptions on the exogenous variables of the model used.

Chapter 7 is the concluding research chapter. Here a two-country CGE model is applied to study the economic benefits (or costs) of trade policy reforms currently discussed for the Mediterranean area. An extension to the sequencing issue of trade reforms is also presented. Chapter 8 describes the differences of this model's equations from those of the previous model.

Chapter 9 contains the main research findings and conclusions reached in the previous chapters, and indicates future developments of the present research.

2 Setting the Stage: the Mediterranean Economic Area

From earliest antiquity to the 15th century, the Mediterranean was the centre of that part of the ancient world situated to the west of India and China. It was here, around the eastern basin of the Sea (Egypt, Babylonia, Persia, Phoenicia and Greece) that the earliest civilisations appeared. From the time of Alexander the Great's conquests, Hellenism gave the region a common imprint. Then within the framework of unification under Rome, this civilisation was gradually transferred to the people of North Africa and northwest Europe. Thus the foundations were laid upon which the medieval worlds of Christendom and Islam were later built. For 1,000 years there was a constellation of societies bound to one another by organic ties of culture and ideology and technological and commercial exchanges to such an extent that it became possible to speak of a system. Some of the key features of capitalism (commodity exchange and merchant capital, free wage labour, private ownership of the land and enterprise) appeared in the region at an early date and, at some periods - notably during the early centuries of Islam and at the time of expansion of the Italian cities (between the 12th and 14th centuries) - became distinguishing features of segments of this system, so much so that the "Mediterranean system" can be seen as prehistoric ancestor of the world system of modern capitalism.[...]

The Mediterranean region was [later] transformed into a periphery as the capitalist system developed. Later, the southern Arab shore was even colonized, while the formation of the bourgeois national state in Italy and the Balkans meant that obvious traces of underdevelopment persisted. The Mediterranean ceased to belong to the people living along its shores and became a geostrategic region for others, dominated by the egemonic power, first Great Britain, then the United States and later the USSR.

From: The Mediterranean. Between Autonomy and Dependency. Faysal Yachir

This chapter presents a brief survey of earlier analyses of the Mediterranean economic area, and a compact statistical overview of the main economic relationships between its northern and southern shores. This should provide the necessary introduction to my study by pointing out strengths and weaknesses of previous approaches, summarising the main results achieved so far, and identifying research potential. This, in turn, should help to put my own work and contribution in perspective.

According to their main subject of analysis, it is possible to divide the literature concerning the economic relationship between Mediterranean countries (the South) and the European Community (the North) into three main categories. The first category focuses on the economic effect of preferential trade agreements, the second on the economic effect of the Single European Market (1992 effect), and the third on the possible economic consequences of further integration.

This categorisation follows a logical as well as a chronological order. In fact the EC international policy has evolved from its initial stages of trade preference agreements, through three enlargements and the 1992 process, to its future possible extensions. Economic analysis of these issues has evolved too. Earlier studies focused on simple measurements of trade flows indices, some considered merely commodities flows while others added factors flows. More recent studies used econometric models, mainly of the partial equilibrium variety. Another branch of applied research has employed computable general equilibrium models. An important advantage of this approach derives from the possibility of simulating the effects of policies not yet implemented: it does not rely on an ex-post approach and on the availability of time series data. In fact a formal analysis of regional integration, one of the major themes of this thesis, can only be carried out with analytical tools capable of considering counter-factuals.

This chapter is organised into four sections. The first three deal with the three categories defined above. The last, divided into two parts, describes the evolution of trade and labour flows in the Mediterranean region in the last two decades, and, by presenting comparable statistics, contrasts the Mediterranean situation with that of NAFTA.

2.1 The Economic Effect of Preferential Trade Agreements

Despite the multilateral approach to tariff reductions fostered by GATT talks, the preferential tariff treatment of exports of developing countries has become a common feature of the international trading system. This regional approach to trade policy has been extensively used by the European Union.

The economic literature that addresses the question of whether regional arrangements are stumbling blocks or building blocks for a more integrated and successful international economy offers mixed evidence.[6] In a recent paper, P. Krishna[7] incorporates political economy factors in a model of trade with imperfect competition in segmented markets,

[6] See J. Bhagwati (1993, and 1992), J. Bhagwati and A. Panagariya (1996), A. Winters (1996), and R.Z. Lawrence (1996).

[7] P. Krishna (1996).

and reaches two conclusions. First, preferential arrangements, which divert trade away from the rest of the world, are more likely to be supported politically, and second, such preferential arrangements will reduce member country incentives for multilateral liberalisation. In a survey of studies on trade preferences for developing countries, D. Brown presents another point of view[8]. She lists four justifications for this special treatment: the first is that "equal treatment of unequals is inherently unequal", in other words developing countries should be exempt from requirements of reciprocity and multilateralism. The second argument is that trade preferences are expected to stimulate local processing and help diversify the economies of developing countries. Third, stimulated exports should provide needed foreign exchange for exchange constrained economies. Finally, preferences are often offered to obtain political influence or to increase economic stability in a volatile region of the world.

It seems that extra-economic reasons (mainly political) are needed to justify the regional approach. And this is especially true for Europe whose main political instrument available to influence international affairs has always been its trade policy.[9] Since its creation, the Community has built a very complex and extended system of preferential trade agreements.

To illustrate this system it is useful to depict the hierarchy of trade preferences as follows:

1. *The Lome' Convention* (which substituted the Younde' Convention after the UK accession) ACP GROUP 69 Countries:
    - 46 African
    - 15 Caribbean
    - 8 Pacific
2. *Association Agreement* - providing eventual full EC membership:
    - Cyprus, Turkey, Malta

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[8] D. Brown (1988), but see also D. Brown (1989).

[9] In Yannopoulos' words: "Not wishing to emulate the patterns of influence exercised by the traditional superpowers and not possessing the diplomatic and military means with which this influence is underpinned, the Community has preferred to rely on trade links as a key factor in enabling it to play a balancing role and promoting conditions of lasting social and economic and hence political stability in those regions". See G.N. Yannopoulos (1977).

3. *Preferential trade and Co-operation Agreement*:

Maghreb (Algeria, Morocco and Tunisia)

Mashraq (Egypt, Jordan, Lebanon, Syria)

Israel

Yugoslavia

4. *Generalised System of Preferences*:

42 Developing countries (not covered by above)

9 Least Developed countries (not covered by above)

Hong Kong, Macao

Bulgaria, Hungary, Mongolia, Poland.

Clearly, historical ties, such as the colonial heritage of France, Belgium, the Netherlands and United Kingdom, and the desire to obtain international influence have been the main factors that shaped the development of this system of hierarchical preferences.

This is of special significance for the Mediterranean countries towards which the European Community has demonstrated special interest and special responsibility. In fact, the place of the Mediterranean countries in the European Community's network of preferential trading arrangements[10] is not only privileged, in the sense of being near the top of the hierarchy, but is also qualitatively different from that of the Community's other special arrangements because of the blatancy with which the Community's Mediterranean policy contravenes the letter and practice of the GATT.

One important conclusion of a series of early studies[11] is that the European Community offered preferences to the Mediterranean countries according to a political strategy while the Mediterranean countries accepted the terms for economic reasons.[12]

Various methods have been employed to analyse the consequences of trade preferences, the most important of which are: (1) examination of the evolution of market

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[10] The Mediterranean policy can be broadly identified with levels (2) and (3) in the above scheme.

[11] R. Pomfret (1981, 1982, 1986a,b).

[12] A more detailed history of the Mediterranean agreements is found in A. Roe (1992a), A. Roe and M.A. Ayub (1992b), G.N. Yannopoulos (1989), R. Pomfret (1981, 1982, 1986a,b) and various documents of the Commission of the European Communities.

shares for preferred and non-preferred suppliers; (2) statistical regression analysis; (3) partial equilibrium analysis in which imports from beneficiaries and non beneficiaries are usually treated as imperfect substitutes; (4) general equilibrium models, which try to avoid some of the shortcomings of the partial equilibrium analysis by considering indirect effects and interactions between different markets.

No general consensus about the effects of preferential treatment of developing countries' exports emerges. Authors present different findings according to which aggregation of countries or products, or which time period is considered, or which method is used.[13]

As far as the specific Mediterranean area is concerned the picture is not much clearer. In this case, even the mere distinction between a developed and developing region seems complicated by the entry in the Community of three Mediterranean countries: Greece, Spain and Portugal. This deeply changed the Community making it much more *Mediterranean*, and transforming it into an agricultural superpower. Moreover, the inclusion of two additional ex-colonial powers broadened the Community economic interests in different areas of the world.[14] These new features had a strong influence on the Mediterranean policy; thus studies concerned with it in the period before the Enlargement are not strictly comparable with those dealing with the situation post-Enlargement.

A number of studies on preferences and trade for the Mediterranean countries are briefly reviewed below.

One of the earliest attempts to quantify the impact of Common Market preference for the Mediterranean countries was by McQueen (1976). The purpose of his research was to estimate the commodity trade effects of agreements concluded with Greece, Turkey, Morocco, Tunisia, Spain and Israel. It considered the effects only on these countries and ignored those on the Community or third countries. It analysed the possible effects of the agreements on the commodity concentration/diversification of exports and on the

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[13] For instance D. Brown (1988) concludes that on balance the Lomé Convention appears to have done little to stimulate industrialisation of the beneficiaries through export incentives, whereas M. McQueen (1992) argues that there is some evidence that the Lomé preferences have been helpful - and that - there is also evidence that imperfections in the convention have been a constraint on more rapid diversification.

[14] A. Tovias (1977, 1990a).

structure of production, employment and incomes of the Mediterranean countries. Very simple measures were considered of the effects of the Agreements on total commodity exports and imports, such as the rate of growth of exports and imports with the EEC before and after the negotiation of the agreement.[15] To identify the extent to which the growth of exports to the EEC was due to the growth of demand for imports by the EEC, he then deflates the rate of growth of exports to the EEC by the rate of growth of imports by the EEC from other LDCs (excluding oil-exporters). The extent to which this ratio [ratio 1] exceeds unity indicates that the countries receiving preference increased their share of EEC imports from developing countries. Additionally, to test whether preference-receiving countries recorded an acceleration in export growth rates due to a possible increased ability to supply goods on a competitive basis (independent from the agreement), the rate of growth of exports from the preference area to the rest of the world is deflated by the rate of growth exports by other LDCs to the rest of the world (Row) [ratio 2]. The extent to which [ratio 1] exceeds [ratio 2] is an indication of the beneficial effects of the agreement on the exports of the preference receiving countries. From McQueen's findings it appears that all six countries have recorded growth rates of exports to the EEC substantially higher than could be expected either from the growth of imports from developing countries as a whole or from any improvement in their competitive position in world markets. The substantial residual element in the growth of exports to the Community is therefore attributed to the third potentially important determinant, namely the beneficial effects of the agreements.[16]

The main result of the second part of his study, the analysis of commodity concentration, is that the agreements appear not to have had any marked effect in

[15] M. McQueen actually warns that these measures are subject to problems of interpretation and in general are of limited use. The tendency to an acceleration in these rates of growth after the signatures is not simply attributable to the agreement but may have been the result of an increase in the rate of growth of demand for imports by the Community that would have taken place irrespective of trade preferences, or of improved ability of the Mediterranean countries to compete both in world markets and in the EEC. To overcome these limitations, he proposes other measures such as: the change in the proportion of exports to the EEC with respect to total exports, or the variations in the balance of trade.

[16] M. McQueen recognises that there are several possible criticisms of this method: firstly, it operates at an overly high level of aggregation (total imports, exports, "EEC", "other LCD's", "Row"); secondly, it assumes that the whole of the residual element in the growth of Mediterranean countries trade with the EEC can be attributed to the agreement; thirdly, the results obtained are sensitive to the time period; and finally there is no proper counterfactual scenario addressing the issue of would have been the most likely level of exports to and from the EEC by the Mediterranean countries in the absence of an agreement.

lowering the commodity concentration of Mediterranean exports to the EC. This leaves the less developed Mediterranean countries still dependent on a few primary products, the only significant exception being Spain.[17] In his final part he briefly offers some evidence of the possible effect of an increase in the capacity to import on the level of investment, and thus on the growth rate, of the Mediterranean economies.

In a series of econometric studies, R. Pomfret[18] analyses similar questions considering smaller aggregates (a smaller group of countries and different types of goods). He investigates the consequences of preferences not only for trade but also for factor flows. As far as trade is concerned, Pomfret' s main conclusion is that preferential access to the community markets did stimulate exports from the Mediterranean countries.[19] By showing that the European effective rate of protection (i.e. the protection granted to value added) is on average around 20 per cent,[20] he denies the general view according to which previous multilateral tariff negotiations had reduced the developed countries' MFN tariffs to such low levels that the effect of any preference would be trivial. He also suggests that the existence of a preferential trade agreement has at times inhibited the community's use of non-tariff barriers. He bases his analyses on both national case studies[21] and on specific commodities (textiles and clothing) cross-section regressions. Despite the more detailed picture offered, especially for the products analysis, Pomfret' s study still suffers from not specifying the counter-factual situation precisely. As far as factor flows are concerned, Pomfret predicts that increased trade flows due to preferential agreements should reduce flows of factors of production but, in

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[17] McQueen' s analysis is based on a Gini-Hirschman coefficient, defined as

$C_j = 100\sqrt{\sum_i (X_{ij} / X_j)^2}$ where: X_{ij} = value of country j's exports of commodity i, and X_j = total value of country j's exports.

[18] See footnote 11 and R. Pomfret (1986c).

[19] This conclusion is actually qualified by the author in the sense that, it is difficult to isolate the impact of preference from that of other simultaneous changes; and there's also the difficulty that preferences will only stimulate exports under favourable domestic conditions.

[20] This calculation is made for the year 1984 when the Community's average nominal tariff was below 10%.

[21] For two single countries - Greece and Turkey; for an homogeneous group - the Maghreb; and for a residual group of other Mediterranean countries.

one important respect, capital movements may be stimulated, and reflected in European investment in export-oriented industries in low-wage countries.[22]

The last interesting issue raised by Pomfret is that of the effect of the second Enlargement[23] and the consequent erosion of preferences. His findings confirm that the second Enlargement should not have great effects on manufactured goods but much greater erosion of the value of preference is possible for agricultural products. Using a *similarity-index* to compare exports of the other Mediterranean countries to the exports of primary products from Greece, Portugal and Spain, the author finds that the outsiders whose exports are most similar to those of these three new members, and that will be most susceptible to erosion of preferences, are Cyprus and Turkey, the Maghreb countries (especially Morocco) and Israel.

To conclude, the Global Mediterranean Policy achievements for non-member Mediterranean countries have been scant. This is argued to be the consequence of three problems. First, the Common Agricultural Policy (CAP) has become increasingly protectionist. Second, despite the general principle of free access - that is, no custom duties or quantitative restrictions on industrial products - the EC has in reality adopted a protectionist attitude especially for textiles. Finally, the extension of initial concessions to other countries and the Enlargement of the EC have eroded the magnitude of the preferences.

2.2 The Economic Effect of the Single European Market (1992 effect)

The second important issue, which is analysed by the literature on the economic relationships between the EC and the Mediterranean countries, is that of the external consequences of the formation of a Single Market in Europe. Any discussion of future trade relations between developing countries and the EC should start by considering the potential benefit and harm caused by European integration. Increased access to the European markets is one of the main interests pursued by North African countries in their foreign economic policy. In fact, the proposed trade agreements between Europe and

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[22] The experience of Spain, Portugal and Greece is a clear example of capital inflows preceding or accompanying measures of trade liberalization, that in these cases are connected with the entry in the EC.
[23] Second Enlargement: Greece; third Enlargement: Spain and Portugal.

North Africa, discussed at length in this thesis, can be seen as an attempt of the Mediterranean developing countries of strengthening their preferential treatment vis à vis an increasingly integrated Europe.

This section presents a very brief survey of theoretical, as well as empirical issues, related to the "1992 effect". It starts by identifying what constitutes a 1992 policy measure, it then looks at what effect these reforms have in the EC (*internal effect*), and considers what are the possible spill-overs for non member countries (*external effect*). Finally some empirical estimates of the external effect are presented.

The Completion of the European Internal Market

Despite the fact that the European Community (at least its greater part) has constituted a Customs Union for 30 years its internal market remains fragmented rather than integrated. For this reason nearly 300 separate directives have been produced to facilitate the free movement of goods, services and factors of production, and eventually to create a Single Market. Specifically, 1992 entails two broad kinds of policy measures:[24] (1) the removal of barriers to trade between member states of the EC; and (2) the implementation of legislation designed to improve the competitiveness of EC firms.[25] For our purposes, this discrimination can be enough to identify the main internal and external consequences.[26]

Internal Impact

The first objective of the '92 program was to achieve *for Europe* (of the Twelve) increased incomes and further economic growth.

There is broad agreement among analysts on the positive effects that can be expected from 92: comparative advantage and economies of scale can be better exploited, and competition between firms of different member states will increase. This *qualitative*

[24] See A. Winters (1991, 1992a, and 1992b).

[25] For instance labour and capital mobility, stimulation of EC R & D, competition policy, etc.

[26] A more detailed description of individual policies can be found in Page (1991a and 1991b) and Greenaway (1991), where the authors describe EC-92 and legal barriers to movement of goods, controls on intra-EC transport, border controls, market access in services (financial services, transport, public procurement), agreement on, or mutual recognition of, standards, fiscal harmonisation, regulation of business practices, factor mobility, development assistance, commercial policy, monetary union.

assessment stems from traditional Customs Union theory[27], its extensions[28], and also from more recent developments of international trade theory.

In Viner' s traditional analysis of trade creation and diversion it is assumed that markets are perfectly competitive and internationally segmented. Thus prices are equal to marginal costs and competitiveness is increased by the same proportion as the reduction of internal barriers: comparative advantage is the only mechanism at work. Looking, however, at the already quite low intra-EC trade barriers (between 1% and 2% of the gross value of trade), and considering the intra-industry nature of most of the commercial relations among Member States, traditional analysis would suggest only minor trade reorientation.

Integration in the presence of economies of scale has been analysed by Corden (1972), who introduced the concepts of cost reduction and trade suppression. In his model, firms from different member States compete for the whole market of the Union; eventually, the most efficient increase their scale, thus decreasing their costs, and forcing the least efficient to exit the market. Despite such cost reduction, these newly established Union firms are unable to match world prices and still require external protection, for, if this was not the case, they could have expanded before establishing the Union by exporting what it was not possible to sell domestically. This implies that import-competing firms can not become exporting ones after completing the internal market yet they are now able to completely dominate the internal market: the Union's existing imports are therefore eliminated (trade suppression). This model applies to homogenous goods and does not consider problems of market structure; its main results are, once again, specialisation and increased intra-community trade.

Patterns of trade may change more dramatically once imperfectly competitive markets enter the picture. In this framework, even with homogenous goods, it is possible for firms in different member states to price discriminate between markets.[29] When barriers are reduced, competition increases, price-cost margins will diminish, and the enhanced openness of markets may reduce costs if scale increases. With differentiated

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[27] J.Viner (1950).
[28] See W.M.Corden (1972).
[29] See Brander and Krugman (1983) model on reciprocal dumping.

products, these effects can be even larger; in this case import competing firms may become exporters (trade reversal). The first application of these ideas to a model aimed at measuring the internal effect of 1992 is by Smith and Venables (1988). Winters, in his overview (1991), identifies two possible extensions to this simple model of reciprocal dumping in which the number of varieties of each good can be variable and the possibility of integrated markets can be included. These have controversial effects on competition and therefore on trade patterns; few empirical studies have been made.

To summarise, more specialisation and increasing competition are expected to lead to lower costs and prices, higher productivity, and expanded incomes.

A detailed analysis of the different *quantitative* estimates of *how much* prices will fall and incomes rise is beyond this section' objectives, however, it is worth mentioning that the EC's preferred estimate for the increase in income is about 5% over five years.[30]

External Effect

Two distinct questions deserve attention in the study of the external effect of EC-92.[31] The first concerns the direct and indirect effects observable in non-member countries due to changes within Europe. The second deals with the international system of economic relations that may originate after the completion of the Single European Market, in particular the new European external trade policy and the potential response of non-EC countries.

Since there is no firm consensus on the magnitude of variations in European prices and incomes due to the 92 program, no well established results are reached as regards the first question.

Trade creation, diversion, suppression, reversal as well as variation in factor flows depend – as described in the previous section – on historical commercial links, past preferential treatment and on assumptions about returns to scale, market structure and the new European common external policy.

Aggregate trade effects are fairly easy to predict. If outside economies are small and dependent on EC trade, external spill-overs can be quite large even for fairly small gains

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[30] Baldwin (1989) argues that this measure is too small by a factor of 2, whereas Peck (1989) and Backhouse (1991) think it is too large by a factor of 2

in EC variables; in practice these depend on the proportion of EC trade with third countries and the share of exports in the third countries' GDP. The relevant parameters are, therefore, the price elasticity of third countries' exports, which measures the sensitivity of trade diversion due to a fall in EC prices, and the income elasticity of EC demand for third countries' exports, which determines how much trade creation may follow an increase in EC incomes. It is also possible to have terms of trade improvements, depending on the composition of imports and exports of specific countries.

As far as factors of production are concerned, the '92 internal effects are rather unclear, which causes uncertainty about the external impact. Growth of intra-EC investment is expected, because of both the income growth effect and the competition effect (restructuring). This can be financed by EC savings and will probably be orientated towards Mediterranean member countries: Spain, Greece and Portugal recorded an increase in investment even before their entry.

It should be noted that political economy factors, such as fears of the so-called "Fortress Europe", may induce other developed countries to invest in Europe, thus diverting important foreign investment flows from going to developing countries. Some authors[32] consider this investment diversion the most damaging external effect of 1992 because of its large consequences in the long run. Regional inequalities in employment opportunities in the EC combined with the removal of internal barriers concerning labour mobility may result in growing pressure for internal migration. At that stage, EC citizens would probably receive a better treatment than non-EC migrants. Concerns about a huge excess supply of low wage labour from East Europe, combined with enhanced competition among European firms that will reduce employment, may be used as justifications to implement a tighter migration policy even if internal movements of people are negligible.

Specific 92 measures such as fiscal harmonisation, standards, public procurement etc. may have effects on trade and on factor markets that differ among countries. A table from Page's study, reproduced here, neatly summarises their likely qualitative impact.

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[31] See Page (1991).
[32] See for instance Hughes Hallett (1994).

Table 2-1: Changes in relative position

	Non-EC relative to EC	Developing relative to non EC developed	Manufacturers exporters relative to primary
Individual "1992" Changes			
Removing internal legal barriers	-	0	-
Removing country preferences	0	0	0
Transport restrictions	-	-	-
Ending border controls	-	-	-
Private services	?	?	?
Public procurement	?	+	-
Standards	-	-	0
Fiscal harmonization	+	+	-
Business regulation	0 or +	-	+
Monetary Union	?	+	+
Total Effects On Goods			
Increased trade from higher income	-	-	+
Trade diversion	-	+	-
Net effects	-	?	?
Effects On Investment			
From structural change	?	+	+
From increased income	-	-	-
Effects On Labour	-	-	?

Source: Page (1991)[33]

One single aspect is not included in this otherwise comprehensive table: environmental regulation. Explicit emissions targets do not appear in any 92 directive, yet environmental standards, such as limitations of the use of certain toxic inputs in food products, are taken into account. These regulations may be misused and hence create trade discrimination against developing countries. In fact, special rules on these issues have been introduced in the NAFTA treaty and in the Uruguay Round agreements. A complete analysis of the linkages between trade and environmental policy is a central theme of this thesis and is developed below.

A very important factor which strongly influences the 1992's external impact is the Community's external trade policy. With the completion of the single market and the removal of borders any national restraints, quotas, VERs or other trade regimes have to be abolished, or substituted for, by a similar Europe-wide measure. It is also important to consider how the creation of the Single European Market may influence the whole system of international trade relations. Many authors judge past Community trade policy

[33] See also Hughes Hallett (1992) who reproduces this same table but extends it by discriminating between perfectly competitive and imperfectly competitive markets.

as an almost constant departure from the multilateral principle implicit in the GATT, and EC-92 is seen as a move towards more regionalisation, rather than globalisation. The process of deepening the Union involves adjustment costs that may require temporary defensive trade measures. The last enlargement towards the Mediterranean basin may also result in restrictive policies in sectors relevant to developing countries. Finally, an economically stronger EC with increased bargaining power may end up with industrial and trade policies that favour its members only. In this respect two interesting issues deserve further analysis. The first concerns the potential response of non-EC countries and the formation of other regional blocs; the second deals with the interactions among those blocs. These themes and in particular the recently negotiated Mediterranean trade agreement are developed in this thesis.

Empirical estimates of the external effect

Most of the studies aiming at measuring the effects of '92 on outsiders are concerned with specific country groups, or with certain sectors.

Winters (1991) identifies two streams of research: one which makes use of econometric models and another which employs calibrated models of the general or partial equilibrium type. Examples of the first are: Jacquemin and Sapir (1988) and Neven and Roller (1991); both of these studies estimate trade effects, using as dependent variables in their equations factor endowments, R&D, product differentiation, and various policy variables. Examples of the second type are: the EC's own Cecchini Report, Norman (1989), Smith (1989) which are of partial equilibrium nature; Haaland (1990), Haaland, Norman (1992) which are CGE models; some of these incorporate scale economies and imperfect competition.

Winters concluded that general equilibrium analysis of "1992" is just getting under way and, for models with imperfect competition, it is just too early to draw any conclusions. Among the issues specifically related to EC trade with third countries in his *agenda for future research* he points out the need for the estimation of general equilibrium models to identify the differing effects on the various partner countries, according to their comparative advantage and degrees of performance (e.g. EFTA vs. USA and Japan, or Mediterranean countries, or other developing countries).

The same sort of conclusion is drawn by Hughes Hallett (1992) in a recent survey of the impact of EC-92 on Developing Countries. He argues that there are very few empirical estimates of the trade effects of EC-92, despite the fact that the central points of trade creation vs. trade diversion, the terms of trade effects, or the impact of imperfect competition and investment diversion, are essentially empirical questions. No analytically rigorous general equilibrium studies of these empirical questions have been published.

Empirical Estimates for the Maghreb Countries

Some estimates of trade effects of EC-92 on the Maghreb countries are contained in Page (1991), Page and Davenport (1991) and Stevens (1990).

Stevens' study aims at a qualitative assessment of the most likely effects. He distinguishes between 1992 direct effects – increased EC incomes and increased EC competitiveness, which result in trade creation and diversion – and indirect effects arguing that for the Maghreb countries the latter may be more important, in particular the outcome of the renegotiating of their bilateral association agreements. He argues that the distribution of benefits and costs between outside states depends on the change in their relative position in the hierarchical system of preferences of the Community, and on the possibility of them obtaining compensation, i.e. enhanced preferences. For instance, the Maghreb may face stiffer competition from other countries (NIC's) as a result of the potential reduction in preference following from the abolition of national quotas. To assess how vulnerable the Maghreb countries will be to changes that involve the loss of preferential treatment, Stevens suggests measuring the relative importance of the most sensitive products in their exports to the EC, and the concentration of these exports on the more protected EC national market, and concludes that a liberalisation of the current MFA may cause special damage to Moroccan and Tunisian exports of clothing and textiles.

Table 2-2: Estimates of "1992" effects on Developing Country Exports of Goods[a] (million ECUs)

	Additional exports to EC		Diversion Effect	Net	% of Export	% of tot
	primary	manufact	manuf only		to EC	Exp
All developing countries	2804	4434	-5655	+1582	+1.5	+0.3
ACP	543	315	-477	+361	+2.3	+1.0
Maghreb Countries	244	370	-534	+80	+0.9	+0.5
Morocco	24	99	-106	+17	+0.8	na
Tunisia	26	96	-108	+15	+0.9	na
South Asia and China	86	920	-1125	-119	-1.0	-0.1
Four Asian NICs	12	2574	-4077	-1491	-6.1	-0.9
ASEAN countries	102	344	-464	-18	-0.3	-0.0
Western Hemisphere	502	495	-751	+246	+1.3	+0.3
OPEC	1556	515	-847	+1224	+3.8	+1.1

[a] The elasticities and calculations are based on those reported in Davenport and Page (1990). For primary goods, the elasticities are between 0.5 and 0.7, except for fuels, at 1.2; for manufactures they are about 2 except for machinery and transport, at 2.4. Diversion effects are expected only for manufactures, and are highest for chemicals and for machinery and transport

The method used by Davenport and Page to calculate trade creation and diversion and terms of trade effects employs estimates available in the literature for all the relevant variables and parameters, namely: variations in the EC's income and prices, and income and price elasticities of EC imports from developing countries (and the Maghreb in particular). This allows them to present quantitative results, reproduced here in Table 2-2. It is worth noting that trade creation and diversion almost offset each other; since diversion derives from manufacturing trade only, EC 92 has the effect of hindering export diversification of the Mediterranean developing countries. Excepting Algeria, whose main export item is oil, the 1987 data used by Davenport and Page show that Morocco and Tunisia exported merchandise worth 1.9 bn ECU and 1.5 bn ECU respectively to the EC; of this, 46% and 35% respectively was in agricultural and other primary goods; clothing accounted for more than half of manufacturing exports with chemicals 14-15%; textile yarn exports made up 11% of exports for Morocco, and 6% for Tunisia; machinery and transport equipment 7% and 9% respectively (page 85). The authors warn that uncertainties about data, parameters and the method of implementing certain 1992 measures, give these estimations a merely "illustrative" character. Furthermore, General equilibrium effects are not taken into account.

As stated earlier, what is important for the Mediterranean countries and Maghreb in particular is their position relative to other potential competitors in future EC trade arrangements.

It is interesting, in this respect, to look at A. Halis Akder' s (1992) paper, in which he considers possible competition between member and non-member Mediterranean countries and East European countries. To do this he calculates various indices of export similarity for total trade, and for agricultural products and manufactures. His main findings are that the Northern Mediterranean countries will compete with the East for German and Italian markets, whereas the southern Mediterranean countries will compete between themselves for the Italian and French markets; in agriculture the potential competition between East and Mediterranean is likely to be greatest for animal products, whereas for other agricultural goods Eastern and Mediterranean countries will primarily be competing with each other. In manufactures the SEM' s outcome will depend heavily on the adjustment process adopted by Mediterranean member countries.

Similar conclusions are reached by J. de Piniés Bianchi.[34]. He suggests that the reallocation of resources implied by the completion of the Single Market imposes high adjustment costs, particularly for the least developed EC members, thus creating pressure for more protectionism, especially in sensitive, labour-intensive products. This is further reinforced by D.J. Neven' s 1990 analysis of labour costs across the EC, in which he concludes that the differences do not allow the exploitation of comparative advantage between Northern and Southern countries, but that the latter could increase their labour-intensive exports. EC-92 will not, therefore, damage greatly outsider producers of hi-tech capital-intensive goods (Japan, USA), but it will affect developing countries as exporters of labour-intensive goods (Mediterranean and Maghreb among these).

2.3 The Economic Consequences of Further Integration

The term "further integration" is used to identify the process of outsider countries joining or becoming more closely associated to a group of countries that have already constituted some form of integrated area (Free trade area, Customs Union, etc.). Various approaches are encountered in the analysis of this issue. They range from theoretical studies of the economics of integration and enlargement, to empirical estimates of the economic consequences of joining a regional group for the new member and the former ones. Several surveys on theoretical and empirical issues are available and hence it is not necessary to reproduce them here. In fact the issue of "further integration" is one of the

[34] J. de Piniés Bianchi (1992).

main themes developed in the subsequent chapters of this thesis. In particular two aspects of this process will be analysed in detail. Firstly, a thorough investigation on the important links between trade liberalisation and the environment will be presented using a single-country CGE model in chapter 5. Secondly, within a multi-county modelling framework, an examination of the static and dynamic effects of the formation of a FTA will be offered in chapter 7.

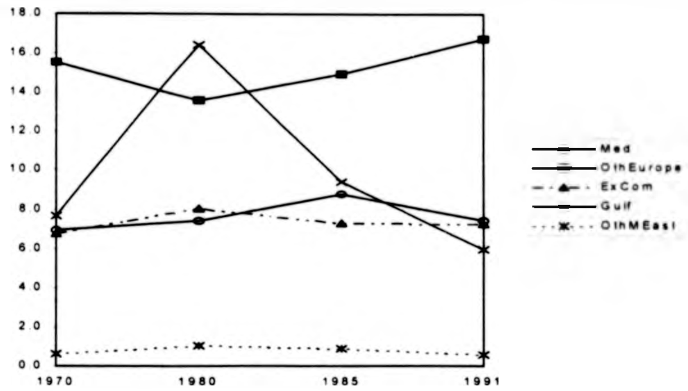
This introduction is concluded with an overview of trade relationships and labour flows in the Mediterranean area. These flows represent the main linkages between the European Community and the Mediterranean developing countries. The descriptive analysis presented here identifies some important consequences that new trade agreements may have for this area, and hence emphasises the relevance of my CGE analysis. Moreover, the Mediterranean economic relationships are here compared with those of another regional group, the NAFTA. This comparison is relevant for two reasons. Firstly although numerous studies have covered the recent NAFTA agreement, very few have dealt with the Mediterranean one, and even fewer have compared the two. Therefore the following comparison conveys new information and fills a gap. Secondly, the similarity found among these two regions and their trade policy reforms may be used to justify the application of analytical tools used in the NAFTA case to the Mediterranean one.

2.4 The Euro-Mediterranean Economic Relationship

2.4.1 Trade

During the past twenty years the evolution of the Euro-Mediterranean trade followed a broadly similar pattern to that of global North-South commercial relations: the oil shocks and counter shocks; the emergence of the South as an exporter of manufactured products, and import contractions as a consequence of the debt crisis for those countries faced by adjustment processes.

Figure 2-1: Percentage Share of selected areas in EU total Trade

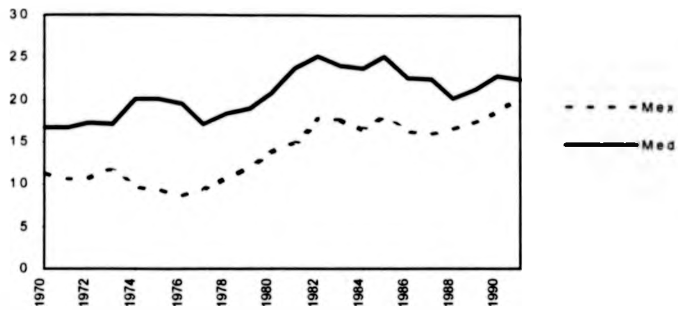


The areas are defined by these countries:
-Med: Morocco, Algeria, Tunisia, Egypt, Turkey, Ex-Yugoslavia, Israel, Cyprus, Andorra, Gibraltar, Malta;
-ExCom: Ex-Ussr, Albania, Bulgaria, Ex-Tcheckoslovack, East Germany, Hungary, Polland, Romania;
-OthEurope: Austria, Finland, Norway, Sweden, Iceland;
-Gulf: Iran, Irak, Kuwait, Saudi-Arabia, Lybia,Oman, etc;
-OthMEast: Jordan, Lebanon, Syria, Yemen

By the early 1970s the Mediterranean percentage share of the EU's trade (excluding intra-Community trade) was about 6.9, and by 1985 reached its maximum of 8.7. In 1991 it was 7.4 %. The second half of the 80s reduction contrasts with the increase in the Asian share but it is less sharp than that of Latin America or of South-Saharan Africa. In 1991 total trade between Mediterranean countries and the EU was 79.2 billions current USD, whereas that of North America (Canada and US) and Mexico was 66.7 billions USD. It is also worth noticing that the relative weight of Mexico and Mediterranean countries' trade with their developed counterparts has been fairly similar (in 1991 around 20%; see Figure 2-1 and Figure 2-2).[35]

[35] See Bensidoun I., and Chevallier A (1994), pag 114. Their measures take into account the changing composition of the EU.

Figure 2-2: % Share of Med (Mex) in EU (North Am) Imports from Developing Countries



Despite the above similarities, there are important differences. First of all it should be noted that when talking about Mediterranean countries we are considering a very differentiated group of countries, even when the analysis is limited to the Mediterranean African ones. Besides, and most importantly, this group is not yet very integrated as shown in the table below.[36] From Table 2-3, it appears that even the newly signed treaties such as the AMU (Arab Maghreb Union)[37] have not been very effective in fostering trade within their member countries.[38]

Table 2-3: Percentage Share of Intra-Group Trade

	Intra-EU	Intra-Med	Intra-Maghreb
1970	52.88	4.74	1.89
1980	53.75	3.50	0.41
1985	55.22	4.40	1.37
1991	60.96	4.40	1.78

Other important differences between the European and the American side are summarised in the table below:

[36] The shares are calculated as follows:

[2 × imports (or exports) within a group] / [tot trade (exports + imports)] .

[37] The AMU was signed in 1988.

[38] This should be taken into account when discussing different economic policies; a positive shock to one Mediterranean country should barely affect its neighbors through trade multiplier effects

Table 2-4: North American and Mediterranean main economic indicators (1991)

ratios of:	GDP	Population	per capita GDP
NorthAm/Mex	23	3.2	7.1
EU/Med	15	1.4	10.4
France/Maghreb	15	0.9	5.0

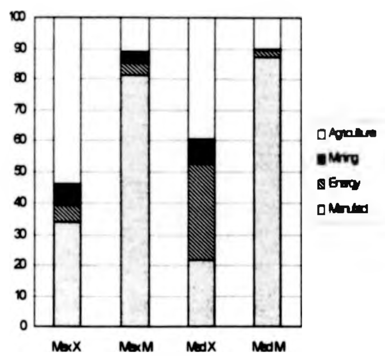
From the above table it is possible to see that the North American GDP and population are respectively 23 and 3.2 times those of Mexico. These ratios far exceed those recorded for the EU and its Mediterranean partners. Yet, when taking into account the disparity in the level of economic development, measured by the per capita GDP, one may conclude that differences are lower for Mexico with respect to North America than for Mediterranean countries with respect to the EU. It is worth noticing that the France - Maghreb countries gap seems to be narrower.

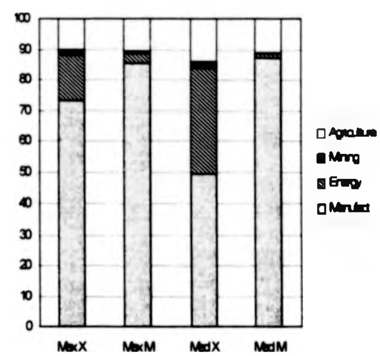
The sectoral composition of trade flows within these two regions is also quite different as shown in the following Figures.

Figure 2-3 and Figure 2-4 show the evolution of the sectoral composition of trade flows for the two groups of countries in question. It is possible to observe that both Mexico and the Mediterranean group remain highly dependent for their imports on manufactured products coming from their developed partners, more than two thirds of their imports is composed of manufactured products. On the contrary, the composition of exports changes quite differently: for Mexico the manufactures share goes from 34 % to 73 % with a sharp reduction in agriculture, and the energy macro sector goes up too; for the Mediterranean group the lower starting point for manufactures did not help (in a catching-up fashion) and by 1991 the manufactures share is still below 50%, agriculture reduces its importance (but less than for Mexico) and the energy macro sector (especially Oil for Algeria) remains very important.

Figure 2-3: Sectoral composition of Mexico – North America and Mediterranean - EU trade flows 1970

Figure 2-4: Sectoral composition of Mexico – North America and Mediterranean - EU trade flows 1991





Looking only at the 1991 picture the main conclusion is that trade between Mexico and North America is going towards a North-North intra industry pattern of international trade, whereas the Mediterranean-EU commercial relationship still shows evidence of complementarity (e.g. Algerian Oil against European manufactures, Mediterranean agro-food or labour intensive products against European capital intensive ones).

1970 - *Mexican and Mediterranean trade % shares with their Developed partners*

	Mex X	Mex M	Med X	Med M
Agriculture	54	11	40	10
Manufact	34	81	22	87
Energy	5	4	30	2
Mining	7	4	8	1

1991 - *Mexican and Mediterranean trade % shares with their Developed partners*

	Mex X	Mex M	Med X	Med M
Agriculture	10	11	14	11
Manufact	73	86	49	87
Energy	15	3	34	1
Mining	1	1	2	1

This situation is also clearly reflected in the trade balance between these two groups (see figures below). The European surplus (mainly driven by the manufactures surplus) was very strong in the 70s when the Mediterranean developing countries, due to the excessive liquidity in the international financial markets, were increasing their foreign debt and were able to increase their imports (more than their oil exports). The surplus has since been eroded due first to the protectionist policies adopted to face the debt crisis, and secondly to the export expansion. For the American side the situation was almost completely driven by the Mexican debt crisis which constrained the country to almost halt its imports. The situation is balancing again in the 90s. The Brady plan and the NAFTA agreement can be partly seen as economic policies towards increasing Mexican export possibilities.

Note that the Figure 2-5 shows only Mexico and Mediterranean group against their partners, whereas Figure 2-6 shows also the Maghreb situation. The latter shows a path closer to the Mexican one.

Figure 2-5: Trade balance as % of Total Trade

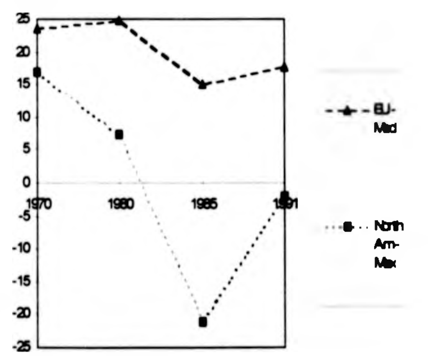
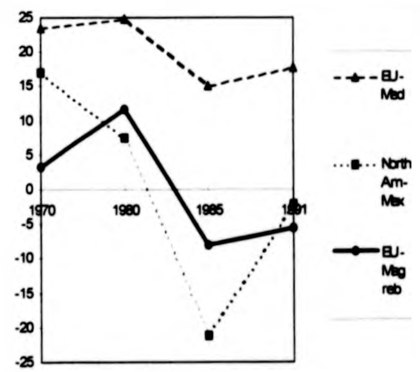


Figure 2-6: Trade balance as % of Total Trade (including Maghreb Group)



Another important difference between the American and the European situation is noticeable in the relevance of the northern partner for the south trade flows. Consider the following three figures.

Figure 2-7: EU % share in Total Mediterranean countries Exports

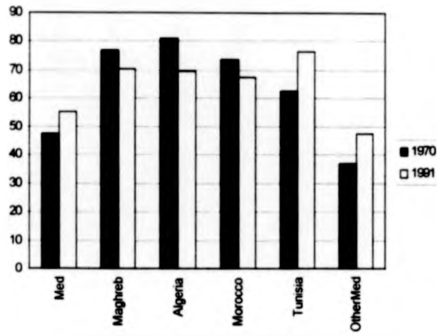


Figure 2-8: EU % share in Total Mediterranean countries Imports

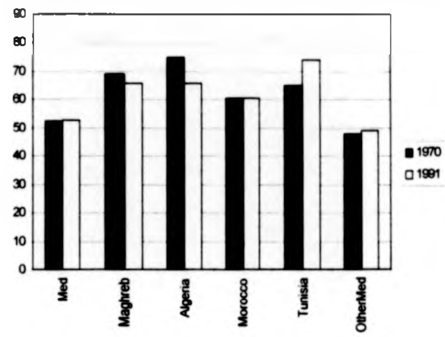
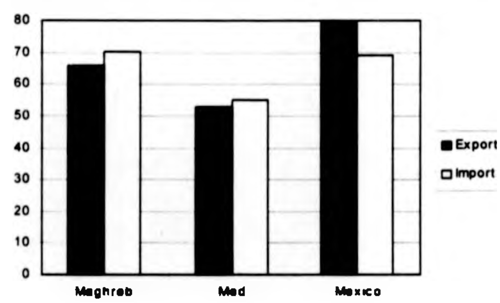


Figure 2-9: North % share in South total trade - 1991



The first two figures show for different country groupings the evolution of the European % share in the Mediterranean trade flows. It can be noted that these do not excessively change in the last 20 years and that the Maghreb countries are on average more dependent on the European market than the other countries (the main countries in this latter group are Egypt, Israel, Turkey and Ex-Yugoslavia that, because of their geographic and strategic position, show a weaker European influence). This is clearly summarised by the third figure where Mexico is shown with the whole Mediterranean and the Maghreb regions. (Note that the South shares in the North total trade shown above were more similar for Europe and NorthAm).

The last difference emphasised here concerns the relative intensity in the trade flows between North and South.

Intensities are defined as follows:

For export flows: $[X_{ij} / X_i] / [M_j / W]$

And for import flows: $[M_{ij} / M_i] / [X_j / W]$

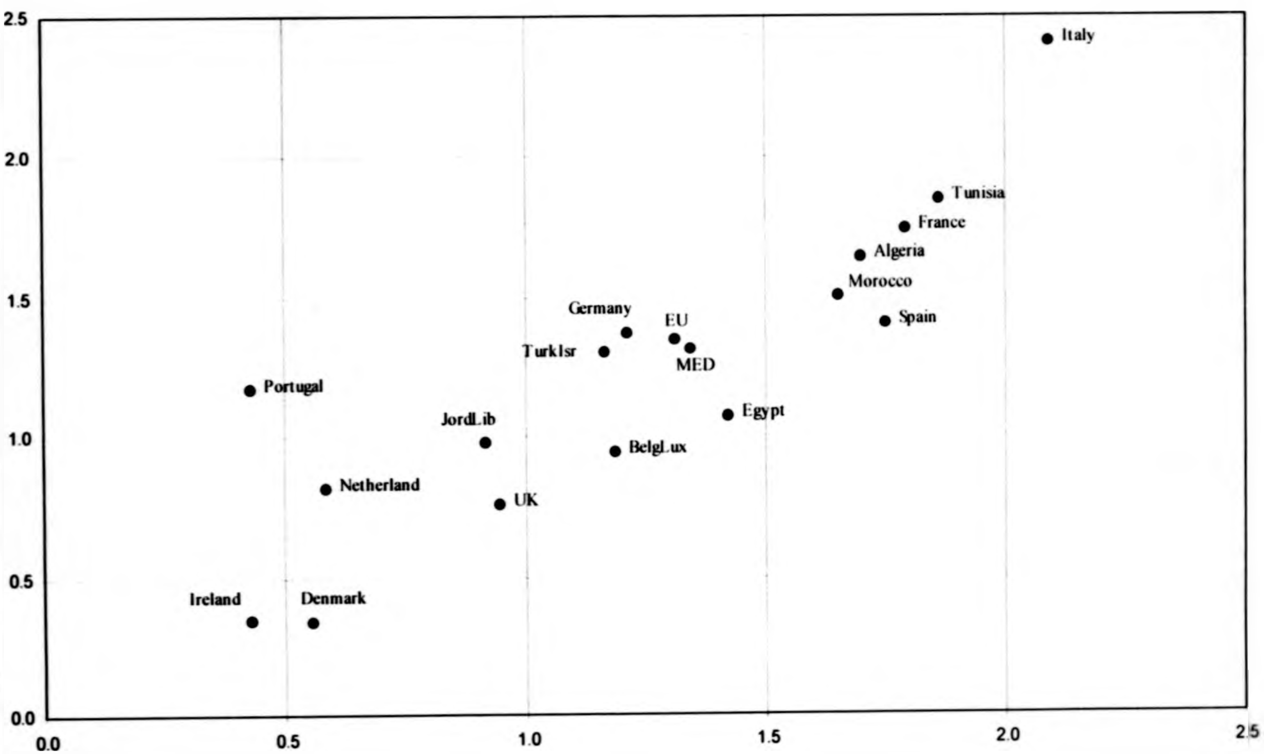
For the export flow the bilateral trade intensity is the quotient of two ratios: in the numerator there is the share of the exports of country i towards country j and in the denominator there is the weight of the imports of country j in the world total imports. Therefore a value equal to 1 means that the influence of country j (the destination country) on country i is equal to the influence of j over the total world trade. In other words the relative bilateral trade intensity is in line with the average. Similar comments apply to the import flow indicator.

The main conclusion is that the average intensities for the Mediterranean-EU trade are quite weak, being equal to 1.31 for the EU to Mediterranean flows and 1.34 for the Mediterranean to EU. Moreover, they result from a mix of some very strong localised bilateral relations (France, Spain, Italy <--> Maghreb) and some very weak ones (North Europe <--> Med). It should be noted that the average intensity for Mexico – North America is more than 6.

The graph depicted in Figure 2-10 should be read as follows: the co-ordinates of each point represent the export intensity (X axis) and the import intensity (Y axis) for a particular country. The further from the origin the higher the intensity, the closer to the 45 degree line the more similar the export and the import intensities.

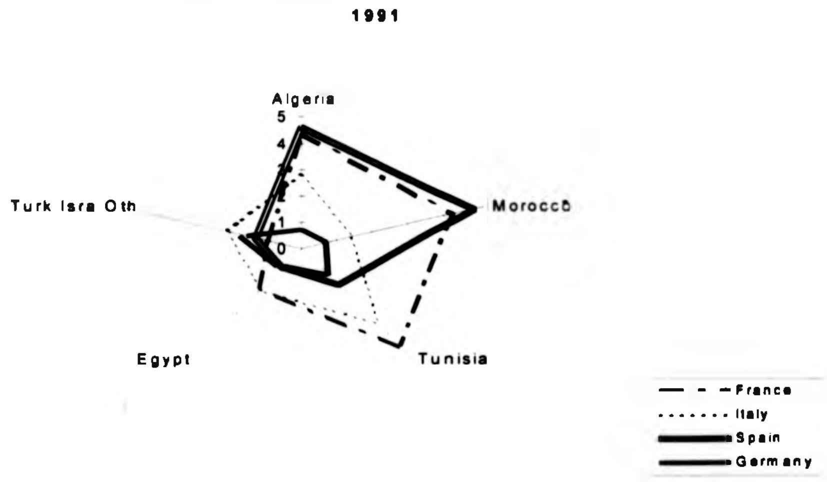
It clearly appears that three European countries, France Italy and Spain, and the Maghreb countries register some significant trade intensity; Germany, Turkey Egypt and Israel are in an intermediate position; North Europe has not very intense trade relations with the Mediterranean countries; Portugal shows a weak export intensity and an average import intensity.

Figure 2-10: Relative Intensities of the EC - Mediterranean Countries Trade (1991)



In the figure below, the Southern Europe - Maghreb countries stronger trade intensities are shown in a different way. Here we have the country by country relation, and it is possible to note the very strong relation between France and the Maghreb countries; between Spain with Morocco and Algeria; between Italy with Tunisia, Algeria and a less strong relation with Morocco, Turkey and Egypt. Germany has its strongest relations with Turkey, but the intensity is much less strong than in the French case.

Figure 2-11: Export Intensities of Southern Europe with selected Mediterranean Countries Countries (1991)



2.4.2 Labour

The structure and functioning of labour markets and international migration are of crucial importance when modelling Mediterranean African countries' economic relationship with Europe.

In a world of intensifying capital mobility, demographic trends are becoming increasingly important determinants of international comparative advantage and this is particularly relevant for the Mediterranean region[39]. These facts have been recently pointed out in a similar context for Latin America with an applied general equilibrium model built at the OECD. That model was constructed to examine the implications of more liberal trade relations for economic growth in Latin America. One of its main conclusions is that the removal of trade distortions could accelerate growth considerably if this policy is combined with measures that raise human capital and facilitate efficient labour markets.[40]

Here a few stylised demographic statistics are presented. The North American situation is again contrasted with the Mediterranean region to emphasise both differences and similarities.

The following two figures show the evolution over the last 30 years of the Mediterranean demographic balance. The left panel displays the population shares of EU12 and the Mediterranean countries (see Figure 2-1 for a definition of this group). In the right panel, the same shares are calculated for the northern (Portugal, Spain, France, Italy and Greece) and southern shores (Maghreb + Egypt) of the Mediterranean sea. The evolution is basically the same for the two groups: in 30 years the northern population share has been reducing from almost 70% to less than 60%. In absolute terms, in 1991, the southern shore population was 110 millions, whereas that of the Northern shore was 170 millions.

The World Bank and UN have presented forecasts up to the year 2020 for these regions where the trends shown in the figures below are expected to continue. By the year 2020 the northern shore weight will be reduced to 37-39%. It should also be noticed that the age structure and the dependency rates of the north and south populations will be very different. Between 1985 and 2020, the population of the south and east of the Mediterranean will be increased by 170-180 million people, and 30% of the population will be aged 15 years or less. The population of north will increase by 15-20 million, and the people of 65 years or older will account for 20% of the total.

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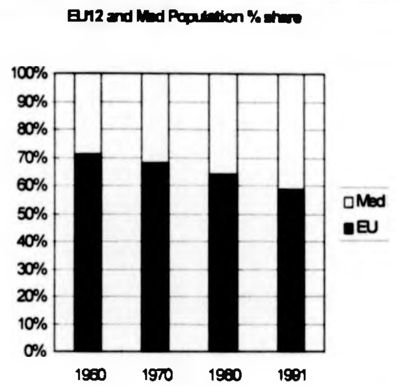
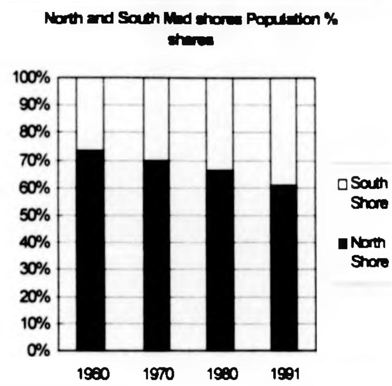
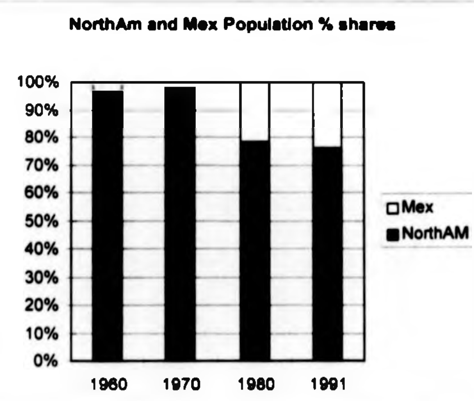
[39] See Horton, Kanbur, Mazumdar (1994).
[40] See Collado,J.C., D. Roland-Holst, D. van der Mensbrugghe (1995).

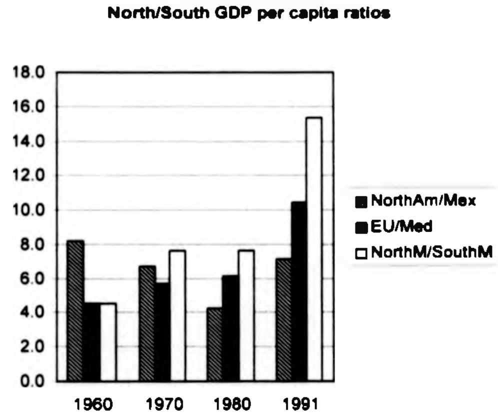




The picture for North America is shown below. Note the difference in the corresponding proportions. In 1991 the US + Canada populations were still more than 75% of the total NAFTA population. In fact, for North American policy makers, one crucial reason for the NAFTA treaty signature had been the hope to stop massive Mexican migration. This same reason may apply to the EU-Mediterranean case where the forthcoming demographic imbalances may become even worse than those recorded in North America.



The next figure shows the income differential that is one of the most important variables used to explain international migration. Three facts should be noticed. Firstly, European GDP per capita varies from about 4 times that of Mediterranean to more than 10 times, and constantly increases.[41] Secondly, the North American differential has been decreasing through the first 20 years, with an increase between 1980 and 1991. Even if in 1960 the North American ratio was higher than the EU-Mediterranean one, the described trend resulted in a lower 1991 value. And, thirdly, the North shore / South shore differential has been increasing faster than the EU-Mediterranean differential.

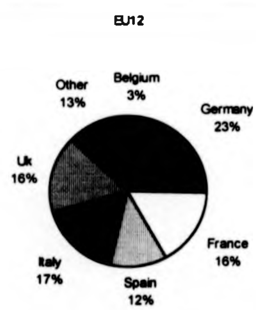


These points, especially the third one, become clear when considering the evolution of international migration towards European and American destinations. During the 1970s the southern European countries ceased to be countries of origin and became countries of destination for migrant workers. Also the migrant nationalities were changing from being southern European to being North African and other third world countries.

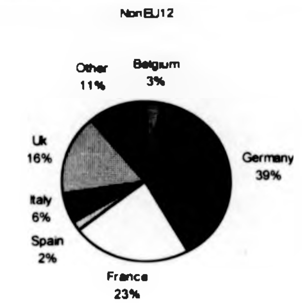
[41] Note that these are measured in current dollars with average nominal exchange rates, the same differentials calculated in dollar PPP are obviously less pronounced.

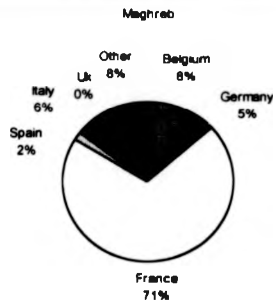
The combination of pull factors (such as that of the income differential) and push factors (such as that of demographic imbalance) is especially important when considering the restricted group of southern Europe and North Africa.

The next three figures[42] show, for the six most important European receiving countries (plus a residual area labelled "other"), the percentage shares of resident populations of EU nationals, Non EU and Maghreb respectively. The top figure shows, for each of the seven EU receiving countries, the respective population of European origin as a percentage of the total EU-12 population. The middle figure shows similar percentages calculated using population of non-European origin. Clearly Germany and France appear as the largest immigrant receiving countries among EU-12. Notice that Italy and Spain, jointly accounting for 33 per cent of total European population, register only 8 per cent of total immigrants. The bottom figure displays percentage shares of Maghreb immigrants across European destination. France has a dominant role and north European countries, except maybe Belgium, register very low percentages. Overall, as in the case for trade, south European countries are more intensively linked with the North Africa than north European countries.

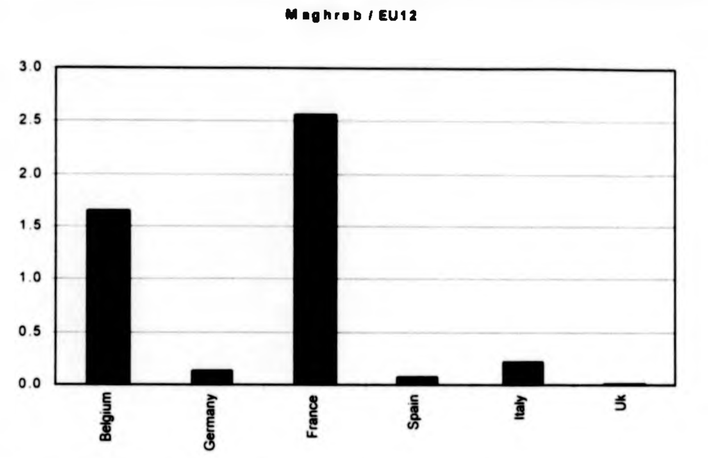


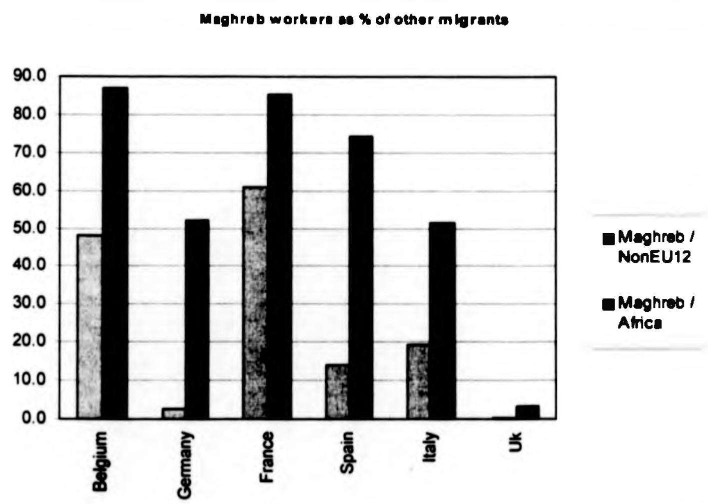
[42] The next figures are obtained using data for 1991 from EUROSTAT





To look at the situation within specific countries, we can see that the maximum percentage share of Maghreb workers over the EU nationals is 2.5% and is registered for France. Besides Maghreb workers are certainly the most important foreign population resident in European countries.





2.5 *Conclusion*

This chapter's main objective of introducing the thesis and providing further motivation for the subsequent analyses has been achieved in two ways. Firstly, the succinct literature survey allows appreciation of earlier results and points out gaps in previous studies of the Mediterranean area. In particular, several authors recognise the need for additional research on regional trade policy and its consequences. Some also indicate that applied general equilibrium models might be more appropriate tools of analysis.

Secondly, a compact statistical overview of the main economic relationships in the Mediterranean basin permits to identify what is at stake when further regional integration is implemented. It appears that southern Europe has a much larger interest in the economic development of North Africa than northern Europe. The geographic proximity and economic differentials (measured for instance by per capita GDP) make this South Europe – North Africa group quite similar to the NAFTA region.

3 Data and models: what are the connections?

3.1 Introduction

A fundamental step in any rigorous applied economics study is the compilation of reliable and updated databases. In the particular case of regional integration, for which the most apt research technique appears to be applied general equilibrium analysis, the relevant databases normally take the form of Social Accounting Matrices (SAMs).

This chapter's initial purpose is to present a new detailed SAM for France and Morocco. This SAM offers a sound database on which a quantitative analysis of the Euro-Mediterranean economic relationships can be based. Reducing the choice to only two countries is motivated primarily by the need to have a tractable SAM, in the sense of it being detailed and updated.[43] Other reasons favour these particular countries, such as their special post-colonial economic ties, their being representative of the broader interdependencies between the EC and the southern Mediterranean developing countries and their relative similarities to the Mexico-USA case.[44]

Additional reasons, beyond the mere illustration of the France-Morocco SAM, motivate this chapter.

Firstly, a simple fixed-price multiplier model is constructed to allowing a preliminary examination of the main linkages among the countries under study. Although this analysis could be encompassed within the subsequent CGE approach, multiplier models present some practical advantages and complementarity with more complex CGE models. Fixed-price multiplier models are easily implemented and have a very simple and transparent structure, which is strongly dependent on the SAM data. For these

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[43] On the construction of a SAM for Europe see for instance the various articles in Volume 3 of the journal Economic System Research (1991) and in particular J.I. Round (1991), pages 249 – 268.

[44] For the European region as a whole few results from CGE models are available. Most of the discussion is on the historical evolution of the EC foreign trade policy, and its main effects for specific sectors and countries. For instances of CGE results consult Haaland J.I., Norman V. (1992) and Haaland, J. (1990). For partial equilibrium results see various articles in the volume 28 of the Journal of Common Market Studies (1990) or Smith, A. and Venables, A.J. (1988). For an historical perspective see Shlaim A., and G.N. Yannopoulos eds (1976), Tovias A. (1977), Pomfret R. (1986), Grilli E.R., (1993) and the previous chapter. For the North American region a collection of papers is in USITC (1992); see also Brown, D.K., A.V. Deardorff and R.M. Stern (1992); de Melo, J., and D. Tarr (1992); and Roland-Holst, D.W., K.A. Reinert, and C.R.Shiells (1994).

reasons, a multiplier model highlights the main structural features of the economies under study. For instance, it clarifies the inter-industrial intermediate demand structure, identifies the most important sectors (in terms of GDP, value added, exports, etc.), clearly displays linkages between final demand, production and import activities, illustrates income distribution, and shows sectoral and regional trade dependency. In other words a multiplier analysis makes clear the fundamental connection between data and models. In fact this connection, mediated by extra-SAM elasticity data and a more elaborated analytical structure, may not be apparent in a CGE context. In practice, I am advocating a two-stage approach: first a multiplier analysis and then a CGE model. By providing applications of both types of models to the Mediterranean case this chapter additionally fills a gap in the literature, which offers almost no study dealing jointly with these two model families.[45]

A second reason motivating this chapter is given by the study of the sensitivity of the multiplier model's results to changes in the base year SAM. This can be explained in more detail.

The magnitude of CGE models results clearly depends on some crucial elasticities that define the slopes of demand and supply functions and determine quantity and price responses to exogenous shocks. For this reason, the robustness of results should be tested by experimenting with different elasticity values. Though quite rarely CGE studies include a thorough analysis of the sensitivity of their results to changes in elasticity values, almost none of them extend this analysis to other parameters, such as intercepts or share parameters. These latter parameters are normally calculated through the calibration of the model from the base year SAM. Obviously changes in the base year values may affect results as well. Consider, for instance, the case of simulating trade policy reform. The solution values for imports will depend, amongst other things, on how demand functions are estimated. Normally these are calibrated using initial shares of imported and domestically produced commodities and, evidently, the size of these shares has a direct influence on the final results of CGE experiments. This chapter provides, for the

[45] For a comparison among these two model types see Kraybill (1989) and for an example of the two-stage approach (first SAM analysis and then CGE model) for NAFTA see Reinert, K.A., D.W. Roland-Holst and C.R.Shiells (1993).

Moroccan-French case, a special instance of *share* sensitivity analysis. In the context of a fixed-price model, multiplier analysis is extended to study the effect of a change in the SAM accounting framework.

Given the trade policy focus of the thesis, a particular case of sensitivity analysis to import shares is studied. In a SAM imports can be (1) classified by purchasers, (2) classified by goods (competitive or complementary imports), and (3) classified by both of the above criteria.[46] In fact only within the accounting structure of (3), a precise calculation of the shares of imported and domestically produced goods in total demand is possible. These shares can only be approximated with simple assumptions when imports are treated as in (1) or (2) above. The sensitivity analysis conducted here addresses a simple question: how much is the multipliers' size affected by a change in the imports accounting structure? The answer is not much.

Although fixed-price and CGE models differ in many important ways, the particular experiment of altering the imports accounting structure affects domestic and imported shares in the multiplier analysis as well as in the import demand functions of a CGE model. The main conclusions of the multiplier sensitivity analysis may therefore be extended to the CGE context. Judging from the modest multipliers' variations, one important conclusion is that the information loss of going from the comprehensive accounting structure of (3) to that of (2) is minor. This conclusion justifies the use of CGE import demand functions calibrated on an import accounting structure as in (2), and allows expecting no major share sensitivity of CGE results.

This chapter is organised as follows. The next two sections are devoted to the first descriptive objective of the chapter. Section 3.2 adds some more information to that of section 3.2 of the previous chapter on the main linkages between France and Morocco and contrasts them with those in the NAFTA. Section 3.3 outlines the construction of the Morocco-France matrix[47]. Section 3.4 is focused on the second objective of the chapter. It presents the methodology for decomposing multipliers, explains their use in the analysis

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[46] In practice in case (3) we have two separate input-output tables, one for domestic goods and one for imported goods.

[47] The construction of the single country SAMs for Morocco and France are described in detail in chapter 4.

of trade patterns and, by comparing the regional multipliers in the described different settings, develops the share sensitivity analysis. Some brief conclusions close the chapter.

3.2 The economic interdependence between Morocco and France

A version of the Mediterranean France-Morocco SAM that will be described in the next section very naturally can provide many additional insights to those investigated in the previous chapter of the economic linkages between France and Morocco. In this section upstream and downstream effects are calculated and contrasted with those derived from a similar NAFTA SAM.[48]

Upstream effects

Upstream effects of changes in final demand can be easily obtained by calculating expenditure shares from the SAM. These coincide with column normalisation of the SAM, i.e. with the ratios of each matrix element to its corresponding column total.[49]

A few characteristics of the expenditure structure are worth noting. Firstly, it shows a comparatively weak trade dependency of France with Morocco. French expenditure shares on Moroccan imports exceed 0.6% only for vegetables and fruits, apparel (textiles are at 0.2%) and leather products. Conversely Moroccan trade dependency on French imports is higher and expenditure shares exceed 3% for cereals, apparel, paper and wood products, metal products, machinery (22%), transport equipment (19%), chemicals, rubber and other manufactures. This asymmetry is exactly replicated in the US-Mexican case with the highest US expenditure shares on Mexican petroleum, leather products and electric machinery not exceeding 1.7%, and with Mexican activities spending up to 40% in US capital goods.

Secondly, French expenditure shares on foreign goods above 20% are recorded for the following sectors: mining and energy, textiles, apparel, leather products, machinery, transport equipment, chemicals, rubber, and other manufactures. For all of these sectors,

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[48] See tables 7 and 8 in Reinert, K.A., D.W. Roland-Holst and C.R.Shiells (1993), pages 308-315. In fact, it was possible to check that the conventions used in the two SAMs are the same. This is a requirement to validate the comparison in the text.

[49] The SAM of version 1 of section 3.4.1 below is used here to calculate expenditure shares. Basically this version does not properly discriminate between domestically produced and imported goods: its activities column/row total values represent the sum of domestic and imported goods. Given the descriptive objective of this section, the highest level of product disaggregation suggested the use of this version.

with the exception of mining and energy, the EC shares exceed those of the non-EC world. It can also be noticed that French agricultural sectors[50] have, on average, low expenditure shares on foreign goods. In the case of Morocco, in 6 out of the 10 sectors with highest (above 20%) expenditure shares on foreign goods, imports for France records a higher ratio than those coming from the rest of EC. Again a similar pattern is recorded for the NAFTA case, where the US rely more significantly on markets external to the north American region than Mexico.

The asymmetry in the Mediterranean trade is similar to that in NAFTA, where France's strongest linkages are with the European Community rather than with Morocco. They also show that the strongest bilateral linkages are in textiles and derived products, machinery and transport equipment.

Downstream effects

Receipt shares are calculated as row normalisation of the original SAM. They show the percentage distribution of a specific sector supply, illustrating downstream effects that originate from deliveries to intermediate, domestic and export use.

French export structure is similar to its structure of imports, reflecting the intra-industry aspect of its trade. This is clearly noticeable for trade with the EC: textiles, apparel, durables, chemicals and plastic products all register very close import and export ratios. Morocco is a significant (above 0.2%) export market for French cereals, textiles, metal products, capital goods and chemicals. As expected, US exports similarly depend on global markets and its receipt shares from Mexico are of comparable magnitude, averaging 1% for leather, non-electrical machinery and electrical machinery.

Moroccan dependency on exports to France is much stronger than the reverse. Export ratios above 4% are shown for vegetable and fruits (10%), food products, apparel (37%), leather products, and machinery. For all these sectors the French share exceeds that for the rest of EC and the ROW. Likewise Mexican receipts from the US exceeding 10% are petroleum, apparel, rubber and plastic products, non-ferrous metals, electrical machinery and other manufactured products.

As far as agriculture is concerned, comparative advantage resulted in the Moroccan specialisation in exports of vegetable and fruit and other products (fishing), and,

[50] Agriculture is a sensitive issue in the Moroccan-EC negotiations on further regional integration.

associated with the EC agricultural policy, shaped the French concentration in cereals and industrial crops.

To summarise, regional interdependence is strongest in the sectors producing capital goods, textiles and derived products and it is unbalanced, in the sense that Moroccan trade dependency on France is higher than vice versa. Despite some sectoral differences, the magnitudes of the Mediterranean linkages shown in the French-Moroccan SAM are similar to those shown in the NAFTA case.

3.3 The France-Morocco SAM

The two-country France-Morocco SAM was derived from merging two individual country SAMs. This process entailed three separate steps. First the commodities/activities classification schemes had to be normalised. The common definitions and standards adopted in the French and Moroccan national accounts systems facilitated this task. The sectoring scheme included 18 activities, which are shown along with the factors of production and households categories in Appendix A.

Secondly, Moroccan Dirhams and French Francs were converted into US dollars at rates 8.24 and 5.44 respectively. These rates are yearly averages of market exchange rates from the International Monetary Fund, *International Financial Statistics* for 1991. The purchasing power parity rate could be considered a more appropriate conversion factor for certain components of the SAM and for a discussion see Reinert, K.A., D.W. Roland-Holst and C.R.Shiells (1993). Thirdly the bilateral trade flows and other transactions (factor payments and transfers) had to be estimated and subtracted from the rest of the world accounts. This will be described more fully below.

The result at a macro-economic level is shown in Table 3-5, where transactions are recorded among 23 accounts. These are (note that the first two letters in the labels 'Fr' or 'Mr' denote the country: France or Morocco):

- Activities (production sectors)
- Capital and Labour (factors of production)
- Households, Corporations Government (institutions)
- Capital Account (saving-investment account)
- Indirect Taxes

- Commercial Margins
- Subsidies
- Tariffs (international trade taxes)
- Rest Of the World (international transactions)

A schematic representation of Table 3-5 takes the form:

$$\mathbf{T} = \begin{pmatrix} \mathbf{T}_{11} & \mathbf{T}_{12} & \mathbf{R}_{13} \\ \mathbf{T}_{21} & \mathbf{T}_{22} & \mathbf{R}_{23} \\ \mathbf{R}_{31} & \mathbf{R}_{32} & \mathbf{R}_{33} \end{pmatrix} \quad (1)$$

The matrices on the main diagonal of (1) represent within country transactions, matrices $\mathbf{T}_{12}$ and $\mathbf{T}_{21}$ contain the inter-country transactions and matrices $\mathbf{R}_{ij}$ record French and Moroccan transactions with the Rest of the world ($\mathbf{R}_{33}$ does not contain any relevant data either for France or for Morocco).

It can be added that matrices $\mathbf{T}_{ii}$ on the main diagonal in Table 3-5 are consistent with the national accounts of each country.

Table 3-5: French-Moroccan Macro SAM (1990) - million US current dollars

	Fr Activ	Fr Cap	Fr Lab	Fr HH	Fr Corp	Fr Govnt	FrCap Acct	FrInd Taxes	Fr C Marg	Fr Tariff	Fr Subsid	Mr Activ	Mr Cap	Mr Lab	Mr HH	Mr Corp	Mr Govnt	MrCap Acct	MrInd Taxes	Mr C Marg	Mr Tariff	Mr Subsid	ROW
Fr Activ	983994	0	0	709113	0	218114	268545	0	165332	0	25065	1934	0	0	0	0	0	0	0	0	0	0	267652
Fr Capital	420684	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fr Labour	619214	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3018
Fr HH	0	199506	618978	0	76554	270436	59370	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	4519
Fr Corpor	0	200104	0	36159	61583	20949	298447	0	0	0	0	0	0	0	0	114	0	0	0	0	0	0	2958
Fr Govern	0	21074	0	339699	59330	50604	33584	169415	0	55	0	0	0	0	0	0	374	0	0	0	0	0	13400
Fr CapAcct	0	0	0	141560	416108	95068	13029	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54734
Fr IndTaxes	178592	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fr ComMrg	165332	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fr Subsid	0	0	0	0	0	18564	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6501
Fr Tariff	2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mr Activ	1724	0	0	0	0	0	0	0	0	0	0	28008	0	0	17795	0	4001	6501	0	4587	0	55	3229
Mr Capital	0	0	0	0	0	0	0	0	0	0	0	8186	0	0	0	0	0	0	0	0	0	0	198
Mr Labour	0	0	11	0	0	0	0	0	0	0	0	11659	0	0	0	0	0	0	0	0	0	0	3
Mr HH	0	0	0	2783	0	0	0	0	0	0	0	0	2305	11665	750	3909	2108	0	0	0	0	0	625
Mr Corpor	0	0	0	0	0	0	0	0	0	0	0	0	6060	0	0	0	0	0	0	0	0	0	0
Mr Govern	0	0	0	0	0	141	0	0	0	0	0	0	0	0	972	951	0	0	3870	0	2377	0	76
Mr CapAcct	0	0	0	0	0	0	66	0	0	0	0	0	0	0	4567	1002	831	312	0	0	0	0	35
Mr IndTaxes	0	0	0	0	0	0	0	0	0	0	0	3870	0	0	0	0	0	0	0	0	0	0	0
Mr ComMrg	0	0	0	0	0	0	0	0	0	0	0	4587	0	0	0	0	0	0	0	0	0	0	0
Mr Subsid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0
Mr Tariff	0	0	0	0	0	0	0	0	0	0	0	2377	0	0	0	0	0	0	0	0	0	0	0
ROW	268198	0	3243	67	6740	13660	47457	9176	0	1955	0	5279	20	6	44	84	1018	0	0	0	0	0	7191
Tot	2639747	420684	622233	1229381	620315	687535	720498	178592	165332	2010	25065	65900	8385	11673	24145	6060	8386	6813	3870	4587	2377	55	364139

The Activities account[51] buys inputs and two types of factor services (from the capital accounts), moreover it pays indirect taxes, tariffs and commercial margins on the outputs. Thus, commodities are valued at market prices. The Household account (HH) buys commodities for its final demand, pays income taxes to the government and saves. It receives its income directly from the factors it owns or through transfers from other accounts. The government account collects taxes (direct and indirect) and tariffs and pays for its final demand, transfers to other institutions and subsidies. The Capital account closes the system transforming savings from various institutions into investment demand. Off diagonal matrices $\mathbf{T}_{ij}$ contain all the relevant data on the economic relationships between France and Morocco. At the aggregate level of Table 3-5, it is possible to see bilateral trade data, households and other institution transfers.

3.4 The French Moroccan Regional Multiplier Model

This section studies in detail the regional decomposition of multipliers. In particular it offers a special case of share sensitivity analysis through an evaluation of the main differences in the multipliers emerging from three different versions of the SAM. *Version 1* organises bilateral trade data in simple diagonal import matrices, *version 2* displays distinct domestic and import input-output tables where the latter is obtained from original data on imported intermediates,[52] *version 3* reproduces *version 2* with the import IO table estimated from the initial IO table.[53] It is quite clear that *version 2* of the SAM includes more information than *version 1*, in the sense that bilateral trade flows are disaggregated by destination of use and not simply recorded as geographical transfers[54]. The aim of the sensitivity analysis is to judge, by the extent of the variation of multipliers, the value of the extra information contained in a "true" import IO table, as in *version 2*. The next three

[51] Notice that there is no distinction between activities and commodities. This simplifies the analysis but implicitly rules out the possibility of sectors producing more than one commodity.
[52] *Version 1* and *version 2* correspond to classification (2) and (3) of the introduction.
[53] *Version 1* correspond to treatment (2) in the introduction, whereas *version 2* to treatment (3).
[54] The import tables of *version 1* of the SAM "represent transfers which simply augment the receipts of an account in one region and simultaneously deplete the same (functional) account in the other region". They correspond therefore to geographical (*inter*-country) flows as defined in Round (1985). The quotation is from that same paper.

sub-sections detail the construction of the three versions of the SAM and examine multiplier decomposition and variation.

3.4.1 Three versions of a two-country SAM[55]

Table 3-6 and Table 3-7 illustrate versions 1 and 2 of the French-Moroccan SAM. The main structure of these SAMs is exactly the same as that described in section 3.2 where, for simplicity, the sectors have been reduced to 4. The households and corporate accounts have been aggregated into one single institutional current account labelled 'Cons', and two other accounts are considered: 'trade', which accumulates all external trade, and 'other' account, which consolidates all remaining accounts (government, indirect taxes, commercial margins, tariffs, subsidies).

The only difference in the two versions is the treatment of trade flows. Consider the highlighted squares of the SAMs. These are the *"domestic" input-output tables* (cells 1,1 - 4,4 for France and 9,9 - 12,12 for Morocco[56]), *the bilateral imports tables* (cells 9,1 - 12,4 for France and 1,9 - 4,12 for Morocco), the *"domestic" private final demand* (cells 1,7 - 4,8 for France and 9,15 - 12,16 for Morocco), the *bilateral imported private final demand* (cells 9,7 - 12,8 for France and 1,15 - 4,16 for Morocco) and the *trade flows* with the rest of the world (cells 17,1 - 17,4 and 17,7 - 17,8 for France and 17,9 - 17,12 and 17,15 17,16 for Morocco).

In *version 1* - considering the French point of view and its trade relations with Morocco - the import table is a diagonal matrix where Moroccan products are geographically transferred to the French corresponding sectors. In this case, for example, 216 millions US $ of agricultural goods are imported by France from Morocco, and then delivered by the account *FrAgri* (on row 1) for intermediate use or final private demand[57]. France's imports from other countries are shown in the 'trade' account. In the above example, France imports 9,301 millions of agricultural goods. The French "domestic" IO table therefore records the use of French intermediates as well as imported

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[55] The analysis in this section has some precedents in the input-output literature. In particular see the discussion on alternative treatments of imports in the I-O table in Bulmer-Thomas (1982), pages 105-111.

[56] A sort of spreadsheet convention is used to denote specific portions in the SAMs where the first couple of numbers, separated by a comma, indicates the row and column indices of the upper left corner and the second couple refers to the lower right corner of that portion.

[57] For the sake of precision they can also be used for investment or re-exported.

ones. In other words, row 1 sum (102,457 millions) represents the total supply of domestically produced and imported agricultural goods available in the French market. This format has been used in the multiplier analysis of the NAFTA region in another study.[58]

Version 2 of the SAM treats domestic and imported transactions separately. This entails two changes in the arrangement of transactions. Firstly, the "domestic" IO table (for France or Morocco) is now truly domestic in the sense that it records intermediates use of purely domestically produced goods. Intermediates imported from Morocco are found in the import IO table and those coming from other trading partners are in the 'trade' row. Secondly, imported final consumption and investment goods are allocated directly to final private demand (the 'Cons' and 'Invest' accounts)[59]. In this case therefore, considering the previous example, the 216 millions of Moroccan agricultural imports are used as intermediates by sectors *FrAgri* (9 millions), *FrManuf* (91 millions) and *FrServ* (12 millions), and the remaining 104 millions are consumed by French households (and therefore subtracted from the *"domestic" private final demand*) or used to satisfy investment demand. The further 9,301 millions of agricultural imported goods are allocated in the same way.[60] Row 1 total sum (92,940 millions) now shows the availability in the French market of purely domestic agricultural goods.[61]

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[58] Reinert K.A., D.W. Roland-Holst and C.R. Shiells (1993). It should also be added that this format, with the import matrices collapsed to vectors, has been used in the calculation of the expenditure and receipt shares in section 3.2 (shown in Appendix A).

[59] The case where imports from partner-country are exported is implicitly excluded.

[60] Notice that to show the exact allocation Table 3-6 and Table 3-7 should present the 'trade' account sectorally disaggregated.

[61] The difference in Row 1 total value between version 1 and 2 corresponds exactly to 9,517 millions US $, the total imports of agricultural goods from Morocco (216 millions) and from other countries (9,301 millions).

Table 3-6: France - Morocco SAM 1990 millions US $ - Version 1

	FrAgri	Fr MinEne	Fr Manuf	FrServ	Fr Capital	Fr Labour	Fr(X,F) Cons	Fr(X,F) Invest	Mr Agri	Mr MinEn	Mr Manuf	Mr Serv	Mr Cap	Mr Labor	Mr(X,F) Cons	Mr(X,F) Invest	Trade	Other	Total
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	
1 FrAgri	13486	21	41506	2977	0	0	25878	2116	80	0	0	0	0	0	0	0	14053	2339	102457
2 FrMinEne	2392	24550	20138	23194	0	0	37649	-110	0	49	0	0	0	0	0	0	11380	609	119851
3 FrManuf	17151	3577	229860	133776	0	0	320320	111597	0	0	1650	0	0	0	0	0	202731	6325	1026988
4 FrServ	3214	10557	113623	343971	0	0	325265	154941	0	0	0	154	0	0	0	0	39489	399238	1390452
5 FrCapital	29435	4131	73792	313327	0	0	0	0	0	0	0	0	0	0	0	0	0	0	420684
6 FrLabour	5348	7029	146791	460045	0	0	0	0	0	0	0	0	0	2	0	0	0	3018	622233
7 Fr(X,F) C	0	0	0	0	399611	618978	174296	357817	0	0	0	0	0	0	130	0	0	298862	1849696
8 Fr(X,F) I	0	0	0	0	0	0	557668	13029	0	0	0	0	0	0	0	0	0	149802	720498
9 MrAgri	216	0	0	0	0	0	0	0	664	4	1685	90	0	0	5281	-253	467	0	8153
10 MrMinEne	0	82	0	0	0	0	0	0	167	1080	1421	900	0	0	888	37	689	0	5263
11 MrManuf	0	0	1283	0	0	0	0	0	449	123	7453	5576	0	0	6827	3664	1500	55	26930
12 MrServ	0	0	0	143	0	0	0	0	604	235	1835	5724	0	0	4800	3052	573	8588	2554
13 MrCapital	0	0	0	0	0	0	0	0	2619	1151	1433	2984	0	0	0	0	0	198	8385
14 MrLabour	0	0	0	0	0	11	0	0	1483	279	2172	7725	0	0	0	0	0	3	11673
15 Mr(X,F) C	0	0	0	0	0	0	2783	0	0	0	0	0	8365	11665	4659	0	0	2733	30205
16 Mr(X,F) I	0	0	0	0	0	0	0	66	0	0	0	0	0	0	5569	312	0	866	6813
17 Trade	9301	33926	199418	25553	0	0	0	0	301	1452	3395	131	0	0	0	0	0	2298	275775
18 OtherAcc	21914	35977	200577	87465	21074	3243	405836	81042	1785	891	5886	2271	20	6	2051	0	4894	291239	1166171

Table 3-7: France - Morocco SAM 1990 millions US $ - Version 2

	FrAgri	Fr MinEne	Fr Manuf	FrServ	Fr Capital	Fr Labour	Fr(X,F) Cons	Fr(X,F) Invest	Mr Agri	Mr MinEn	Mr Manuf	Mr Serv	Mr Cap	Mr Labor	Mr(X,F) Cons	Mr(X,F) Invest	Trade	Other	Total
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	
1 FrAgri	13102	13	37498	2448	0	0	21638	1770	9	0	52	0	0	0	17	2	14053	2339	92940
2 FrMinEne	1993	4009	14833	16866	0	0	36210	-106	1	12	10	6	0	0	20	0	11380	609	85843
3 FrManuf	13234	3202	159193	105934	0	0	258872	75146	28	5	443	398	0	0	281	494	202731	6325	826287
4 FrServ	3176	9906	108885	328006	0	0	322351	153553	0	1	3	39	0	0	111	0	39489	399238	1364756
5 FrCapital	29435	4131	73792	313327	0	0	0	0	0	0	0	0	0	0	0	0	0	0	420684
6 FrLabour	5348	7029	146791	460045	0	0	0	0	0	0	0	0	0	2	0	0	0	3018	622233
7 Fr(X,F) C	0	0	0	0	399611	618978	174296	357817	0	0	0	0	0	0	130	0	0	298862	1849696
8 Fr(X,F) I	0	0	0	0	0	0	557668	13029	0	0	0	0	0	0	0	0	0	149802	720498
9 MrAgri	9	0	91	12	0	0	96	8	621	4	1438	88	0	0	5188	-251	467	0	7771
10 MrMinEne	1	49	13	15	0	0	3	0	133	726	1107	717	0	0	296	13	689	0	3762
11 MrManuf	30	1	385	99	0	0	696	73	359	108	5757	4473	0	0	5914	2435	1500	55	21885
12 MrServ	0	4	26	89	0	0	16	8	604	234	1829	5652	0	0	4631	3015	573	8588	25268
13 MrCapital	0	0	0	0	0	0	0	0	2619	1151	1433	2984	0	0	0	0	0	198	8385
14 MrLabour	0	0	0	0	0	11	0	0	1483	279	2172	7725	0	0	0	0	0	3	11673
15 Mr(X,F) C	0	0	0	0	0	0	2783	0	0	0	0	0	8365	11665	4659	0	0	2733	30205
16 Mr(X,F) I	0	0	0	0	0	0	0	66	0	0	0	0	0	0	5569	312	0	866	6813
17 Trade	4698	21522	84204	50450	0	0	69231	38093	129	353	1754	916	0	0	1335	793	0	2940	276417
18 OtherAcc	21914	35977	200577	87465	21074	3243	405836	81042	1785	891	5886	2271	20	6	2051	0	5536	291239	1166814

Data for version 2 - France

The additional information necessary to compile version 2 was obtained differently for the two countries.

The French data were provided by the National Statistical Office in the format of an import IO table with no disaggregation by country of origin.

The final partner-country[62] import IO table was then estimated in the following way. Firstly the sector specific ratios of intermediate to final use were calculated for total imports and applied to the Moroccan imports vector. Then, the vector of Moroccan imported intermediates were allocated to the French sectors by use according to the ratios computed from the original import IO table. Thus, these two steps together coincide with the following formula[63]:

$$M_{MOR\ ij}^{Intermediate} = \frac{M_{FRA\ ij}^{Intermediate}}{M_{FRA\ ij}^{Tot}} \times M_{MOR\ ij}^{Tot} \tag{1}$$

where:

$M_{MOR\ ij}^{Intermediate}$	are Moroccan intermediate goods of sector i imported by French sector j,
$M_{FRA\ ij}^{Intermediate}$	intermediate goods of sector i imported by French sector j,
$M_{FRA\ ij}^{Tot}$	total French imports of goods i,
$M_{MOR\ ij}^{Tot}$	total French imports of Moroccan goods i.

Final consumption and investment goods imported from Morocco were allocated accordingly to the French 'Cons' and 'Invest' accounts.[64]

Data for version 2 - Morocco

In the case of Morocco an indirect estimation procedure was also used. Average sector specific ratios of imported to total intermediate demand were calculated from two import IO tables available for other developing countries: Costa Rica and Indonesia. The main advantage in using these tables was that their sectoring scheme almost perfectly

[62] *Partner countries* are the two countries in the SAM, namely France and Morocco. Therefore for France the partner country import IO table collects intermediates imported by French sectors exclusively from Morocco.

[63] This procedure implicitly assumes no distinction between the distribution among sectors (or even among the intermediate or final private demand destination) of world and Moroccan imports to France. This is because the original import IO table is not available in versions disaggregated by country of origin.

[64] Clearly although this is not a *pure* version 2, in the sense that it relies on ratios and secondary sources, it includes substantial new information.

matched the original Moroccan IO table. Firstly a world import IO table was calculated directly by applying the above ratios to the Moroccan (total) IO table. Then a partner-country imported IO table was obtained basically using equation (1) with the appropriate modifications.

Version 3 of the SAM represents the case where the detailed information on imports by origin and sector of destination is assumed not to be available. It is possible to consider two hypothesis: in the first the broad sectoral destination of use of imported goods is *known*, i.e. imports can be classified between intermediates or final demand goods, in the second it is *unknown*. In other words, *version 3* in the first hypothesis will differ from *version 2* only for the imported IO tables, whereas in the second it will differ also for the imported final private demand.

Table 3-6, the *version 1* SAM, can be schematically represented as:

$$\mathbf{SAM}_1 = \begin{pmatrix} \mathbf{S}_{11} & \hat{\mathbf{m}}_{12} & \mathbf{x}_1 & \mathbf{f}_1 & \mathbf{q}_1 \\ \hat{\mathbf{m}}_{21} & \mathbf{S}_{22} & \mathbf{f}_2 & \mathbf{x}_2 & \mathbf{q}_2 \\ \mathbf{w}_1 & \mathbf{w}_2 & \mathbf{0} & \mathbf{0} & \mathbf{0} \end{pmatrix}$$

where:

$\mathbf{S}_{ii}$ are the "domestic" intermediate tables,
$\mathbf{m}_{ij}$ bilateral trade ('^' represents diagonal matrices),
$\mathbf{x}_i$ final domestic demand (includes private final consumption and investment demands),
$\mathbf{f}_i$ final foreign demand (includes private final consumption and investment demands)[65],
$\mathbf{q}_i$ other accounts (not affected by partner-country trade),
$\mathbf{w}_i$ value added,
indices i , j = 1 , 2.

It should be noticed that in this schematic version of Table 3-6, $\mathbf{m}_{ij}$ aggregates partner-country and other countries imports (the 'trade' account).

Consider now *version 3*, where no prior information about the destination of use of the imported goods is available[66]. In this case imports are used domestically as intermediates and final demand goods. The calculations necessary to construct *version 3* can be summarised using matrix algebra as follows.

Define $\mathbf{u}_i$, the vector sum of domestic use, as:

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[65] Note that these are zeros initially (in version 1).

$\mathbf{u}_1 = \mathbf{S}_{11}\,\mathbf{i} + \mathbf{x}_1 = \mathbf{y}_1 - \mathbf{m}_{12} - \mathbf{q}_1$

$\mathbf{u}_2 = \mathbf{S}_{22}\,\mathbf{i} + \mathbf{x}_2 = \mathbf{y}_2 - \mathbf{m}_{21} - \mathbf{q}_2$

where $\mathbf{y}_i$ are SAM total incomes (expenditures). Domestic use can be disaggregated into its imported and domestic components. The following set of ratios are calculated for the imported component[67]:

$\mathbf{a}_1 = \hat{\mathbf{u}}_1^{-1}\,\mathbf{m}_{21}$

$\mathbf{a}_2 = \hat{\mathbf{u}}_2^{-1}\,\mathbf{m}_{12}$

The estimated intermediate tables $\mathbf{S}_{ii}^*$, imported IO tables $\hat{\mathbf{m}}_{ij}^*$, domestic and foreign final consumption $\mathbf{x}_i^*$ and $\mathbf{f}_i^*$ take the form:

$\mathbf{S}_{11}^* = (\mathbf{I} - \hat{\mathbf{a}}_1)\,\mathbf{S}_{11}$	$\hat{\mathbf{m}}_{21}^* = \hat{\mathbf{a}}_1\,\mathbf{S}_{11}$	$\mathbf{x}_1^* = (\mathbf{I} - \hat{\mathbf{a}}_1)\,\mathbf{x}_1$	$\mathbf{f}_1^* = \hat{\mathbf{a}}_2\,\mathbf{x}_2$
$\mathbf{S}_{22}^* = (\mathbf{I} - \hat{\mathbf{a}}_2)\,\mathbf{S}_{22}$	$\hat{\mathbf{m}}_{12}^* = \hat{\mathbf{a}}_2\,\mathbf{S}_{22}$	$\mathbf{x}_2^* = (\mathbf{I} - \hat{\mathbf{a}}_2)\,\mathbf{x}_2$	$\mathbf{f}_2^* = \hat{\mathbf{a}}_1\,\mathbf{x}_1$

Finally to estimate the *partner-country* import IO tables it is necessary to calculate the ratio of partner-country imports to total imports and apply it to the $\hat{\mathbf{m}}_{ij}^*$, $\mathbf{x}_i^*$ and $\mathbf{f}_i^*$ just calculated. This allows also to obtain a 'trade' account as in the original Table 3-6.

3.4.2 The multiplier decomposition[68]

Consider matrix **T** of section 3.2. Let row sums of **T** be represented by a vector of incomes **y** and column normalization of **T** by the matrix of expenditure shares **A**. Thus, the very well known property of a balanced SAM can be expressed by the following identity:

$$\mathbf{y} = \mathbf{A}\,\mathbf{y} \qquad (1)$$

---

[66] This is the most general case. The other one, where the destination of use of imported goods is *known*, is briefly analysed in Appendix B.

[67] It is possible to define $\mathbf{z}_i$, total domestic supply, as total supply (income) minus imports:

$$\mathbf{z}_1 = \mathbf{y}_1 - \mathbf{m}_{21} = \hat{\mathbf{b}}_1\,\mathbf{S}_{11}\,\mathbf{i} + \hat{\mathbf{b}}_1\,\mathbf{x}_1 + \mathbf{m}_{12} + \mathbf{q}_1 = \hat{\mathbf{b}}_1\,\mathbf{u}_1 + \mathbf{m}_{12} + \mathbf{q}_1$$

$$\mathbf{z}_2 = \mathbf{y}_2 - \mathbf{m}_{12} = \hat{\mathbf{b}}_2\,\mathbf{S}_{22}\,\mathbf{i} + \hat{\mathbf{b}}_2\,\mathbf{x}_2 + \mathbf{m}_{21} + \mathbf{q}_2 = \hat{\mathbf{b}}_2\,\mathbf{u}_2 + \mathbf{m}_{21} + \mathbf{q}_2$$

in words, domestic supply is sold domestically in the intermediate and final private consumption good markets and as an export in the foreign markets. The $\mathbf{b}_i$ ratios for the domestic component take the form:

$$\mathbf{b}_1 = \hat{\mathbf{u}}_1^{-1}\,\mathbf{z}_1 - \hat{\mathbf{u}}_1^{-1}\,\mathbf{m}_{12} - \hat{\mathbf{u}}_1^{-1}\,\mathbf{q}_1$$

$$\mathbf{b}_2 = \hat{\mathbf{u}}_2^{-1}\,\mathbf{z}_2 - \hat{\mathbf{u}}_2^{-1}\,\mathbf{m}_{21} - \hat{\mathbf{u}}_2^{-1}\,\mathbf{q}_2$$

Note that:

$$\hat{\mathbf{a}}_i + \hat{\mathbf{b}}_i = \mathbf{I}$$

This follows from the definition of domestic use and the formulas for the ratios $\mathbf{a}_i$ and $\mathbf{b}_i$ since:

$$\hat{\mathbf{a}}_i + \hat{\mathbf{b}}_i = \hat{\mathbf{u}}_i^{-1}\,(\hat{\mathbf{m}}_{ji} + \hat{\mathbf{z}}_i - \hat{\mathbf{m}}_{ij} - \hat{\mathbf{q}}_i) = \hat{\mathbf{u}}_i^{-1}\,(\hat{\mathbf{m}}_{ji} + \hat{\mathbf{y}}_i - \hat{\mathbf{m}}_{ji} - \hat{\mathbf{m}}_{ij} - \hat{\mathbf{q}}_i) = \hat{\mathbf{u}}_i^{-1}\,\hat{\mathbf{u}}_i\,.$$

[68] This section is based on Pyatt and Round (1979), and Round (1985).

Assuming m accounts as endogenous and k as exogenous equation (1) can be written as:

$$\begin{pmatrix} \mathbf{y}_m \\ \mathbf{y}_k \end{pmatrix} = \begin{pmatrix} \mathbf{A}_{mm} & \mathbf{A}_{mk} \\ \mathbf{A}_{km} & \mathbf{A}_{kk} \end{pmatrix} \begin{pmatrix} \mathbf{y}_m \\ \mathbf{y}_k \end{pmatrix} \tag{2}$$

from which endogenous incomes can be calculated as follows:

$$\begin{aligned} \mathbf{y}_m &= \mathbf{A}_{mm}\,\mathbf{y}_m + \mathbf{A}_{mk}\,\mathbf{y}_k \\ &= \mathbf{A}_{mm}\,\mathbf{y}_m + \mathbf{x} \qquad (3) \\ &= (\mathbf{I} - \mathbf{A}_{mm})^{-1}\,\mathbf{x} \;=\; \mathbf{M}\,\mathbf{x} \end{aligned}$$

x being a m x 1 vector of exogenous injections, and M the multiplier matrix. This matrix can be multiplicatively decomposed as follows.

Consider a partition of matrix $\mathbf{A}_{mm}$ by country where the subscripts 1 and 2 correspond to France and Morocco respectively. Equation (3) now takes the form:

$$\begin{pmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \end{pmatrix} = \begin{pmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} \\ \mathbf{A}_{21} & \mathbf{A}_{22} \end{pmatrix} \begin{pmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \end{pmatrix} + \begin{pmatrix} \mathbf{x}_1 \\ \mathbf{x}_2 \end{pmatrix} \tag{4}$$

Then matrix Amm can be decomposed as

$$\mathbf{A}_{mm} = \begin{pmatrix} \mathbf{A}_{11} & 0 \\ 0 & \mathbf{A}_{22} \end{pmatrix} + \begin{pmatrix} 0 & \mathbf{A}_{12} \\ \mathbf{A}_{21} & 0 \end{pmatrix} = \mathbf{B} + \mathbf{C} \tag{5}$$

from equation (5), endogenous incomes are calculated as

$$\begin{aligned} \mathbf{y}_m &= \mathbf{B}\,\mathbf{y}_m + \mathbf{C}\,\mathbf{y}_m + \mathbf{x} \\ &= (\mathbf{I} - \mathbf{B})^{-1}\mathbf{C}\,\mathbf{y}_m + (\mathbf{I} - \mathbf{B})^{-1}\,\mathbf{x} \qquad (6) \\ &= [\mathbf{I} - (\mathbf{I} - \mathbf{B})^{-1}\mathbf{C}]^{-1}\,(\mathbf{I} - \mathbf{B})^{-1}\,\mathbf{x} \;=\; (\mathbf{I} - \mathbf{D})^{-1}(\mathbf{I} - \mathbf{B})^{-1}\,\mathbf{x} \;=\; \mathbf{M}_2\,\mathbf{M}_1\,\mathbf{x} \end{aligned}$$

It should be noticed that $\mathbf{M}_1$, being expressed in terms of matrix **B**, measures *intra*-country multipliers effects, and that $\mathbf{M}_2$ accounts for the remaining *inter*-country effects.[69] In the following experiments I will consider an additive decomposition which is interpreted more easily. This takes the form[70]

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[69] $\mathbf{M}_2$ can be further decomposed as follows

$$\mathbf{y}_m = (\mathbf{I} - \mathbf{D}^2)^{-1}\,(\mathbf{I} + \mathbf{D})\,(\mathbf{I} - \mathbf{B})^{-1}\,\mathbf{x} = \mathbf{M}_3\,\mathbf{M}_{22}\,\mathbf{M}_1\,\mathbf{x} \tag{7}$$

In equation (7) $\mathbf{M}_1$ has not changed, but *inter*-country multipliers has been decomposed in the so called *open*-loop ($\mathbf{M}_{22}$) multipliers and *closed*-loop ($\mathbf{M}_3$) multipliers.

[70] With the *open- closed-* loop multipliers the additive decomposition would be:

$$\mathbf{M} - \mathbf{I} = \mathbf{M}_3\,\mathbf{M}_{22}\,\mathbf{M}_1 - \mathbf{I} =$$

$$\mathbf{M} - \mathbf{I} = \mathbf{M}_2 \mathbf{M}_1 - \mathbf{I}$$
$$= (\mathbf{M}_2 - \mathbf{I}) \mathbf{M}_1 + \mathbf{M}_1 - \mathbf{I}$$
$$= \mathbf{N}_2 + \mathbf{N}_1 - \mathbf{I}$$

where $\mathbf{N}_2 = (\mathbf{M}_2 - \mathbf{I})$ and $\mathbf{N}_1 = \mathbf{M}_1$. This decomposition can be applied to either version 2 or version 3 of the SAM since they are consistent and identical in format.

3.4.3 Stylised results

This section presents the main results derived from the application of the multipliers decomposition to versions 2 and 3 of a French Moroccan SAM with 13 sectors, 4 production factors, and 6 households.[71] The multipliers shown in the following tables are *fixed price* multipliers, this means that a fundamental assumption in their calculation is that any increase in exogenous demand is satisfied by expanding supply. In other words this analysis cannot take into account supply constraints, price variations and substitution effects. Nonetheless its validity is probably tenable when the exogenous shocks are of small magnitude or in the cases of short-run excess capacity and unemployment or long-run infinite elasticity of supply of factors of production: in these cases the multipliers can approximate *marginal* variations[72]. Furthermore, a thorough multiplier analysis can offer a clear illustration of the main interdependencies among the various actors in the economies under study helping the construction of an effective more complex general equilibrium model.

Two subsections follow. The first illustrating the multipliers calculated exclusively from version 2, fulfils the purpose of detailing all the main interdependencies of the France-Morocco SAM. The second evaluates data intensive frameworks by collecting the most relevant differences between version 2 and 3 multipliers and offers some conclusions on share sensitivity analysis.

$$=(\mathbf{M}_3 - \mathbf{I})\mathbf{M}_{22} \mathbf{M}_1 + (\mathbf{M}_{22} - \mathbf{I}) \mathbf{M}_1 + \mathbf{M}_1 - \mathbf{I}$$
$$= \mathbf{N}_3 + \mathbf{N}_{22} + \mathbf{N}_1 - \mathbf{I}$$

[71] Activities, factors and households accounts are endogenous whereas Government, Investment and Foreign transactions represent exogenous demand. Endogeneity of the accounts is determined following Pyatt and Round (1979). The exogenous accounts include also Tariffs, Commercial Margins, Indirect taxes and Subsidies.

[72] To be more precise it should be noticed that these are *accounting* multipliers - i.e. based on averages - and not *marginal* coefficients (for the following analysis this would matter if marginal and average propensities to consume were different; assuming them equal is equivalent to impose a unitary income elasticity of consumption). See Pyatt and Round (1979) page 861.

SAM multipliers: version 2

Version 2 (the "true" import table version) $\mathbf{N}_1$ multipliers shown in Table 3-9 are interpreted as the *intra*-country multipliers or as those multipliers that would be obtained from two separate SAMs for France and Morocco. An entry of Table 3-9 should be read as the income variation of the row sector given an increase in the exogenous demand of the column sector (the units are cents per dollar).

Consider firstly injections originating from production sectors (the first 13 columns). In fact, these multipliers can be compared to the Leontief inverse and have the expected magnitude[73]. For both countries, strong linkages are registered on the main diagonal and for the service sector. Also, Morocco records very significant interdependencies among agricultural, mining and food product activities and the other industries. This confirms the relevance of these sectors in the Moroccan economy. However, the quite different economic structure and development of the two countries clearly appears in the lower part of the table. Here it is possible to appreciate how exogenous demand injections affect income distribution among factors of production and households. Consider the rows for factors of production. In France, the relative weight of multiplier effect for *corporate* with respect to *small* capital is much higher, showing more mature and concentrated capital markets than in Morocco, where small business capital still plays a very important role. The same relative measure for *skilled* with respect to *unskilled* labour is lower for France, reflecting a more homogeneous work force with lower skill differentials. Moreover, the maximum effect for *corporate* capital originates from French agriculture, revealing its hi-tech extensive character, and Moroccan mining, which is dominated by huge government enterprises. For *small* capital the maximum effect results from French services and from Moroccan agriculture. *Skilled* labour highest multipliers are derived from French services and Moroccan leather sector, *unskilled* labour ones from French metal product and Moroccan leather sector. The more mature character of the French economy is also revealed when the household sector is considered. Although a greater degree of uniformity is noticeable with the urban proprietors and professional group

[73] See, for example, Leontief (1953). Notice that these *intra*-country multipliers could be further decomposed to obtain $\mathbf{M}_3\ \mathbf{M}_2\ \mathbf{M}_1$ multipliers within countries, and that the activity portion of $\mathbf{M}_1$ would be properly defined as the intra-industry multiplier.

playing the major role across sectors in both countries, some differences still appear. In Morocco, urban government employees, rural farmers and rural agriculture workers, the typical greater part of a developing country population, record stronger multiplier effects than their French counterparts. The injections generating highest effects, across all households, are from leather, services and agriculture in Morocco, and services, capital goods and other durables in France.[74]

Consider now injections from factors of production or households (the rightmost 10 columns). In this case, multipliers are not immediately interpretable as a Leontief inverse, and they essentially measure the income generating effect of an exogenous shock through the income expenditure loop of the SAM. An injection to a household group produces multiplier effects according to its specific expenditure pattern. Considering activity rows, one can note that multipliers do not markedly differ across households for each country, reflecting similar consumption patterns. However this similarity is not maintained across countries. In fact, the main difference between France and Morocco is represented by Morocco showing higher multipliers for basic goods (agriculture, food, beverages, apparel) and lower for capital goods than those for France. In the household-to-factor multipliers shown in the second panel of the table, it is important to note that although households do not directly consume labour or capital, their consumption of final goods indirectly cause factoral income effects. Due to this indirect link, these multipliers present once more, across households, a fairly high degree of homogeneity. The size of household-to-household multipliers depends in part on inter-household transfers and on the indirect income expenditure loops. The multipliers depicted in the factors of production columns and activity rows measure an indirect effect, too. An income injection to a factor is transmitted to its owners and, through their expenditure patterns, to the other SAM sectors/institutions.

An analysis of factor-to-household multipliers reveals some important differences among Moroccan and French factoral income distribution. French factoral income multipliers seem to be more evenly distributed across households (with the exception of rural skilled labour), as shown by Table 3-8 below.

[74] The strong effects recorded for services are a direct consequence of the aggregation of the SAMs.

Table 3-8: Factor-to-Households N_l multiplier standard deviations (SD)

	SmallCap	CorpCap	UnskLab	SkillLab
SD urb Fr	3	21	2	2
SD urb Mr	29	26	3	20
SD rur Fr	1	10	16	10
SD rur Mr	36	16	32	6

This implies that injections will have differential effects on the various households groups with implications for the income distribution.

The above analysis can be supplemented by examining the injections and leakages matrices. These are defined in the following equation:

$$\begin{pmatrix} \mathbf{N}_l & \mathbf{J}_l \\ \mathbf{L}_l & \mathbf{0} \end{pmatrix} = \begin{pmatrix} \mathbf{N}_l & \mathbf{N}_l\mathbf{A}_{mk} \\ \mathbf{A}_{km}\mathbf{N}_l & \mathbf{0} \end{pmatrix}$$

where:

$\mathbf{N}_l$ is the intra-country multipliers matrix,

$\mathbf{J}_l$ the injection matrix,

$\mathbf{L}_l$ the leakage matrix,

$\mathbf{A}_{mk}$ exogenous account expenditure shares (government, subsidy, investment, export accounts)

$\mathbf{A}_{km}$ exogenous account expenditure shares (government, indireet taxes, tariff, saving, import accounts)[75].

[75] Refer to equation 2 of section 3.4.2 for a definition of the **A** matrices.

Table 3-9: (N_i - I) intra-country multipliers (cents per dollar of new demand) - Version 2

	Agri	Min	Food	BvTb	Text	App	Leath	WNM	Met	CapG	Chem	OthM	Serv	SmK	CrpK	UL	SL	UPP	UPG	UL	RF	RNA	RAL
FrAgricult	22	1	37	6	4	2	3	6	4	3	3	2	5	0	3	7	7	5	7	8	5	7	8
FrMining	5	6	4	3	5	3	2	5	10	5	7	4	6	0	3	6	6	5	6	7	4	7	6
FrFoodPr	14	2	16	5	8	4	6	6	6	5	6	3	8	1	5	12	11	8	11	14	9	12	14
FrBevTobac	1	1	2	6	1	1	1	1	2	1	2	1	2	0	1	3	3	2	3	4	2	3	3
FrTextile	0	0	0	0	9	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FrApparel	2	1	2	1	3	7	3	2	3	2	3	3	3	0	2	4	4	4	5	4	3	4	4
FrLeather	0	0	0	0	0	0	5	1	1	1	0	0	1	0	0	1	1	1	1	1	1	1	1
FrWoodNMetal	4	2	6	6	6	4	4	23	6	6	7	7	10	1	3	7	7	6	8	8	4	7	5
FrMetalProd	1	2	2	1	2	2	2	3	26	13	3	3	3	0	1	2	2	2	2	2	1	2	2
FrCapGood	4	3	4	4	5	3	2	5	8	15	5	4	8	1	3	7	7	6	8	8	4	7	5
FrChem	9	3	6	4	6	4	4	7	8	7	13	8	5	0	3	6	6	4	6	6	3	6	6
FrOthManuf	1	0	1	1	1	0	0	1	1	1	1	0	1	0	1	1	1	1	2	1	1	1	1
FrServices	28	28	38	33	54	33	25	53	55	51	48	32	70	4	27	57	58	50	64	67	30	49	41
MrAgricult	34	16	58	12	14	19	31	16	11	7	12	6	26	40	25	55	42	36	35	48	43	54	61
MrMining	9	28	15	4	5	5	7	17	9	4	26	5	13	8	5	10	10	9	10	10	8	11	10
MrFoodPr	13	8	17	6	6	9	15	8	5	3	6	3	13	19	12	26	21	19	18	24	20	25	28
MrBevTobac	3	2	2	10	1	2	3	2	2	1	2	1	6	4	2	4	4	4	5	5	3	4	4
MrTextile	3	2	3	1	71	67	3	5	2	1	3	2	4	3	2	4	4	4	5	5	3	4	4
MrApparel	4	2	3	1	15	15	4	3	2	1	2	1	4	5	3	6	6	6	6	6	4	6	6
MrLeather	3	2	3	1	3	5	82	7	2	1	4	1	6	4	3	5	5	4	5	5	3	5	5
MrWoodNMetal	6	5	7	7	4	4	6	26	7	4	6	4	16	7	5	8	8	8	9	9	6	8	8
MrMetalProd	4	3	7	3	2	3	3	8	45	11	3	23	8	4	3	5	5	4	5	5	3	5	5
MrCapGood	2	2	2	1	1	1	2	2	2	8	1	1	3	2	1	3	3	2	3	3	2	3	3
MrChem	8	6	11	4	6	6	7	9	6	6	19	12	11	8	6	11	10	9	10	10	8	12	11
MrOthManuf	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1
MrServices	40	31	44	21	26	29	38	46	35	19	34	14	65	42	30	50	55	55	61	57	33	51	45
FrSmallCap	1	5	2	2	2	1	1	2	3	2	3	1	7	0	1	2	3	2	3	3	1	2	2
FrCorpCap	47	8	31	29	23	15	13	26	27	23	23	16	38	1	8	17	17	14	19	20	10	16	14
FrUnskLab	11	6	14	9	19	15	15	18	25	17	13	12	14	1	4	7	8	6	8	9	4	7	6
FrSkillLab	12	15	19	15	28	18	15	29	32	32	28	19	51	1	9	20	20	17	22	23	11	18	15
FrUPrpPrfH	23	9	19	17	20	14	12	21	24	20	19	13	30	6	43	35	39	11	14	15	8	12	11
FrUNPrGov	8	6	10	8	13	9	8	14	16	14	12	9	19	1	7	32	36	7	9	9	5	7	6
FrULabH	7	6	10	7	14	10	9	14	16	14	12	9	20	1	5	34	39	7	9	9	5	7	6
FrRFarmH	9	2	6	5	5	3	3	5	5	5	4	3	7	2	20	4	4	3	4	4	2	3	3
FrRNAgWkrH	6	4	7	5	9	7	6	10	12	9	8	6	12	1	5	31	19	4	6	6	3	5	4
FrRAgWkrH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
FrCorpor	27	8	19	18	15	10	9	17	18	15	15	10	27	72	60	13	14	16	14	14	18	12	11
MrSmallCap	22	4	12	3	8	12	10	6	5	2	4	2	10	8	5	11	9	8	8	10	8	11	12
MrCorpCap	33	46	24	15	16	18	34	24	15	10	20	9	27	16	11	21	19	17	18	20	16	21	22
MrUnskLab	9	1	5	2	3	5	10	3	2	1	2	1	3	3	2	4	4	3	3	4	3	4	5
MrSkillLab	34	23	34	17	25	35	67	32	23	16	24	14	60	23	16	29	29	27	29	31	21	30	29
MrUPrpPrfH	28	24	20	10	14	18	29	17	12	7	14	7	25	56	50	18	31	15	15	17	13	18	18
MrUNPrGov	16	11	16	8	11	16	31	15	11	7	11	6	27	11	7	24	58	13	13	14	10	14	13
MrULabH	6	4	6	3	4	6	11	5	4	2	4	2	9	4	3	20	19	4	5	5	4	5	5
MrRFarmH	23	15	15	6	10	14	19	11	8	5	9	4	17	67	30	13	19	11	11	13	10	13	14
MrRNAgWkrH	4	2	3	1	2	3	6	3	2	1	2	1	5	2	1	18	9	2	2	3	2	3	3
MrRAgWkrH	11	4	8	4	5	8	16	6	5	3	4	3	11	5	4	71	21	6	6	18	5	26	7
MrCorpor	33	46	24	15	16	18	34	24	15	10	20	9	27	16	111	21	19	17	18	20	16	21	22

The injections and leakages matrices have been reproduced in Table 3-10, with the latter transposed.

The values reproduced in columns 1 to 5 are averages of the respective row of the multiplier matrix N_1 weighted by the expenditure shares of the exogenous accounts. They can be interpreted as the aggregate effect on the income of a particular row of one dollar injection from an exogenous account, holding its expenditure composition constant. Those in columns 6 to 13 measure how one[76] unit leakage is spent by endogenous accounts, holding the expenditure composition on exogenous accounts constant.

Domestic injections (columns 1 and 2) produce comparable multiplier effects on French and Moroccan activities and other accounts (factors and households). Services exhibit the highest values in both countries. Capital goods and other durables are also important for France, while agriculture, mining, and food products register significant effects in Morocco[77]. Corporate capital, skill labour and urban households seems to be the most responsive among factors and institutions.

More interesting differences emerge when foreign demand injection (columns 3 to 5) are inspected. Clearly, France has important linkages via its exports to the European Community and with a diminishing intensity to the remaining European countries and the rest of the world. It can also be noticed that its strongest interdependencies are for services and durables with multipliers averaging 50 cents. Moroccan export dependency is primarily from France and this explains the very low values presented in the Moroccan part of columns 3, 4 and 5.

As far as domestic leakages (columns 6 to 10) are concerned, direct taxes (column 6 and household rows) appear to have higher leakage values in France, savings (column 7 and household rows) are more significant in Morocco, indirect taxes (column 8 and activity rows) are more evenly distributed across sectors in France, tariffs are clearly important in Morocco and finally commercial margins record similar effects across the two countries.

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[76] Notice that since N_1 takes into account only intra-country effects, the leakages total values, shown in column 14, differ from 100 in several cases.

[77] It should be reminded that for both countries government expenditures are mostly concentrated on the service sector and investment demand on capital good sector. This coupled with the fixed composition assumption partly explains the multipliers result.

Foreign leakages show a similar pattern to the corresponding injections. It should be added that France displays maximum values for durables, demonstrating the inter-industry character of its international trade and, as already stated, Moroccan import dependency is strongest for capital goods[78].

The above observations are clearly summarised by the bottom part of Table 3-10, where simple means (M) and standard deviations (SD) are shown for the two countries activities, factors and households accounts.

Inter-country N_2 multipliers account for the effects of an increase in the exogenous demand in country 1 on incomes of country 2. Their value basically depends on the magnitude of the elements in matrix **C**, that is the pattern of bilateral trade, remittances and other transfers.

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[78] What has been said for Moroccan exports to France, should be repeated for imports and it should also explain why total values are below 100 as explained in footnote 76.

Table 3-10: N_1 Injections and leakages matrices (cents per dollar)

	Injections					Leakages								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
	Gov	**CapAc**	**EC**	**ROE**	**ROW**	**Gov**	**CapAc**	**IdTax**	**Tar**	**CmMg**	**EC**	**ROE**	**ROW**	**Tot**
FrAgricult	4	2	14	12	7	18	25	9	0	32	8	1	6	100
FrMining	4	3	10	7	9	10	9	29	0	21	11	3	17	100
FrFoodPr	6	4	14	10	10	17	19	12	0	35	10	1	6	100
FrBevTobac	2	1	4	3	6	14	17	21	0	37	7	0	3	100
FrTextile	0	0	2	1	1	19	17	10	0	14	28	1	10	99
FrApparel	2	2	6	6	6	13	11	16	1	40	11	1	6	100
FrLeather	0	0	1	1	2	12	10	17	1	45	9	0	5	100
FrWoodNMetal	6	4	13	8	11	20	19	14	0	27	12	1	7	100
FrMetalProd	2	3	13	10	12	23	20	12	0	17	19	1	7	100
FrCapGood	5	12	41	35	47	20	17	15	0	23	16	1	8	100
FrChem	3	3	20	18	19	18	17	12	0	25	20	1	8	100
FrOthManuf	1	1	2	1	4	13	11	17	0	47	6	0	4	100
FrServices	79	48	63	49	60	30	28	17	0	8	10	1	6	100
FrSmallCap	3	2	3	2	3	47	50	1	0	1	1	0	0	100
FrCorpCap	19	13	27	21	24	30	53	4	0	5	5	0	3	100
FrUnskLab	7	6	15	12	14	40	23	9	0	11	10	1	6	99
FrSkillLab	24	16	29	23	29	40	23	9	0	11	10	1	6	100
FrUPrpPrfH	20	18	21	16	20	42	28	7	0	8	8	0	5	100
FrUNPrGov	15	8	13	10	12	40	21	10	0	11	10	1	6	100
FrULabH	18	7	13	10	13	38	21	10	0	12	11	1	6	99
FrRFarmH	5	5	5	4	5	37	40	5	0	7	6	0	4	100
FrRNAgWkrH	11	6	9	7	8	39	24	9	0	11	10	1	6	100
FrRAgWkrH	0	0	0	0	0	29	21	7	0	10	9	1	5	83
MrAgricult	18	10	0	1	0	9	25	11	6	31	4	2	7	95
MrMining	7	8	0	2	0	10	21	7	24	14	3	3	13	96
MrFoodPr	9	7	0	0	0	7	18	12	9	27	7	3	11	94
MrBevTobac	3	4	0	0	0	4	9	50	5	23	2	1	3	98
MrTextile	2	2	0	0	0	5	13	9	15	33	11	2	8	96
MrApparel	2	2	0	0	0	6	17	9	10	33	6	2	12	96
MrLeather	3	7	0	0	0	10	28	23	5	14	4	2	7	95
MrWoodNMetal	8	13	0	0	0	6	16	15	13	23	7	5	8	94
MrMetalProd	4	10	0	0	0	4	11	11	21	25	12	3	7	94
MrCapGood	2	28	0	0	0	3	7	7	28	29	8	3	6	91
MrChem	6	8	0	1	1	5	13	9	17	29	10	4	8	94
MrOthManuf	0	1	0	0	0	2	6	5	20	48	5	1	7	96
MrServices	79	81	1	2	1	8	24	21	7	14	5	3	10	93
MrSmallCap	6	5	0	0	0	11	40	9	5	15	5	2	8	95
MrCorpCap	14	16	0	1	0	22	42	6	3	10	3	2	5	95
MrUnskLab	2	2	0	0	0	9	29	11	6	20	6	3	10	94
MrSkillLab	30	33	0	1	0	9	34	11	6	16	6	3	9	94
MrUPrpPrfH	13	14	0	1	0	10	37	10	5	15	5	3	9	94
MrUNPrGov	14	15	0	0	0	9	34	11	6	15	6	3	9	94
MrULabH	10	5	0	0	0	9	30	11	6	18	6	3	10	94
MrRFarmH	9	9	0	0	0	11	44	8	5	15	5	2	7	96
MrRNAgWkrH	2	2	0	0	0	9	28	11	6	20	7	3	10	94
MrRAgWkrH	12	6	0	0	0	9	29	10	6	21	6	3	10	94
FrAct - M	9	6	16	12	15	17	17	16	0	28	13	1	7	
FrAct - SD	21	13	18	14	18	5	6	5	0	12	6	1	4	
MrAct - M	11	14	0	1	0	6	16	15	14	26	7	2	8	
MrAct - SD	21	21	0	1	0	3	7	12	8	9	3	1	3	
FrFact - M	14	9	18	15	18	39	37	6	0	7	6	0	4	
FrFact - SD	10	6	12	10	11	7	16	4	0	5	4	0	3	
MrFact - M	13	14	0	1	0	13	36	9	5	15	5	2	8	
MrFact - SD	13	14	0	0	0	6	6	2	1	4	1	1	2	
FrHH - M	12	7	10	8	10	38	26	8	0	10	9	1	5	
FrHH - SD	8	6	7	6	7	4	7	2	0	2	2	0	1	
MrHH - M	10	8	0	0	0	9	34	10	6	17	6	3	9	
MrHH - SD	4	5	0	0	0	1	6	1	1	3	1	0	1	

Table 3-11 shows the maximum values of the N_2 multiplier matrix.[79] The first column records income variations accrued to French sectors and other accounts from an expansion of Moroccan demand, the second column shows the reverse relationship: Moroccan income growth due to higher French demand (by one unit). The maximum values shown in columns 1 and 2 are calculated for injections only in the activities accounts. The stronger dependency of Morocco on France is clearly shown by the difference in the size of the multipliers in the two columns. The highest degree of interdependency is registered for textiles, apparel and durable goods, confirming the conclusion of section 3.2. Column 3 of the table presents instead the maximum value for Moroccan multipliers obtained from all possible French injections. It should be noticed that almost invariably they are derived from injections in French rural agricultural worker households.

Columns 2 and 3, while they do not differ in their distribution across rows, diverge in the size of the effect and this is due to the remittances of Moroccan workers[80].

The highest multiplier values for French factors of production and households originate from Moroccan capital goods exogenous demand, whereas the maximum effect on Moroccan incomes is obtained from French injections in the textile and apparel sectors, another confirmation of the relative specialization of the two countries.

[79] This is done for brevity, the other elements of matrix N_2 will be considered below when commenting on *version 3* of the SAM.

[80] In fact, in the French-Moroccan SAM these remittances are classified as transfers from French to Moroccan households, with their highest relative values in the rural agricultural worker household category. Notice the advantage of dealing with SAMs: within a simple input-output multiplier analysis it would have not been possible to calculate column 3 much higher values.

__Table 3-11: Inter-country N_2 Multipliers (cents per dollar of new demand) - Version 2__

	Fr.Mor *1*	Mor.Fr *2*	Mor.Fr* *3*
Agricult	2.09	0.31	10.25
Mining	0.65	0.09	1.76
FoodPr	0.94	0.10	4.66
BevTobac	0.18	0.01	0.64
Textile	0.89	0.27	0.78
Apparel	0.70	0.34	1.11
Leather	0.73	0.24	0.83
WoodNMetal	2.65	0.03	1.28
MetalProd	4.28	0.02	0.77
CapGood	8.28	0.02	0.43
Chem	3.60	0.10	1.84
OthManuf	0.11	0.00	0.13
Services	4.92	0.22	7.63
SmallCap	0.23	0.07	2.00
CorpCap	2.22	0.12	3.65
UnskLab	1.56	0.03	0.81
SkillLab	2.90	0.16	4.86
UPrpPrfH	1.94	0.11	3.10
UNPrGov	1.28	0.08	2.26
ULabH	1.32	0.14	0.88
RFarmH	0.44	0.08	2.34
RNAgWkrH	0.87	0.02	0.45
RAgWkrH	0.02	0.09	17.88
Corpor	2.90	0.12	3.65

Finally an analysis of income distribution can be illustrated from Table 3-12 below. This shows how exogenous demand, via trade linkages between the partner-countries, affects in quite different ways the factoral and household incomes in the two countries. Injections into Moroccan activities lead to enhanced French income for corporate capital, skilled labour and urban proprietor and professional households, with the remaining factors and households weighting half or below the maxima. The reverse, i.e. injections in French activities, generates its strongest effects on Moroccan corporate capital, skilled labour and urban labour households. Notice also though that urban proprietors and professionals, urban government employees, rural agriculture workers, farmers and small capital in Morocco enjoy generally higher multipliers than in France. This seems to suggest that expanding its particular trade linkages with France, Morocco may expect beneficial effects on its income distribution.

Table 3-12: N_2 Multipliers as a percentage of their column maxima (version 2)

	Agri	Min	Food	BvTb	Text	App	Leath	WNM	Met	CapG	Chem	OthM	Serv
FrSmallCap	10	12	8	10	9	9	10	9	10	8	10	9	10
FrCorpCap	93	85	100	96	99	94	90	87	85	76	84	84	84
FrUnskLab	52	50	45	53	58	56	53	56	65	54	49	58	51
FrSkillLab	100	100	79	100	100	100	100	100	100	100	100	100	100
FrUPrpPrfH	80	81	71	80	80	78	79	75	74	67	71	72	73
FrUNPrGov	47	46	38	47	48	48	49	46	48	44	44	46	46
FrULabH	45	45	37	46	47	47	46	46	49	46	44	47	45
FrRFarmH	20	19	20	20	20	19	19	18	17	15	17	17	17
FrRNAgWkrH	31	31	26	31	32	32	31	31	33	30	29	31	30
FrRAgWkrH	1	1	1	1	1	1	1	1	1	1	1	1	1
MrSmallCap	36	27	42	30	41	35	23	28	25	26	29	27	25
MrCorpCap	72	100	75	60	75	58	57	55	53	52	66	54	48
MrUnskLab	15	11	17	13	17	14	15	12	10	10	12	11	10
MrSkillLab	100	96	100	87	100	100	100	82	75	79	93	79	73
MrUPrpPrfH	60	67	64	51	64	54	49	47	44	45	54	46	41
MrUNPrGov	46	44	46	40	46	46	46	38	35	37	43	37	34
MrULabH	85	93	82	100	69	54	55	100	100	100	100	100	100
MrRFarmH	44	45	48	38	48	40	34	35	32	33	38	34	30
MrRNAgWkrH	17	15	16	17	14	13	13	16	15	15	16	16	14
MrRAgWkrH	79	65	69	79	57	47	48	72	72	69	71	71	67

This is further stressed when injections directly from factors or households are taken into account. In fact, Table 3-13 reverts the results of the corresponding Table 3-8 calculated for N_1.

Table 3-13: Factor-to-Households standard deviations of N_2 multiplier(SD)

	SmallCap	CorpCap	UnskLab	SkillLab
SD urb Fr	0.26	0.27	0.27	0.26
SD urb Mr	0.00	0.01	0.09	0.11
SD rur Fr	0.19	0.15	0.23	0.24
SD rur Mr	0.01	0.02	0.08	0.06

SAM multipliers share sensitivity: versions 2 and 3 compared

The main advantage of *version 3* over *version 2* consists in estimating partner-country imports tables directly from the original SAM with the simple procedure described in section 3.4.1, that is with no need for new data. It is of interest to assess the validity of this short-cut method by measuring the differences in the N_1 and N_2 multipliers derived from these two versions.

Table 3-14 displays percentage differences in the N_1 *intra*-country multipliers only for the production accounts. From this table it is possible to get a measure of the distortions in the multipliers when these are actually calculated from gross "domestic" IO tables. The convention is that a negative entry corresponds to a larger multiplier in *version 3*. In the case of France, it is possible to note how higher *version 3* $\mathbf{N}_1$ multipliers coincide with the mining, textile, apparel and chemical sectors. This can be easily explained by noticing that intermediate imports are especially concentrated in these sectors, therefore an injection in one of them will exert different effects in *versions 2* and *3* of the SAM. In particular, *version 3* over-estimates the domestic income effects derived from positive exogenous shocks whereas part of the effect in fact leaks out through greater imports, while this is properly taken into account in *version 2*. The reverse is true for agriculture and also in part for the beverage and tobacco sector. In the case of Morocco, *version 3* over-estimation is particularly intense for the capital goods sectors (consider both the row and the column), proving once more its import dependency, whereas some degree of under-estimation is recorded for the textile and apparel sectors. Table 3-14's main feature is its concise evaluation of the distortions created in the inter-industry linkages when these are not derived from a proper domestic IO table (as version 2). A special version of this same table was calculated from a modified *version 3*, which included domestic and non-partner country imported goods. Interestingly the French portion of the table recorded values very close to zero proving that its inter-industry linkages were almost unaltered, whereas the differences in the Moroccan multipliers only marginally diminished in absolute values. This confirms once more the Moroccan dependency on France.

Larger differences are shown in Table 3-15. These result from the discrepancies in the treatment of bilateral trade in SAM_2 and SAM_3 and correctly accounted for by the *inter-*country $\mathbf{N}_2$ multipliers. The different impact of external shocks requires a separate analysis for the two countries.

The case of income effects on French sectors due to an increase in Moroccan final demand is displayed in the upper part of Table 3-15. Here, a basic characteristic is the concentration of the highest positive entries along the capital goods column. Notice that *version 3* under-estimates (by slightly less than 25% on average) the effects of an injection from Moroccan capital goods also for French factors and households.

Table 3-14: N_1 intra-country multipliers (% Differences : Version 2- Version 3)

	Agri	Min	Food	BvTb	Text	App	Leath	WNM	Met	CapG	Chem	OthM	Serv
FrAgricult	8	-16	3	3	-63	-21	-9	-3	-2	-2	-13	0	0
FrMining	5	-75	9	11	-7	6	5	4	-12	-6	-11	-12	2
FrFoodPr	-1	-15	-10	1	-26	-9	-14	-2	-1	-2	-9	0	0
FrBevTobac	1	-15	1	-17	-15	-3	-3	-1	-1	-2	-5	2	0
FrTextile	1	-10	3	6	-50	1	20	8	4	3	-3	17	4
FrApparel	-1	-14	0	3	-4	-29	9	-7	0	-1	-1	10	0
FrLeather	4	-13	2	3	-13	-15	-36	7	0	-1	-6	3	0
FrWoodNMetal	2	-14	5	-3	-9	0	2	-12	0	-2	-10	7	1
FrMetalProd	7	-4	5	9	-16	8	11	6	-9	-3	-4	-2	1
FrCapGood	14	-8	4	6	-14	-1	-1	-3	7	-5	-1	3	1
FrChem	-8	-3	-2	1	-44	-6	-11	7	7	0	-42	8	6
FrOthManuf	-4	-14	-1	10	-14	-2	0	1	-2	-2	-8	3	0
FrServices	1	-17	0	0	-13	-3	-2	-1	-2	-3	-8	2	-1
MrAgricult	-1	1	-9	-1	-6	0	1	-1	1	-4	0	-1	1
MrMining	-1	0	5	3	1	-2	-11	7	8	-2	10	-1	3
MrFoodPr	-2	1	-13	0	4	4	1	-1	1	-5	-1	-1	1
MrBevTobac	-2	-1	-5	0	3	3	-2	-2	0	-5	0	-3	2
MrTextile	-4	-6	-6	-2	17	19	-6	14	3	-8	-18	-5	3
MrApparel	-1	-1	-5	0	9	10	0	1	1	-5	-3	-2	0
MrLeather	-2	-2	-6	-1	5	4	3	-1	-1	-6	-1	-5	0
MrWoodNMetal	0	1	-3	-1	5	6	1	-18	-1	-5	-4	-3	-1
MrMetalProd	5	12	8	14	12	11	3	11	-1	-5	10	5	5
MrCapGood	-17	-3	-13	-1	-11	-8	-9	-14	-1	-40	-11	-9	-30
MrChem	3	4	2	2	0	6	2	4	2	-11	-16	-14	2
MrOthManuf	4	4	-1	4	8	8	5	2	4	-2	3	0	1
MrServices	0	0	-3	1	4	5	0	-2	0	-5	-1	-2	0

Similar observations could be made for other durable sectors and chemicals. Considering injections directly into Moroccan households in the last 6 columns, over-estimation is registered for agriculture[81], mining and other manufactures, and under-estimation for textiles, leather products, capital goods and services. Viewing the second panel of the table, overall, Moroccan household inter-dependency with French households and factors is under-estimated by *version 3* with a decreasing intensity proportional to the household income.

Moroccan sectors' income effects due to changes in French final demand are especially under-estimated for the cases of textile, apparel and leather, whereas slightly higher multipliers are found in *version 3* for agriculture. Factors and households injections display a rather uniform low over-estimation.

As already noticed, the strongest *inter*-country multiplier effects accrue to French incomes from Moroccan injections and it is therefore interesting to further inspect their distortions in *version 3*.

[81] This is reported because agriculture is a sensitive sector. Apparently, examination of *version 3* (with estimated import tables) will suggest stronger effects on French agriculture.

Table 3-16 offers a qualitative analysis of the divergence of the N_2 multipliers in the two versions. The first 10 columns of the table show the multipliers as a percentage of their own column maxima. This provides evidence of the effects on the ranking and distribution of income for a given injection to each account. Although some variations are registered, it is remarkable that only for two inflows, namely labour and household accounts, the maximum multiplier changes its position. It is also significant that 63% of the cells show values slightly greater in *version 3* (of about 4% on average) and that, as shown by the standard deviation figures, dispersion is not affected.

The figures in the leftmost columns represent multipliers as percentages of their own row maxima and give an indication of the order and distribution of income effects for each account across sources of injection. Once again only in two cases, for food-beverages-tobacco and capital accounts, there is a shift in the maximum, and dispersion remains almost constant. On average 68% of the entries display a value 10% greater in *version 3*.

It is worth noticing that Table 3-16 result holds also for more disaggregated versions of the SAM, in the case of French injections to Moroccan accounts and for the N_1 *intra*-country multiplier.

3.5 Conclusion

As stated at the outset of this chapter a thorough quantitative analysis of the regional interdependencies in the Mediterranean area needs to be based on a detailed and updated SAM. This can also provide indispensable data used in the calibration of CGE simulation models. Most previous analyses, with few exceptions, have focused on the North American area. Considering the advantages of starting the analysis of the Mediterranean regional economic integration from two exemplar economies, this paper offers a new Mediterranean SAM for France and Morocco for 1990. A comparative examination of this SAM with a similar one built for NAFTA is carried out and some common characteristics are outlined, especially the much higher dependency of the developing partners on the more advanced regional group.

The more interesting results of this chapter are found in the second part where a fixed-price multiplier model is constructed. In an effort to detect the connection between data and models, the multiplier analysis is used to highlight some crucial structural features of the economies under study and to carry out a special case of share sensitivity analysis. The results of the share sensitivity analysis are then used to assess the effort of gathering data-intensive full import input-output matrices. I conclude that these tables can be actually estimated from the original gross domestic input-output table with alternative proposed methods without great loss of information, especially in the case in which, at least, imports flows can be distinguished between intermediate and final demand goods. This is inferred from the observation that the described changes in SAM accounting framework induce only modest variations in the multipliers. In the case of France and Morocco, this conclusion may be extended to a CGE model in the sense that results should not be too sensitive to share parameters in the relevant import demand functions.

Table 3-15: N, inter-country multipliers (% Differences : Version 2- Version 3)

	Agri	Min	Food	BvTb	Text	App	Leath	WNM	Met	CapG	Chem	OthM	Serv	SmK	CrpK	UL	SL	UPP	UPG	UL	RF	RNA	RAL
FrAgricult	2	-9	90	9	63	19	-12	0	-5	10	0	-1	-5	-10	-8	-11	-8	-6	-5	-8	-13	-12	-13
FrMining	-6	-13	-11	-10	-5	-4	-3	-15	-13	9	-16	-7	-7	1	2	0	2	3	3	1	0	2	0
FrFoodPr	7	-4	61	1	-5	-9	-13	1	-1	19	9	6	0	-1	0	-2	0	1	2	-1	-3	-2	-3
FrBevTobac	6	2	5	104	-2	-1	2	5	1	23	17	17	2	13	12	11	13	14	14	14	10	11	10
FrTextile	15	19	7	13	-32	-35	17	-18	5	16	22	8	7	23	23	22	24	25	25	24	20	21	21
FrApparel	1	2	-1	2	-34	-31	-1	-4	1	18	6	6	3	5	5	5	5	6	6	5	4	5	5
FrLeather	35	43	24	24	4	-19	-58	-37	15	24	-14	16	0	69	65	72	67	64	63	67	73	73	75
FrWoodNMetal	0	-2	-1	5	-4	-4	-5	69	4	15	12	11	3	1	1	0	2	2	2	1	0	0	0
FrMetalProd	-8	-16	-17	-20	-8	-8	-9	-22	0	9	-9	-9	-5	-7	-6	-7	-6	-6	-6	-7	-7	-7	-7
FrCapGood	14	3	7	3	11	10	8	10	4	37	13	9	26	9	9	8	9	10	10	9	7	8	7
FrChem	-11	-13	-16	-7	0	-5	-10	-16	-5	16	25	33	-6	-7	-6	-6	-6	-7	-6	-7	-6	-6	-7
FrOthManuf	-22	-21	-17	-17	-18	-20	-25	-11	-9	10	-7	-1	-6	-24	-23	-25	-24	-23	-23	-24	-25	-25	-26
FrServices	5	1	0	-2	-8	-5	5	4	1	21	9	10	7	15	16	13	18	20	22	17	10	13	10
MrAgricult	-30	-4	-14	-9	88	31	16	0	-2	-1	-1	0	0	0	0	0	0	0	-1	0	-1	-1	1
MrMining	-7	80	-3	-12	22	18	9	-7	-1	-3	12	3	-6	-10	-9	-10	-10	-8	-9	-10	-9	-11	-12
MrFoodPr	-1	-5	25	-5	29	26	29	-1	-3	-2	-3	1	-1	-1	-2	-1	-1	-2	-2	-1	-3	-2	0
MrBevTobac	-12	-1	-6	44	23	27	15	-3	-4	-1	-5	-3	-1	-3	-3	-3	-3	-3	-3	-2	-3	-3	-3
MrTextile	12	-4	9	4	68	61	-11	19	6	8	-7	-6	10	10	12	8	9	14	14	5	14	12	-6
MrApparel	3	-13	1	-6	-8	69	-23	10	-4	-3	-19	-18	0	0	0	0	0	0	0	-1	0	0	-1
MrLeather	-7	-9	-4	-6	11	36	71	-9	-4	-1	-4	-4	-1	-2	-2	-2	-2	-1	-1	-3	-1	-2	-4
MrWoodNMetal	-11	4	-4	-4	29	30	16	12	-2	2	2	-4	1	-1	-1	-1	-1	-2	-2	-1	-2	-1	0
MrMetalProd	-5	10	7	-1	36	37	21	4	5	6	6	3	4	2	2	2	2	2	2	2	3	2	1
MrCapGood	-24	-19	-14	-16	2	6	2	-8	-18	4	-17	-6	-10	-9	-9	-9	-9	-9	-9	-10	-9	-9	-8
MrChem	4	-13	4	-8	40	31	26	-5	-6	4	46	10	-3	-3	-5	-3	-3	-6	-7	-2	-6	-5	0
MrOthManuf	-4	1	0	-5	24	31	20	2	2	3	0	2	4	4	3	4	4	3	3	4	3	3	4
MrServices	-11	6	-3	-6	32	32	16	-2	-3	4	1	-3	2	-2	-3	-2	-2	-3	-3	-2	-3	-2	-1
FrSmallCap	3	-4	-2	-3	-5	-3	4	0	-1	20	5	8	5	12	13	10	15	17	18	14	7	10	7
FrCorpCap	3	-3	24	2	0	-5	-6	8	0	23	11	9	5	5	6	3	7	9	10	6	1	3	1
FrUnskLab	2	-4	6	-1	-12	-13	-15	10	0	24	11	5	5	5	6	4	6	7	8	6	2	4	3
FrSkillLab	3	-2	0	-2	-9	-8	-2	7	0	25	11	10	7	9	10	8	11	13	14	11	6	8	6
FrUPrpPrfH	3	-2	11	0	-5	-7	-6	7	0	23	11	8	5	6	5	4	8	8	10	7	3	5	2
FrUNPrGov	3	-2	3	-2	-9	-9	-6	7	0	24	11	8	6	7	8	6	8	10	9	8	4	6	4
FrULabH	3	-2	2	-2	-10	-10	-7	8	0	24	11	8	6	8	9	6	10	11	12	9	5	6	4
FrRFarmH	2	-3	21	2	0	-5	-5	7	0	23	11	9	5	5	4	3	7	8	9	6	1	3	1
FrRNAgWkrH	3	-3	4	-1	-10	-10	-9	8	0	24	11	7	6	7	7	5	8	10	11	8	4	6	4
FrRAgWkrH	3	-2	6	-1	-9	-9	-8	8	0	24	11	7	6	6	6	5	8	10	10	8	3	5	3
MrSmallCap	-23	-3	-10	-8	64	46	15	1	-2	0	-3	-4	1	0	0	0	0	0	-1	-1	-1	-1	0
MrCorpCap	-18	31	-8	-7	51	38	27	-1	-2	0	4	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-3	-2
MrUnskLab	-23	-4	-11	-7	64	46	33	1	-2	0	-3	-4	0	0	0	0	0	0	0	-1	-1	0	0
MrSkillLab	-13	6	-4	-6	39	44	31	0	-3	2	1	-4	1	-1	-1	-2	-2	-1	-2	-2	-2	-2	-1
MrUPrpPrfH	-18	18	-8	-7	51	42	26	0	-2	1	1	-3	0	-1	-1	-2	-2	-1	-2	-2	-2	-2	-1
MrUNPrGov	-13	6	-4	-6	40	44	31	0	-3	1	1	-4	1	-1	-1	-1	-1	-1	-2	-2	-2	-2	-1
MrULabH	-2	-13	-1	-1	-3	8	6	-2	-2	-1	-6	1	0	1	1	0	0	1	1	0	1	1	-1
MrRFarmH	-19	14	-8	-7	55	43	23	0	-2	0	0	-3	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
MrRNAgWkrH	-8	-6	-3	-3	17	26	19	-1	-2	-1	-4	-1	0	0	0	0	0	0	0	-1	0	0	-1
MrRAgWkrH	-5	-10	-2	-2	6	16	12	-1	-2	-1	-6	0	0	0	0	0	0	1	1	0	1	0	0

Table 3-16 N_2 Multipliers as percentage of their col and row maxima (only Mor inject. to Fr considered)

	N₂ as % of Col Max										N₂ as % of Row Max										
	AgMin	FoodB	TextAL	Durabl	OthMfg	Serv	Cap	Lab	HH	Corpor	AgMin	FoodB	TextAL	Durabl	OthMfg	Serv	Cap	Lab	HH	Corpor	SD
	True Import Version 2																				
FrAgrMin	43	77	38	13	27	23	35	37	37	28	50	100	44	49	49	59	47	62	61	41	17
FrFoodBT	21	32	19	8	14	14	20	21	21	16	59	100	54	71	63	83	65	84	84	59	15
FrTextAL	23	17	65	6	14	14	26	28	28	21	35	29	100	31	32	46	46	61	61	40	22
FrDurabl	96	88	76	100	61	100	82	87	87	65	31	32	24	100	30	70	30	40	40	26	24
FrOthMfg	42	45	42	18	100	32	40	42	43	31	28	33	27	37	100	46	30	39	39	26	22
FrServices	96	91	95	52	78	77	97	100	100	77	58	61	57	97	72	100	66	86	85	59	17
FrCap	46	51	45	26	40	36	43	45	45	34	57	71	55	100	75	96	61	79	79	54	17
FrLab	69	68	71	44	62	58	65	69	69	52	50	55	51	100	69	91	54	71	71	48	18
FrHH	100	100	100	59	85	80	100	98	98	83	54	60	54	100	71	94	62	76	75	57	16
FrCorpor	62	49	49	20	34	33	94	39	40	100	49	43	39	50	41	56	84	44	44	100	21
SD	30	27	26	29	30	30	31	29	29	29											
	Estim. Import Version 3																				
FrAgrMin	47	56	33	17	37	28	41	44	44	30	76	100	58	69	76	88	72	95	95	64	15
FrFoodBT	21	23	19	9	16	15	22	23	23	16	68	82	67	78	68	98	78	100	100	69	14
FrTextAL	21	17	96	8	16	15	23	25	26	17	20	18	100	20	20	29	25	33	33	22	25
FrDurabl	93	92	69	100	70	100	84	92	93	63	37	39	29	100	34	76	36	48	48	31	23
FrOthMfg	49	56	42	23	100	39	46	50	51	34	39	48	36	47	100	60	40	53	53	35	19
FrServices	93	94	89	58	89	82	89	94	95	67	59	65	60	94	70	100	61	79	79	55	15
FrCap	46	49	44	29	45	39	43	46	47	32	62	71	62	98	76	100	63	82	82	56	15
FrLab	68	70	72	48	68	61	64	70	70	48	56	62	62	100	70	97	57	76	75	51	17
FrHH	100	100	100	64	95	85	100	100	100	78	61	66	65	100	73	100	66	81	80	61	15
FrCorpor	63	49	47	23	39	36	99	42	42	100	49	42	39	45	38	54	84	43	43	100	21
SD	29	29	28	29	31	30	30	28	29	28											

3.6 Appendix A: Accounts classification

Sectoring scheme for France-Morocco SAM

Sectors

1 *Cereals*
Hard Wheat
Soft Wheat
Barley
Maize
Legumes
2 *IndCrops*
Sugar Beets
Oil Seeds
3 *VegFruit*
Vegetables
Fruit
4 *Livestock*
5 *OthAgri*
Other Agricultural Products
Forestry
Fishery
6 *MinEne*
Mining
Petroleum
Refined Products
7 *FoodPr*
Meat Processing
Dairy Products
Bakery
Grain Milling
Refined Sugar
Other Food Products
8 *Beverages*
9 *TobaccoPr*
10 *Textile*
11 *Apparel*
12 *Leather*
Leather Products
Shoes
13 *PaperWood*
Wood Products
Furniture
Paper Products
Printing and Publishing
14 *NonMetMinPr*
Construction Materials
Glass Products
15 *MetalProd*
Iron and Steel
Metal Products
16 *Machin*
Agriculture Machinery
Other Machinery
Electrical Machinery
17 *TranspEqp*
Motor Vehicles
Railroad Materials
Ship Building
Aircraft Building
18 *Chemicals*
Basic Chemicals
Pharmaceuticals
19 *Rubber*
Tire and Rubber Products
Plastic Products
20 *OthManuf*
21 *Constructn*
22 *Electricity*
23 *Commerce*
24 *TranspComm*
Transport
Communication
25 *FinanInsur*
Banking
Insurance
26 *OthService*
Other Services
Public Administration Serv.

Other Accounts: Factors and Households

1	SmallCap	Private Small Business Capital
2	CorpCap	Private and Public Large Corporate Capital
3	UnskLab	Unskilled (or low skilled) Wage Workers
4	SkillLab	Salaried & Independent Workers, Employers
1	UPrpPrfH	Urban Professional or Proprietor Household Head
2	UNPrGov	Urban Non Laborer Non Professional or Government employee Household Head
3	ULabH	Urban Laborer Head of Household
4	RFarmH	Rural Farmer or Non Agriculture Proprietor Head of Household
5	RNAgWkrH	Non Agriculture Worker Head of Household
6	RAgWkrH	Agriculture Worker Head of Household

3.7 Appendix B: SAM v. 3 - Destination of use of imported goods known

In order to derive *version 3* SAM in the special case where imports can be distinguished by their destination of use as imported intermediates or imported final demand goods the following calculations are necessary.

Define $\mathbf{j}_i$, the vector sum of intermediate deliveries as:

$\mathbf{j}_1 = \mathbf{S}_{11}\,\mathbf{i}$

$\mathbf{j}_2 = \mathbf{S}_{22}\,\mathbf{i}$

θ_i, the row normalized matrix of intermediates deliveries takes the form:

$\theta_1 = \hat{\mathbf{j}}_1^{-1}\,\mathbf{S}_{11}$

$\theta_2 = \hat{\mathbf{j}}_2^{-1}\,\mathbf{S}_{22}$

$\hat{\mathbf{m}}_{ij}^{*}$, the new imported IO tables are estimated from θ_i and the imported intermediates vector $\mathbf{m}_{ij}$ (that in this case is supposed to be *known*):

$\hat{\mathbf{m}}_{21}^{*} = \hat{\mathbf{m}}_{21}\,\theta_1$

$\hat{\mathbf{m}}_{12}^{*} = \hat{\mathbf{m}}_{12}\,\theta_2$

and finally $\mathbf{S}_{ii}^{*}$, the new domestic IO tables are derived as residuals:

$\mathbf{S}_{11}^{*} = \hat{\mathbf{j}}_1^{*}\,\theta_1$ with $\mathbf{j}_1^{*} = \mathbf{j}_1 - \mathbf{m}_{21}$

$\mathbf{S}_{22}^{*} = \hat{\mathbf{j}}_2^{*}\,\theta_2$ with $\mathbf{j}_2^{*} = \mathbf{j}_2 - \mathbf{m}_{12}$

In this special case of *version 3*, $\mathbf{f}_i^{*}$ and $\mathbf{x}_i^{*}$ are equal to the corresponding vectors of *version 2*.

4 A Mediterranean Social Accounting Matrix

4.1 Introduction

A Social Accounting Matrix is part of the benchmark data-set in the construction of the fix-price multiplier model of the previous chapter and in the calibration of the applied general equilibrium models presented in the subsequent chapters. Properties and advantages of SAMs for this purpose are well established in the recent literature on policy simulation modelling: they provide a comprehensive and consistent data foundation for policy analysis, as well as ensuring that the share parameters in behavioural functions reflect observed facts. Their usefulness has recently been reflected in the United Nations and joint agency new edition of the 1993 SNA manual on national accounts, which dedicates an entire chapter to SAMs.[82]

The next two sections detail the data sources and methods followed in the construction of the 1990 Moroccan SAM. As far as the French SAM is concerned, only the data sources are documented here. Two related facts suggested this choice of presentation. Firstly, for historical reasons, Moroccan and French statistical offices use the same standards and conventions and both countries' national accounts (one of the main sources for a SAM) which also follow the guidelines of the United Nations System of National Accounts (SNA), so describing the SAM construction for one country avoids unnecessary repetition. Secondly, Morocco was chosen because its data presented more serious deficiencies and inconsistencies and therefore required supplementary adjustment and estimation procedures.

The detailed description of the SAM construotion should allow us to assess the strengths (and weaknesses) of the empirical models built on these data. Moreover, although the process of SAM assembly cannot yet be entirely standardised, the methods described below are fairly general and can be considered as guidelines in the SAM construction procedure and in overcoming many of the most common obstacles.[83]

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[82] See S. Keuning (1994).

[83] Data inconsistencies and/or deficiencies are the most common problems and they usually become worse at high levels of disaggregation.

The development of good economy-wide data should be based on three main criteria: detail, consistency, and timeliness. Detail, in the context of CGE models, refers to sectoral and domestic institutional (e.g. household) classification. The more disaggregated a SAM one can construct, the more flexible its future uses are. Availability of transactions among a large number of sectors, factors of production and household types allows informative empirical analysis of trade policy, environmental impacts, income distribution and factor market adjustments. Different levels of aggregation may be needed according to the specific problem investigated. This suggests the construction of a fairly disaggregated Mediterranean SAM, even though the *complete* detail has not been used in the subsequent models. As long as the other two criteria are concerned, economywide consistency is achieved primarily by reconciling input-output transactions and household survey data with standard national macro accounting, and timeliness is achieved by choosing the latest year for which the majority of data are available.

Section 4.2 deals with the estimation of the full-blown 133-sector Input-Output table for Morocco, including references to all the data sources that were incorporated. Section 4.3 describes the extra steps necessary to obtain the complete SAM from the IO table, and the final section provides data sources for the French SAM.

4.2 Construction of the 1990 Moroccan Input-Output table

The general approach to assembling data for the IO table was hierarchical and sequential. When direct estimates were available from official sources, these were incorporated first. The second category of estimates includes updates of data from previous years. Finally, when data were missing or considered extremely unreliable, indirect estimation methods, such as share imputation and matrix balancing, were used. The use of these conventions is explicitly shown at each stage below.

The main source of information on the Moroccan industrial structure and linkages was the 1990 Input-Output table constructed by the Ministry of Industry.[84] This table was in turn based on a combination of contemporaneous official data and an inter-industry table compiled from source in 1980 by the Moroccan National Statistical Office

[84] Ministère du Commerce, de l'industrie et de la privatisation, Morocco (1993).

(MNSO).[85] The later table appears to have updated the 1980 one, combining 1990 final demand and value added data with the earlier intermediate table and using a matrix balancing procedure to produce a consistent table. Since these represent the most detailed official estimates of Input-Output accounts for a recent year, it has been chosen as the basis of the present, more detailed, table. The present table is consistent, by aggregation, with the latest official table.

The 1990 Ministry of Industry table contains 32 sectors. These include 7 sectors covering agriculture (an aggregate), mining (Phosphates, Non Metal Mineral, Metal Mineral, Crude Petroleum Products), and energy (Refined Petroleum Products, Electricity and Water). These are followed by 18 manufacturing sectors (Food Industry, Other Food Industry, Beverages and Tobacco, Textiles, Clothing, Leather and Shoes, Wood, Paper, Quarrying, Metal Industry, Metal Products, Machinery, Transport equipment, Electronic Products, Precision Instruments, Chemicals, Rubber, Other Manufactures). Service activities are decomposed into 8 activities (Construction, Commerce, Transport Services, Communication, Banking, Insurance, Other Services, and Public Administration).

The essence of the I-O table construction described here was to disaggregate this table to 133 activities. To do so it was necessary to rely on a variety of official domestic and international data sources. A special effort was made in the disaggregation to detail agricultural activities, which in the two previous tables had been represented only by one aggregate sector.[86] The result is a group of 23 sub-sectors, whose disaggregation is described below.

4.2.1 Disaggregation of Agriculture

The agricultural activities detailed in the 133-sector Input-Output table are presented in the table below. These sectors aggregate consistently to the figures for Gross Output, Trade, Domestic Demand, and Value Added for the corresponding single agriculture sector in the Ministry of Industry table. Direct information was available for most of the

[85] Ministère du Plan, Direction de la statistique, Morocco (1986).
[86] Another independent attempt to disaggregate Moroccan agriculture in an input-output framework is to be found in the estimates of Sadoulet reported in Mateus (1988). These have in turn been used by a variety of authors, including Martens *et al* (1990), and Rutherford, Rudstrom, and Tarr (1993).

final demand and value added components of the detailed agriculture sectors. This section describes how intermediate demands for the 23 sub-sectors were estimated.

Table 4-1: Agriculture sectors

1	Hard Wheat	7	Sugar Beets	13	Bersim	19	Other Fruit
2	Soft Wheat	8	Sugar Cane	14	Citrus	20	Other Agriculture
3	Barley	9	Oil Seeds	15	Olives	21	Livestock
4	Maize	10	Raw Fibre	16	Grapes	22	Forestry
5	Rice	11	Vegetables	17	Dates	23	Fishing
6	Legumes	12	Alfalfa	18	Almonds		

For simplicity, it is useful to distinguish the 133 sectors of the IO table in two categories: (1) Agriculture (Ag, the first 23 sectors) and (2) Non-Agriculture (N-Ag, all remaining sectors). The data available in the Ministry of Industry IO table are – considering the column – total purchases of Ag from Ag (a scalar) and from N-Ag (a vector of 32 elements), and – considering the row – total deliveries of Ag to Ag (the same scalar considered above) and deliveries of Ag to N-Ag. These data are clearly not sufficient to estimate the square (Ag x Ag) matrix of transactions within Agriculture and the two rectangular (Ag x N-Ag and N-Ag x Ag) matrices of transactions (deliveries and purchases) of agricultural sectors with the rest of the economy. A special study commissioned from FAO by the Ministry of Agriculture was used as an additional source of information.[87] This study considers the evolution of intermediate consumption for selected agricultural categories for the years 1969, 1975, 1980, 1985.[88] The relevant information and the estimation procedure used are shown in Table 4-2. The first column contains the broad categories covered by the FAO study, and in the second column are estimates for intermediate consumption. The third and the fourth columns show the disaggregation of column 2 obtained using output shares for the 23 sectors of the last column.[89] The fifth column represents updated intermediate demands estimated by using the shares of column 4 and the total value of 17,524 million Dh for agricultural output recorded in the Ministry of Industry table. The assumption underlying these estimates is

[87] FAO - Ministère de l'Agriculture, Morocco (1988).

[88] The agricultural sectors considered here are: Cereals, Legumes, Oil Seed, Industrial Crops, Tree Crops (Fruits), Vegetables, Forages, Livestock, Forestry and Fishing.

[89] As described below, the 23 sectoral gross output values were obtained directly from 1990 official statistics.

that intermediate demand is proportional to gross output and that the composition of the more aggregate (FAO) intermediate demands has not changed significantly since 1985.

Table 4-2: Agriculture Intermediate Demand -- (Millions of current Dh)

(1)	(2)	(3)	(4)		(5)
FAO sectors groups		Intermediate demand			1990 IO sectors
Years	1985	1985	1985	1990	
	10^6 Dh	10^6 Dh	shares	10^6 Dh	
		907	0.079	1383	Hard Wheat
		937	0.082	1429	Soft Wheat
		669	0.058	1020	Barley
		173	0.015	265	Maize
CEREALS	2716	2	0.000	3	Rice
LEGUMES	293	293	0.025	446	Legumes
		162	0.014	247	Sugar Beets
		40	0.003	61	Sugar Cane
OILSEEDS	24	24	0.002	36	Oil Seeds
INDUSTRIAL CROPS	232	30	0.003	45	Raw Fibre
VEGETABLES	855	855	0.074	1305	Vegetables
		72	0.006	109	Alfalfa
FORAGE	109	37	0.003	57	Bersim
		314	0.027	479	Citrus
		186	0.016	284	Olives
		72	0.006	110	Grapes
		130	0.011	199	Dates
		251	0.022	383	Almonds
TREE CROPS	1048	95	0.008	145	Other Fruit
		28	0.002	42	Other Agri
LIVESTOCK	5541	5541	0.482	8452	Livestock
FORESTRY	0	0	0.000	0	Forestry
FISHING	671	671	0.058	1024	Fishing
TOTAL	11489	11489	1.000	17524	

The next step was to disaggregate the values in column 5 (the total expenditures of Ag) among the Ag and N-Ag delivering sectors. The information contained in the FAO study treated delivering sectors at a relatively aggregated level, so it was necessary to use the basic data of the Ministry of Industry IO table. Production shares were again used to disaggregate the Ag sectors and then obtain agricultural intermediate consumption shares for the N-Ag sectors. The industrial sectors of the N-Ag group were further disaggregated from the original 18 to 96. To do this, output shares were used within each group. This allowed me to obtain both the square matrix Ag x Ag and the rectangular matrix Ag x N-Ag. Deliveries of Ag to N-Ag were obtained by disaggregating the row vector of the original IO table using Ag output shares.

The final result obtained by applying the methodology just described was not fully satisfactory for a number of reasons. Firstly, the Ag x Ag matrix presented some unrealistic linkages[90]. Secondly, the Input-Output technology implied by the above approach is very homogeneous across the Ag sectors. To overcome these problems two corrections were applied. Firstly, unrealistic linkages (e.g. Sugar to Wheat) were eliminated in the Ag x Ag matrix and, using FAO estimates of the feed/seed ratio, diagonal elements were corrected for the principal crops.[91] The second correction entailed modification of the Input-Output coefficients based on data for the same agricultural activities in other countries. The best available information in terms of agriculture detail and comparability of technology was found in IO tables estimated for Indonesia, Japan, and the United States.[92] To make these tables comparable to the Moroccan IO table, it was necessary to consistently aggregate the sectoring schemes of the other three tables. The simple average of three columns of Input-Output coefficients was then applied to Moroccan total intermediate expenditures for each of the 23 agricultural sectors.

4.2.2 Gross Output and Related Data Sources

This section describes the data sources and the estimation procedures applied to calculate Gross Output. Agricultural and non-agricultural sectors are considered separately.

For gross production in Agriculture, basic data for quantities and producer prices were obtained from official yearly survey of production and in a study conducted by the Ministry of Agriculture.[93] The first source reports data on areas, yield and quantities produced for all the crops in the new Input-Output table, the second document contains producer prices for Hard Wheat, Soft Wheat, Barley, Maize, Sugar Beets, Sugar Cane, Cotton (Raw Fibres) Oil Seeds. Since these data are not sufficient to estimate the production values for all 23 agricultural sub-sectors, it was necessary to obtain some

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[90] In the absence of direct information, this matrix was assumed to be diagonal for all crops except *Other Agriculture* and the remaining non zero elements represent linkages for *Livestock, Forestry* and *Fishing* with the rest of Agriculture.

[91] The FAO estimates are contained in the Agrostat Database of that Organisation.

[92] For the US IO table see K.A.Reinert and D.Roland-Holst (1992); for the Indonesia-Japan international IO table see Institute of Developing Economies (1992).

[93] Royaume du Maroc. Ministère de l'Agriculture (1992).

additional information. In particular, prices for Vegetables, Fruits, Legumes and Forages are derived using farm gate prices from of a World Bank irrigation project and FAO price estimates.[94] For the Fishery sector, production data were taken from the 1992 Statistical Yearbook.[95] The production values for Livestock and Forestry are estimated as the difference between total production of Agriculture (a value given by the Ministry of Industry IO table) and the sum of Fishery and Crops production. This residual value was then allocated among the two remaining sectors according to output shares calculated from the most recent figures available in the Moroccan National Accounts.[96]

The current estimates of gross production by the N-Ag sectors should distinguish between Industrial sectors, Mining and Energy sectors, and Service sectors. The main problem in calculating gross output for the Industrial sectors was to reconcile the disaggregated data (96 sectors) with that in the Ministry of Industry IO table (18 sectors). An additional problem was the treatment of production from the informal sector. Informal activity estimates are derived from a study conducted by the MNSO for the year 1988.[97] This study covers the urban informal activities of the Industrial sectors (only at the aggregate level of 18 sectors), Commerce and Services. The other sectors, mainly primary sectors and those linked to Public Administration, are excluded. Informal sector production was included in the original table and, for 1988, accounted as a whole for 11.5 per cent of GDP.[98] Since, at the 96-sector level of detail, the only data available were official figures of gross production,[99] the solution adopted for estimation of informal production was to assume that sub-sectors belonging to each of the 18 aggregate groups had informal activity proportional to their gross outputs, summing to the informal estimate for the whole subgroup. This assumption maintains consistency with the more aggregate table. A similar procedure was adopted for the service sectors.

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[94] Data concerning this project are taken from World Bank (1993). Note that for Forages it was also necessary to estimate production quantities from yield and area data. Finally, it is noteworthy that the project prices were usually quite close to the FAO estimates or to actual prices surveyed by the Ministry of Agriculture.

[95] See table 3.25 page 64 in Direction de la statistique (1992).

[96] See table 1.14 page 107 in Direction de la statistique (1988a).

[97] Direction de la statistique (1988b).

[98] See chapter II page 51 in Direction de la statistique (1988b).

[99] These data are contained in files made available by the Ministry of Foreign Trade under concession of the Ministry of Industry. The same data are available in the yearly survey of the Industrial sectors, see Ministry of Industry (1991).

4.2.3 International Trade

All the trade data used for constructing the disaggregated table come from trade statistics of the Ministry of Foreign Trade of Morocco.[100] The data were contained in text files and are organised by product. The available information includes: values (in local currency, FOB for imports, CIF for exports), country of origin/destination, import tariffs, import tariff exemptions.

The Ministry of Foreign Trade arranged these data following the same scheme as the Foreign Trade Yearbook published by the *Office des Changes*, so that there is exact matching between the two sources. This scheme consists of a six-digit product classification with 99 merchandise groups. The trade data were first aggregated into three regions: EEC, Europe non-EEC (ROEU) , Rest of the World (ROW). Then they were further aggregated into the Ag/N-Ag sectoring scheme described above. The first two regional groups were constituted as follows:

	EEC		Rest of Europe - Non-EEC
1	France	1	Iceland
2	U.E.B.L (Belgium and Luxembourg)	2	Norway
3	Netherlands	3	Sweden
4	Germany (RFA)	4	Finland
5	Italy	5	Switzerland
6	United Kingdom	6	Austria
7	Ireland	7	Gibraltar
8	Denmark	8	Malta
9	Portugal	9	Yugoslavia
10	Spain	10	Turkey
11	Greece	11	Andorra
		12	USSR
		13	Germany (RDA)
		14	Poland
		15	Czechoslovakia
		16	Hungary
		17	Romania
		18	Bulgaria
		19	Albania

N.B. EEC is composed of 11 countries only, because Belgium and Luxembourg are aggregated and it does not include the EFTA counties. West Germany is considered separately from East Germany, which is part of the ROEU region. USSR is part of ROEU.

The raw trade data were classified into almost 8,000 different products, and a bridge between the six-digit product classification and the 133-sector IO table's sectoring

[100] The only exception is imports and exports of Services.

scheme was devised to aggregate them. For the N-Ag sectors, this function was already available in a bridge table prepared by the Moroccan sources. For agriculture, it was necessary to build an original bridge between products and sectors.

4.2.4 Investment by Origin

The basic source for data on investment is the table of the National Accounts, reproduced below in its original format.[101]

Table 4-3: Investment (1990 million Dh)

Matériel et outillage	24.302
Bâtiment	15.542
Travaux publics	9.599
Aménagement et plantations	898
Bétail	662
Total	51.004

In constructing its 1990 Input-Output table, the Moroccan Ministry of Industry used these values in the following way. First, values for Plantations and Livestock are aggregated and allocated to Agriculture. Second, the values concerning Construction (*Bâtiment and Travaux Publics*) are again aggregated and allocated to the corresponding sector. Finally, the remaining 24,302 million Dhs are disaggregated among the 18 Industrial sectors. The disaggregation takes place in 2 steps. First, imports of capital goods are distinguished by sector. Second, the residual value is allocated among domestic suppliers. Relevant data on domestic production of capital goods are taken from the official yearly survey of the industrial sector.[102] For the new Input-Output table, this procedure was replicated at the 96-sector level.

For Agriculture, Investment was allocated to Livestock according to the value in the National accounts (*Bétail* 662.2) and to Other agriculture and Forestry according to output shares. The remaining values (*Travaux publics et Bâtiment*) were allocated to Construction.

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[101] See table 20.6 page 511 in Direction de la statistique, Morocco (1992).

[102] See pages 4 and 5 in Ministère du Commerce, de l'industrie et de la privatisation, Morocco (1993) and Direction de la statistique, Morocco (1988a).

4.2.5 Variation of Stocks

Estimation of the Variation of stocks is based on a variety of sources of information. For the Industrial sectors, basic data are found in the yearly survey.[103] For Agriculture, estimates are given by the *Office National Interprofessionnel des Céréales et des Légumineuses* (O.N.I.C.L.).[104] For Mining and the remaining sectors, relevant information is available from the Statistical Yearbook and the Input-Output study of the Ministry of Industry.[105] The estimates of variation of stocks for Agriculture are based on the same assumptions employed by the Ministry of Industry in constructing their table, namely that the Cereals and Legumes are the only sectors that keep stocks. The total Variation of stocks in Agriculture is then allocated among the Cereals and Legumes sub-sectors according to output shares. For the Industrial sectors, the variation of stocks was estimated at the detailed level, again applying a method employed by the Ministry of Industry, i.e. subtracting sales from production. This did not, however, result in estimates consistent with the data contained in the 32-sector Input-Output table. In order to reconcile the two different estimates, the detailed sub-sector estimates were normalised using the 18-sector values as control totals. For the informal sector, it was assumed that no stocks are kept. For the remaining primary and service sectors, data on Variation of stocks were taken directly from the Ministry of Industry table.

4.2.6 Trade Margins, Private Consumption and Government Demand

The Moroccan Ministry of Industry estimated trade margins from value added of the Commerce sector. For formal activities, value added was calculated from statistics of the MNSO and then corrected to take into account informal activity. For the new table, gross output shares were use to disaggregate the margin values in the Ministry of Industry Table.

Once Production, Imports, Custom Duties, Commercial Margins and Investment, Exports, Variation of Stocks are estimated, a residual value can be computed as the sum

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[103] Ministère du Commerce, de l'industrie et de la privatisation, Morocco (1992).
[104] See: Ministère du Commerce, de l'industrie et de la privatisation, Morocco (1993).
[105] See: Direction de la statistique, Morocco (1992) and Ministère du Commerce, de l'industrie et de la privatisation, Morocco (1993).

of private consumption, government consumption and intermediate consumption. In all Moroccan Input-Output tables, government consumption is not sectorally disaggregated, and in the absence of additional information the new table follows the same convention. Subtracting this from the residual value gives the sum of private consumption and intermediate consumption. Data on private consumption are available from two sources: a survey on household consumption[106] and official data for imports of consumer goods. Unfortunately, the information in these sources is not quite sufficient to estimate sectorally detailed private consumption. Therefore an estimation procedure was devised and applied to private consumption and total intermediate demand.

For Agriculture, data from the household survey are quite detailed and allow private consumption and intermediate demand to be estimated separately. The Survey on household consumption is the second extensive attempt of Moroccan authorities to measure domestic living standards, the first was undertaken in 1984-85. It contains data on rural and urban consumption patterns, size of households, head of household employment and other factors affecting consumption. The following expenditure categories are considered in detail: (1) Food and Beverages, (2) Clothes, (3) Housing and Energy, (4) Durable Goods, (5) Health Care, (6) Transport and Communication, (7) Education and Leisure, (8) Other Expenditures. To aggregate the products considered in the survey in a manner consistent with the IO table sectoring scheme, it was necessary to build another bridge. The estimates for private consumption and intermediate demand that are obtained in this way, however, are not consistent with the values contained in the Input-Output table. To reconcile the two, the RAS technique was used with control totals given by the sum of the values of intermediates demand and private consumption.[107]

For the Industrial sectors, the 18-sector values for intermediates and private consumption were used as control totals and further disaggregation was undertaken using the shares from the residual values as sub-sectoral weights and the shares between Intermediates and Consumption as weights to discriminate between these. For the remaining sectors - Mining, Energy, Services, and government Services - the data were taken directly from the Ministry of Industry table.

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[106] Direction de la statistique, Morocco 1992.
[107] For a survey of RAS and other matrix balancing methods, see Bacharach (1980).

4.2.7 Value Added

The main source of Value Added data was the Ministry of Industry Input-Output table whose relevant values are reproduced here in Table 4-4.

The values of this table are taken from the Moroccan National Accounts published by MNSO. Due to lack of detailed data on production subsidies and social costs, these were included in indirect taxes and wages, respectively.[108] Various adjustments were made to the values of this table. Since in the new Input-Output table Agriculture is composed by 23 sub-sectors, it was necessary to disaggregate the values in the above table. Value added was allocated to the agricultural sub-sectors according to output shares. This was then decomposed into labour and capital payments and indirect taxes according to their respective shares for total Agriculture. But this was not entirely satisfactory, since it implied the same factor intensities throughout agriculture. Once again this inconvenience was overcome by borrowing data from other countries. In practice a simple average of factors payments and indirect taxes shares of US, Japan and Indonesia was adopted for Morocco. To correct the resulting excessive capital intense technology, that simple average was normalised using the Moroccan shares of aggregate agriculture.

For the Industrial sectors, the adjustment implied using estimates of value added derived from the official yearly industrial survey. This includes the full 96-sector disaggregated level of the new IO table and useful data on employment, indirect taxes, and capital value added. For the remaining sectors (Mining and Energy and Services), the value added estimates and its decomposition are taken from the Ministry of Industry Input-Output table.

[108]See page 5 in Ministère du Commerce, de l'industrie et de la privatisation, Morocco (1993)

Table 4-4: Value Added Decomposition (million Dh)

	VALUE ADDED	WAGE	IND TAXES	CAPITAL
Agriculture	35870	9623	1780	24466
Phosphates	4494	1489	310	2695
Autres Minér Non Mét	203	67	14	122
Minéraux Métall.	656	478	40	138
Combust Sol et Pétr Brut	304	202	4	97
Pétrole Raffiné	6678	179	184	6314
Électricité et Eau	6086	1582	1217	3286
Industries Alimentaires	1595	913	303	379
Autres Ind Alimentaires	3234	1851	614	769
Boisson Et Tabacs	5324	619	4003	702
Textiles et Bonneterie	2905	1306	429	1168
Habillement	3770	2255	173	1342
Cuirs et chaussures	7401	4257	1242	1902
Articles en bois	1687	826	333	527
Papier et carton	1312	612	249	450
Matériaux de carrière	3272	929	948	1394
Industrie métallique	761	489	179	92
Ouvrages en métaux	1669	666	324	678
Construction de machines	533	318	99	115
Matériel de transport	1177	479	379	317
Matériel électrique	1109	502	249	357
Instuments de précision	58	32	13	13
Chimie para-chimie	3441	1611	673	1156
Plastique et caoutchouc	861	375	216	269
Autres industries	155	88	18	48
Bâtiment.Travaux Publics	11489	7391	2160	1937
Commerce	24095	9536	7473	7084
Transport	10553	5276	1899	3377
Communication	3574	1107	784	1683
Institution De crédit	6896	2895	292	3708
Assurances	33	253	37	-257
Autres Serv Marchands	25199	13999	6108	5090
Serv n march des admin	25341	25279	14	48
TOTAL	201751	97497	32773	71480

4.3 A 1990 Social Accounting Matrix for Morocco

This section describes the methodology employed in building a 1990 SAM for Morocco. The starting point is the input-output table described in the previous section 4.2. That table details economic transactions among 133 sectors (intermediate demands), sectors and factors of production (Labour and Capital), sectors and institutions (final demand, import demand). In order to build a SAM from an IO table it is necessary to take into account a variety of other transactions, so that the complete circular flow of income is captured. In this particular case this required two main steps: the measurement of non-production related transactions, and the disaggregation of the household and factor accounts.

Non-production related transactions include those between factors of production and their owners (domestic institutions: households, corporations and government, and ROW institutions), other domestic and international economic transactions among institutions (such as: tax payments, governmental transfers, remittances and other transfers paid or received from abroad) and domestic and foreign savings. In order to develop detailed household and factor accounts, I first constructed a balanced macro SAM[109] and then disaggregated it to include the complete set of household and factor types. These steps are described in more detail below.

4.3.1 The Moroccan Macro-SAM

A macro-SAM main function is to link coherently in a compact matrix format a country macro-economic national accounts with an aggregate version of its input-output accounts. In this way the main macro-economic relationships in the economy – private income generation, consumption and savings; government budget; foreign balance; and investment savings balance – are clearly recognisable and economy-wide consistency can easily be checked. This section presents a brief description of the sources and the calculations used in building the macro - SAM shown in Table 4-5.

[109] An example of how a macro SAM has been built is in Reinert K.A. and D Roland-Holst (1992).

Table 4-5: Macro SAM – 1990 (Millions current Dh)

	1 ACT	2 CAP	3 LAB	4 HH	5 GOV	6 CPACC	7 INVNT	8 I TAX	9 MARG	10 SUBSID	11 TARIFF	12 ROW	Total
1 ACTIVITIES	230844			146669	32976	51005	2575		37803	451		40821	543143
2 CAPITAL	67470											1635	69105
3 LABOR	96092											115	96207
4 HOUSEHOLDS		67307	96144		17371							28090	208912
5 GOVERNMENT				15848				31895			19591	1781	69115
6 CAP ACC				45900	6846							835	53580
7 INVENTORY						2575							2575
8 IND TAX	31895												31895
9 MARGINS	37803												37803
10 SUBSIDIES					451								451
11 TARIFF	19591												19591
12 ROW	59448	1799	63	495	11471								73277
Total	543144	69105	96207	208911	69115	53580	2575	31895	37803	451	19591	73277	

This macro SAM follows the standard convention that rows represent receipts and columns expenditures and that these must be fully balanced so that for each account total receipts are equal to total expenditures. Following the SAM ordering and commenting[110] first on the expenditures (columns), we have:

Activities

Payments are made to:

- *Activities* for intermediate demand (IO table)
- *Capital* and *Labor* for factors demand - value added (IO table)
- *Indirect Tax* for value added taxes (IO table)
- *Margins* for commercial services (IO table)
- *Tariff* for custom duties and other import taxes (IO table)
- ROW for imports (IO table)

receipts are from:

- *Activities* (see above)
- *Households* for private consumption (IO table)
- *Government* for public expenditure (IO table)
- *Capital Account* for investment demand (IO table)
- *Inventory* for variation of stocks (IO table)
- *Margins* (see above)
- *Subsidies* for import subsidies (IO table)
- *ROW* for exports (IO table)

Note that the first row and column are the aggregated version of the IO table.

Labour and Capital

Payments are made to:

- *Households* for income generated by their factor endowments. Capital payments are equal to value added plus a residual negative value of 163 millions current Dh. This residual is calculated as the difference between interest payments on external debt (7816 millions) and capital revenues received from abroad (7979 millions). Labour payments are equal to the value added plus 52 millions. This value corresponds to net salaries received from abroad. [111]

- *ROW* for value added originated from foreign owned factors of production. Capital pays a value (1799 millions) calculated as the difference between total foreign

[110] Note that data sources are given in parenthesis or in the footnotes.
[111] Direction de la Statistique (1992), tab 12, page 11.

capital revenues (9615 millions)[112] and interest payments (7816 millions, defined above). Labour pays a value equals to wages remitted abroad[113].

Receipts are from:

- *Activities* (see above)

- *ROW* for capital inflows[114] for the Capital account and wage remittances[115] for the Labour account.

Indirect Taxes

Payments are made to:

- *Government* for indirect tax revenues (IO table).

Receipts are from:

- *Activities* (see above).

Margins

Row and Column are self-explanatory.

Households

Payments are made to:

- *Activities* for final private consumption (IO table).

- *Government* for Tax payments as results from Table 4-6.[116]

- *Capital Account* for domestic private savings, the value is calculated as the difference between Gross domestic private savings (52746 millions)[117] and government savings (6846 millions).[118]

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[112] Direction de la Statistique (1992), tab 9, page 10.
[113] Ibid.
[114] Ibid.
[115] Ibid.
[116] Comptes du Tresor (1993) Unpublished table.
[117] Direction de la Statistique (1992), tab 4, page 8.
[118] Direction de la Statistique (1991), table page 85.

Table 4-6: Taxes paid by Households and Firms

Impôt agricole	1
Patente	549
Impôt sur Bénéfices Prof.	826
Impôt sur les Sociétés	4613
Impôt Général Revenus	3457
Prelev. Traitements Salariales	811
Taxe Urbaine	38
Taxe de Licence	19
Contribution Complémentaire	436
Taxe Produits des Actions	103
Majoration	62
Taxe Profit Immobiliers	124
Partecip. Solidarité Nationale	771
Enregistrement	2463
Monopoles	1575
Tot	15848

- *ROW* for transfers (such as remittances of foreign workers employed in Morocco)[119].

Receipts are from:

- *Capital* and *Labour* (see above).
- *Government* transfers, independent sources
- *ROW* for transfers

Government

Payments are made to:

- *Activities* for public expenditure (IO table).
- *Households* for transfers (see above).
- *Capital Accounts* for public investments (= savings see above).
- *Subsidies* (IO table).
- *ROW* for transfers (payments of interests on external debt), independent sources.

Receipts are from:

- *Indirect taxes* (see above).
- *Households* (see above).
- *Tariffs* for custom duties (IO table).
- *ROW* for public transfers[120].

Inventory, Subsidies and Tariffs

[119] Direction de la Statistique (1992), tab 9.1, page 10
[120] Bank Al-Maghrib (1992), tab A37.

Rows and Columns are self explanatory.

ROW

See other accounts.

A description of the disaggregation of the households and factor (Labour and Capital) accounts, and the accompanying factor income distribution are presented in the following sections.

4.3.2 Consumption Disaggregation.

Cell 1,4, in the Macro-SAM depicted in Table 4-5, allocates all private consumption to one single type of institution. This poorly describes the actual Moroccan economy, where different type of institutions have different patterns of consumption and resource endowments. The approach followed here is that of classifying households according to the main source of income of their heads. The aim of such a classification, as suggested in the 1993 UN manual on national accounting, is to ensure the maximum level of variation, in both income sources and consumption patterns, between household types and, at the same time, minimise that within the same groups. For Morocco, the data needed for disaggregating the household sector were available in a series of studies which will be presented in the exposition below.

The list of representative institutions detailed in the SAM is given in Table 4-7.

Table 4-7: Households and corporation in the Moroccan SAM

Rural Households	*Urban Households*
1.Family Farm	6.Proprietor Head of Household
2.Large Farm	7.Labourer Head of Household
3.Household with Agriculture Worker Head	8.Non Labourer non professional working H. Head
4.Non Agriculture Proprietor Head of Household	9.Professional Household Head
5.Non Agriculture Worker Head of Household	10.Government Employee Household Head
Corporations	
11.Private Corporations	
12.Public Corporations	
13.Foreign Corporations	

In this section the first 10 Institutions are considered and small and large farms are aggregated into one single farm sector. Corporations do not participate to private consumption, and their role is analysed below.

The estimation of the rural and urban components of total consumption represented the first step in the disaggregation process. In order to implement this disaggregation, it was necessary to use data from the 1990 survey on household living standards[121] and build a bridge between its sectoring scheme and that of the IO table. A summary of the survey's data is presented in Table 4-8. This table aggregates into 9 macro-sectors the 205 types of goods/expenditures included in the survey.

Table 4-8: Macro-sectors DAMP[122] 1990-91 (current Dh)

Sectors	Urban	Rural
Food and Beverages	3718.2	2527.5
Clothing	577.4	271.8
Housing and Energy	1706.7	711.1
Durable goods	419.4	180.9
Health care	725.9	211.6
Transport and communication	604.5	217.8
Leisure and Education	680.6	140.1
Other Expenditures	483.6	258.2
Other Expenditures (non consumption)	307.2	104.3
Total	9223.5	4623.3

In order to find an optimal allocation of these 205 items into the 133 sector scheme of the IO table, the following procedure was adopted separately for the rural and urban component. Firstly, the survey goods/expenditures were allocated to an IO table sector when their correspondence was easily recognisable.[123] Secondly, the remaining goods/expenditures were allocated to multiple IO table sectors when they were corresponding to more than one single sector because of their generality. The allocation was made according to IO table consumption shares.[124] Finally, exceptional expenditures (and some other minor items) were allocated to all the IO table sectors according to their shares.

[121] Direction de la Statistique (1992 b)

[122] DAMP is a French acronym (Dépense Annuelle Moyenne par Personne) standing for 'yearly average expenditure per person'.

[123] For example: Blé dur en grains (sector 1, in the survey) = Hard Wheat (sector 1, in the IO table).

[124] For example: Légumes et légumineuses (sector 52, in the survey) was allocated to: Legumes and Vegetables (sectors 6 and 11 of the IO table) using the IO consumption shares of the latter sectors.

In this way it was possible to obtain two separate vectors of 133 DAMPs matching the IO table sectoring scheme. New consumption shares were calculated from these vectors and multiplied by their respective urban and rural total values. These were calculated according to Table 4-9.

Table 4-9: Population and Consumption

	Rural	Urban	Total
Total consumption per capita	4499	8850	
Population	13603356	12005170	
Total (million Dh)	61200	106245	167445

The first row in Table 4-9 represents the sum of the 133 DAMPs just mentioned. The survey's data on population are shown in the second row, and the last row is the simple multiplication of the first two. The total value for consumption derived from this procedure is just 14% larger than the corresponding figure of the IO table, however this overestimation is not evenly distributed across sectors. To solve this problem, for all sectors the urban share of total consumption was calculated from the ***survey-estimated*** values, and then multiplied by the original IO table vector of final consumption. The rural component was then obtained as a residual. This procedure allowed the best use of the survey information while maintaining consistency with the IO table.

The next stage consists of a further disaggregation of the urban and rural element of private consumption estimated above. Since the desired institutional detail was not available in the survey on household living standards, it was necessary to use other sources of information and then, to make the obtained estimates consistent with each other, employ statistical procedures. The main difficulty in this estimation was represented by the fact that the 10 Institutions listed in Table 4-7 were not directly considered in any Moroccan study, so that a correspondence between different classifications was to be devised. Table 4-10 and Table 4-11 show how the SAM institutions are defined in terms of Moroccan classifications.

Table 4-10: Correspondence Moroccan Categories - SAM **Rural** *Institutions*

	Employeur	Independants	Salaries	Aide, apprentis	non declare
1 Personnel des prof. scientif. et liberal.	NAGP	NAGP	NAGW	NAGW	NAGW
2 Personnel commerc.	NAGP	NAGP	NAGW	NAGW	NAGW
3 Travailleurs services	NAGP	NAGP	NAGW	NAGW	NAGW
4 Exploitantes agric.	F	F	AGW	AGW	AGW
5 Travailleurs agric	F	F	AGW	AGW	AGW
6 Foresters, chasseurs, pecheurs,etc	F	F	AGW	AGW	AGW
7 Ouvriers et manoeuvr non agric.	NAGP	NAGP	NAGW	NAGW	NAGW
8 Autres	NAGP	NAGP	NAGW	NAGW	NAGW

Table 4-11: Correspondence Moroccan Categories - SAM **Urban** *Institutions*

	Employeur	Independants	Salaries	Aide, apprentis	Travail. domic.	Associé coop.	non declare
1 Personnel des prof. scient. lib.	PF	PF	PF	PF	PF	PF	PF
2 Personnel commerc.	PR	PR	NLNPF	NLNPF	NLNPF	NLNPF	NLNPF
3 Personnel administratif	PR	PR	GOV	GOV	GOV	GOV	GOV
4 Travailleurs services	PR	PR	NLNPF	NLNPF	NLNPF	NLNPF	NLNPF
5 Agriculteurs, eleveurs, etc	PR	PR	L	L	L	L	L
6 Ouvriers et man non agric.	PR	PR	L	L	L	L	L
7 Autres	PR	PR	L	L	L	L	L

The row and column labels are the Moroccan names for *job type* and *worker status*[125], respectively. The actual content of the tables are acronyms of the 10 Institutions. In order to clarify how the SAM Institutions result from the above combinations, consider the following definitions [126].

The acronyms are defined as follows:

Rural

1. F — Family Farm
2. F — Large Farm
3. AGW — Household with Agriculture Worker Head
4. NAGP — Non Agriculture Proprietor Head of Household
5. NAGW — Non Agriculture Worker Head of Household

[125] In the surveys used here Moroccan authors use these terms: *Profession principale* and *Situation dans la profession*. For some detailed definition see Direction de la statistique (1993) pages 30-33.

[126] For more details see: Direction de la statistique (1993) pages 30-33, Direction de la statistique (1990) pages 21-23 and Direction de la statistique (1992b) pages 33-35.

Urban

6. PR	Proprietor Head of Household
7. L	Labourer Head of Household
8. NLNPF	Non Labourer non professional Working Household Head
9. PF	Professional Household Head
10. GOV	Government Employee Household Head

While the labels are given by:

Rows

Personnel des prof. scientif. et liberal.	Personnel of scientific, technical, liberal, professions, managers, administrative staff
Personnel commerc.	Personnel commercial and salesmen
Personnel administratif	Personnel of Public Administration (mainly)
Travailleurs services	Workers specialised in the service sector
Exploitantes agric.	Smallholders (only rural)
Travailleurs agric	Farm workers (only rural)
Foresters, chasseurs, pecheurs,etc	Loggers, Hunters, Fishermen (only rural)
Agriculteurs, eleveurs, etc	Agriculture workers (label used for Urban Inst. only)
Ouvriers et manoeuvr non agric.	Non agricultural laborers
Autres	Other

Columns

Employeur	A person with his/her own business employing at least one person permanently
Independants	A person with his/her own business not employing anyone else permanently
Salaries	A person receiving wages from public or private employer
Aide	A person working for another member of the family
Apprenti	A person less than 25 working to learn some specific job
Aide, apprenti	The two above together
Travailleur a domic.	A person working at home for his/her business or for someone else
Associé coop.	A person working for an association (cooperative)
Non declaré	Not specified

The ideal situation would be to have for each of the 133 IO table sectors Table 4-10 and Table 4-11 filled with values for final consumption, so that, with simple aggregations, it would be possible to have all the desired institutional detail. Unfortunately these tables are not available either at that *level of detail* or with the required *format*. The available data consist of population and employment values organised as in Table 4-10 and Table 4-11 and consumption averages for *job type* and *worker status* separately. The population estimates come from statistical surveys on rural and urban active populations and from the survey on household living standards. As long as the urban population is concerned, a table with the same format of Table 4-11 was available in the population survey[127]. For the rural region, population figures for the categories of Table 4-10 were available only for the year 1987. A RAS estimation for which the controls were derived from the living standards survey data was employed to update these statistics. The final results is presented in Table 4-12.

Table 4-12: SAM Institutions Population

RURAL AGGREGATION	People (000)	%	tot %	% of activ
Farms	1167	8.58	4.56	20.65
Household with Ag H of H	3388	24.90	13.23	59.95
NonAgPropriet H of H	432	3.18	1.69	7.65
NonAgWorker H of H	664	4.88	2.59	11.75
Inactive+Unemployed	7953	58.46	31.06	
total	13603	100.00	53.12	
total without Inact/Unemp	5651			
URBAN AGGREGATION				
Professional H of H	355	2.95	1.38	9.57
GovernEmployee H of H	353	2.94	1.38	9.52
Laborer H of H	1627	13.56	6.36	43.90
Proprietor H of H	718	5.98	2.80	19.37
NonLabNonProf H of H	654	5.44	2.55	17.63
Inactive+Unemployed	8298	69.12	32.40	
total	12005	100.00	46.88	
total without Inact/Unemp	3707			
TOTAL (Urb+Rur)	25609		100.00	

Combining the figures for population with the consumption averages, it is possible to measure total consumption for each of the rows and columns types of Table 4-10 and Table 4-11 separately, but this is not sufficient to estimate the SAM Institutions' consumption. To do that, data considering simultaneously *job type* and *worker status* are necessary. To clarify consider Table 4-13. This table is a stylised version of Table 4-10 (or Table 4-11). To calculate total institutional consumption values, bivariate distributions of population and average consumption are needed. With the available data it was possible to measure the marginal distributions of total consumption. In order to estimate its bivariate distribution two alternative methods can be adopted: either assuming independence (in the statistical sense) between job type and worker status or applying an RAS estimation technique using the marginal distributions as controls and the population bivariate distribution as starting point of the iterations.

[127] See table 4.14 in Direction de la statistique (1993).

Table 4-13: Schematic Empovment Distribution

	Employeur	Independants	Others	Total
Personnel des prof.	bivariate distribution			marginal distribution
Personnel commerc.				
Others				
Total	marginal distribution			

By adopting the first method, it is implicitly assumed that the consumption behaviour of, say, *Personnel commerc.* does not vary according to its status: *Employeur, Independants*, etc. This was not considered satisfactory and therefore the RAS procedure was applied generating the results of Table 4-14 shown below.

Table 4-14: Total private consumption

RURAL AGGREGATION	million DH	%	tot %
Farms	5256	9.33	3.58
Household with Ag HofH	14323	25.41	9.77
NonAgPropriet HofH	2648	4.70	1.81
NonAgWorker HofH	2657	4.71	1.81
Inactive+Unemployed	31475	55.85	21.46
total	56358	100.00	38.43
URBAN AGGREGATION			
Professional HofH	5826	6.45	3.97
GovernEmployee HofH	5502	6.09	3.75
Laborer HofH	11206	12.41	7.64
Proprietor HofH	5609	6.21	3.82
NonLabNonProf HofH	6084	6.74	4.15
Inactive+Unemployed	56084	62.10	38.24
total	90311	100.00	61.57
TOTAL(Urb+Rur)	146669		100.00

It should be noted that the overall total consumption (146,669 Million Dh) corresponds exactly to the IO table value. This correspondence was obtained by uniform adjustment of the consumption averages for job type and worker status before the use of the RAS method.[128] Up to this point, the described procedure was sufficient to overcome the *format* problem but not the *level of detail* one; in other words, it was possible to obtain Table 4-10 and Table 4-11 with the correct format only for total consumption with no sectoral disaggregation. In order to estimate sector specific consumption figures, the following three stages procedure was adopted. Firstly, macro sector specific tables of consumption were estimated for the urban and rural population pooled together. Secondly, these tables were then decomposed into urban and rural components. And thirdly, a final disaggregation was undertaken to obtain the IO table 133 sectors.

Macro Table Estimation

For rural and urban populations together, new macro sector specific tables were estimated by using information from the survey on household living standards and combining it with population figures. The schematic tables shown below were a first result:

Table 4-15: Schematic Consumption Patterns 1

	Employeur	Independants	Others	Total
Sector 1	A			C
Sector 2				
Others				

Table 4-16: Schematic Consumption Patterns 2

	Personnel des prof.	Personnel commerc.	Others	Total
Sector 1	B			C
Sector 2				
Others				

Table 4-15 and Table 4-16 present total consumption by sector and worker status and by sector and job type, respectively. They were estimated multiplying population figures by average consumption data[129]. Note that the total consumption values for each sector (value "C" for sector 1) coincide for the two tables. Then, applying the same ideas of Table 4-13, a RAS procedure was used for each sector, as shown in the following table.

[128] This adjustment was necessary because the two Moroccan sources used here (the IO table and the living standard survey) presented conflicting results, referred to in the comments of Table 4-9.

[129] The survey on household living standards presents consumption averages (DAMPs) in tables D 04 and D 05, at pages 258, 259. The sectoral detail is that of table 4.3 in the text above. Population figures are obtained by simple aggregation of data from Direction de la statistique (1990) and Direction de la statistique (1993) adjusted as described in the text.

Table 4-17: RAS Estimation

Sector I	Employeur	Independants	Others	Total
Personnel des prof.	bivariate distribution - RAS estimates			A
Personnel commerc.				
Others				
Total	B			Total = C

Essentially Table 4-15 and Table 4-16 gave the RAS controls and the final result was 8 macro sector tables with the format of Table 4-17.[130]

Rural - urban Disaggregation

The macro sector specific tables were then disaggregated into rural and urban tables. This was done by adjusting the overall total values "C" of those tables to a rural and urban total value according to the original survey data. The resulting urban and rural consumption figures for the macro sectors are presented in Table 4-18 and Table 4-19. Before further disaggregating these macro sectors into the IO table 133 sectors, two adjustments were necessary. First, a RAS estimation technique was used to make Table 4-18 consistent with the IO table figures. Second, the rural and urban consumption values of *Inactive + Unemployed* were allocated to the other categories with simple share imputation. The result is presented in Table 4-19.

Sectoral Disaggregation

The macro sector specific urban and rural tables were finally disaggregated to the 133 sectors level. In order to obtain this detail, it was necessary to use three components: (1) the urban and rural vectors of private consumption mentioned at the beginning of this section (see page 104); (2) the estimates of Table 4-19; (3) a mapping function of the relationships between the 205 sectors and the 8 macro sectors of the living standards survey and the 133 sectors of the IO table.

[130] The 8-macro sectors correspond to those of Table 4-8.

Table 4-18: Total private consumption - Million Dh

URBAN CATEGORIES	AlimBoiss	Habill	HabitEn	EquipMen	HygMed	TrComm	LoisCult	Autres	total	%	tot%
Profesional HofH	1125	330	589	205	357	612	522	329	4069	3.8	2.4
GovernEmployee HofH	897	269	538	188	312	394	464	362	3423	3.2	2.0
Laborer HofH	7872	1277	2677	815	1295	1500	1232	1110	17778	16.6	10.5
Proprietor HofH	3217	516	1134	343	493	619	454	568	7346	6.9	4.4
NonLabNonProf HofH	1509	375	706	211	459	473	458	316	4506	4.2	2.7
Inactive+Unemployed	30017	4166	14846	3272	5799	3659	5040	3122	69919	65.3	41.5
total	44638	6932	20489	5035	8715	7257	8171	5806	107042	100.0	63.5
RURAL CATEGORIES											
Farms	1076	102	195	65	39	59	24	164	1722	2.8	1.0
Household with Ag HofH	3790	442	703	237	189	332	134	388	6214	10.1	3.7
NonAgPropriet HofH	1460	185	359	110	130	215	89	190	2739	4.5	1.6
NonAgWorker HofH	4936	747	1408	451	605	862	484	881	10374	16.9	6.2
Inactive+Unemployed	23121	2222	7009	1599	1915	1494	1176	1888	40424	65.8	24.0
total	34382	3697	9673	2461	2878	2963	1906	3512	61474	100.0	36.5

Table 4-19: Total private consumption (after adjustment) - Million Dh

URBAN CATEGORIES	AlimBoiss	Habill	HabitEn	EquipMen	HygMed	TrComm	LoisCult	Autres	total	%	tot%
Professional HofH	4436	1239	2276	779	1343	2203	1892	1205	15373	17.0	10.5
GovernEmployee HofH	3970	1135	2334	801	1317	1590	1885	1485	14517	16.1	9.9
Laborer HofH	13482	2085	4496	1345	2117	2343	1938	1763	29569	32.7	20.2
Proprietor HofH	6676	1022	2308	686	977	1173	865	1094	14800	16.4	10.1
NonLabNonProf HofH	5576	1319	2559	752	1617	1594	1553	1082	16053	17.8	10.9
total	34140	6800	13973	4363	7372	8902	8132	6630	90311	100.0	61.6
RURAL CATEGORIES											
Farms	7241	702	1439	460	308	440	191	1124	11904	21.1	8.1
Household with Ag HofH	19164	2291	3905	1268	1127	1867	815	2003	32440	57.6	22.1
NonAgPropriet HofH	3067	398	829	245	322	502	226	407	5997	10.6	4.1
NonAgWorker HofH	2730	424	856	264	394	530	323	497	6017	10.7	4.1
total	32202	3815	7029	2237	2151	3339	1554	4030	56358	100.0	38.4
TOTAL(Urb+Rur)									146669		100.0

4.3.3 Value Added Disaggregation

This section describes the procedures followed to disaggregate the IO table vectors of labour and capital value added. The full list of labour and capital categories is shown in Table 4-20.

Table 4-20: Moroccan SAM factor of production types

Labour	Capital
1. Unskilled workers	1. Small Capital
2. Skilled workers	2. Public Capital
3. Salaried workers	3. Corporation Capital
4. Employers	4. Foreign Capital
5. Independent workers	

The aim of the methodology used in disaggregating capital was to obtain a clear differentiation between corporate capital and small business capital and then to disaggregate the first into its public, domestic private and foreign components. In this way, the obtained results can form the basis for a study of the industrial organisation of the various sectors. One objective of future research is in fact the extension of the CGE models presented in this thesis to include imperfect competition and economies of scale. For this reason, the value added disaggregation procedure is detailed only for the labour factor.

Labour Value Added Disaggregation

This sub section describes the methodology applied to assign to five distinct labour categories the aggregate labour value added of the IO table. The first stage of this methodology consists of estimating employment data. This was done separately for the urban and rural populations, allowing more precise estimations and the distribution of labour income to the appropriate household category. Sources of employment data were the surveys on Rural and Urban Active populations and the survey on living standards.

Three basic problems had to be solved. Firstly, the rural data had to be updated. Secondly, the unskilled and skilled wage workers categories had to be indirectly estimated since they were not explicitly considered in any Moroccan source. And thirdly, the sectoring scheme with which the employment data were originally organised was not as detailed as that of the IO table, therefore some disaggregation rule had to be elaborated. To update the rural data a combination of estimates from the living standards survey and a rural active population survey were used. The final result is shown below.

Table 4-21: Rural Active Population Updated (1990, thousands)

	Empl	Indip	Salar	AideAppr	AssCoop	TravDom	Tot
CerealLegumFourag	12	489	147	1229	14	12	1904
CultIndOleag	3	44	58	111	1	1	218
OthCult ForstFish	3	96	214	195	8	7	525
Livestock	9	545	60	1134	11	9	1768
Industry(+MinEne)	1	139	73	250	2	2	466
Construction	2	11	187	7	1	1	209
Commerce	1	179	23	31	7	6	247
OthServ	2	59	143	15	4	3	225
PAdmin.	0	0	63	0	0	0	63
OtherActivities	0	3	10	5	3	3	24
Tot	34	1565	978	2978	51	45	5651

For the urban population a table similar to Table 4-21 was already available in the Urban Active Population survey for the year 1990. However, the overall total value of this table was not consistent with the data from the living standards survey and a minor adjustment was then required [131]. The result is shown in Table 4-22 below; note that the sectoring scheme is different from that of the Rural Population and that the AideAppr, AssCoop and TravDom categories have been aggregated under the heading of OthCategories.

Table 4-22: Adjusted Urban Active Population (000) 1990

	OthCategories	Salar	Employer	Indip	tot
AgrForFish	25	77	11	19	132
Mines	0	40	0	0	40
IndAlim	5	71	3	1	80
IndTexLeath	266	245	16	23	550
OthInd	52	166	12	21	251
Reparat	41	43	9	26	119
EleWatGas	0	26	0	0	27
Construction	14	173	15	49	251
Commerce	104	140	20	301	565
RestHotel	7	73	6	6	91
TranspCommun	14	114	3	34	164
BankIns	3	53	4	5	65
PersServ	18	166	6	38	229
PublServ	8	283	4	7	301
PAdmin	0	315	0	0	315
OthActivities	4	3	0	1	8
Tot	562	1989	107	530	3189

[131] The total values for *urban active employed people* were: 3.618 million for the Urban Active Population survey and 3.188 million for the living standards survey. Therefore the adjustment ratio was .88.

The estimation of employment data for the two categories of Skilled and Unskilled wage workers was necessary to overcome the second problem. The basic assumption was to use school attainment as a proxy for the worker's skills. Data concerning school degrees were available in the population surveys. The following simple procedure was adopted: firstly, people with no degree or very basic ones were pooled into an unskilled set, secondly the ratios between skilled and unskilled were calculated for different categories of workers and, finally, these ratios were multiplied by the AideAppr, TravDom, AssCoop values of Table 4-21 and Table 4-22 to calculate total employment figures. In other words, since for Salary workers, Employers and Independent workers, there is an exact correspondence between the SAM factors and the categories of Table 4-21 and Table 4-22, the residual groups of those tables were allocated to the Skilled and Unskilled wage workers sets using the school attainment ratios defined above.

Employment figures derived from Ministry of Industry data and Labour Value Added per cent shares from the IO table were used to sectorally disaggregate Table 4-21 and Table 4-22. The Ministry of Industry data allowed the calculation of per cent shares only for the manufacturing group and they were applied to the following categories of Table 4-21 and Table 4-22, respectively: Industry (+MinEne); IndAlim, IndTexLeath and OthInd. This allowed to obtain the full IO table detail for the manufacturing group. The other sectors were disaggregated according to Labour Value Added shares from the IO table assuming implicitly constant average productivities across worker types.

The second stage in the Labour Value Added disaggregation procedure considers labour income distribution estimation. No Moroccan official estimates of average wages were available, so it was necessary to develop an indirect estimation procedure based on data from a recent OECD study [132]. In particular Table 4-23 below is calculated from two analogous tables[133] showing, in the Morrisson study, average incomes and employment data. A few remarks are necessary. Firstly, the sectoring scheme is derived from the Moroccan one. Secondly the columns labels include in the wage earners category: 5. Higher management, 4. Middle management, 3. White-collar workers, 2. Specialised or

[132] C. Morrisson (1991).
[133] See Tables I 1 and I 2 in Morrisson (1991).

qualified workers, 1. Unskilled workers, 0. Specialised or unskilled workers in the traditional sector; and in the non-wage earners category: a. Employers, b. Independents (with premises), c. Independents (without premises) [134].

Table 4-23: Income Distribution in 1980 (10^5 Dh)

		wage earners							non-wage earners			
SECTORS		5	4	3	2	1	0	tot	a	b	c	tot
1	CerIndLivForFruVeg	1530	0	0	0	0	10581	12111	32850	38540	43463	114853
2	CitrFruit	300	0	0	0	0	940	1240	2550	441	143	3134
3	EarlyVeg	0	0	0	0	0	500	500	1850	320	0	2170
4	Fish	240	480	0	0	950	0	1670	600	202	0	802
5	Phosp	690	950	180	0	1656	0	3476	0	0	0	0
6	Mines	145	210	40	0	365	0	760	0	0	0	0
7	Mines(met)	200	280	50	0	480	0	1010	0	0	0	0
8	OilFuels	114	80	67	130	173	146	710	0	0	0	0
9	Ditto.Refin	84	59	50	96	128	109	526	0	1050	0	1050
10	EleWat	530	370	310	600	800	682	3292	0	0	0	0
11	FoodInd	391	365	147	617	893	1246	3659	1029	2570	220	3819
12	OthFoodInd	453	243	250	320	691	1044	3001	1133	840	250	2223
13	BevTob	167	186	207	411	411	138	1520	0	23	5	28
14	Text	600	368	257	1064	1341	1580	5210	177	3880	4530	8587
15	Cloth	125	47	42	175	363	1419	2171	229	4130	1180	5539
16	Leath	102	99	99	236	271	744	1551	64	2160	240	2464
17	TimbWood	170	116	78	177	309	1069	1919	52	2440	350	2842
18	Paper	289	175	179	476	308	174	1601	165	150	20	335
19	Quarr	377	406	200	524	740	565	2812	149	1200	170	1519
20	MetalInd	45	21	14	36	84	161	361	0	43	26	69
21	MetalObj	434	349	224	590	654	891	3142	198	2800	410	3408
22	Machin	162	89	64	179	150	0	644	283	260	40	583
23	TranspEquip	195	163	214	539	158	0	1269	219	116	15	350
24	ElectrEquip	282	148	153	215	310	0	1108	81	135	16	232
25	PrecInst	7	5	3	4	20	0	39	0	32	6	38
26	Chemic	693	557	356	641	832	263	3342	1013	256	42	1311
27	Rubber	205	90	185	206	322	47	1055	109	145	12	266
28	OthManuf	9	3	4	9	20	202	247	33	345	113	491
29	Constuction	1720	1110	630	4070	5469	6463	19462	719	14320	1300	16339
30	Comm	1410	920	510	3360	4520	5353	16073	2641	47201	4799	54640
31	Transp	1520	1110	860	1910	2540	3076	11016	1226	6300	1800	9326
32	Communic	165	130	500	770	450	35	2050	0	0	0	0
33	BankIns	590	475	1780	2737	1590	120	7292	0	0	0	0
34	OthServ	1900	1230	690	4510	6060	7184	21574	4494	23160	4620	32274
35	Admin	7100	1714	21400	32886	19120	1490	83710	0	0	0	0
	Total	22944	12548	29743	57488	52179	46222	221123	51864	153059	63769	268691

[134] For more details see Morrisson (1991) pages 125, 126.

In what follows a brief description of the steps necessary to estimate labour income distribution for the 1990 year is presented. The first step consisted of building a correspondence between the SAM Labour factors and Table 4-23 workers categories. This is shown in Table 4-24. Then, new average incomes were calculated for the SAM factors as simple weighted averages of the two original Morrisson's Tables.

The next step was to disaggregate this new average incomes table to obtain the detail required for the full IO table's 133 sectors. Unfortunately, not having any other information, it was assumed that average income did not vary within the macro sectors of Table 4-23.

Table 4-24: Factors Correspondence

Categories of Table 4-23		SAM Categories
5	Higher management	Salaried Workers
4	Middle management	Salaried Workers
3	White-collar workers	Salaried Workers
2	Specialised or qualified workers	Skilled Wage Workers
1	Unskilled workers	Unskilled Wage Workers
0	Specialised or unskilled workers (trad sect)	Unskilled Wage Workers
a	Employers	Employers
b	Independents (with premises)	Independents
c	Independents (without premises)	Independents

This permitted estimation of a fully detailed table of average incomes (or wages). This was then multiplied by the total (rural plus urban) employment table and a final Total incomes table was obtained[135]. From this table, factors shares were calculated for each sector and then multiplied by the Labour Value Added vector of the IO table. Basically this procedure corrected the compositional distribution of labour incomes of Table 4-23 using employment data and then updated the result with the IO table data. Finally by assuming the same average incomes in the rural and urban areas and applying regional specific employment data, it was possible to decompose the Total incomes table into a rural and urban component.

[135]Note that all these three tables: average incomes, employment data and total income have the same dimensions, namely they are *133 IO sectors* by *5 SAM labour factors* tables.

4.3.4 Factor Income Allocation, Transfers, Savings and Tax Payments Disaggregation

The next step was the allocation of income from different categories of capital and labour to the household types. This entails detailed transactions between 9 factors and 10 households. The fundamental rule employed to allocate factors income was based on the criterion of private ownership. Each household was receiving income according to its factor endowments. The following table illustrates this procedure in more detail.

Table 4-25: Factors Income Allocation

Households	Composed by : Worker Status - Job Type	Receive Income from
URBAN		
Professional HofH	Indipend.Employer.Salar et al - Pers ProfScLib (1)	1 Small Capital in Ser 2 Empl .Indipend LaborVA in Ser
GovernEmployee HofH	Salar et al - Pers Admin.(3)	Unskill,SkillWageWrk and Salar in sector 133
Laborer HofH	Salar et al - Agric and other (5,6,7)	Unskill,SkillWageWrk and Salar. in Ag and Ind
Proprietor HofH	Indipend.Employer-all job types excl ProfScLib (2-7)	1 Small Capital in Ind and MEn 2 Empl .Indipend LaborVA in Ind and MEn
NonLabNonProf HofH	Salar et al - Pers Services and Commerce (2,4)	Unskill,SkillWageWrk and Salar. in Ser
RURAL		
Farms	Indipend.Employer - Agriculture (4,5,6)	1 Small Capital in Ag 2 Empl .Indipend.LaborVA in Ag
Household with Ag HofH	Salar et al - Agriculture (4,5,6)	Unskill,SkillWageWrk and Salar. in Ag
NonAgPropriet HofH	Indipend.Employer - non Agric (1,2,3,7,8)	1 Small Capital in Ind and MEn 2 Empl .Indipend LaborVA in Ind and MEn
NonAgWorker HofH	Salar et al - non Agric (1,2,3,7,8)	Unskill,SkillWageWrk and Salar. in Ind,MEn,Ser

The first column of Table 4-25 lists the SAM household types, column 2 reproduces the concordance rule of Table 4-10 and Table 4-11 (the numbers in brackets are the rows numbers of those tables) and the third column lists the types of factors and the sectors[136] of activity from which the income is generated. The urban and rural components of the labour value added (in its different forms: Unskilled, Skilled, Salary), whose calculation was described in the previous section, were used here to estimate regionally distinct allocations. So, for example, the *urban* component of labour value added in Ag was allocated to the *Laborer HofH*, whereas its *rural* part went to *Household with Ag HofH*. The same procedure could not be used to regionally discriminate the capital value added. Then, for the dubious case of Small Capital in Ind and MEn for *Proprietor HofH* and *NonAgPropriet HofH*, it was decided to allocate to the rural institution the Small Capital of the following sectors: *food processing, leather and shoes* and *wood products*, the rest went to the urban institution.

Households also receive income from two sources: the Rest of the World (mainly remittances) and government. Consider the values shown in Table 4-26. They are the SAM resulting budget surpluses of households after they have received all the available factor income and spent it on consumption, but before their allocation for savings, tax payments and transfers to the rest of the world. The fourth column clearly shows which are the poorest households that were considered recipients of the government transfers. In fact the latter were distributed to the *Labor HofH* and to *Agri HofH* according to the percent shares calculated from the expenditure column shown in column 5.

Table 4-26: Government and Rest of the World Transfers

	Receipts	Expenditures	Difference	ExpShare %	Urban-rural %	Urban-rural pop%
ProfesHofH	20542	15373	5169			
GovEHofH	20544	14517	6027			
LaborHofH	14160	29569	-15409	0.48	0.64	
ProprHofH	21769	14800	6969			
NLbNPrf	20112	16053	4059			
Farms	20796	11904	8892			
Agri HofH	8259	32440	-24181	0.52	0.36	0.84
NAgPrpHoH	8263	5997	2266			
NAgWkHoH	12917	6017	6899		0.36	0.16

The Row transfers were allocated to three categories (considering the available studies on Moroccan migration[137]): *Labor HofH, Agri HofH* and *NAgWkr HofH*. The per cent shares used for this allocation are shown in columns 6 and 7[138]. First the shares in column 6 are used to estimate the rural and urban components of the ROW transfers, then the last column shares are used to distribute the rural component to the two appropriate households. After having allocated all the mentioned transfers, the total values of tax payments and savings were distributed to the households according to the shares calculated from the difference between expenditures and receipts. The last step was to

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[136] 'Ser' stands for all services, 'Ag' for all agriculture, 'Ind' for manufacturing, MEn for mining and energy.

[137] See for instance Faini and de Melo (1993).

[138] Column 6 contains the shares of rural and urban migrant workers derived from Direction de la statistique (1988) tab 3 page 18. Column 7 shows population shares for the two relevant rural households.

disaggregate the Rest of world account in order to obtain three regions: European Community (EC), Rest of Europe non EC (ROEU) and Rest of the World (ROW).

Consider first the column (expenditures of Rest of the world). Exports were disaggregated using data from the IO table. Transfers to the Small capital, government, Capital Accounts, were assigned to the various regions according to the Moroccan exports shares as shown in Table 4-27.

Table 4-27: Rest of the World Disaggregation

	Moroc.Exp	%	Small capital	Govermm	Cap Acc
EC	26547	0.65	1063	1158	543
ROEU	2728	0.07	109	119	56
ROW	11546	0.28	463	504	236
Tot	40821	1.00	1635	1781	835

Transfers to households are disaggregated according to the shares of Moroccan workers resident in the three regions. For the row (receipts of Rest of the world), imports were disaggregated using data from the IO table. Transfers to the Small capital were distributed to the various regions according to their FDI shares. All the other data were disaggregated using the three region GDP shares.

4.4 French SAM main data sources

The following is a list of the main publications that have been used to assemble the data for the construction of the French 1990 SAM.

Institut National de la Statistique et des Etudes Economiques (INSEE) **Les tableaux entrées - sorties (TES) 1990-1993**.

INSEE Madior Fall, **Les Comptes de Revenu des Ménages par catégorie socioprofessionnelle 1984-89**. Emploi - Revenus No 42.

INSEE Recensement de la population de 1990. **Population Active**. Démographie - Société No 25.

INSEE Recensement de la population de 1990. **Nationalités**. Démographie - Société No 21.

INSEE Recensement de la population de 1990. **Ménages - Familles**. Démographie - Société No 22-23.

INSEE Marie-Noelle Suin. **Tableaux d'analyse financière 1988**. Système productif No 65.

INSEE Ministère de l'Agriculture. **Les compte national de l'agriculture** - Méthodologie de la base 1980.

OECD **Economic Surveys**. France (various years).

Additional data on international trade, households, corporations and agriculture were provided on electronic media by researchers at INSEE.

5 Is there a Trade-off between Trade Liberalisation and Pollution Abatement in Morocco? A Computable General Equilibrium Assessment

5.1 Introduction

This chapter develops one of the main themes of the thesis, namely the examination, in the specific Mediterranean context, of the interdependencies of environmental and commercial policies.

Trade and environment linkages are under increasing scrutiny, and a vast literature has emerged on the subject.[139] Important relationships have been identified and major conclusions have been drawn in terms of policy prescriptions. Pressures to use trade instruments to protect the environment have been debunked as a blunt and inefficient approach to environmental policy.[140] Even in a second best world, the optimal policy to abate emissions would be a targeted uniform tax per unit of pollution, as this would directly discourage the emissions of pollutants.[141] However, many questions still remain. Most countries, while being aware of environmental problems, are now engaged in a trade liberalisation process and the coherence between environmental and trade policies is a major concern. Will the realisation of comparative advantages induce a risk of specialisation in dirty activities? Will the implementation of domestic environmental taxes affect international competitiveness? Given the lack of robustness of qualitative results shown in theoretical work concerning these issues,[142] most recent studies have been focused on measuring quantitatively the interdependencies of environmental and commercial policies. Empirical research tends to confirm that developing economies specialise in 'dirty' industries.[143] However, other studies do not find strong evidence that OECD countries stricter environmental regulations *per se* have influenced

[139] See Dean (1992), Cropper and Oates (1992), Beghin, Roland-Holst and van der Mensbrugghe (1994) for surveys.
[140] See Anderson and Blackhurst (1992).
[141] Perroni and Wigle (1994), Braga (1992).
[142] Copeland and Taylor (1995).
[143] Hettige, Lucas and Wheeler (1992), Low and Yeats (1992), Birdsall and Wheeler (1992).

competitiveness.[144] This could suggest that developing economies have a real comparative advantage in dirty productions, and hence a trade-off between trade liberalisation and environmental preservation could occur.

These questions have been typically addressed by using Computable General Equilibrium (CGE) models.[145] Their main advantage lies in the possibility of combining detailed and consistent real world databases with a theoretically sound framework. This chapter extends this line of investigation by offering a new quantitative analysis of the linkages between economic activity and the environment in Morocco, and specifically by evaluating the joint impact of environmental and commercial policies.

The study presented in this chapter significantly differs from previous trade and environment analyses in three ways.

Firstly, earlier research focused on global environmental problems and trade relations. These typically considered just one or two toxic substances, normally greenhouse gases, and included just a few productive sectors and households' types. When the issues of interest are not global but centred on a single country's policy alternatives, the earlier levels of detail are not enough. By embodying a high level of disaggregation for pollutants, products, sectors and types of households the model presented here can be used to simulate abatement policies targeted to specific air emissions, measuring, at the same time, the effect on related water and soil pollutants. From a domestic policy maker point of view, this sort of information may be crucial for a successful implementation of a green tax policy. At the same time, trade policy reform through resource reallocation and expansion or contraction of specific activities has differentiated environmental consequences. The product disaggregation of the model, by signalling critical environmental outcomes of trade policy, might permit prompt adoption of corrective measures. Moreover, income distribution issues arising from environmental and commercial policies, and the question of the redistribution of environmental taxes receipts, are briefly discussed and can be further investigated due to the detailed classification scheme of households.

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[144] OECD (1993), Tobey (1990).
[145] Lee and Roland-Holst (1994), Perroni and Wigle (1994).

A second distinctive feature of the present study is the explicit inclusion of dynamics. The model simulations run to year 2004, allowing the introduction of exogenous factors such as productivity shifts and demographic changes that affect capital accumulation and the growth trajectory. Comparing the trends of output and emissions derived from different scenarios reveals the dynamic interdependencies of environmental and commercial policies.

Third, most economy-wide studies on growth and environment linkages rely on effluent intensities associated with output, and do not allow for substitution between non-polluting and polluting factors.[146] Abating pollution is then achieved principally by reducing output in pollution intensive sectors, with a significant cost in terms of growth. By contrast, in the current model pollution emissions are linked to polluting input use, rather than output. Technical adjustment by substituting non-polluting factors to polluting factors may therefore be assessed.

The investigation in this chapter is organised as follows. Firstly, trade liberalisation, resulting from a free trade area (FTA) agreement between Morocco and the European Community, is examined from the standpoint of the environmental consequences. In this case, I find that the risk of specialisation in dirty activities is very high for Morocco. In a second scenario pollution abatement policies are considered, holding trade policy parameters constant, and their effects on growth, sectoral allocation and trade are measured. An important result is that the cost in terms of growth of abating emissions is marginal, and that targeting one type of emission de facto reduces all the others pollutants. In a third and last scenario, I combine environmental and trade policies and show how they mitigate each other in terms of negative effects (trade-induced pollution and anti-growth effects of environmental policy). This last combined scenario shows how free trade and environment protection can coexist without growth-environment trade-off, by setting targeted effluent taxes.

The following section describes the most important features of the model.[147] Section 5.3 presents some reasons supporting the application of this study in the Moroccan case and briefly surveys this country's trade policies and environmental concerns. It also

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[146] Lee and Roland-Holst (1994)

[147] The model is more fully described in the technical appendix.

presents the main linkages between the Moroccan economic structure and its environment as they result from the model basic run. Section 5.4 illustrates the benchmark scenario, where no economic policy is altered. Against it, scenarios of alternative environmental and commercial policies are contrasted in section 5.5. The final section summarises the main conclusions.

5.2 The model

The model used in this chapter is fully described in the next appendix and is calibrated on data contained in the Social Accounting Matrix estimated for the year 1990 and described in detail previously. The version of the SAM used here includes 10 household categories (5 urban and 5 rural), 48 sectors, 3 labour types, 3 separated trading partners and 13 different polluting emissions.[148] The model is dynamic and solved recursively for the years 1990, 1992, 1995, 1998, 2001, and 2004.[149] It includes approximately 100 generic equations describing agent behaviour, market clearing and other accounting relationships. The following sub-sections briefly illustrate the model's main characteristics.

Production

The Constant Elasticity of Substitution (CES) constant returns to scale production function is a nested structure taking into account the assumed substitution possibilities in the choice of production factors. Output results from two composite goods: non-energy intermediates and energy plus value added. The intermediate aggregate is obtained combining all products in fixed proportions (Leontief structure). The value added and energy components are decomposed in two parts: aggregate labour and capital, which includes energy. Labour is a composite of 3 categories. The capital-energy bundle is further disaggregated into its basic components.[150] By distinguishing between "new" and

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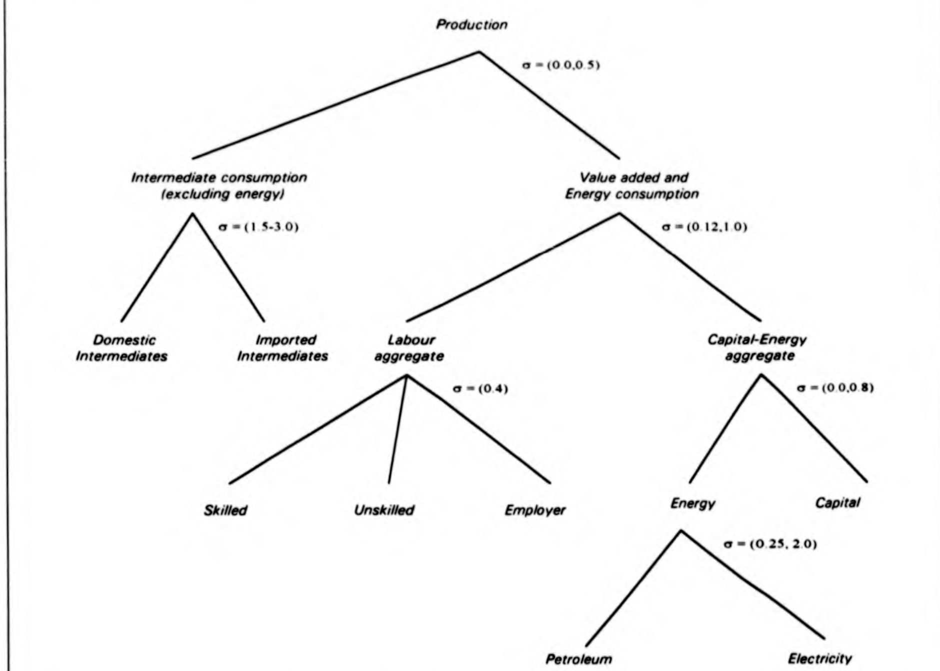
[148] A more sectorally disaggregated SAM could have been derived from the original 133-sector SAM and used to calibrate the model. The 48-sector SAM though combines enough detail with reasonable tractability. Moreover, this aggregation captures the most important trade-production-emission linkages and it merges sectors together in a manner that requires the prior 133-sector disaggregation.

[149] The main reason for choosing these time intervals is practical. The model could be solved for each single year but it would take more computer resources or longer time, besides time intervals do not affect the model results.

[150] The particular production function of this model treats energy as a separate factor of production rather than an intermediate input. Energy use is typically highly polluting and the specific nesting structure adopted here allows monitoring more closely energy-related emissions. Moreover bundling energy together

"old" vintages, the capital existing at the beginning of each period, or already installed, can be separated from that resulting from contemporary investment (putty/semi-putty production function).[151]

Figure 5-1: Nested Production Function



- CES substitution elasticities are differentiated by capital vintage, new capital (higher) elasticities are shown to the right of the comma.
- No substitution is possible among intermediates. Domestic products can be substituted with the corresponding foreign ones.

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with capital is motivated by the fact that new technologies, embodied in new capital goods, are usually energy saving (i.e. energy substituting).

[151] In the short run capital is usually sector-specific, whereas in the long run it can be perfectly mobile across sectors. The "vintages" approach allows integrating in the present dynamic model both short run capital immobility and long run capital mobility. In the modelled economy new capital (equal to the previous period's level of investment) is perfectly mobile and old capital only partially mobile across sectors. Another advantage of the "vintages" approach is that it allows introducing different degrees of substitutability of capital with other factors. In fact, old capital vintage is less substitutable with energy, labour and other inputs than new capital. Both these features add realism to this environment and trade model where enhanced openness should increase investment opportunities and new capital goods should embody cleaner technologies and greater adjustment possibilities.

Finally, the energy aggregate includes two energy substitutes: oil and electricity. Figure 5-1 depicts the nested decision process in the choice of production factors.

Substitution elasticities reflect adjustment possibilities in the demand for factors of production originating from variations in their relative prices. Consider particular values[152]: 0.00 between intermediates and value added with *old* capital plus energy; 0.50 between intermediates and value added aggregate incorporating *new* capital plus energy; 0.12 between aggregate labour and *old* capital-energy bundle; 1.00 between aggregate labour and *new* capital-energy bundle; 0.40 among different types of labour; 0.00 between *old* capital and energy; 0.80 between *new* capital and energy; 0.25 among different sources of energy associated with *old* capital; 2.00 among those associated with *new* capital.

Income Distribution and Absorption

Labour income is allocated to households according to a fixed coefficient distribution matrix derived from the original SAM. Likewise capital revenues are distributed among households, corporations and rest of the world. Corporations save the after-tax residual of that revenue.

Private consumption demand is obtained through maximisation of household specific utility function following the Extended Linear Expenditure System (ELES).[153] Household utility is a function of consumption of different goods and saving. Income elasticities are different for each household and product and vary in the range 0.20, for basic products consumed by the household with highest income, to 1.30 for services.[154] Once their total value is determined, government and investment demands[155] are disaggregated in sectoral demands according to fixed coefficient functions.

[152] These elasticities are derived from the most recent relevant literature. In fact, they are mostly derived from background studies done for the construction of the OECD GREEN model. See for instance Burniaux, Nicoletti and Oliveira-Martins (1992).

[153] A useful reference for the ELES approach is found in Lluch (1973). More detailed explanations of this modelling choice are given in the technical appendix.

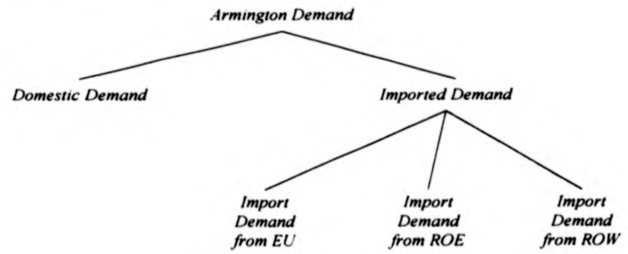
[154] Among the various sources for these elasticities see Blanciforti and Green (1983), Eastwood and Craven (1981), Lopez (1989) and Maki (1988).

[155] Aggregate investment is set equal to aggregate savings, while aggregate government expenditures are exogenously fixed.

International Trade

In the model we assume imperfect substitution among goods originating in different geographical areas.[156] Imports demand results from a CES aggregation function of domestic and imported goods. Export supply is symmetrically modelled as a Constant Elasticity of Transformation (CET) function. Producers decide to allocate their output to domestic or foreign markets responding to relative prices. The model implements a two-stage procedure for determining both import demand and export supply. For imports consider Figure 5-2. At the first stage aggregate demand is decomposed into a domestic component and an aggregate import component. At the second stage, aggregate import demand is allocated across the various trading partners.

Figure 5-2: Import demand nesting



Export supply is treated in a symmetric fashion (see Figure 5-3). Producers allocate production between domestic sales and aggregate export sales. At the second stage, aggregate exports are sold to the various trading partners based on the relative price the exporter can receive in each market.[157]

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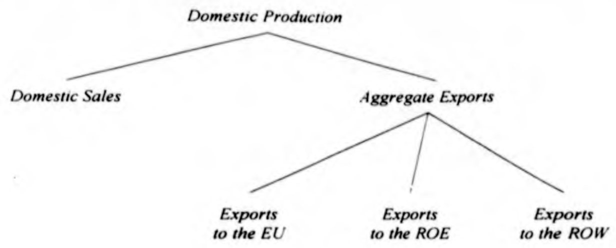
[156] Armington (1969).
[157] Elasticities between domestic and foreign products are of comparable magnitude for imports demand and exports supply. Their values are 3.00 for agricultural goods, 2.00 for manufactured goods and 1.50 for services. Similar values are used for the second nesting.

Figure 5-3: Export supply nesting



As Morocco is unable to influence world prices the small country assumption holds, and its imports and exports prices are treated as exogenous. The balance of payments equilibrium is determined by the equality of foreign savings (which are exogenous) to the value for the current account. With fixed world prices and capital inflows, all adjustments are accommodated by changes in the real exchange rate: increased import demand, due to trade liberalisation must be financed by increased exports, and these can expand owing to the improved resource allocation. Price decreases in importables drive resources towards export sectors and contribute to falling domestic resource costs (or real exchange rate depreciation).

Model Closure and Dynamics

The equilibrium condition on the balance of payments is combined with other closure conditions so that the model can be solved for each period. Firstly consider the government budget. Its surplus[158] is fixed and the household income tax schedule shifts in order to achieve the predetermined net government position. Secondly, investment must equal savings, which originate from households, corporations, government and rest of the world.

The dynamic structure of the model results from the equilibrium condition between savings and investment. A change in the savings volume influences capital accumulation

[158] Its initial value is determined in the 1990 SAM.

in the following period. Exogenously determined growth rates are assumed for various other factors that affect the growth path of the economy, such as: population and labour supply growth rates, labour and capital productivity growth rates and energy efficiency factor growth rate. Agents are assumed to be myopic and to base their decisions on static expectations about prices and quantities. The model dynamics are therefore recursive, generating a sequence of static equilibria.[159]

Emissions

Emissions are determined by either intermediate or final[160] consumption of polluting products. In addition, certain industries display an autonomous emission component linked directly to their output levels. This is introduced in order to include some polluting production processes that would not be accounted for by only considering the vectors of their intermediates consumption. It is assumed that labour and capital do not pollute. Emissions coefficients associated with each type of consumption and production are derived from a previous study[161] on the determinants of polluting intensity for the US and here adapted to the Moroccan case.[162] A change in sectoral output, or in consumption vectors, both in levels or composition, therefore affects emission volumes. Formally, the total value for a given polluting emission takes the form:

$$E = \sum_i \sum_j \alpha_j C_{i,j} + \sum_i \beta_i X_i^{Output} + \sum_j \alpha_j X_i^{Armington}$$

where i is the sector index, j the consumed product index, C intermediate consumption, X^{Output} output, $X^{Armington}$ final consumption (at the Armington composite goods level), α_j the emission volume associated with one unit consumption of product j and β_i the

[159] The model's long-run properties are discussed in the technical appendix.

[160] Final consumption, in this context, is restricted to households, government and investment demand. Exports are not considered since the analysis is limited to *local* emission.

[161] See Dessus, Roland-Holst, van der Mensbrugghe (1994). Instead of focusing on pollution output at individual industrial sources, they advocate moving back up the production process. Factories producing pollution can be numerous and very dispersed geographically. The evidence reported in their study indicates that only a few commodities are responsible for determining pollution levels when they are consumed as intermediates. Their econometric estimates indicate that over 90 per cent of the variation in emission of most toxic pollution can be explained by consumption of less than a dozen intermediate commodities. Their calculations are based on a 345 sector US input-output table (see Reinert and Roland-Holst (1992)) and on the 1987 IPPS (Industrial Pollution Projection System) database developed at the World Bank for the US (Hettige, Martin, Singh, Wheeler (1994)).

[162] The actual values used in the model are shown in section 5.7.

emission volume associated with one unit production of sector i. Thus, the first two elements of the right hand side expression represent production-generated emissions, the third one consumption-generated emissions.

There are 13 types of polluting substances. Their volume is independently determined and measured in metric tons. Toxic emissions in air (TOXAIR), water (TOXWAT) and soil (TOXSOL) depend primarily on the consumption of chemicals (especially fertilisers for water pollution), oil derived products and mineral products. Bio-accumulative emissions differ from the previous ones for their long term effects on bio organisms, due to their high lead (or other heavy metal) concentration. Again, these are distinguished according to the medium where they are released: into the air (BIOAIR), water (BIOWAT) and soil (BIOSOL). These emissions are a result of the use of mineral and metal products, generally found in construction-related sectors. There are 5 types of toxic substances released in the air: sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO), volatile organic compounds (VOC) and suspended particulates (PART). Their levels depend primarily on fuels consumption: oil and coal derived products. Finally, two additional categories of water polluting substances are considered: suspended solids (SS) and those measured by their biochemical oxygen demand (BOD). These emissions are related to the consumption of mineral products.

The household utility functions do not include among their arguments any term directly related to environmental qualities. In other words, pollution levels are assumed not to explicitly affect household utility. Despite the theoretical validity of the utility-environment relationship, empirical applications would require estimates for utility values that household assign to environmental qualities. Unfortunately statistical information on which these estimates can be based is still too limited.[163] Likewise, environmental degradation is not assumed to affect production factors productivity. Productivity gains resulting from new investments in greener technology are not measured in this model. Thus, the potential gains from environmental protection policies are almost certainly going to be under-estimated.

[163] Perroni and Wigle (1994).

Policy Instruments

The model includes a variety of important instruments of economic policy: direct and indirect taxes on production, consumption and revenues, tariffs and other taxes and subsidies on international transactions. Each of these taxes/subsidies is differentiated by sector, product, household, production factor, consumption type or income source. A uniform tax on each unit of polluting emission (for type of toxic substance) is also introduced and paid by the polluter agents. This tax can be endogenously determined if specified levels of emission (abatement) are to be targeted, otherwise it can be exogenously fixed. In this latter case, emissions levels become endogenous.

5.3 Economic Activity and Environment in Morocco

A single-country CGE model has been constructed to investigate the links between trade and environment policies in Morocco. Several reasons make Morocco an especially instructive case study. Morocco's sustained growth, and openness rate slightly below 70 per cent[164], make its economy very sensitive to commercial policy reforms. Its exports are concentrated in the primary sectors and textiles, whose production requires extensive use of polluting chemical intermediates. Abatement policies would impose additional costs and would modify its export competitiveness. This would also result in a different income distribution between rural and urban households. In contrast, a more open commercial policy would imply an increase in polluting production.

In addition new pressures on implementing environmentally sound policies can arise from Morocco's main trading partners, namely the EU. In fact, the new Euro-Mediterranean policy platform promulgated by the EU includes environment conservation policies among the crucial issues for a sustainable development of the area. For example, the latest EU financial policy agreement, the 1992 agreement, although still making crop diversification and export promotion a priority, explicitly includes the environment as a new concern. Consequently, training, technical assistance and investment related to environmental conservation are eligible for assistance. Demographic pressure is

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[164] Defined as the sum of exports plus imports on total income and measured for 1990.

also mentioned as a factor in environmental degradation (Article 3-2) and therefore family planning is eligible for financing if requested by the country in question.

The same emphasis is found at a national level when considering aid flows. France, Italy and Spain, the main aid donors for Morocco, Algeria and Tunisia,[165] recently proposed the promotion of debt-for-nature swaps (DNS) to reduce indebtedness and at the same time promote sustainable development projects. Since the first DNS with Bolivia in 1987, more than 30 agreements have been implemented. Although most DNSs went to Latin America, some African countries, and more recently Tunisia (1992-93) have also benefited. In relative terms, the face value of such commitments is small: the average face value of DNS over 1987-93 was $5.7 million. In Tunisia's case, the Swedish government swapped $1.8 million in ODA, while Tunisia made the counter-value in local currency available for projects directed towards environmental preservation. This clause was integrated in the Moroccan 1990 rescheduling agreement.[166]

In summary, although Morocco made considerable progress in negotiating increasing access of its export markets, the progressive tightening of European Community and national rules as regards environmental issues, and the harmonisation of EC arrangements for industrial standards, have the potential to become significant non-tariff barriers to trade. Thus, any comprehensive approach to the Morocco-EC relations should take into account the environmental implications of commercial policy changes and the economic implications of environmental policy implementation. By tracing all direct and indirect linkages between the economic activity and the environment, the present Moroccan environment and trade model represents an ideal approach to study the co-ordination[167] of these policies. However, before using the model to examine the dynamic evolution of the environmental and economic variables, this section presents a detailed account of the basic pollution intensities of the Moroccan production and consumption. This offers a reference point useful for evaluating the potential environmental effects due to economic growth and increased trade.

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[165] These three countries, notwithstanding political instability in Algeria, accounted for more than $1 billion of bilateral aid in 1991-92. See Fontagné & Péridy (1995).
[166] See Fontagné & Péridy (1995).
[167] Co-ordination here is intended in the sense of simultaneous use.

From a static perspective, Table 5-1 depicts the estimates for the sectoral emission intensities for production in 1990, i.e. the volume of emissions per unit of output. The Moroccan economy has been disaggregated (for a summary presentation) into 9 sectors: food agriculture (FAg), export agriculture (ExpAg), mining and other primary products (Min), food products (FPr), Textiles (Texl), highly polluting manufacturing (PollM), other manufactured products (OthM), polluting services (PollS) and services with low rates of pollution (NPollS).[168] The last column displays economy-wide averages weighted by sectoral outputs, the last 3 rows show respectively per cent shares of sectoral production, export to output ratios and EC per cent shares of total export. From this summary table, it is possible to observe the distribution of emissions intensities across sectors. This depends on the initial input-output structure of the Moroccan SAM (for the term $\alpha_j C_{ij}$) and on the vector of output (for the term $\beta_i X_i^{Output}$). A sector i would then have a higher pollution intensity (E/X_i^{Output}) the more polluting intermediates it consumes and the higher the value of its own β_i coefficient. By considering the relative weights shown in Table 5-1 (last three rows), it is also possible to see which are the most polluting industries in volume terms and what might be the environmental consequences of increased market access of Moroccan products in the EC.

Consider first pollution intensities. The aggregate PollM certainly records the worst case in terms of bio-accumulative substances, oxides and air polluting materials. A tax proportional to emission intensities will therefore result in higher production costs for this sector. Conversely, a specifically targeted tax levied on toxic emissions and BOD substances is likely to affect mostly the polluting services. Export agriculture is notably more polluting than food agriculture (with the exception of bio accumulative substances). Textiles, which record the highest EC share of total exports, enjoy relatively low emission intensities whereas Mining shows the highest export to output ratio and fairly severe emission intensities.

[168] Food agriculture consists mainly of basic staple crops (cereals) and livestocks plus oilseeds. Export agriculture includes vegetables, fruits, fishing and other agricultural products. Highly polluting manufacturing aggregates pulp and paper, chemicals, oil refinery, iron and steel and construction materials industries. Polluting services (PLSV) are transports, electricity and construction.

Table 5-1: Sectoral emission intensities for production - 1990 (Kg per 10^9 Dirham)

	FAg	ExpAg	Min	FPr	Texl	PollM	OthM	PollS	NPollS	Total
TOXAIR	1.0	1.3	3.8	2.7	14.0	19.7	3.0	19.5	2.5	8.3
TOXWAT	3.5	4.9	6.7	5.4	0.7	24.1	4.5	33.1	5.4	11.2
TOXSOL	2.4	3.1	14.7	6.7	0.5	99.2	10.0	129.1	7.3	36.2
BIOAIR*	1.2	0.7	39.5	1.5	0.1	608.4	34.7	153.6	0.9	129.8
BIOWAT*	1.2	1.5	2.2	0.5	0.1	33.0	0.3	14.3	4.2	9.3
BIOSOL*	25.4	15.6	824.2	29.4	0.6	12778.6	211.5	3161.3	16.5	2700.2
SO2	5.2	7.2	11.0	8.8	0.3	34.8	2.1	9.3	4.8	10.8
NO2	3.0	4.2	6.4	5.1	0.2	23.8	1.3	5.4	2.8	6.9
CO	0.5	0.7	4.2	0.9	0.0	53.7	0.2	13.1	0.5	11.6
VOC	1.3	1.9	3.5	3.8	0.4	8.2	3.3	2.4	2.4	3.3
PART	0.7	1.0	1.8	1.2	0.0	10.0	0.3	2.4	0.7	2.6
BOD	0.1	0.1	1.3	4.7	0.0	5.8	1.0	17.2	0.8	3.6
TSS	2.4	1.5	78.1	2.7	0.0	1219.6	0.0	296.7	1.4	256.4
Output %	11	4	2	8	9	18	4	11	34	100
X/Output	0	28	59	11	21	12	11	6	2	
X to EC/Tot X	65	69	53	75	85	47	72	65	65	

* Bio-accumulative pollution intensities are in grams per billion of Dirham

In terms of volumes, emissions from manufacturing and polluting services represent 82 per cent of the total toxic emissions, 99 per cent of total bio-accumulative pollutants, 80 per cent of total oxides, 65 per cent of other air pollutants and 99 per cent of other water pollutants.

Although production activity is the dominant environmental agent in the economy, final consumption of goods and services can equally cause considerable pollution, especially for specific emission categories. Analogous results of emissions intensities for consumption are shown in Table 5-2. These estimated intensities refer to consumption of final goods (and services) and do not consider households' waste. Except for water bio-accumulative, consumption generates emissions only in correspondence of polluting manufactured products, as in the case of consumption of refined fuels or chemicals. Bio-accumulative metals and toxic waste released through consumption, similarly to production, usually degrade soil.

Table 5-2: Sectoral emission intensities for final consumption - 1990 (Kg per 10^9 Dirham)

	FAg	ExpAg	Min	FPr	Texl	PollM	OthM	PollS	NPollS	Total
TOXAIR	0.0	0.0	0.0	0.0	0.0	18.8	0.0	0.0	0.0	1.9
TOXWAT	0.0	0.0	0.0	0.0	0.0	44.0	0.0	0.0	0.0	4.5
TOXSOL	0.0	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.0	3.9
BIOAIR*	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.5
BIOWAT*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	275.3	0.0	39.3
BIOSOL*	0.0	0.0	0.0	0.0	0.0	37.7	0.0	0.0	0.0	3.8
SO2	0.0	0.0	0.0	0.0	0.0	59.1	0.0	0.0	0.0	6.0
NO2	0.0	0.0	0.0	0.0	0.0	34.4	0.0	0.0	0.0	3.5
CO	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.5
VOC	0.0	0.0	0.0	0.0	0.0	24.3	0.0	0.0	0.0	2.5
PART	0.0	0.0	0.0	0.0	0.0	8.2	0.0	0.0	0.0	0.8
BOD	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.3
TSS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cons %	16	6	0	10	4	10	11	14	28	100

* Bio-accumulative pollution intensities are in grams per billion of Dirham

5.4 The Benchmark Scenario

The definition of a plausible evolution for the Moroccan economy is based on several simplifying hypotheses. The following simulations should therefore not be considered as a forecast exercise, for CGE models are not adequate forecasts tools. In fact, the definition of a growth path, supported by exogenous assumptions, serves the purpose of establishing a scenario with no policy interventions. Impacts of different economic policies are then evaluated against this reference scenario by measuring the variations in the economic aggregates. Fixing values for exogenous variables within a realistic confidence interval seems to imply no major consequences: the relative variations of the different economic aggregates measured during the evaluation of alternative policies with respect to the reference scenario seem uninfluenced by those a priori choices.

Growth hypotheses

Crucial growth rates have to be fixed in order to define the reference scenario. The GDP growth rate up to the year 2004 is exogenously determined so that the capital productivity growth rate can be estimated.[169] A yearly average growth rate was estimated at 4.0 per cent, corresponding to the historic growth rate of Morocco in the years 1930-

[169] In the reference scenario real GDP growth rate is fixed and the capital productivity growth rate is endogenously determined. In the alternative policies simulations the previously estimated capital productivity growth rate is exogenous and GDP growth rate becomes endogenous.

1990.[170] Population and labour force are supposed to grow at the same exogenously fixed rate of 2 per cent per year.

A further hypothesis concerns the monetary transfers among agents in the economy and public expenditures. These are supposed to be growing at the same rate as GDP. The government budget surplus is assumed to decrease during the simulation period so that it reaches balance at the year 2004. The last hypothesis on exogenous growth rates assumes that the energy efficiency factor increases at a yearly rate of 1 per cent and labour productivity at 1 per cent for skilled labour and 0.5 per cent for unskilled labour.[171] Apart from the latter assumptions about efficiency, no other modification affects the current technology. However, this can become less polluting because of factors substitution due to changes in tax structure, production and consumption. The remaining part of this section focuses on the joint evolution of Moroccan economic activity and pollution in the benchmark scenario.

Growth and emissions

The joint evolution of economic activity and emission volumes can be seen in Table 5-3 where the long-term pollution elasticities with respect to production and consumption are depicted. These are measured as the ratio of the yearly average growth rates of polluting emissions to those of production (and consumption, during the period 1991 - 2004) obtained in the benchmark scenario, i.e. without any policy change.

Notice that aggregate pollution grows more or less at the same rate of economic activity, as the elasticities are very close to unity. In other words, given that output growth rate has been exogenously fixed at 4.0 per cent per year, without policy intervention, we expect this same rate (or a very close one) for the growth of the 13 pollutants considered. In addition the relative weights of production and consumption generated emissions do not vary significantly during the simulation period.

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[170] This yearly average growth rate results from the estimation of a linear trend of the logarithm of GDP at constant (1987 base year) prices (in parenthesis are shown t-Student values):

$$y = \underset{(602)}{24.6} + \underset{(31.7)}{0.043}\, t \qquad R^2 = 0.97$$

[171] See the technical specification of the model for details.

Table 5-3: Emission elasticities - Benchmark scenario 1991 – 2004

	Output	Consumption
TOXAIR	1.07	1.04
TOXWAT	1.01	1.01
TOXSOL	1.13	1.05
BIOAIR	1.15	1.36
BIOWAT	1.13	1.37
BIOSOL	1.15	1.36
SO2	0.74	0.98
NO2	0.78	0.98
CO	1.12	0.98
VOC	0.90	1.02
PART	0.92	0.98
BOD	1.11	1.12
TSS	1.15	0

The analysis of the decomposition of emission by origin, as shown by Grossman and Krueger (1992) can be instructive. Three types of effects are distinguished in the variation of emission levels: the *composition effect* takes into account the modification of the proportion of polluting products in the aggregate output; the *technological effect* reflects changes in pollution due to alteration in the production technology; the *scale effect* describes the impact of increased volumes of output on the environment.

Consider the following identity, which simply states that total emission (for each type of pollutant) is equal to the sum of sectoral emissions:

$$E = \sum_i E_i = \sum_i \left(\frac{X_i^{Output}}{X_{tot}^{Output}} \frac{E_i}{X_i^{Output}} X_{tot}^{Output} \right)$$

The total variation in emission levels can then be measured as the sum of the mentioned three effects by differentiating the shown identity:

$$\partial E = \sum_i \left[\partial \left(\frac{X_i^{Output}}{X_{Tot}^{Output}} \right) \frac{E_i}{X_i^{Output}} + \partial \left(\frac{E_i}{X_i^{Output}} \right) X_i^{Output} + \partial \left(X_{Tot}^{Output} \right) \frac{E_i}{X_{tot}^{Output}} \right]$$

where ∂ is the differential operator, E total emission volume, X_{Tot}^{Output} total output (in real terms), E_i the sectoral emission volumes and X_i^{Output} the sectoral outputs. A similar formula is used in the case of emissions originating from final consumption.[172]

The determinants of variations in the levels of emissions due to changes in production or consumption vectors are displayed in Table 5-4. Observing the values in the *scale effect* column, it clearly emerges that the predominant role in environmental degradation (across all types of emission) is played by the increase in activity volumes. The proportion of polluting goods and services produced and consumed expands from 1991 to 2004, thereby increasing, with the exception of sulphur and nitrogen oxides emissions, the aggregate pollution volumes (*composition effect*). Finally, production technologies appear to be cleaner at the end of the period, specifically because of the improvements derived from the assumed gains in the energy efficiency factor and from some substitution in production factors (*technology effect*). Bio-accumulative emissions are once more the exception, but register very low magnitudes.

The actual mechanics of the technology effect deserve some additional elaboration. The production technology specification was briefly described in the previous section, but it is worthwhile highlighting again some of its important characteristics. In the current CGE model production technology is defined as a combination of intermediate inputs and primary factors. Some substitution among these two groups is possible, while intermediate inputs are combined among themselves in fixed proportions. The primary factor bundle is composed of three substitutable components: energy, capital and labour, with energy producing toxic emissions when used. Energy is furthermore decomposed in oil products and electricity, with each of them having different polluting characteristics. Therefore a producer may reduce its emissions at any of the described levels by substituting intermediates and factors, or by replacing energy with non-energy factors, or,

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[172] In this case, the technological effect is absent, given that each component of final consumption is associated to an emission coefficient invariant with time. The emission volumes variation due to a modified consumption vector takes the form:

$$\partial E = \sum_i \left[\partial \left(\frac{X_i^{Armington}}{X_{Tot}^{Armington}} \right) \frac{E_i}{X_i^{Armington}} + \partial \left(X_{Tot}^{Armington} \right) \frac{E_i}{X_{tot}^{Armington}} \right]$$

where $X_{Tot}^{Armington}$ is total final consumption (of the Armington composite good) in real terms and $X_i^{Armington}$ final consumption in real terms of product i.

finally, by switching among energy sources. Actual substitutions result from alterations in relative prices of the constituents (intermediates and factors), and relative prices are changed, among other things, by indirect tax variations. For instance, in the basic scenario where a real exchange rate devaluation is registered, increases in the price of imported oil induce the energy demand to shift towards electricity, thus causing a reduction in the emission intensities of domestic production (consider column 3 in Table 5-4). This effect is particularly evident in the hydrocarbon gas categories (SO2 and NO2), where emissions grow more slowly than production or consumption (see Table 5-3).

Table 5-4: Decomposition analysis of emission variations, 1990-2004 (Benchmark scenario)

	Production			Consumption		
	Composition	Technology	Scale	Composition	Technology	Scale
Variations in Volumes (1000 metric tons)						
TOXAIR	1.7	-0.3	28.0	0.1	0.0	2.6
TOXWAT	1.7	-1.4	36.3	0.0	0.0	6.0
TOXSOL	12.0	-0.7	125.1	0.2	0.0	5.4
BIOAIR*	50.0	-0.7	454.9	0.2	0.0	0.7
BIOWAT*	3.1	0.0	32.2	16.2	0.0	61.9
BIOSOL*	1052.9	-14.1	9469.3	1.6	0.0	6.0
SO2	-1.1	-5.0	30.6	-0.1	0.0	8.0
NO2	-0.5	-2.9	20.0	-0.1	0.0	4.6
CO	4.0	-0.5	40.0	0.0	0.0	0.7
VOC	0.1	-0.8	10.1	0.1	0.0	3.3
PART	0.2	-0.7	8.0	-0.0	0.0	1.1
BOD	1.0	0.0	12.4	0.0	0.0	0.4
TSS	100.5	-1.3	899.4	0.0	0.0	0.0
Variations in percentages						
TOXAIR	6	-1	95	3	0	97
TOXWAT	5	-4	99	1	0	99
TOXSOL	9	-1	92	4	0	96
BIOAIR	10	0	90	20	0	80
BIOWAT	9	0	91	21	0	79
BIOSOL	10	0	90	20	0	80
SO2	-4	-21	125	-1	0	101
NO2	-3	-18	120	-1	0	101
CO	9	-1	92	-1	0	101
VOC	1	-8	108	2	0	98
PART	3	-9	106	-1	0	101
BOD	7	0	93	8	0	92
TSS	10	0	90	0	0	0

* Bio-accumulative pollution intensities are in metric tons

Even if this specification incorporates a quite complex adjustment process, it should be noticed that some important links between pollution and technology are not precisely taken into account. For instance, innovation or technology transfers, which may explain how substitution among factors and inputs can be realised, are not explicitly modelled. Besides, emissions reduction, cleaning and other end-of-pipe techniques are not considered. The basic mechanism is governed by an endogenous response to changes in relative prices of factors/inputs and its flexibility is limited by empirical substitution elasticities.

In summary, with no policy intervention, economic activity growth results in a significant increment of emissions despite output and consumption shifts towards less polluting products and the implementation of cleaner technology.

5.5 Trade and Environmental Policy Scenarios

Having defined a 'Business as Usual' (BaU) base scenario, this section examines the interactions between international trade policy and the environment, between environmental policy and the economy, and finally the effects obtained by a joint implementation of these two policies. In most cases, the links between the environment and economic activity are significant. Their complexity though should discourage policy makers from adopting corrective measures based on a heuristic approach or partial analyses. In particular, I estimate that trade liberalisation, in the form of a free trade area with the European Community, results in remarkable increase in both levels and intensities of major pollutants in the absence of any environmental policy. Moreover, policies aiming at a direct reduction in emissions may obtain quite positive environmental results but with prejudicial and unintended effects on economic growth. Finally, co-ordinated policies may in a certain measure realise the two objectives of improving growth opportunities and reducing environmental damage. The fact that the FTA with Europe will ultimately imply some sort of harmonisation with emissions restrictions of the Community, makes it reasonable to think that Morocco will be forced to adopt some regime of policy co-ordination.

The first scenario simulates a policy of trade liberalisation through a progressive reduction in import tariffs. These international trade distortions are decreased *ad valorem* by 5 per cent with respect to the benchmark case in 1992, by 27.5 per cent in 1998, by 58.5 per cent in 2001 and completely abolished at the end with a perfect convergence of domestic and international prices.

The second round of simulations consider a progressive reduction of each type of emission (i.e. it consists of 13 different experiments). A target in terms of emissions abatement is exogenously fixed as follows. Emissions levels are reduced with respect to the reference scenario by 2 per cent in 1992, 8 per cent in 1998, 17 per cent in 2001 and 25 per cent in the end of the period. The instrument used to reach this target is a uniform tax per unit of emission paid by the agent causing that pollution and endogenously determined by the model.[173]

Trade liberalisation

Moroccan import protection is relatively high for international standards and it is also fairly dispersed across sectors.[174] Even if these distortions do not seem substantial when measured as weighted averages against imports, they confer price advantages to particular domestic production sectors such as, for instance, agriculture. This section explores the effects of the FTA agreement between Morocco and the European Community. Within the discussed exogenous growth hypotheses, the model simulates a reduction of Moroccan restrictions against imports originating in the EC. This liberalisation, according to the letter of the agreement, eliminates tariffs progressively in four years and non-tariff barriers in six years. There are some important differences between the simulated and the agreed FTA liberalisation. Firstly, the simulations do not exempt agricultural goods as in the current version of the agreement. Secondly, it is assumed that the Moroccan government budget does not vary and that increasing households' direct taxes compensate revenue losses from reduced import duties. This particular scenario, by eliminating negative fiscal effects, allows to better isolating the pure and simple effects of the trade policy.[175]

In order to render more legible our results presented in the following tables, emissions are aggregated into five groups: toxic pollutants (TOXAIR, TOXWAT, TOXSOL), bio-accumulative metals (BIOAIR, BIOWAT, BIOSOL), oxide emissions (SO_2, NO_2, CO), other air pollutants (VOC, PART) and other water pollutants (BOD, SS). These

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[173] See the technical specification of the model for more details.
[174] See chapter 7, Table 7-3.
[175] A detailed account of different closures is given in chapter 7.

aggregations are consistent in physical terms and do not hide relative variations of opposite sign. In fact, emissions show a high correlation degree within each group.[176]

Table 5-5 summarises the main results in terms of emission elasticities. The figures in this table correspond to a percentage change in emission groups with respect to 1 per cent change in total production or consumption. The first row (BaU) shows for each emission group the elasticities of the reference scenario, so that, for instance, average yearly growth rates for bio-accumulative emissions in the period 1991 – 2004 in the reference case are estimated to be equal to 1.15 times the average growth rate for production; or, considering consumption originated emissions, 1.37 times the corresponding growth rate for final demand.

Table 5-5: Emission elasticities. Separated environmental and commercial policies

	With respect to production					With respect to consumption				
	Tox	**Bio**	**Nox**	**Air**	**Wat**	**Tox**	**Bio**	**Nox**	**Air**	**Wat**
BaU	1.09	1.15	0.91	0.91	1.15	1.03	1.37	0.98	1.01	1.12
EC FTA	1.26	1.63	1.11	1.05	1.64	1.15	1.43	1.00	1.11	1.17
TOXAIR	0.67	0.20	0.49	0.63	0.20	0.73	1.05	0.95	0.87	0.52
TOXWAT	0.59	0.43	0.16	0.36	0.43	0.52	0.80	0.73	0.80	0.20
TOXSOL	0.68	0.32	0.50	0.64	0.31	0.77	0.96	0.97	0.94	0.45
BIOAIR	0.92	0.62	0.70	0.77	0.62	0.96	1.29	0.98	0.97	1.07
BIOWAT	0.73	0.54	0.60	0.71	0.53	0.96	0.80	0.98	0.97	1.08
BIOSOL	0.92	0.64	0.71	0.77	0.63	0.96	1.30	0.98	0.97	1.07
SO2	1.03	1.16	0.57	0.63	1.16	0.92	1.28	0.67	0.86	0.94
NO2	1.00	1.14	0.55	0.62	1.14	0.90	1.23	0.67	0.86	0.85
CO	0.91	0.59	0.68	0.75	0.59	0.95	1.29	0.97	0.96	1.06
VOC	0.85	0.41	0.17	0.29	0.41	0.73	1.34	0.63	0.57	1.11
PART	0.81	0.49	0.33	0.48	0.49	0.84	1.19	0.73	0.83	0.88
BOD	0.77	0.97	0.70	0.78	0.96	0.83	0.75	1.00	1.02	0.13
TSS	0.93	0.65	0.71	0.78	0.64	0.96	1.30	0.98	0.97	1.07

Notes : *Tox*: toxic pollutants; *Bio*: bio-accumulatives metals; *Nox*: sulfur, nitrogen and carbon oxides; *Air*: other air pollutants; *Wat*: other water pollutants.

The second row in Table 5-5 shows emission elasticities for the FTA case and the differences with the reference case are remarkable. It clearly appears that trade liberalisation vis-à-vis the European Community, in the absence of counteractive measures, will result in increased pollution intensities for both supply and demand in Morocco across all emissions categories. In fact, for some cases, emissions intensities increase considerably with trade opening. The main reason for this effect is the

[176] In the following sub-sections the results from the above simulations are presented. For the sake of clarity only global or very aggregated results are shown, even though the model is run with about 50

intensification of Morocco's traditional comparative advantage. This is causing a stronger specialisation towards more polluting activities compared to the benchmark, in particular activities linked with export agriculture, mining, and polluting manufacturing record significant growth rates.

Table 5-6 shows how changes in emissions induced by the European FTA can be decomposed. It clearly appears that both *composition* and *technology* effects contribute to increase pollution elasticities, with the first being the larger component.

Table 5-6: Decomposition analysis of emission variations, 1990-2004 (EC FTA scenario)

	Production			Consumption		
	Composition	Technology	Scale	Composition	Technology	Scale
Variations in Volumes (1000 metric tons)						
TOXAIR	6.9	0.1	39.3	0.4	0.0	3.1
TOXWAT	1.9	-0.6	42.1	0.7	0.0	7.1
TOXSOL	31.6	1.4	159.6	0.7	0.0	6.3
BIOAIR*	250.6	4.3	681.4	0.4	0.0	1.0
BIOWAT*	14.5	0.4	46.1	19.3	0.0	71.2
BIOSOL*	5413.5	89.9	14331.8	3.4	0.0	7.9
SO2	-3.5	-3.9	33.9	0.0	0.0	8.9
NO2	-2.2	-2.3	22.0	0.0	0.0	5.2
CO	21.4	0.0	59.7	0.0	0.0	0.8
VOC	0.5	-0.5	12.1	0.4	0.0	4.0
PART	1.4	-0.5	10.2	0.0	0.0	1.2
BOD	0.5	0.2	13.9	0.1	0.0	0.4
TSS	523.5	8.5	1368.3	0.0	0.0	0.0
Variations in percentages						
TOXAIR	15	0	85	11	0	89
TOXWAT	4	-1	97	9	0	91
TOXSOL	16	1	83	10	0	90
BIOAIR	27	0	73	29	0	71
BIOWAT	24	1	76	21	0	79
BIOSOL	27	0	72	30	0	70
SO2	-13	-15	128	0	0	100
NO2	-13	-13	126	0	0	100
CO	26	0	74	0	0	100
VOC	4	-4	100	9	0	91
PART	13	-5	92	0	0	100
BOD	3	1	95	20	0	80
TSS	28	0	72	0	0	0

* Bio-accumulative pollution intensities are in metric tons

In other words, Moroccan specialisation in polluting activities is mainly explained by a shift in the output composition towards more pollution intensive products rather than by the use of dirtier technologies across all industries. This *composition* effect reflects the full exploitation of Moroccan comparative advantage in polluting sectors.

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sectors. Detailed results, averaging more than 3000 values per period are available.

The *technology* effect is generally positive in this FTA scenario for two reasons. Firstly, import liberalisation reduces relative prices of various polluting inputs, among which are chemicals. Secondly, prices of oil products originating in the EC fall with respect to oil coming from other sources and domestic electricity. The first effect induces trade diversion and the second a technological shift towards a more polluting energy product.[177] The *scale* effect plays the most important role, significantly raising aggregate emissions levels. Similar reasoning applies to consumption.

It appears then that trade liberalisation in the form of a FTA with EC will give rise to higher levels of local pollution in Morocco. Not only the total volume of emissions will increase, but also, in the absence of environmental policies, it will grow at a faster rate than total production and consumption.

To better clarify the links between trade liberalisation and emissions, Table 5-7 presents, for the FTA case, sectoral results for production, consumption, and total emissions.

Table 5-7: Sectoral adjustments resulting from an EC FTA

	Real Production	Real Consumption	Total Emissions	Production %	Emissions %	Ratio Emiss./Prod.
FoodAgri	0.32	1.30	0.75	10.74	0.16	0.02
ExpAgri	7.98	1.90	9.99	4.30	0.06	0.01
Mining	12.51	0.00	15.00	1.87	0.58	0.31
FoodPr	-2.69	4.19	-0.04	7.62	0.18	0.02
Textile	14.15	6.74	15.84	8.86	0.05	0.01
PollMan	7.57	10.67	10.49	18.15	84.89	4.68
OthMan	-4.76	19.65	-4.34	3.55	0.30	0.09
PollServ	6.99	6.23	9.24	10.96	13.25	1.21
NPollServ	5.72	2.27	7.96	33.96	0.53	0.02
Total				100.00	100.00	

The first 3 columns show percentage differences with respect to the BaU case. The last 3 columns are calculated form the 1990 base year data.

Even at this relatively aggregate level, the sources of pollution caused by trade liberalisation become apparent. Considering the production side, these include export agriculture, mining, textiles and polluting manufacturing. These are the Moroccan sectors that enjoy traditional comparative advantage. The last column shows that for two of these macro-sectors, mining, and polluting manufacturing the emission intensities are well

[177] Notice that in this FTA scenario SO2 and NO2 still record negative values but their reduction is *lower* than in the benchmark case (confront the relevant rows in Table 5-4 and Table 5-6).

above the average.[178] Direct pollution from export agriculture does not seem to be above average, but its upward linkages with chemical products bring about significant emissions.

Final consumption growth generates additional emissions especially in the polluting manufacturing and polluting services (particularly in transport services and electricity). These are typically expanding sectors of a growing economy and adequate regulation should be put in place.

Environmental policy

Although the apparent negative environmental consequences of the described FTA agreement for Morocco, it has been established that import protection is an inefficient policy for environment protection.[179] Pollution taxes directly targeted to affect polluting agents' behaviour are much more efficient, but they may have some costs in terms of economic growth. In this section, the Moroccan trade and environment model has been used to determine the effects of these environmental taxes.

The last 13 rows of Table 5-5 correspond to the hypothetical implementation of a specific emission tax. This takes the form, for each of the 13-emission types, of a uniform tax levied on producers and consumers so that an exogenously assigned emission reduction with respect to the benchmark level is achieved within the period considered.[180] For instance, if a uniform tax were levied on water pollutants (TOXWAT) so that 25 per cent abatement with respect to the benchmark were the target for the year 2004, average yearly growth rates for bio-accumulative emissions would be equal to 0.43 times the average growth rate for production. Or, considering consumption originated emissions, 0.80 times the corresponding growth rate for final demand (consider the forth row in Table 5-5).

Form the figures of Table 5-5 it clearly appears that targeted emission taxes have considerable reduction effects. For each simulation and across pollutant groups, emissions elasticities with respect to production are smaller than in the benchmark. The

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[178] In fact, also polluting services register emission intensity above the average, but their export to output ratio is very low (see Table 5-1) making their trade-related contribution to pollution less important.

[179] See Beghin, Roland-Holst and van der Mensbrugghe (1995) and Perroni and Wigle (1994).

only exception is represented by the policies targeted at sulphur oxides: in this case a slight increase (0.01 points) with respect to the benchmark is registered in the elasticities for Bio emissions and water pollutants. It is also worth noting that a specific abatement policy not only reduces its targeted toxic emissions but also those of other pollutants. Substitution effects among different types of emission are not induced in the production processes. This may be explained by two related facts: firstly specific intermediates (for example oil) are used in the production of most goods and generate emissions of most types, and secondly, given the Leontief structure of intermediate consumption no substitution is possible among them. Thus targeting a specific effluent has the connected beneficial effects of reducing other pollutants.

Aggregate reduction in the emission volumes is primarily the result of the decrease in production generated emissions. And this is due to a shift of production towards less polluting activities as well as, within each activity, to the implementation of cleaner technologies. A detailed analysis decomposing the various reduction effects would show a significantly lower output for those sectors producing highly polluting goods (POLL), up to 20 per cent with respect to the reference scenario in the year 2004 (*composition effect*). It would also illustrate that emissions abatement in the other industries is obtained through diminished pollution intensities (*technology effect*), as the result of substitution of toxic intermediates with more labour and capital and cleaner energy sources.

Table 5-8: Real GDP, exports and imports growth rates (per cent average yearly rates 1991-2004)

	BaU	Tox			Bio			other							ave.	FTA
		Air	Wat	Sol	Air	Wat	Sol	SO2	NO2	CO	VOC	PART	BOD	TSS		
RGDP	4.0	3.9	3.8	3.8	4.0	3.8	4.0	4.1	4.0	4.0	3.9	3.9	3.8	4.0	3.9	4.6
Export	4.7	4.1	4.4	4.3	4.4	4.3	4.4	4.7	4.7	4.4	4.4	4.4	4.5	4.4	4.4	11.1
Import	3.5	3.0	3.3	3.2	3.2	3.2	3.2	3.5	3.5	3.2	3.3	3.3	3.4	3.2	3.3	9.0

Once the efficiency of the emission taxes has been shown, the next important question concerns their cost in terms of reduced economic growth. Judging from the

[180] For an exogenous reduction rate in emission volumes the model endogenously calculates the tax rate. The result is analogous to the implementation of tradable pollution rights where the equilibrium price of these rights is equal to the applied tax.

results of Table 5-8, the different progressive abatement policies examined have quite low costs in output terms. The average yearly GDP growth rate in the simulations is found in the range of 3.8 and 4.1 per cent, very close to the benchmark rate of 4.0 per cent.

This low cost may be explained by several related reasons. Firstly, as explained above, the *composition effect* plays an important role and even if certain sectors reduce considerably their output, and consequently their factor demands, other industries expand and take advantage of the non-polluting resources released by the contracting sectors. Moreover, these expanding activities may also benefit from the assumed substitution possibilities between different inputs and factors, shifting their technologies towards cleaner input combinations, thus avoiding rising costs due to the emission taxes.[181]

Secondly, the redistribution scheme of the emission tax revenue seems to almost cancel out the distortionary effect of these same taxes. It should be noticed that in the simulations with abatement policies, savings are higher, even in the current model with myopic agents who do not anticipate future emission taxes. This is due to the tax redistribution scheme. Revenues from emission taxes are redistributed to the households as a function of their income tax rates.[182] In the Moroccan case, households with higher income tax rates also record larger savings rates, hence a large part of the increased government transfers they receive is saved. This results in larger investment possibilities and faster capital accumulation, a sort of double dividend effect. Besides new capital vintages enjoy larger production substitution elasticities helping the economy to adjust more quickly without compromising aggregate growth rates.

It should also be noticed that environmental policy does not significantly affect Moroccan external competitiveness, for its aggregate exports (in real term) growth rates are at most (in the case of an air toxic emission abatement policy) decreased by 0.3 percentage points, with respect to the benchmark. The same reasons justifying the limited

[181] Table 5-11, in the annex to this chapter, shows the initial pollution coefficients for both production and consumption (the α's and β's of equation at page 129). It clearly appears that, in the Moroccan case, these coefficients are concentrated in a few sectors. In fact, targeted emission taxes considerably affect only that small number of industries that are making an intense use of the polluting inputs. This, jointly with the other reasons exposed in the main text, explains why additional relative price distortions caused by emission taxes are not spread to too many sectors, and why aggregate growth is not affected in a marked way.

reduction of production growth rates might be applied for the international competitiveness case. In addition, given their initial input combinations and the emission coefficients' concentration in a few sectors, relative price changes due to emission taxes do not greatly affect Moroccan export activities.[183]

Abatement policies seem to be much less effective on the emission volumes generated through final consumption. This can be explained considering two facts. Firstly, in the model households' reactions to emissions taxes are sluggish, in the sense that there is no "technological" improvement in their consumption pattern. This slow reaction is also confirmed by empirical data observed in the OECD countries context,[184] and is primarily due to the households' lower, as compared to enterprises, replacement rate of appliances and other durable equipment (housing, vehicles) which are the main source of pollutants (fuels, chemicals). Secondly, most of the tax burden (in percentage of total revenues) is on producers, these being the main polluters through their production activities.

Co-ordinated environmental and commercial policies

The rewards in terms of positive environmental results of pollution abatement policies and the economic gains of trade liberalisation suggest the possibility of a co-ordination of these policies. This section presents a menu of different options that combine an EC FTA agreement with specific targeted emission taxes.

Apart from the intuitive attractiveness of this policy co-ordination, the Moroccan current trade liberalisation without connected corrective environmental measures seems unsustainable for several supplementary reasons. On one hand, given the current Moroccan comparative advantage structure, tariff elimination will favour the most polluting sectors. This tendency could be exacerbated if Moroccan trade partners, among which EC countries play a major role, tighten their environmental policies. In these countries production costs of locally polluting goods will rise further promoting cheaper imports from Morocco.[185] On the other hand, anti-pollution pressures could originate

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[182] These are calculated from the base year SAM.
[183] See footnote 181.
[184] See Dessus (1989).
[185] A country exporting goods intensive in polluting inputs is also exporting a pollution service, retaining domestically the effluents emissions effects of the production and saving to the importing countries the

from neighbour countries thus inducing the Moroccan government to adopt higher environmental quality standards. These demands could even arise locally, once a more developed society discounts disutility from pollution at a higher rate. All these factors contribute to make a combination of trade liberalisation and abatement policy the most plausible scenario for Morocco in future years.

Table 5-9 shows pollution elasticities for 13 experiments with co-ordinated environmental and trade policies. Notice that both policies are now jointly implemented and that their time paths and rates are exactly the same as in the previous simulations.

The co-ordination of environmental and commercial policies produces positive results: it significantly reduces emissions and yet allows income and consumption to grow. Invariably, in all experiments pollution taxes mitigate the negative effects of a pure trade policy, and pollution elasticities are below the values registered when that policy is implemented in isolation. In some cases, co-ordination even reaches elasticities values below those of a pure abatement policy (compare for instance row "*TOXAIR+L*" in Table 5-9 with the corresponding row in Table 5-5), in other cases it appears less effective (oxides).

Table 5-9: Emission elasticities. Co-ordinated environmental and commercial policies (EC FTA case)

	WRT Production					WRT Consumption				
	Tox	**Bio**	**Nox**	**Air**	**Wat**	**Tox**	**Bio**	**Nox**	**Air**	**Wat**
BaU	1.09	1.15	0.91	0.91	1.15	1.03	1.37	0.98	1.01	1.12
EC FTA Lib.	1.26	1.63	1.11	1.05	1.64	1.15	1.43	1.00	1.11	1.17
TOXAIR+L	0.63	0.08	0.43	0.59	0.08	0.83	1.11	0.97	0.96	0.62
TOXWAT+L	0.58	0.40	0.12	0.32	0.40	0.62	0.87	0.78	0.90	0.30
TOXSOL+L	0.67	0.28	0.44	0.58	0.28	0.90	1.03	0.99	1.04	0.60
BIOAIR+L	0.89	0.61	0.65	0.72	0.61	1.05	1.30	1.00	1.06	1.12
BIOWAT+L	0.69	0.45	0.52	0.65	0.45	1.05	0.83	1.00	1.06	1.13
BIOSOL+L	0.90	0.61	0.65	0.73	0.62	1.05	1.31	1.00	1.06	1.13
SO2+L	1.18	1.59	0.79	0.78	1.59	1.05	1.34	0.69	0.96	1.02
NO2+L	1.16	1.58	0.78	0.78	1.59	1.04	1.31	0.71	0.97	0.95
CO+L	0.88	0.57	0.62	0.70	0.57	1.05	1.30	0.99	1.05	1.12
VOC+L	0.78	0.26	0.06	0.21	0.26	0.82	1.34	0.68	0.66	1.17
PART+L	0.79	0.46	0.31	0.46	0.47	0.97	1.22	0.80	0.95	1.00
BOD+L	0.91	1.37	0.85	0.87	1.37	0.95	0.84	1.02	1.12	0.20
TSS+L	0.90	0.62	0.66	0.73	0.62	1.05	1.31	1.00	1.06	1.13

environmental cost. This effect should be distinguished from the "pollution heaven" effect that is a capital markets response to differentials in environmental standards.

In the co-ordination simulation, emission elasticities with respect to consumption are almost always slightly higher. In other words, consumption-generated pollution is highest in the EC FTA case, lowest in the pure emission abatement policy case, and somewhere in between when the two policies are combined. This is due to the fact that trade liberalisation increases households' incomes and this shifts consumption towards more polluting products.[186]

Output of polluting products (POLL) increases according to Moroccan comparative advantage. In the co-ordinated policy case, the composition effect is less important but is compensated by more substantial factor substitutions that reduce the emission volumes per unit of output. In fact, this technology effect is reflected in the substitution of toxic intermediates with more labour and capital value added. Larger savings, generated from increased households' incomes, reduce capital rental rates and allow enterprises to make the new investments necessary to reduce emissions without excessively rising output costs.

Finally, although all the above results referring to trade reform have been obtained simulating a FTA policy with respect to the European Community partners, the model allows experimenting with other regional specific liberalisation policies. In particular, Table 5-10 shows the results for co-ordinated environmental and commercial policies when these consist of a full unilateral liberalisation vis-à-vis all trading partners.[187] The main point here is that no significant *qualitative* change is registered. These results are not surprising given the importance of the Moroccan trade with the EU. A detailed analysis of these results requires a precise assessment of the differences in the trade patterns Morocco shows with respect to its commercial partners. A further chapter is focused on this particular issue, so that Table 5-10 and Table 5-9 can be compared with the results obtained below.

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[186] The income elasticities for consumption of services used in the model are larger than unity. This enhances the consumption shifts towards polluting services due to the income increase caused by trade liberalisation.

[187] The last row displays the pure policy of global trade liberalisation.

Table 5-10: Emission elasticities. Co-ordinated environmental and commercial policies (Global trade liberalisation case)

	WRT Production					WRT Consumption				
	Tox	Bio	Nox	Air	Wat	Tox	Bio	Nox	Air	Wat
BAU	1.09	1.15	0.91	0.91	1.15	1.03	1.37	0.98	1.01	1.12
Global Lib.	1.83	2.81	1.84	1.59	2.82	1.34	1.55	1.07	1.23	1.25
TOXAIR+L	0.63	0.06	0.49	0.63	0.06	0.89	1.08	1.16	1.07	0.64
TOXWAT+L	0.56	0.43	0.10	0.29	0.43	0.67	0.80	0.93	0.98	0.31
TOXSOL+L	0.65	0.30	0.46	0.58	0.31	0.96	0.95	1.20	1.15	0.62
BIOAIR+L	0.87	0.59	0.66	0.72	0.59	1.10	1.21	1.21	1.16	1.12
BIOWAT+L	0.68	0.50	0.55	0.65	0.50	1.11	0.77	1.20	1.16	1.13
BIOSOL+L	0.87	0.59	0.66	0.72	0.59	1.10	1.22	1.21	1.16	1.12
SO2+L	1.33	1.95	0.99	0.92	1.95	1.08	1.35	0.74	1.00	1.00
NO2+L	1.31	1.95	0.99	0.92	1.95	1.06	1.31	0.77	1.01	0.92
CO+L	0.85	0.54	0.62	0.69	0.54	1.10	1.21	1.19	1.15	1.12
VOC+L	0.75	0.23	0.02	0.17	0.23	0.85	1.27	0.81	0.72	1.18
PART+L	0.74	0.44	0.26	0.41	0.44	1.01	1.13	0.96	1.04	1.00
BOD+L	1.05	1.73	1.05	1.01	1.73	1.02	0.79	1.21	1.22	0.16
TSS+L	0.87	0.59	0.66	0.72	0.60	1.10	1.22	1.20	1.16	1.12

Notes : *Tox*: toxic pollutants; *Bio*: bio-accumulatives metals; *Nox*: sulfur, nitrogen and carbon oxides; *Air*: other air pollutants; *Wat*: other water pollutants.

5.6 Conclusion

From a policy analysis point of view, two general lessons may be learned from this research, which support the main conclusions from previous studies as well as providing new insights.[188] Firstly, in Morocco there are strong linkages between trade flows and the environment and a co-ordinated approach of commercial and environmental policies is necessary to avoid undesired secondary effects. Secondly, these linkages are rather complex and policy makers who base their decisions on simple intuition or unsuitable empirical methods will not be able to conceive nor implement policies that even approach optimality.

More specifically, the results obtained above indicate that, in the absence of a counter-balancing environmental policy, an agreement of the type Morocco has negotiated with the European Community will shift the economy towards more polluting production and consumption structures. For certain major effluent categories, pollution may increase by as much as 65 per cent more rapidly than GDP. Consequently the

[188] Consider Beghin, Roland-Holst and van der Mensbrugghe (1994), Bovenberg and Goulder (1993), ECC (1994), and Perroni and Wigle (1994).

considerable economic gains resulting from trade liberalisation may cause significant environmental degradation.

The analysis of the isolated environmental policy proved three main advantages of fiscal instruments targeted to specific emissions. Firstly, sectoral outputs and emission volumes no longer grow at the same rates. Secondly, the economic costs (in growth terms) of a similar policy appear to be quite low. Thirdly, even when a single specific emission is taxed little substitution towards other pollutants is induced; this is a direct consequence of linking emissions to input use (and the technology assumptions) rather than simply to output. It can be added that emission taxes are much more efficient in reducing pollution than an indirect measure such as trade barriers. These in fact do not have a particularly beneficial environmental effect unless raised to unrealistic and very costly (in terms of GDP) levels.[189]

A final set of results illustrated the advantages of a co-ordination in environmental and commercial policies. When implemented in concert with the FTA agreement, emission taxes may realise appreciable pollution reduction without neutralising most of the gains from trade liberalisation. In particular, in the co-ordination case, structural adjustment in the direction of a more efficient resource allocation induced by trade reforms is guided towards cleaner sectors.

Future research may improve the current model specification in some new directions. In particular, future versions may include the relationship between factor productivity and environmental degradation, an explicit modelling of new technologies, and the incorporation of household preferences towards the environment. Removal of the existing limitations will probably result in higher estimated gains from well-conceived abatement policies and their co-ordination with trade liberalisation.

Another interesting direction for future research may be a more complete study of the green tax redistribution mechanism and its potential linkages with income distribution and growth.

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[189] Although this is not shown, a simulation was conducted in which trade barriers were raised in order to obtain the same 25% reduction in emissions levels. The resulting tariff levels were above 100% for a considerable number of sectors.

5.7 Annex: Moroccan emission coefficients

Table 5-11: Emissions coefficients for Output

(β_i - expressed in pounds / Million Dirham 90)

	TOX			BIO			OTHER						
	Air	Wat	Sol	Air	Wat	Sol	SO2	NO2	CO	VOC	PART	BOD	TSS
HardWheat	0	0	0	0	0	0	0	0	0	0	0	0	0
SoftWheat	0	0	0	0	0	0	0	0	0	0	0	0	0
Barley	0	0	0	0	0	0	0	0	0	0	0	0	0
Maize	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0
Legumes	0	0	0	0	0	0	0	0	0	0	0	0	0
Sugar	0	0	0	0	0	0	0	0	0	0	0	0	0
OilSeeds	0	0	0	0	0	0	0	0	0	0	0	0	0
RawFibre	0	0	0	0	0	0	0	0	0	0	0	0	0
Vegetables	0	0	0	0	0	0	0	0	0	0	0	0	0
Citrus	0	0	0	0	0	0	0	0	0	0	0	0	0
Olives	0	0	0	0	0	0	0	0	0	0	0	0	0
Grapes	0	0	0	0	0	0	0	0	0	0	0	0	0
Dates	0	0	0	0	0	0	0	0	0	0	0	0	0
Almonds	0	0	0	0	0	0	0	0	0	0	0	0	0
OthAgri	0	0	0	0	0	0	0	0	0	0	0	0	0
Livestock	0	0	0	0	0	0	0	0	0	0	0	0	0
Forestry	0	0	0	0	0	0	0	0	0	0	0	0	0
Fishing	0	0	0	0	0	0	0	0	0	0	0	0	0
PhosphMin	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum	0	0	0	0	0	0	0	0	0	0	0	0	0
Elect	0	0	0	0	0	0	0	0	0	0	0	0	0
AgroFood	0	0	0	0	0	0	0	0	0	0	0	103.05	0
AnimalFeed	0	0	0	0	0	0	0	0	0	0	0	0	0
Beverage	0	0	0	0	0	0	0	0	0	79.46	0	0	0
Textile	0	0	0	0	0	0	0	0	0	0	0	0	0
Carpets	0	0	0	0	0	0	0	0	0	0	0	0	0
Apparel	843.27	0	0	0	0	0	0	0	0	0	0	0	0
Leather	0	0	0	0	0	0	0	0	0	0	0	0	0
Shoes	0	0	0	0	0	0	0	0	0	0	0	0	0
WoodProd	0	0	0	0	0	0	0	0	202.72	253.59	61.54	0	0
PaperPub	44.91	766.41	122.53	0	0	0	324.33	143.62	119.18	0	41.21	287.21	302.85
StoneCeram	0	0	0	0	0	0	1,223.37	1,243.18	0	0	256.79	0	0
Metals	0	0	0	0.14	0	0	0	0	0	0	0	0	0
MetalProd	0	0	0	0	0	0	0	0	0	0	0	0	0
NonElecMch	0	0	0	0.18	0	0	0	0	0	64.80	0	0	0
Vehicles	0	0	0	0.42	0	0	0	0	0	0	0	0	0
ElecMach	0	0	0	0	0	0	0	0	0	0	0	0	0
ChemFert	0	0	0	0	0	0	0	0	0	0	0	0	0
OtherChem	0	0	0	0	0	0	0	0	0	0	0	0	398.26
OthMfg	0	0	0	0	0	0	0	0	0	0	0	0	0
Construct	0	0	0	0	0	0	0	0	0	0	0	0	0
Commerce	0	0	0	0	0	0	0	0	0	0	0	0	0
Transport	0	0	0	0	0	0	0	0	0	0	0	0	0
Communic	0	0	0	0	0	0	0	0	0	0	0	0	0
BankInsRe	0	0	0	0	0	0	0	0	0	0	0	0	0
OthPrivSrv	0	0	0	0	0	0	0	0	0	0	0	0	0
PublicAdm	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5-11(cont.): Emissions coefficients for Consumption

(α_i - expressed in pounds / Million Durham 90)

	TOX			BIO					OTHER				
	Air	Wat	Sol	Air	Wat	Sol	SO2	NO2	CO	VOC	PART	BOD	TSS
HardWheat	0	0	0	0	0	0	0	0	0	0	0	0	0
SoftWheat	0	0	0	0	0	0	0	0	0	0	0	0	0
Barley	0	0	0	0	0	0	0	0	0	0	0	0	0
Maize	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0
Legumes	0	0	0	0	0	0	0	0	0	0	0	0	0
Sugar	0	0	0	0	0	0	0	0	0	0	0	0	0
OilSeeds	0	0	0	0	0	0	0	0	0	0	0	0	0
RawFibre	0	0	0	0	0	0	0	0	0	0	0	0	0
Vegetables	0	0	0	0	0	0	0	0	0	0	0	0	0
Citrus	0	0	0	0	0	0	0	0	0	0	0	0	0
Olives	0	0	0	0	0	0	0	0	0	0	0	0	0
Grapes	0	0	0	0	0	0	0	0	0	0	0	0	0
Dates	0	0	0	0	0	0	0	0	0	0	0	0	0
Almonds	0	0	0	0	0	0	0	0	0	0	0	0	0
OthAgri	0	0	0	0	0	0	0	0	0	0	0	0	0
Livestock	0	0	0	0	0	0	0	0	0	0	0	0	0
Forestry	0	0	0	0	0	0	0	0	0	0	0	0	0
Fishing	0	0	0	0	0	0	0	0	0	0	0	0	0
PhosphMin	3,198 3	0	17,800 4	174 3	9 7	3,736 6	0	0	14,945 3	0	1,314 4	0	360,081 4
Petroleum	189 9	1,164 9	491 3	0	0	0	4,167 9	2,424 7	360 9	650 5	577 1	0	0
Elect	0	0	0	0	0	0	0	0	0	0	0	0	0
AgroFood	0	0	0	0	0	0	0	0	0	0	0	0	0
AnimalFeed	0	0	0	0	0	0	0	0	0	0	0	0	0
Beverage	0	0	0	0	0	0	0	0	0	0	0	0	0
Textile	0	0	0	0	0	0	0	0	0	0	0	0	0
Carpets	0	0	0	0	0	0	0	0	0	0	0	0	0
Apparel	0	0	0	0	0	0	0	0	0	0	0	0	0
Leather	0	0	0	0	0	0	0	0	0	0	0	0	0
Shoes	0	0	0	0	0	0	0	0	0	0	0	0	0
WoodProd	0	0	0	0	0	0	0	0	0	0	0	0	0
PaperPub	73 7	353 6	0	0	0	0	0	0	0	0	0	0	0
StoneCeram	2,351 4	4,450 8	16,810 1	0	0	0	0	0	0	0	0	2,573 3	0
Metals	0	0	463 4	6 5	0	54 0	0	0	0	0	0	0	0
MetalProd	0	0	0	0	0	0	0	0	0	0	0	0	0
NonElecMch	0	0	0	0	0	0	0	0	0	0	0	0	0
Vehicles	0	0	0	0	0	0	0	0	0	0	0	0	0
ElecMach	0	0	0	0	0	0	0	0	0	0	0	0	0
ChemFert	993 0	3,603 3	2,375 9	0	0	0	0	0	0	698 0	0	0	0
OtherChem	669 1	0	0	0	0	0	0	0	0	965 8	0	0	0
OthMfg	0	0	0	0	0	0	0	0	0	0	0	0	0
Construct	0	0	0	0	7 7	0	0	0	0	0	0	0	0
Commerce	0	0	0	0	0	0	0	0	0	0	0	0	0
Transport	0	0	0	0	0	0	0	0	0	0	0	0	0
Communic	0	0	0	0	0	0	0	0	0	0	0	0	0
BankInsRe	0	0	0	0	0	0	0	0	0	0	0	0	0
OthPrivSrv	0	0	0	0	0	0	0	0	0	0	0	0	0
PublicAdm	0	0	0	0	0	0	0	0	0	0	0	0	0

6 The Technical specification of the Environment and Trade model

6.1 Introduction

An overview of the Environment and Trade model, together with a discussion of its main characteristics, have been provided in the previous chapter. This chapter describes in detail the algebraic structure of the model dealing with its static equilibrium and the transition equations used in recursive dynamics. This Environment and Trade model was constructed for this thesis and its basic equations are derived from a prototype model constructed at the OECD Development Centre and another model built for the Moroccan government's Ministry of trade.[190] It incorporates characteristics from both of these previous models, creating in this way a new environmental and trade model for the study of Morocco. In particular, the main differences of the current model with respect to the OECD prototype include a more complex treatment of trade with the disaggregation of rest of the world account into three separated trade partners. This was necessary to simulate region specific trade liberalisation, such as the negotiated FTA agreement between Morocco and the European Community. Moreover, in the new model 'corporations' appear as an additional institution, and the 'households' account is disaggregated into 10 different household types. This implied several modifications to the modelling of consumption and income distribution. Several equations have been amended to include the green tax redistribution mechanism. These additions incorporated here allow a more precise study of the Moroccan case and a more complete analysis of the income distribution-growth linkages than existed in either of the earlier modelling exercises.

The remainder of this section introduces the dimensions of the Environment and Trade model utilised in the previous chapter.

[190] See Beghin, Dessus, Roland-Holst and van der Mensbrugghe (1996) and Bussolo, Roland-Holst and van der Mensbrugghe (1995).

There are four main dimensions: sectors, regions, households types and labour skills, and time. Some of these broad dimensions are split into sub-dimensions (or subsets to use the GAMS terminology).

The base data set is constructed around a 48-sector database, derived from the Moroccan SAM presented previously. The sectors are defined in Table 6-1. The usual indices are shown under each table title. In the case of multiple indices, they are simply synonyms (or aliases) for each other. Table 6-2 provides the definition of the regions. Table 6-3 defines the household type and labour skill dimension. Table 6-4 defines the time dimension.

Table 6-1: **Sectoral Definition**

(i,j)

1.	Hard Wheat	25.	Beverage
2.	Soft Wheat	26.	Textile
3.	Barley	27.	Carpets
4.	Maize	28.	Apparel
5.	Rice	29.	Leather
6.	Legumes	30.	Shoes
7.	Sugar	31.	Wood Product
8.	Oil Seeds	32.	Paper Publishing
9.	Raw Fibre	33.	Stone Ceramic
10.	Vegetables	34.	Metals
11.	Citrus	35.	Metal Products
12.	Olives	36.	Non Electric Machines
13.	Grapes	37.	Vehicles
14.	Dates	38.	Electric Machines
15.	Almonds	39.	Chemicals Fertiliser
16.	Other Agriculture	40.	Other Chemicals
17.	Livestock	41.	Other Manufacturing
18.	Forestry	42.	Construction
19.	Fishing	43.	Commerce
20.	Phosphates Mining	44.	Transport
21.	Petroleum	45.	Communication
22.	Elect	46.	Bank Insurance Real Estate
23.	Agro Food	47.	Other Private Services
24.	Animal Feed	48.	Public Administration

Table 6-2: **Regional Definition**

(r,r')

1.	European Community	3.	Rest of the World
2.	Other European Countires		

Table 6-3: **Household types and Labour Skills**

(h)

1. Urban professional
2. Urban government worker
3. Urban labourer
4. Urban proprietor
5. Urban non-professional
6. Small family farm
7. Large farms
8. Agricultural labourer
9. Non-agricultural rural labourer
10. Non-agricultural rural proprietor

(l)

1. Unskilled labour
2. Skilled labour
3. Other labour (independent workers, employers)

Table 6-4: **Time Definition**

(t)

1. 1990
2. 1992
3. 1995
4. 2001
5. 2004

6.2 Model blocks

6.2.1 Household Consumption

In many CGE models household expenditure behaviour functions are derived from the maximisation of Cobb-Douglas or Constant Elasticity of Substitution (CES) utility. The limitation of using these functional forms for consumption is that they imply unitary income elasticity of demand. This fails to account for the way changes in income affect the structural adjustment of the economy to exogenous shocks. In order to avoid such drawbacks, consumption demand in the current model is determined by using the utility function associated with the extended linear expenditure system (ELES). The ELES is similar to the LES or Stone-Geary system[191], but incorporates household saving into the utility function.

Consumers under the ELES are assumed to maximise the following utility function:[192]

$$\max U = \sum_i \mu_i \ln(C_i - \theta_i) + \mu_s \ln\left(\frac{S}{P}\right)$$

subject to the budget constraint:

$$\sum_i P_i^c C_i + S = Y^d$$

C is consumer spending, S is saving (in value), Y^d is disposable income, P^c are consumer prices, and μ and θ are the ELES parameters.[193] The Engel aggregation condition[194] requires the following constraints on the parameters μ:

$$\sum_i \mu_i + \mu_s = 1$$

The following demand functions can be derived:

$$C_i = \theta_i + \frac{\mu_i}{P^C{}_i}\left(Y^d - \sum_j P_j^C \theta_j\right)$$

The usual interpretation of this demand function is that consumption is composed of two parts. The first part has been referred to as the subsistence minima (or floor consumption), θ. The term in parenthesis represents residual income, or *supernumerary* income, i.e. it is the residual income after subtracting expenditures on the subsistence minima. Therefore the second part of consumption is a share of supernumerary income. Note that there is no minimal consumption of savings, i.e. θ_s is 0. Saving can be determined via the budget constraint:

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[191] See Stone (1954).

[192] Note that the same specification has been used for each household type.

[193] In the utility function, S needs to be deflated by an appropriate price, which would represent the consumer spot price of future consumption. This price does not need to be specified for the model since household saving can be derived as a residual from the budget constraint. For welfare calculations, the consumer price index, *cpi*, has been chosen as the saving deflator since there is no forward-looking behaviour in EMMA.

[194] See Deaton and Muellbauer (1980) page 16.

$$S = Y^d - \sum_i P_i^C C_i$$

The income and price elasticities are given by the following formula:

$$\eta_i = \frac{\mu_i Y^d}{P_i^C C_i} = \frac{\mu_i}{\chi_i}$$

$$\varepsilon_i = \frac{\theta_i(1-\mu_i)}{C_i} - 1$$

The income elasticity is equal to the ratio of the marginal propensity to consume good i out of supernumerary income, μ, over the average propensity to consume good i out of income.

The relevant model equations are presented in Table 6-5. Equation (6-5.1) defines supernumerary income. The subsistence minima are calibrated in the base year on a per capita basis, therefore they are multiplied each period by the total population (pop) in order to grow with population. The indices i and h identify the consumer goods and household type respectively. Equation (6-5.2) defines consumer demand in terms of Armington composite, X_{ih}^{AC}. Equations (6-5.3) and (6-5.4) define specific (S_h^H) and total (S_{tot}^H) household saving.

Table 6-5: **Household Consumption**

(6-5.1) $Y_h^* = Y_h^d - Pop_h \sum_i P_{ih}^C \theta_{ih}$

(6-5.2) $X_{ih}^{AC} = \theta_{ih} Pop_h + \frac{\mu_{ih}}{P_{ih}^C} Y_h^*$

(6-5.3) $S_h^H = Y_h^d - \sum_i P_{ih}^C C_{ih}$

(6-5.4) $S_{Tot}^H = \sum_h S_h^H$

Table 6-6 describes consumer prices. Equation (6-6.1) simply sets the consumer price equal to the Armington price. Equation (6-6.2) defines the consumer price index.

Table 6-6: **Consumer Prices**

(6-6.1) $P_{ih}^{C} = PA_{i}$

(6-6.2) $P_{h}^{CPI} = \dfrac{\sum_{i} P_{ih}^{C} X_{ih}^{AC}}{\sum_{i} P_{ih,0}^{C} X_{ih}^{AC}}$

6.2.2 Other Final Demands

Apart from household consumption, final demands include government current and capital expenditures, and private capital expenditures (private investment). These are integrated into a single final demand matrix component. All these final demand vectors are assumed to have fixed expenditure shares.

Equation (6-7.1) determines the composition of final demand components. The demands for goods are determined as constant shares of the volume of total final demand D^{TFD}. The index f covers government current and capital expenditures (f=g), and private investment (f=inv). Equation (6-7.2) determines the value of final demand expenditures, D^{VTFD}. Equation (6-7.3) determines the price of final demand expenditures, which, without any taxes or subsidies, is equal to the Armington price.

Table 6-7: **Final Demand Expenditure Equations**

(6-7.1) $X_{if}^{AF} = a_{if}^{FD} D_{f}^{TFD}$

(6-7.2) $D_{f}^{VTFD} = \sum_{i} P_{if}^{FD} X_{if}^{AC}$

(6-7.3) $P_{if}^{FD} = PA_{i}$

Government aggregate expenditures on goods and services (D_{g}^{TFD}) are fixed in real terms. Total nominal government expenditures, G^{Exp}, is determined in Equation (6-8.1) as the sum of total value of expenditures on goods and services (D_g^{1TFD} as in Equation (6-7.2)) plus two exogenous elements: transfers to the rest of the world, F^{Gout}, and transfers to households, T_h^G. Equation (6-8.2) defines the government expenditure deflator, P^G.

Table 6-8: **Government Expenditure Equations**

(6-8.1) $$G^{Exp} = D_g^{1TFD} + E^{RATE} \sum_r F_r^{Gout} + \sum_h P^{Index} T_h^G$$

(6-8.2) $$P^G D_g^{TFD} = \sum_i P_{ig}^{FD} X_{ig}^{AC}$$

6.2.3 Production

The production inputs choice is modelled as a nested structure with different degrees of elasticity of substitution (CES) at the different levels.

At the top level, the producer chooses a mix of value added aggregate (V^A) and an intermediate demand aggregate (N^D). The optimisation problem takes the following form:

$$\min P_i^V V_i^A + P_i^N N_i^D$$

subject to the production function:

$$XP_i = \left[a_i^V V_i^{A^{\rho_{i,p}}} + a_i^N N_i^{D^{\rho_{i,p}}} \right]^{1/\rho_{i,p}}$$

where P_i^V is the aggregate price of value added, P_i^N is the price of the intermediate aggregate, a_i^V and a_i^N are the CES share parameters, and ρ is the CES exponent. The exponent and the CES elasticity are related via this relationship:

$$\sigma = \frac{1}{1-\rho} \Leftrightarrow \rho = \frac{\sigma - 1}{\sigma}$$

note that in the model, the share parameters incorporate the substitution elasticity using the following relationships:

$$\alpha_i^V = \left(a_i^V\right)^\sigma \quad \text{and} \quad \alpha_i^N = \left(a_i^N\right)^\sigma$$

The solution to this minimisation problem yields Equations (6-9.1) and (6-9.3) in Table 6-9. Notice that because of the existence of vintage capital, each producing sector is modelled as comprising two distinct technologies, producing an homogeneous good, but with different production parameters. Hence, intermediate and value added aggregate demands are indexed by vintage (using the index v). Moreover, due to the importance of energy in terms of pollution, the demand for energy has been separated from the rest of intermediate demand, and incorporated in the value added nest. Hence, the equations below are not specified in terms of a value-added bundle, but a value added plus energy bundle. Equation (6-9.1) determines the volume of aggregate intermediate non-energy demand, by vintage, Nv^D. Equation (6-9.2) determines the total demand for non-energy intermediate inputs (summed over vintages), N^D. Equation (6-9.3) determines the level of the composite bundle of value added demand and energy Q^{KEL}.

Table 6-9: **Top Level Production Nest**

(6-9.1) $N_{jv}^{D} = \alpha_{jv}^{N}\left(\frac{PXv_{jv}}{P_j^N}\right)^{\sigma_j^p} XPv_{jv}$

(6-9.2) $N_j^D = \sum_v Nv_{jv}^D$

(6-9.3) $Q_{jv}^{KEL} = \alpha_{jv}^{KEL}\left(\frac{PXv_{jv}}{P_{jv}^{KEL}}\right)^{\sigma_j^p} XPv_{jv}$

The next level of the production nest concerns on one side aggregate intermediate demand N^D, and, on the other side, the Q^{KEL} bundle. The relevant equations are shown in Table 6-10. In Equation (6-10.1), N^D is split in its single inputs components (at the Armington level, i.e. before disaggregation into import demand and demand for domestically produced commodities) assuming a Leontief technology. The index *nf* identifies elements pertaining to the set of non-energy commodities. Notice that in Equation (6-10.1) aggregate intermediate demand is determined directly (i.e. summing over vintage), since non-energy intermediate demand is not dependent on the vintage. The matrix *a*, is the matrix of input-output coefficients for non-energy intermediate inputs.

At the same level, the Q^{KEL} bundle is split into aggregate labour demand on the one hand L^A, and the Q^{KE} bundle on the other. This is done using a CES function with the substitution elasticity σ^{kel}, which is assumed to be vintage specific. Equations (6-10.2) and (6-10.3) provide the reduced form first order conditions for this level of the nest. The decomposition of aggregate labour demand into labour demand by skill type is independent of vintage therefore it is summed directly in Equation (6-10.2) where L^{Ad} represents aggregate sectoral labour demand. P^{KEL} is the aggregate (or CES dual) price of the Q^{KEL} bundle, W^{A} is the price of aggregate labour in each sector, and P^{KE} is the price of the Q^{KE} bundle. The share parameters are α^{L} for labour, and α^{KE} for the Q^{KE} bundle.

Table 6-10: **Second Level CES Production Equations**

(6-10.1) $$X^{AP}_{nf,j} = a_{nf,j} N^{D}_{j}$$

(6-10.2) $$L^{Ad}_{j} = \sum_{v} \alpha^{L}_{jv} Q^{KEL}_{jv} \left(\frac{P^{KEL}_{jv}}{W^{A}_{j}} \right)^{\sigma^{KEL}_{jv}}$$

(6-10.3) $$Q^{KE}_{jv} = \alpha^{KE}_{jv} Q^{KEL}_{jv} \left(\frac{P^{KEL}_{jv}}{P^{KE}_{jv}} \right)^{\sigma^{KEL}_{jv}}$$

The next level of the CES nesting disaggregates the Q^{KE} bundle into the energy bundle on one side, and capital demand on the other side. The equations in Table 6-11 provide the reduced form first order conditions for demand for E^{P} and Kv.

Table 6-11: **Demand for the Energy Bundle and Capital**

(6-11.1) $$E^{P}_{jv} = \alpha^{E}_{jv} Q^{KE}_{jv} \left(\frac{P^{KE}_{jv}}{P^{EP}_{jv}} \right)^{\sigma^{KE}_{jv}}$$

(6-11.2) $$Kv^{d}_{jv} = \alpha^{K}_{jv} \frac{Q^{KE}_{jv}}{\lambda^{K}_{jv}} \left(\frac{\lambda^{K}_{jv} P^{KE}_{jv}}{R_{jv}} \right)^{\sigma^{KE}_{jv}}$$

(6-11.3) $$K^{d}_{j} = \sum_{v} Kv^{d}_{jv}$$

E^{P} is demand for the energy bundle (by vintage), P^{Ep} is the price of the energy bundle, Kv^{d} represents capital demand by vintage, and R is the vintage specific rental rate of capital. The share parameters are α^{E} for the energy bundle, and α^{K} for capital. Capital demand incorporates changes in capital factor efficiency. Equation (6-11.3) determines aggregate sectoral capital demand.

There remain two more bundles to decompose: aggregate labour and the energy bundle. Table 6-12 list the equations for determining labour demand by skill type and energy demand by fuel type.

There is a single nesting for labour by type which implies that the substitution between any pair of labour skills is the same. L^{d} represents demand for labour of type l in sector j, the CES share parameters are α^{LS}, and the CES substitution elasticity for labour is σ^{L}. Labour is assumed to be perfectly mobile across sectors which implies a uniform economy-wide wage rate. However, we allow for the possibility of differential sectoral wages (for the same labour skill) to take into account observed data which reflect specific institutional features. The parameter ω is fixed and determines the relative wage across sectors, where W represents the equilibrium wage for skill l. Finally, the parameter λ^{L} incorporates labour efficiency improvement.

Table 6-12: **Demand for Labour by Skill Type and Energy by Fuel Type**

(6-12.1) $$L_{lj}^{d} = \alpha_{lj}^{LS} \frac{L_j^{A^d}}{\lambda_{lj}^{L}} \left(\frac{\lambda_{lj}^{L} W_j^{A}}{\omega_{lj} W_l} \right)^{\sigma_j^L}$$

(6-12.2) $$X_{e,j}^{AP} = \sum_{v} \alpha_{e,j,v}^{EP} \frac{E_{jv}^{P}}{\lambda_{jv}^{EP}} \left(\frac{\lambda_{jv}^{EP} P_{jv}^{EP}}{PA_e} \right)^{\sigma_{jv}^{EP}}$$

Energy demand is vintage specific, and the substitution possibilities across fuels are generally lower for old capital than for new capital. The current version of the model uses a single energy nesting, i.e. the decomposition of the energy bundle into the fuel components requires only one CES function. The index *e* represents the fuel commodities in the sectoral disaggregation. Equation (6-12.2) determines the demand for each fuel and incorporates energy efficiency improvement which is both sector and vintage specific (but not fuel specific).

This completes the description of the production structure. Starting from output, *XPv*, the nested CES tree structure of production unfolds until at the end of each branch a basic commodity (at the Armington level) or factor of production is specified. The next section will describe the formulation of prices in the production sector. The description of prices proceeds in the opposite direction. It starts at the bottom of the tree, using the fundamental (or the economy's equilibrium prices), and moves up the tree to define the price of the different CES aggregate bundles.

A graphical description of the production structure is given in Figure 5-1 in the previous chapter.

6.2.4 Production Prices

In this section it is assumed that all equilibrium prices are given. The equilibrium prices include the Armington prices and the factor prices. The aggregate prices are all determined going from the bottom up. Table 6-13 describes the (CES) price of the energy bundle. It is an aggregation of the Armington price of the individual fuels.

Table 6-13: **Price of the Energy Bundle in Production**

(6-13.1) $$P_{jv}^{EP} = \left[\sum_{v} \alpha_{e,j,v}^{EP} \left(\frac{PA_e}{\lambda_{jv}^{EP}} \right)^{1-\sigma_{ij}^{EP}} \right]^{1/(1-\sigma_{ij}^{EP})}$$

Similarly, Equation (6-14.1) defines the aggregate price of labour by sector. It is the CES dual price of the skill-specific wages.

Table 6-14: **Aggregate Price of Labour**

(6-14.1) $$W_j^A = \left[\sum_{l} \alpha_{lj}^{LS} \left(\frac{\omega_{li} W_l}{\lambda_{li}^{L}} \right)^{1-\sigma_j^L} \right]^{1/(1-\sigma_j^L)}$$

Table 6-15 provides the equations describing the remaining prices in production. The price of aggregate non-energy intermediate demand, specified in Equation (6-15.1), is given by adding up the unit price of non-energy input goods. Equation (6-15.2) determines the CES dual price of the capital-energy bundle, *PKE*. The price of the Q^{KEL} bundle is provided by the formula in Equation (6-15.3). Equation (6-15.4) determines the CES dual price of production by capital vintage, *PXv*. Equation (6-15.5) determines the average unit cost of production, *PX*, averaged over both types of capital. Finally, Equation (6-15.6) provides the producer price, *PP*, which is equal to the cost of production plus an indirect tax.

Table 6-15: **Price of the Q^{KE} and Q^{KEL} Bundles, and Unit Production Cost**

(6-15.1) $$P_j^N = \sum_{nf} a_{nf,j}^N PA_{nf}$$

(6-15.2) $$P_{jv}^{KE} = \left[\alpha_{jv}^E \left(P_{jv}^{EP} \right)^{1-\sigma_{jv}^{KE}} + \alpha_{jv}^K \left(\frac{R_{jv}}{\lambda_{jv}^K} \right)^{1-\sigma_{jv}^{KE}} \right]^{\frac{1}{1-\sigma_{jv}^{KE}}}$$

(6-15.3) $$P_{jv}^{KEL} = \left[\alpha_{jv}^L \left(W_j^A \right)^{1-\sigma_{jv}^{KEL}} + \alpha_{jv}^{KE} \left(P_{jv}^{KE} \right)^{1-\sigma_{jv}^{KEL}} \right]^{\frac{1}{1-\sigma_{jv}^{KEL}}}$$

(6-15.4) $$PXv_{jv} = \left[\alpha_{jv}^N \left(P_j^N \right)^{1-\sigma_{jv}^P} + \alpha_{jv}^{KEL} \left(P_{jv}^{KEL} \right)^{1-\sigma_{jv}^P} \right]^{\frac{1}{1-\sigma_{jv}^P}}$$

(6-15.5) $$PX_j XP_j = \sum_v PXv_{jv} XPv_{jv}$$

(6-15.6) $$PP_i \, XP_i = PX_i (1 + \tau_i^P) XP_i$$

6.2.5 Equilibrium in the Factor Markets

This section describes the determination of factor market equilibria. There are two parts to this section: the labour markets, and the capital markets.

There are as many labour markets as there are labour skills. Labour demand by skill type is determined by production decisions. A simple labour supply curve is implemented in Equation (6-16.1), with labour supply a function of the real wage.

Table 6-16: **Equilibrium on the Labour Markets**

(6-16.1) $$L_l^S = a_l \left(\frac{W_l}{P^{index}} \right)^{\omega_l}$$

(6-16.2) $$L_l^s = \sum_i L_{l,i}^d$$

Equation (6-16.2) is the market clearing condition and determines the equilibrium on the labour markets.

For the capital market it is necessary to distinguish between comparative statics and recursive dynamics.

Table 6-17: **Equilibrium on the Capital Market (comparative static)**

(6-17.1)	$$\begin{cases} R^A = \left[\sum_i \alpha_i^k \left(R_i^{Old}\right)^{1+\omega^k}\right]^{1/(1+\omega^k)} & \text{if } \omega^k < \infty \\ K^s = \sum_i K_i^d & \text{if } \omega^k = \infty \end{cases}$$
(6-17.2)	$$\begin{cases} K_i^{s,Old} = \alpha_i^k \left(\frac{R_i^{Old}}{R^A}\right)^{\omega^k} K^s & \text{if } \omega^k < \infty \\ R_i^{Old} = R^A & \text{if } \omega^k = \infty. \end{cases}$$
(6-17.3)	$$K_i^{s,Old} = K_i^d$$

In comparative static mode, all the dynamic transition equations are left out of the model definition. The putty/semi-putty structure of production is also irrelevant, and only *old* capital exists (i.e. only the *old* production elasticities are used). The sectoral supply of capital is determined using a CET supply function. An elasticity of substitution of zero implies sector-specific capital, and an elasticity of infinity implies perfectly mobile capital[195].

The equations in Table 6-17 determine sectoral capital supply in comparative static mode. In the case of finite elasticities, Equation (6-17.1) determines the aggregate (or average) rental rate using the definition of the CET dual price function. Equation (6-17.2) determines the sector-specific capital supply as a function of the sector specific rental rate relative to the average rate of return. Equation (6-17.3) determines the sector-specific rental rate through a market equilibrium equation. If the CET elasticity is zero, it is easy to see through Equation (6-17.2) that capital supply then becomes sector-specific.

If capital is perfectly mobile, i.e. the CET elasticity is infinite, Equation (6-17.1) determines the economy-wide (i.e. uniform) rate of return on capital, in other words, this equation is a market equilibrium equation. Equation (6-17.2) trivially sets the sectoral rental rate to the uniform rate, and Equation (6-17.3) trivially equates sector supply to sector demand.

In a long-term model, profit rates across sectors should be equal and therefore capital is usually assumed to be perfectly sectorally mobile. In a short-term model, the opposite is observed, i.e. that sectors register different rates of profitability, and this leads to model capital as sector specific. The recursive dynamic framework used in the model allows us to have an intermediate situation between these two extremes by combining short term capital immobility (or low degree of mobility) for the old (or installed) vintage of capital and long-term perfect mobility for new capital.

In order to do that it is first necessary to determine the supply of old capital. At the beginning of a period if a sector is expanding, its supply of old capital, KO^s, is insufficient to produce its expanding output and therefore it will demand new capital. In this case it is assumed that the rental price of the old capital is the same as the rental price of the new capital. There is a unique economy-wide rental rate on new capital. If, however, a sector is declining, it will want to disinvest its beginning of period capital stock. In the case of a declining sector, the rental rate on old capital is sector specific. The disinvestment function is based on the relative rates of return of old capital versus new capital. The following equation determines the supply of old capital to a sector in decline:

$$KOld_{i,t}^{s} = KO_{i,t}^{s}\left[\frac{r_{i,t}^{Old} / r_{i,t}^{New}}{r_{i,t-1}^{Old} / r_{i,t-1}^{New}}\right]^{\eta_i^{k}}$$

[195] In the current comparative static version of the model capital is assumed to be perfectly mobile across sectors.

Supply of old capital[196] will increase with the rental rate of old capital, with an absolute limit when the rental ratio of old and new capital is equal to 1. The equilibrium condition for old capital is that supply must equal demand, therefore, in the equation above, we replace directly the supply for old capital by demand for old capital, in other words the above equation is combined with the equilibrium equation. Finally, the above equation is inverted and solved for the rental ratio. This leads to Equation (6-18.1) in Table 6-18, where R^R is the ratio of the rental rate of old capital to the rental rate of new capital, and η^k is the disinvestment elasticity. The rental rate ratio is bounded above by 1.

Table 6-18: **Supply of Old Capital in Declining Sectors**

(6-18.1) $$R^R_{i,t} = \min\left(R^R_{i,t-1}\left[\frac{Kv^d_{i,old,t}}{KO^s_{i,t}}\right]^{1/\eta^k_i}, 1\right)$$

The single rental rate on all capital, which is not part of a declining sector, remains to be calculated. In other words, the single rental rate which applies to all new capital, plus old capital in expanding sectors, plus old capital being disinvested by declining sectors has not yet been determined. Equation (6-19.1) determines the rental rate of new capital, R^{-1}, which is a single economy-wide rental rate. Equation (6-19.2) determines the sector specific rental rate of old capital. This could be determined as well by an equilibrium condition, but this was already integrated into Equation (6-19.1). Therefore the rental rate of old capital is simply determined by multiplying the rental rate ratio, by the rental rate of new capital. Finally, Equation (6-19.3) sets the rental rate of new capital.

[196] It is possible by simply subtracting $KO_{i,t}^s$ form both sides of the above equation, to represent the supply of disinvested capital as: $KO^s_{i,t} - KOld^s_{i,t} = KO^s_{i,t}\left[1 - \left(\frac{r^{Old}_{i,t} / r^{New}_{i,t}}{r^{Old}_{i,t-1} / r^{New}_{i,t-1}}\right)^{\eta^k_i}\right]$.

Table 6-19: **Equilibrium on the Capital Market (recursive dynamics)**

(6-19.1)	$\sum_i K_{i,t}^d + K_{g,t}^d = K_t^s$
(6-19.2)	$R_t^{Old} = R^A R_t^R$
(6-19.3)	$R_t^{New} = R^A$

6.2.6 Determination of Vintage Output

In each period, producers are faced with the decision to optimally allocate production across vintages. The model implements a simple rule. First, producers will use all the capital installed at the beginning of the period, i.e. old capital. If demand for output is greater than what can be produced with the installed capital, producers will demand new capital to produce the residual amount. If demand is less than what producers desire to produce with the installed capital, i.e. if a sector is in decline, producers will market the surplus capital on the second-hand market. The production allocation decision of the producer can be derived from the optimal capital/output ratio for each type of capital. The optimal capital/output ratio can be derived from Equations (6-9.3), (6-10.3), and (6-11.2). Equation (6-20.1) provides the capital/output ratio for each vintage type. The optimal capital/output ratio will depend on all the prices in the nested CES structure and will only be constant if the entire production structure is a Leontief technology. Equation (6-20.2) determines output produced by old capital. It uses the capital/output ratio to determine the optimal production with installed capital. If the latter is less than production, than that quantity is assigned to "old" production. If the quantity is greater than total demand, than the quantity produced with old capital will be set equal to total demand, and the residual capital will be disinvested. Finally, Equation (6-20.3) determines the quantity of output produced with new capital. It will simply be the difference between total production and the amount produced with old capital.

Table 6-20: **Allocation of Domestic Production across Vintages**

(6-20.1) $$\chi_i^v = \alpha_{jv}^{KEL}\left(\frac{PXv_{jv}}{P_{jv}^{KEL}}\right)^{\sigma_j^p} \alpha_{jv}^{KE}\left(\frac{P_{jv}^{KEL}}{P_{jv}^{KE}}\right)^{\sigma_j^{kel}} \frac{\alpha_{jv}^k}{\lambda_{jv}^k}\left(\frac{\lambda_{jv}^k P_{jv}^{KE}}{R_{jv}}\right)^{\sigma_j^{ke}}$$

(6-20.2) $$\begin{cases} XPv_i^{Old} = \dfrac{KO_i^s}{\chi_i^{Old}} & \text{if} \quad \dfrac{KO_i^s}{\chi_i^{Old}} \leq XP_i \\ XPv_i^{Old} = XP_i & \text{if} \quad \dfrac{KO_i^s}{\chi_i^{Old}} > XP_i \end{cases}$$

(6-20.3) $$XPv_i^{New} = XP_i - XPv_i^{Old}$$

6.2.7 Income Distribution

Production generates income, both wage and non-wage, which is distributed to three main institutions: households, government and financial institutions (both domestic and foreign). In Table 6-21, Equation (6-21.1) determines operating surplus (net of depreciation allowance), Y^K. It is the sum across sectors and vintages of capital remuneration, and it incorporates factor payments from abroad. Equation (6-21.2) defines the depreciation allowance on the total capital stock of the previous period. Y^{DEPR} is the value of the depreciation allowance, δ is the depreciation rate (defined on the aggregate capital stock), and R^A is the economy-wide rental rate. Equation (6-21.3) defines company income, Y^{CORP}, it is equal to a share of net operating surplus (the rest being distributed to households and to foreigners). Equation (6-21.4) determines corporate direct taxes, C^{TAX}, with the base tax rate given by the parameter κ^C. Equation (6-21.5) defines retained earnings, i.e. corporate saving. Corporate saving is equal to a residual share of after-tax company income, net of transfer to the rest of the world.

Table 6-21: **Corporate Earnings Equations**

(6-21.1)	$Y^{K} = \sum_{v}\sum_{i} R_{iv} Kv_{iv}^{d} + E^{RATE}\sum_{r} F_{r}^{K} - Y^{DEPR}$
(6-21.2)	$Y_{i}^{DEPR} = \delta\ R_{i}^{A} K_{i}$
(6-21.3)	$Y^{CORP} = \chi^{K}\ Y^{K}$
(6-21.4)	$C^{TAX} = \kappa^{CORP} Y^{CORP}$
(6-21.5)	$S^{CORP} = \left(1 - \sum_{h} \phi_{h}^{C}\right)\left(1 - \kappa^{CORP}\right) Y^{CORP} - E^{RATE} \sum_{r} F_{r}^{C}$

Household income derives from two main sources, capital and labour income. Additionally, households receive transfers from the government and from abroad. Equation (6-22.1) defines total labour income, Y^{L} as the product of total labour demand and the wage rate. There are two adjustments. One comes from wages earned abroad, the other concerns wages remitted to foreign labour. In the former case foreign wage income is assumed to be constant (in value), while, in the latter case, a fixed share (χ_{l}^{F}) of total domestic labour income is assumed to be distributed to foreign labour.

Labour income is distributed to the households. Equation (6-22.2) defines total households income, Y^{H}. It is the sum of labour income, distributed capital income and net company income, and transfers from the government T_{h}^{G} and from abroad F_{rh}^{T}. Capital and company income are distributed using fixed shares. Households direct tax, H^{TAX}, is given in Equation (6-22.3), where κ^{H} is the tax rate. The adjustment factor δ^{HTAX} becomes endogenous with the fixed government budget closure. In this case, when government revenues are changed during a policy simulation, the household tax schedule shifts in or out to achieve net government balance. Finally Equation (6-22.4) defines household disposable income Y^{D}. Disposable income is equal to total household income less taxes and transfer payments to the rest of the world.

Table 6-22: **Household Income**

(6-22.1) $$Y_l^L = \chi_l^F \sum_i \omega_{lj} W_l L_{lj}^d + E^{RATE} \sum_r F_{rl}^l$$

(6-22.2) $$Y_h^H = \sum_l \Xi_{h,l} Y_l^L + \phi_h^K \chi^h Y^K + \phi_h^C \left(1 - \kappa^{CORP}\right) Y^{CORP}$$
$$+ P^{Index} T_h^G + E^{RATE} \sum_r F_{r,h}^{Tin}$$

(6-22.3) $$H_h^{TAX} = \delta^{HTAX} \kappa_h^H Y_h^H$$

(6-22.4) $$Y_h^D = Y_h^H - H_h^{TAX} - E^{RATE} \sum_r F_{r,h}^{Tout}$$

6.2.8 Trade Equations

Import Structure

Demand by all economic agents has now been specified at the Armington level of aggregation, i.e. a composite demand of goods produced domestically and imports. In the current model, it is assumed that import demand by all agents is identical, in other words, we will not differentiate between producer's and consumer's propensity to import. This implies that we can aggregate the Armington demand across all agents before determining the optimal allocation of the Armington demand between domestic goods and imported goods[197].

Recall that the Armington assumption simply posits that goods are differentiated with respect to region of origin. The model has implemented this assumption using a nested structure. At the top level, each domestic agent optimises some objective function (e.g. cost minimisation or utility maximisation). This leads to demand for a composite commodity that has been referred to as the Armington commodity. At the next level, agents minimise the cost of the Armington bundle, subject to an aggregation function between goods produced domestically and an aggregate import bundle. In the case of this

[197] I explained in chapter 3 how this formulation is less data intensive and that it does not necessarily result in distorted estimations.

model, this is a CES aggregation function. At the next and final level, agents minimise the cost of the aggregate import bundle, again subject to an aggregation function over imports originating in each region of the model, namely the EC region the other European countries region and the Rest of the World.

The mathematical formulation leads to:

$$\begin{aligned}&\min P^D\ D + P^M\ M\\ &\text{s.t.}\\ &X = \left[a_d D^\rho + a_m M^\rho\right]^{1/\rho}\end{aligned}$$

where X is the demand for the Armington good, D is demand for domestic production, M is aggregate import demand, P^D is the price of domestic sales, and P^M is the domestic price of imports (tariff inclusive).

The first order conditions lead to the following demand functions:

$$D = \alpha_d X\left(\frac{PA}{P^D}\right)^\sigma \quad \text{where} \quad \alpha_d = a_d^\sigma$$

$$M = \alpha_m X\left(\frac{PA}{P^M}\right)^\sigma \quad \text{where} \quad \alpha_m = a_m^\sigma$$

and the substitution elasticity is given by:

$$\sigma = \frac{1}{1-\rho} \Leftrightarrow \rho = \frac{\sigma - 1}{\sigma}$$

PA is the (Armington) CES dual price determined using *PD* and *PM*:

$$PA = \left[\alpha_d {P^D}^{1-\sigma} + \alpha_m {P^M}^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

Table 6-23 specifies the equations relative to the first level of the Armington nest. Equation (6-23.1) determines aggregate Armington demand, *XA*, i.e. the sum of Armington demand across all agents. Equations (6-23.2) and (6-23.3) decompose the aggregate Armington demand into respectively the domestic component, *XD*, and the aggregate import component, *XM*.

Table 6-23: **Armington Decomposition**

(6-23.1) $$XA_i = \sum_j X_{i,j}^{AP} + \sum_h X_{ih}^{AC} + \sum_f X_{if}^{AF}$$

(6-23.2) $$X_i^D = \alpha_i^d XA_i \left(\frac{PA_i}{P_i^D}\right)^{\sigma_i^m}$$

(6-23.3) $$X_i^M = \alpha_i^m XA_i \left(\frac{PA_i}{P_i^M}\right)^{\sigma_i^m}$$

Equation (6-24.1) in Table 6-24 determines the Armington price, *PA*, which is the CES dual price of the Armington component prices, i.e. P^D and P^M.

Table 6-24: **Armington Price**

(6-24.1) $$PA_i = \left[\alpha_i^d P_i^{D^{(1-\sigma_i^m)}} + \alpha_i^m P_i^{M^{(1-\sigma_i^m)}}\right]^{\frac{1}{1-\sigma_i^m}}$$

The next stage in the Armington decomposition is to decompose the aggregate Armington demand across the regions of the model. Again, the CES functional form is used to implement the imperfect substitutability of commodity demand across regions.

Equation (6-25.1) in Table 6-25 determines import volume by sector and region of origin, $X_{r,i}^{MReg}$. The relevant import price, is the partner-specific import price $P_{r,i}^{MReg}$, in domestic currency and inclusive of partner-specific import tariff. Equation (6-25.2) determines the price of the aggregate import bundle, P_i^M, which is the CES dual price. Equation (6-25.3) defines the domestic import price, $P_{r,i}^{MReg}$, which is equal to the import price of the trading partner converted in local currency, and inclusive of the partner-specific tariff rate.

Table 6-25: **Second-Level Armington Equations**

(6-25.1) $$X_{r,i}^{MReg} = \beta_{r,i}^{Reg}\left(\frac{P_i^M}{P_{r,i}^{MReg}}\right)^{\sigma'_i} X_i^M$$

(6-25.2) $$P_i^M = \left[\sum_r \beta_{r,i}^{Reg}\left(P_{r,i}^{MReg}\right)^{(1-\sigma'_i)}\right]^{\frac{1}{1-\sigma'_i}}$$

(6-25.3) $$P_{r,i}^{MReg} = E^{RATE} P_{r,i}^{World}\left(1+\tau_{r,i}^{M}\right)$$

Export Structure

Export supply is treated symmetrically to import demand. Producers are assumed to differentiate between the domestic market and the export market. Producers are modelled as maximising sales between the domestic and export markets subject to being on a production possibilities frontier. The model uses the Constant Elasticity of Transformation (CET) specification to implement the production possibilities frontier. The resulting equations are similar to the CES first order condition with reversals in signs to reflect that producers are maximising revenues, as opposed to the CES where agents are minimising costs. As for the Armington specification, there are two levels in the export supply structure. Exporters are assumed to differentiate across regions, in response to changes in relative regional export prices.

Equation (6-26.1) and (6-26.2) provide the first order conditions for determining the producers supply decisions. Equation (6-26.1) determines the optimal supply of goods for the domestic market, X^D. Notice the change from the CES functional form. A rise in the domestic price (with respect to the producer price), leads to a rise in domestic supply. The computer implementation of the model allows for the possibility of infinite CET elasticities in which case the producer does not differentiate between domestic and foreign markets. Under this assumption, the domestic and foreign sales price are identically equal to the producer price. Equation (6-26.2) determines export supply, E^S. Equation (6-26.3) is the CET dual price function which replaces the primal CET function in the case of finite elasticities.[198] In the case of infinite elasticities, output is equal to the simple sum of domestic supply and export supply.

Table 6-26: **CET Decomposition**

(6-26.1)
$$\begin{cases} X_i^D = XP_i\left(\dfrac{P_i^D}{\alpha_{i,t}^d PP_i}\right)^{\sigma_i^T} & \text{if } \sigma_i^T < \infty \\ P_i^D = PP_i & \text{if } \sigma_i^T = \infty \end{cases}$$

(6-26.2)
$$\begin{cases} E_i^S = XP_i\left(\dfrac{P_i^E}{\alpha_{i,t}^E PP_i}\right)^{\sigma_i^T} & \text{if } \sigma_i^T < \infty \\ P_i^E = PP_i & \text{if } \sigma_i^T = \infty \end{cases}$$

(6-26.3)
$$\begin{cases} PP_i = \left[\alpha_{i,t}^D P_i^{D^{\sigma_i^T+1}} + \alpha_{i,t}^E P_i^{E^{\sigma_i^T+1}}\right]^{1/(\sigma_i^T+1)} & \text{if } \sigma_i^T < \infty \\ XP_i = X_i^D + E_i^S & \text{if } \sigma_i^T = \infty \end{cases}$$

The final trade equations determine the second nest of the CET decomposition of exports. The regional disaggregation of exports is given in Equation (6-27.1). Equation (6-27.2) determines aggregate export price P^E.

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[198] The primal function is given by the following formula:

$$XP_i = \left[a_{i,t}^d X_i^{D^{\rho_i^t}} + a_{i,t}^e E_i^{S^{\rho_i^t}}\right]^{1/\rho_i^t}$$

where the following relations hold:

$$\rho_i^t = \frac{\sigma_i^t + 1}{\sigma_i^t} \Leftrightarrow \sigma_i^t = \frac{1}{\rho_i^t - 1} \quad \text{and} \quad a_{i,t}^d = \left(\alpha_{i,t}^d\right)^{1-\rho_i^t} \quad a_{i,t}^e = \left(\alpha_{i,t}^e\right)^{1-\rho_i^t}$$

Table 6-27: **Second-Level CET Equations**

(6-27.1) $$E_{r,i}^{SReg} = \alpha_{r,i}^{Reg} E_i^S \left(\frac{PE_{r,i}^{Reg}}{P_i^E} \right)^{\Omega_i^r}$$

(6-27.2) $$P_i^E = \left[\sum_r \alpha_{r,i}^{Reg} \left[PE_i^{Reg} \right]^{(1+\Omega_i^r)} \right]^{\frac{1}{1+\Omega_i^r}}$$

Table 6-28 presents the equations which determine export demand by the regional trading partners, and the export market equilibrium condition. Equation (6-28.1) defines export demand by the trading partner E^D. Since it is assumed that Morocco has no market power in its export markets (small country assumption), the export demand elasticity is infinite, i.e. it is a flat demand curve which determines the fixed price of exports. Equation (6-28.2) defines the export market equilibrium, i.e. the equality between export supply and foreign demand.

Table 6-28: **Export Demand and Market Equilibrium**

(6-28.1) $$PE_{r,i}^{Reg} = E^{RATE} \overline{P}_{r,i}^{EWorld}$$

(6-28.2) $$E_{r,i}^{SReg} = E_{r,i}^{DReg}$$

6.2.9 Government Revenues and Saving, and Macro Closure

Table 6-29 presents the government revenues and closure rules. Equations (6-29.1) and (6-29.2) determine respectively the government's tax revenues from the production tax and the import tax. Note that in Equation (6-29.2) the regional indices are explicitly used. The tariff rates are trading-partner specific, i.e. the tariff rate is allowed to vary depending on the region of import. Equation (6-29.3) identifies miscellaneous government revenues, these are all revenues minus household direct taxes. Equation (6-29.4) provides total nominal government revenues, G^{rev}.

Table 6-29: **Government Revenues and Saving**

(6-29.1)	$Y^{INDTAX} = \sum_i \tau_i^P PX_i XP_i$
(6-29.2)	$Y^{TARIF} = E^{RATE} \sum_r \sum_i \tau_{r,i}^M P_{r,i}^{World} X_{r,i}^{MReg}$
(6-29.3)	$Y^{MiscRev} = Y^{INDTAX} + Y^{TARIF} + C^{TAX} + E^{RATE} \sum_r F_r^{Gin}$
(6-29.4)	$G^{Rev} = Y^{MiscRev} + \sum_h H_h^{TAX}$
(6-29.5)	$S_g = P^{GDP} \overline{S}_g$
(6-29.6)	$S_g = G^{Rev} - G^{Exp}$

The government closure rule is specified in Equation (6-29.3): government saving is fixed (in real terms). Government saving is simply the difference between government revenue and government expenditure and is determined by Equation (6-29.4). With exogenous government saving the household tax schedule is endogenous. Household taxes are determined by solving Equation (6-22.3) for δ^{HTAX}, i.e. δ^{HTAX} is the equilibrating variable to achieve the fixed government balance.[199]

Table 6-30 includes the equations for the closure of the saving and investment account, and other macro closures. Domestic investment is equal to domestic saving plus a fixed level of foreign saving. Under this rule, foreign saving does not react to regional changes in relative rates of return. In this case, the *value* of investment, D_{inv}^{VTFD}, is determined by Equation (6-30.1). Aggregate investment (in value) is the sum of saving, plus depreciation. Saving includes retained corporate earnings, S^{CORP}, household saving,

[199] In the reference scenario, government saving is held fixed at its base year level which implies that, as a share of GDP, government saving (or the deficit) declines over time.

$S^H{}_{Tot}$, government saving, S_g, and total foreign saving, $\sum_r S_r^f$. Foreign savings are exogenous in each time period.

Table 6-30: **Determination of Aggregate Investment and Macro Closure**

(6-30.1) $$D_{inv}^{UTFD} = S^{CORP} + S_{Tot}^H + S_g + E^{RATE} \sum_r S_r^F + Y^{DEPR}$$

(6-30.2) $$E^{RATE} \sum_i \sum_r P_{r,i}^{World} X_{r,i}^{MReg} = \sum_i \sum_r PE_{r,i}^{Reg} E_{r,i}^{SReg} + E^{RATE} \sum_r S_r^F$$
$$-\sum_l \left(1 - \chi_l^F\right) \sum_i \omega_{lj} W_l L_{lj}^d + E^{RATE} \sum_r F_{rl}^L$$
$$-\chi^r Y^K + E^{RATE} \sum_r F_r^K - E^{RATE} \sum_r F_r^C$$
$$-E^{RATE} \sum_r \sum_h \left(F_{r,h}^{Tout} - F_{r,h}^{Tin}\right) - E^{RATE} \sum_r \left(F_r^{Gout} - F_r^{Gin}\right)$$

(6-30.3) $$X^{GDP} = \sum_l W_l \sum_l \omega_{li} L_{li}^d + \sum_v \sum_i R_{iv} Kv_{iv}^d$$

(6-30.4) $$X^{RGDP} = \sum_l W_{l,0} \sum_l \omega_{li} \lambda_{li}^L L_{li}^d + \sum_v \sum_i R_{iv,0} \lambda_{iv}^K Kv_{iv}^d$$

(6-30.5) $$P^{Index} = \frac{X^{GDP}}{X^{RGDP}}$$

In the model, Walras law has been defined to be the equality of the trade balance and the (negative) of foreign saving. Equation (6-30.2) defines Walras law. On one side of the balance sheet are exports, evaluated at world prices, net total foreign saving, and net transfers and factor payments. On the other side of the balance sheet is the sum of imports evaluated at world prices (excluding tariffs). Due to Walras' Law, one equation is redundant, and Equation (6-30.2) is dropped from the model.

The final equations of the model, Equations (6-30.3)-(6-30.5) are used to calculate the domestic price index which is used to inflate real domestic transfers. Equation (6-30.3) calculates the current value GDP, X^{GDP}. Equation (6-30.4) defines real GDP, X^{RGDP}, as the sum of factor demands in efficiency units, evaluated at base year prices. Equation (6-

30.5) defines the GDP deflator, P^{Index}. The GDP deflator is defined as the value of factor payments, divided by the sum of factor volumes.

Any price in the model can be chosen as the numéraire. In the current version of the model, the foreign price index, E^{RATE}, has been designated as the numéraire, and its value is always set to 1.

6.2.10 Aggregate Capital Stock and Productivity Growth

This section, and the next, provide the key equations for describing the transition from one period to the next. The aggregate capital stock is not pre-determined because it depends on the current level of investment. The one-year gap transition equation is given by:

$$K_t = (1-\delta)K_{t-1} + I_{t-1}$$

where K is the aggregate capital stock, δ is the annual rate of depreciation, and I_{t-1} is the level of real investment in the previous period. A problem appears when the gap between solution periods is greater than 1 year. Since investment in the intervening years is not calculated assumptions must be made in order to integrate the stream of investment. The transition equation for a multi-period gap expanded has this form:

$$\begin{aligned} K_t &= (1-\delta)\left[(1-\delta)K_{t-2} + I_{t-2}\right] + I_{t-1} \\ &\vdots \\ K_t &= (1-\delta)^n K_{t-n} + \sum_{j=1}^{n}(1-\delta)^{j-1} I_{t-j} \end{aligned}$$

The model does not calculate investment between periods. A linear growth model is assumed to explain investment in intermediate years, i.e.:

$$I_j = (1+\gamma^i)I_{j-1}$$

where

$$\gamma^i = \left(\frac{I_t}{I_{t-n}}\right)^{\frac{1}{n}} - 1$$

where the annual growth rate of investment is derived from the annualised growth rate of investment in the current period compared to investment in the previous period. We can re-write the multi-year transition equation to be:

$$K_t = (1-\delta)^n K_{t-n} + \sum_{j=1}^{n} (1-\delta)^{j-1} (1+\gamma^i)^{n-j} I_{t-n}$$

The transition equation is then derived and given by Equation (6-31.2) in Table 6-31, where the growth parameter γ^i is determined in Equation (6-31.1). The capital stock is only pre-determined in Equation (6-31.2) if the gap between periods is equal to one year. Due to base year normalisation rules (the rental rate is set to 1 in the base year), the aggregate stock of capital, K, is normalised to yield K^s (Equation (6-31.3)), which is the level of capital used in determining equilibrium on the capital market.[200]

Table 6-31: **Aggregate Capital Stock**

(6-31.1)	$\gamma^i = \left(\frac{I_t}{I_{t-n}}\right)^{\frac{1}{n}} - 1$
(6-31.2)	$K_t = (1-\delta)^n K_{t-n} + \frac{(1+\gamma^i)^n - (1-\delta)^n}{\gamma^i + \delta} I_{t-n}$
(6-31.3)	$K_t^s = \frac{K_{t-n}^s}{K_{t-n}} K_t$

Productivity

The efficiency growth of labour and energy is always assumed to be exogenous. The efficiency growth of capital is normally exogenous, but in the reference scenario, the

[200] The following numerical example may shed some light on the normalisation rule. Assume the value of capital in a region is 100. Assume, as well, that capital remuneration is 10. Capital remuneration is simply rK where r is the rental rate and K the demand for capital. In this example, rK is equal to 10, which implies a rental rate of 0.1. EMMA uses a different normalisation rule. It assumes that the base year rental rate is 1, and normalises the capital data to be consistent with this normalisation rule, in other words, the normalised capital demand is 10, and it is really an index of capital volume. The non-normalised level of capital is used only in the accumulation function (Equation 16.1.2), and in determining the value of capital depreciation allowance. All other capital stock equations use the normalised value of capital.

capital efficiency factor is calibrated in order to achieve a target growth rate for real GDP. Since there is only one target growth rate for real GDP per region, there can only be one instrument to achieve this target. In the current version of the model, it is assumed that capital efficiency is uniform across sectors and vintages. The capital efficiency parameter is only endogenous in the reference (or business-as-usual) scenario. In all shock simulations, the capital efficiency parameter is exogenous.

Equation (6-32.1) determines the real growth rate of GDP, γ^y, in most simulations. However, in the reference simulation, γ^y is exogenous, and Equation (6-32.1) is used to determine the capital efficiency growth parameter, γ^k. Equation (6-32.2) determines the cumulative capital efficiency factor.

Table 6-32: **Productivity Factors for Capital**

(6-32.1) $$X_t^{RGDP} = \left(1+\gamma^y\right)^n X_{t-1}^{RGDP}$$

(6-32.2) $$\lambda_{jv,t}^k = \left(1+\gamma_t^k\right)^n \lambda_{jv,t-n}^k$$

The remaining equations deal with the pre-determined variables, which are updated at the beginning of each period. These are transition equations do not rely on any contemporaneous variable, hence are not directly an endogenous result of the model.

Table 6-33: **Initial Supply of Old Capital**

(6-33.1) $$KO_{i,t}^s = (1-\delta)^n K_{i,t-n}^d$$

In Table 6-33 KO^s represents the installed old capital at the beginning of each period by sector.[201] It is simply equal to the sector's previous period's total (depreciated) capital

[201] The base year data does not provide capital stock data by sector only capital remuneration by sector. Since the price of capital in each sector is set to 1 in the base year, the sectoral capital stock data should be

stock. The end of period stock of old capital (in a given sector) may be less than the initial stock. If the sector is declining, old capital will be disinvested and the actual stock of old capital will be less than the initial stock.

Table 6-34: **Other Pre-Determined Exogenous Variables**

(6-34.1) $a_{l,t} = (1+\gamma_t^l)^n al_{*,t-n}$

(6-34.2) $Pop_t = (1+\gamma_t^P)^n Pop_{t-n}$

(6-34.3) $D_{g,t}^{TFD} = (1+\gamma_t^Y)^n D_{g,t-n}^{TFD}$

In Table 6-34, Pop_t is the population at time t. D_g^{TFD} is the level of total real government expenditures on goods and services is assumed to grow at the same rate as the economy.[202] Equation (6-34.1) determines the labour supply shift factor which is equal to the previous period's labour supply shift factor multiplied by an exogenously specified labour supply growth rate.

The energy efficiency factors are also exogenous and pre-determined leading to the following set of transition equations:

Table 6-35: **Energy and Labour Efficiency Factors**

(6-35.1) $\lambda_{i,t}^E = (1+\gamma_{i,t}^E)^n \lambda_{i,t-n}^E$

(6-35.2) $\lambda_{i,t}^l = (1+\gamma_t^l)^n \lambda_{i,t-n}^l$

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seen as an index volume and not a volume, which has been observed. Since it is further assumed that the aggregate capital stock is the sum of the sectoral capital stocks, this implies that the price of capital is the same across sectors in the base year.

[202] Note that the real level of transfers from government to households is assumed to grow at the same rate as the economy, too.

The annual autonomous energy efficiency factor is given by γ^{p}, representing the growth in energy efficiency in production. The energy efficiency factors in production are specific to both sector and vintage. The cumulative factor is given by the λ variable. Equation (16.6.2) determines the labour efficiency factor. The growth in labour efficiency is exogenous and is labour-type specific.

Vintage Re-Calibration

The model has a vintage structure of capital which is based on an assumption of a putty/semi-putty structure of production. It is further assumed that the substitutability of capital differs across vintage, with old capital typically less substitutable than new capital. There are only two vintages, *old* and *new*. New capital is generated by investment in the previous period. Old capital is the installed capital in the previous period. Over time, the structure of old capital changes as the previously new capital gets merged into the old capital. Rather than keep track of each vintage over time, we modify the structural parameters of the old capital to reflect its changing composition. The key rule that has been adopted is that the share parameters associated with old capital should be able to produce all of the previous period's production (with the substitution elasticities of the old capital). For example, assume we have a CES production function in capital (K), labour (L), and energy (E). Production then has the form:

$$X_v = [a_{k,v}K_v^{\rho_v} + a_{l,v}L_v^{\rho_v} + a_{e,v}E_v^{\rho_v}]^{1/\rho_v}$$

where

$$\sigma_v = \frac{1}{1-\rho_v}$$

and X is output (by vintage), K_v is capital by vintage, L_v is labour, and E_v is energy. The share parameters are vintage specific as is the substitution elasticity. The first order conditions for cost minimisation lead to:

$$K_v = \alpha_{k,v} X_v \left(\frac{P_v}{r_v}\right)^{\sigma_v} \quad \text{where} \quad \alpha_{k,v} = a_{k,v}^{\sigma_v}$$

$$L_v = \alpha_{l,v} X_v \left(\frac{P_v}{w}\right)^{\sigma_v} \quad \text{where} \quad \alpha_{l,v} = a_{l,v}^{\sigma_v}$$

$$E_v = \alpha_{e,v} X_v \left(\frac{P_v}{e_v}\right)^{\sigma_v} \quad \text{where} \quad \alpha_{e,v} = a_{e,v}^{\sigma_v}$$

where r, w, and e are respectively the price of capital, labour, and energy. (Note that the model uses the modified share parameters, i.e. the share parameters of the CES function raised to the power of the substitution elasticity. The former share parameters are never formally employed in the model since only the first order conditions and the CES price function are used.) P is the CES dual price which is given by the following equation:

$$P_v = \left[\alpha_{k,v} r_v^{1-\sigma_v} + \alpha_{l,v} w^{1-\sigma_v} + \alpha_{e,v} e_v^{1-\sigma_v}\right]^{1/(1-\sigma_v)}$$

We assume that the production structure of output associated with new capital is constant over time, i.e. the share parameters and substitution elasticities are not time dependent (except for the efficiency factors). However, old capital changes over time as in each time period previously new capital is added to the old capital stock. In order to account for the change in old capital the share parameters for the production structure associated with old capital are modified in such a way that the total of the factors in the previous period could produce all of the previous period's output assuming the old substitution elasticities. To continue with the above notation, we re-calibrate the share parameters according to the following formula:

$$\bar{\alpha}_{k,o} = \frac{K_{t-1}}{X_{t-1}} \left(\frac{r_{t-1}}{P_{t-1}}\right)^{\sigma_o}$$

$$\bar{\alpha}_{l,o} = \frac{L_{t-1}}{X_{t-1}} \left(\frac{w_{t-1}}{P_{t-1}}\right)^{\sigma_o}$$

$$\bar{\alpha}_{e,o} = \frac{E_{t-1}}{X_{t-1}} \left(\frac{e_{t-1}}{P_{t-1}}\right)^{\sigma_o}$$

where the re-calibrated share parameters, α, are calibrated at the beginning of each period, and all the volumes are the sum of the old and new vintages from the previous period, and the prices are the average prices (N.B. the subscript o is used for old capital, and n for new capital):

$$
\begin{aligned}
X_{t-1} &= X_{o,t-1} + X_{n,t-1} \\
K_{t-1} &= K_{o,t-1} + K_{n,t-1} \\
E_{t-1} &= E_{o,t-1} + E_{n,t-1} \\
P_{t-1} &= \left[P_{o,t-1}X_{o,t-1} + P_{n,t-1}X_{n,t-1}\right] / X_{t-1} \\
r_{t-1} &= \left[r_{o,t-1}K_{o,t-1} + r_{n,t-1}K_{n,t-1}\right] / K_{t-1} \\
e_{t-1} &= \left[e_{o,t-1}E_{o,t-1} + e_{n,t-1}E_{n,t-1}\right] / E_{t-1}
\end{aligned}
$$

With the above definitions of the aggregate factors and average factor prices, the production function associated with the α parameters is consistent with the aggregate output X_{t-1}.

For brevity, the above formulas are not repeated for all the nested CES production functions. As described in more detail below, the production structure can be represented by a nested tree structure of CES and Leontief functions. Within this structure, there are several CES aggregation functions whose old-vintage share parameters are re-calibrated in the manner described above.

6.2.11 Emissions

The emission data used in this model have been derived from an extensive data set constructed for the United States. The emission data for the United States have been collated for a set of over 400 industrial sectors. Generally, the emission data have been directly associated with the volume of output, with the consequence that the only way to reduce emissions, with a given (abatement) technology, is to reduce output. Furthermore this ignores important sources of pollution outside the production side of the economy, namely households' consumption. In an attempt to ameliorate this situation, the pollution data of the United States has been regressed on a small subset of inputs of the US input output table. Using econometric estimates, it has been shown that the level of emissions can be explained by a very small subset of inputs.[203] This allows producers to substitute away from polluting inputs, and to use the same pollution coefficients for final demand consumption. Since the emission coefficients are originally calculated from a US data base, they are appropriately scaled so as to be consistent with the definition of output and inputs in Morocco. The following example shows how this is done in practice. Assume, in a specific sector, that output in 1990 has the value \$ 1 billion, and that the estimated amount of lead emitted from that sector is 13,550 pounds. If the output price in 1990 is normalised to 1, the emission factor has units 1.355×10^{-5} pounds per (1990) USD, or 13.55 pounds per million (1990) USD. If output in the same sector is 800 million dirhams (in Morocco in 1990), the dollar equivalent is 100 million. This leads to lead emissions of 1355 pounds. The emission factor for lead in Morocco (in this sector) would then be 1.70 pounds per million 1990 dirhams (Dh).

Equation (6-36.1) defines the total level of emissions for each type of pollutant *p*.[204] The bulk of the pollution is assigned to the direct consumption of goods which is the second term in the expression. The level of pollution associated with the consumption of each good is constant (across the row of the SAM), i.e. there is no difference in the amount of pollution emitted per unit of consumption whether it is generated in production or in final demand consumption. The first term in Equation (6-36.1) represents *process* pollution. It is the residual amount of pollution in production which is not explained by the consumption of inputs. In the estimation procedure, a process dummy has proven to be significant in certain sectors.

The remaining equations in Table 6-36 re-produce the corresponding equations in the text if a pollution tax is imposed. This is actually endogenously calculated as the shadow price of Equation (6-36.1), once a target on the level of emission has been exogenously specified. The tax is implemented as an excise tax, i.e. it is implemented as a tax per unit of emission. It is converted to a price wedge on the consumption of the commodity (as opposed to a tax on the emission), using the commodity specific emission coefficient. For example in Equation (6-15.5'), the tax adds an additional price wedge between the unit cost of production exclusive of the pollution tax and the final cost of production. Let production be equal to 100 (million Dh), and let the amount of pollution be equal to 1 tonne of emission per 10 million Dh of output. Then the total emission in this case is 10

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[203] See Dessus et al. (1994).

[204] There are 13 different types of pollutant explicitly considered in the model. See page 130 in chapter 5.

tonnes. If the tax rate is equal to 25 Dh per tonne of emission, the total tax bill for this sector is 250 Dh. In the formula below, π_p^{Prod} is equal to 0.1 (tonnes per million Dh), XP is equal to 100 (millions Dh), and τ_p is equal to 25 Dh. The consumption based pollution tax is added to the Armington price, see Equation (6-24.1'). However, the Armington decomposition occurs using basic prices, therefore, the taxes are removed from the Armington price in the decomposition formulae, see Equations (6-23.2') and (6-23.3'). Equation (6-29.4') determines the modification to the government revenue equation.

Table 6-36: **Emissions and Price Wedges**

(6-36.1) $$E_p = \sum_i \pi_{i,p}^{Prod} XP_i + \sum_i \pi_{i,p}^{Cons}\left(\sum_j X_{ij}^{AP} + \sum_h X_{ih}^{AC} + \sum_f X_{if}^{AF}\right)$$

(6-15.5') $$PP_i\, XP_i = PX_i(1+\tau_i^p)XP_i + \sum_p \pi_{i,p}^{Prod} XP_i\, \tau^{Poll}$$

(6-24.1') $$PA_i = \left[\alpha_i^d P_i^{D^{(1-\sigma_i^m)}} + \alpha_i^m P_i^{M^{(1-\sigma_i^m)}}\right]^{\frac{1}{1-\sigma_i^m}} + \sum_p \pi_{i,p}^{Cons}\, \tau^{Poll}$$

(6-23.2') $$X_i^D = \alpha_i^d XA_i \left(\frac{PA_i - \sum_p \pi_{i,p}^{Cons}\, \tau^{Poll}}{P_i^D}\right)^{\sigma_i^m}$$

(6-23.3') $$X_i^M = \alpha_i^m XA_i \left(\frac{PA_i - \sum_p \pi_{i,p}^{Cons}\, \tau^{Poll}}{P_i^M}\right)^{\sigma_i^m}$$

(6-29.4') $$G^{Rev} = Y^{MiscRev} + \sum_h H_h^{TAX} + \sum_p \tau^{Poll} E_p$$

6.3 Conclusion

This chapter described the algebraic structure of the model used in the study of the interdependencies of trade and environmental policies in Morocco. Although some of its characteristics are quite conventional in the literature on these type of models some features stands out as particularly innovative.

Firstly its level of detail: this model accommodates 48 sectors, 10 household types, 3 labour categories, 3 disaggregated trade partners, and 13 types of emissions. A second peculiar characteristic is the way emissions are accounted for. Environmental contamination is generated through consumption (of intermediates or final goods) and, differently from previous studies that link emissions to output, this allows a reduction in pollution without necessarily contracting output. Another characteristic is the use of putty-semi putty structure of production. This lets me model with separate elasticity of substitution two capital vintages representing old and new investment goods, and, in turn, adds realism to my study. In fact new capital, with a higher elasticity of substitution, offers a greater scope for abating pollution without having to reduce output and implicitly this accounts for the observed fact that new investment goods are usually more 'environment friendly'.

Finally this model, by including differentiated household groups, allows one to study the effects of environmental (and trade) policy on income distribution. The issues of green tax incidence and redistribution of its revenues are only hinted at in the previous chapter, but they can be thoroughly analysed with the current model and should form part of future investigation.

7 A General Equilibrium Analysis of Mediterranean Economic Integration

7.1 Introduction

A key issue in the debate on the growth of regionalism in international economic relations is the proliferation of regional trade treaties and their consequences. A vast literature primarily focuses on three key groupings: Europe, the Americas and South-East Asia. Although economic integration in these three areas is at different stages and presents different characteristics and problems, their common characteristic of deepening and widening regional trade treaties should call for some uniform analytical approach in the analysis. In particular, computable general equilibrium (CGE) models appear to be among the most apt analytical tools in applied economic research of trade policy reform. Surprisingly though, even when the focus is merely on trade, one discovers that these sort of models are employed, with few exceptions, only in studies for the North American region.[205]

This chapter makes a step forward in this unified approach by constructing a prototype two-country CGE model which includes all the main characteristics of a larger multi-country model of the Mediterranean area. The countries chosen for the prototype are Morocco and France. In order to provide a fuller picture of the integration process, a comparative static and a recursive dynamic version of the same CGE model have been used. In this way, it has been possible to assess the static welfare effects and also the growth interactions of the alternative trade policy scenarios.

The analysis in this chapter is based on the most recent policy package considered during the 1995 Barcelona conference between EU ministers and representatives of non-EU Mediterranean countries. Although the European Mediterranean policy covers a broad range of measures and countries - from full EU membership discussed with Malta, Cyprus and Turkey, to minor political links with other countries - the analysis here is further restricted to the proposal of trade integration between Morocco and the EU. In

[205] For an example of this disparity in geographical approach, confront the three papers on Europe, North America and Pacific integration collected in the Economic Journal Policy Forum: Regionalism in the World Economy, see Greenaway D. (1992), D.K. Brown, A.V. Deardorff, R. Stern (1992), I. Yamazawa (1992) and A. Sapir (1992). For instances of CGE analysis of the NAFTA see Roland-Holst D., K. Reinert, C. Shiells (1994) or Sobarzo, H. (1994).

particular, the Euro-Med. Conference in Barcelona set 2010 as a target date for a FTA between the EU and its twelve Mediterranean partners as far as industrial goods are concerned.

Beyond this valuable "geographic originality", this chapter's additional contribution is found in the development of the discussion of the sequencing issue of trade reforms. The economic literature on this topic is mainly devoted to establishing the correct order of liberalisation between the current and capital account[206] and, surprisingly, it neglects the problem of sequencing in tariff reduction across sectors of the current account. In fact, adjustment costs generated by the non-instantaneous realignment of goods and factor prices may be quite different across sectors, and choosing the correct sectoral liberalisation sequence represents a major concern for policy makers. By using a recursive dynamic version of the multi-country CGE model, a comparison of trade reforms, which differ in their liberalisation sequence, is presented with an estimation of their effects in terms of adjustment costs and growth rates. The use of a dynamic CGE model in the analysis of these issues fills a gap in the literature, whose main contribution revolves around the theory of piecemeal reform.[207] In particular, several authors identify conditions under which proportional and concertina reform programs are welfare improving,[208] but none of these studies explicitly includes dynamic interactions of growth and adjustment costs.

The plan for the chapter is as follows. The next section extends the analysis of the French-Moroccan data set of chapter 3 by presenting additional information on the structure of production, income, trade and protection of these two economies.[209] Section 7.3 introduces the basic features of the CGE model used here; section 7.4 describes the policy experiments with the model in comparative statics mode; section 7.5 presents the dynamic version of the model and reports the results for different trade reforms discussing the sequencing issue. Some brief conclusions are presented in the last section.

[206] See for a survey Edwards, S. (1990).
[207] See Rodrik, D. (1995).
[208] See Falvey, R. (1994).
[209] These data are presented here, rather than in chapter 3, because of their relevance in explaining the model results.

7.2 The French - Moroccan structure of production, income trade and import protection

The French-Moroccan SAM provides the basic data set for the CGE model used here. Although it has already been extensively examined in chapter 3, this section presents some additional information on the structural features of the Mediterranean countries' economies which is particularly useful for the interpretation of the simulation results reported later in this chapter.

Table 7-1 shows structural data for France. For each of the 24 sectors and three aggregate macro-sectors (primary, manufactures and services), the benchmark data for shares of gross output (column 1), value-added (2), total demand (3), exports (4), and imports (5) are shown. These columns summarise the sectoral composition of production, income, supply, demand and trade in France. Services dominate the production side of the economy, generating almost 60 per cent of gross output and more than 70 per cent of value added. Correspondingly primary sectors represent 9 per cent of production and 6 per cent of value added. Given a different production technology and a larger consumption of intermediate inputs, the manufacturing sector's share of gross output (33 per cent) exceeds its value added share (21 per cent); while the opposite is true for services. Columns 4 and 5 list export and import shares. It can be seen that manufacturing alone records above three-quarters of total trade flows. Notice also – in columns 8 and 9 – that exports and imports shares of output and demand respectively, are much higher for primary (13 and 19 per cent) and manufacturing (25 and 25 per cent) than services (3 and 2 per cent[210]).

Columns 6 and 7 present the unskilled and skilled labour to capital ratios (in percentage terms). Apart from the manufacturing sectors of *Textiles*, *Apparel* and *Leather Shoes*, which exhibits similar ratios for the two types of skills, all the other sectors differ by at least an order of magnitude. Returns to skilled labour appear to be highest for the high tech industries (sectors 16,17,18) whereas primary sectors return on average seven times more to capital.

Columns 8 and 9 measure trade dependency as ratios of exports to gross output and imports to demand. The most striking feature of the data in these two columns is the symmetry of export and import dependence of the French economy. The economy-wide ratios (11 per cent) and the ratios for manufacturing (25 per cent) are the same in columns 8 and 9. Exceptions showing a stronger import dependency are recorded for *Estate crops* (mainly fruits), *Other primary* (fisheries, forestry and mining, the most import intensive sector), and *Energy*. The intra-industry peculiarity of French trade is confirmed when analysing durable goods sectors: *Equipment, Transport material* and *Electrical machinery*, which collectively account for 36 and 34 per cent of total exports and imports respectively, also show the highest and almost equal trade dependency ratios among manufacturing sectors (around 35 per cent).

Table 7-1 Basic structure of the French economy 1990 (figures in percentages)

		1 X	2 VA	3 D	4 E	5 M	6 LUsk/K	7 LSk/K	8 E/X	9 M/D	10 MMor/M	11 EMor/E
1	Food Crops	3	3	3	4	2	0	12	15	9	2	1
2	Estate Crops	0	0	0	0	1	1	39	17	24	6	0
3	Other Primary	1	1	1	3	5	16	104	29	41	1	0
4	Energy	4	2	5	2	8	4	81	6	18	0	0
	All Primary	9	6	9	10	16	3	44	13	19	1	0
5	Milling Conf	1	1	1	2	1	19	80	14	8	0	0
6	Food Product	4	1	4	4	5	55	116	12	13	2	0
7	Beverage Tobacco	2	1	1	3	1	6	39	21	8	0	0
8	Textiles	0	0	0	1	1	104	178	28	32	1	1
9	Apparel	2	1	2	4	5	116	179	21	26	5	1
10	Leather Shoes	0	0	1	1	1	141	178	21	31	2	1
11	Wood	1	1	1	1	2	66	126	8	15	0	1
12	Paper	2	2	3	3	4	31	205	11	16	0	1
13	Quarrying Min	1	1	1	2	2	43	123	16	15	0	1
14	Metal Ind	1	1	1	3	3	26	155	39	36	0	1
15	Metal Obj	2	2	2	2	3	59	208	12	13	0	1
16	Equipment	2	2	2	7	8	37	279	34	35	0	1
17	Transp Mat	5	2	4	17	12	39	204	40	33	0	1
18	Electr Machine	3	3	4	11	13	32	212	35	39	0	1
19	Chemicals	3	2	3	11	9	18	142	34	31	0	1
20	Rubber	1	1	1	3	3	81	171	24	26	0	1
21	Other Ind	1	0	1	2	2	59	163	25	27	0	0
	All Manufactures	33	21	33	76	74	72	287	25	25	1	1
22	Transp Communic	4	7	4	4	3	7	134	10	7	1	0
23	Banking Insurance	6	4	6	3	3	1	171	6	6	0	0
24	Other Services	48	61	48	7	4	8	141	1	1	1	1
	All Services	59	72	58	14	9	8	142	3	2	1	0
	Economy-wide	100	100	100	100	100	13	134	11	11	1	1

The last two columns display imports from and exports to Morocco as ratios of total French trade flows. It is clear, as already pointed out in previous chapters, that French dependency over Morocco as a trading partner is very limited. It can be highlighted the higher import dependency for primary sectors (with *estate crops* recording 6 per cent) and apparel and leather products; notice also that export supply is concentrated in the

[210] It should also be noticed that sectors 24 "Other Services" aggregates non-tradable sectors such as

durable goods of manufacturing. A free trade area or customs union with the elimination of trade barriers, especially for agriculture (the Common Agricultural Policy) and for textiles and derived products (MFI) might have some trade diversion effect.

Table 7-2 shows comparable data for the Moroccan economy and close inspection reveals interesting similarities as well as contrasts with its northern partner. Notice, first of all, the very different production and income structure. The reliance of the Moroccan economy on primary sectors is much higher as shown by their 19 and 31 per cent shares for gross output and value added. In terms of the first two columns, *Food crops* represent the second largest sector (after the *Other Services* one). Manufacturing is concentrated in traditional sectors (*Food, Textiles* and derived products) and *Chemicals* (which includes the phosphate derived products).

Column 3 displays the demand structure (total demand) and this also shows the backwardness of the Moroccan economy relative to France, with a much higher share of income spent on food, other primary sectors, manufacturing necessities, and less on services.

The trade structure illustrated in columns 4 and 5 shows some features of a typical middle income developing country. Although previous trade policy reforms resulted in some export diversification, these are still concentrated in some crucial sectors. Phosphates (as raw material in sector 3, in conjunction with fisheries, forestry and other mining, and as derived products in sector 19) account for almost one third of all exports, followed by *Apparel, Food products* and other agricultural products. As far as imports are concerned, manufacturing and energy account for most of them.

It is particularly interesting to contrast the value-added ratios in column 6 and especially 7 with their French counterparts. Moroccan returns to *skilled labour* seem larger in the service sectors (driven up by the salaried component of the public administration in sector 24) and in the durable goods industries, but the economy-wide ratios register very similar values (133% and 134%) for the two countries. A significant difference is represented instead in the *gap* between the skilled and unskilled labour ratios that appears higher in Morocco than in France, signalling wider wage dispersion in the former.

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construction, real estate and public administration.

Table 7-2 Basic structure of the Moroccan economy 1990 (figures in percentages)

		1 X	2 VA	3 D	4 E	5 M	6 LUsk/K	7 LSk/K	8 E/X	9 M/D	10 MFr/M	11 EFr/E
1	Food Crops	10	16	10	4	5	22	35	3	6	22	58
2	Estate Crops	2	3	1	4	0	3	32	18	1	4	55
3	Other Primary	3	5	2	19	5	5	72	54	28	8	9
4	Energy	5	7	7	3	16	0	19	5	26	2	10
	All Primary	19	31	20	29	26	12	35	12	15	7	20
5	Milling Conf	3	1	3	0	1	16	218	0	4	13	89
6	Food Product	3	2	3	9	3	11	232	23	11	15	41
7	Beverages Tobacco	2	1	2	0	1	10	78	1	5	11	68
8	Textiles	3	1	3	4	6	9	96	12	24	6	12
9	Apparel	3	3	2	15	1	17	134	42	7	87	92
10	Leather Shoes	3	4	2	2	1	25	199	7	3	76	71
11	Wood	1	1	1	1	3	8	148	6	21	8	5
12	Paper	1	1	2	1	2	8	128	7	16	35	24
13	Quarrying Min	3	1	3	1	1	2	65	2	6	32	9
14	Metal Ind	1	0	2	1	7	23	178	6	42	12	1
15	Metal Obj	2	1	2	0	2	5	94	1	11	48	25
16	Equipment	1	0	2	0	11	11	265	3	58	37	47
17	Transp Mat	1	0	3	1	10	5	146	6	43	45	49
18	Electr Machine	1	1	2	3	8	6	139	20	41	59	74
19	Chemicals	4	2	4	17	10	3	136	31	26	29	14
20	Rubber	1	0	1	1	2	7	132	5	19	39	4
21	Other Ind	0	0	0	0	0	10	172	4	16	65	71
	All Manufactures	33	18	37	56	70	11	140	14	21	33	46
22	Transp Communic	4	7	3	7	1	2	124	15	3	54	16
23	Banking Insurance	3	4	3	0	0	2	90	1	0	54	58
24	Other Services	41	40	38	7	3	4	399	1	1	54	22
	All Services	48	51	44	14	4	3	288	2	1	54	20
	Economy-wide	100	100	100	100	100	9	133	8	11	27	35

Analysis of columns 8 and 9 confirms what has already been mentioned about the Moroccan trade structure. Here it is possible to appreciate even more clearly the Moroccan export specialisation reflecting its comparative advantage, and an import dependency that is highest in capital goods. Morocco still appears to rely on a north-south typology in its pattern of trade, whereas France reflects its full integration into developed intra-industry trade.

The last two columns highlight another important difference, namely the much stronger dependency of the southern country on bilateral trade. On average Morocco relies on France for one third of all its exports and imports, but its dependency is not uniform and varies across sectors.

The next important step in the study of trade policy reform is to assess the current levels of protection. Table 7-3 below contains the basic data on trade protection that has been used in the model presented here. These were calculated directly from the SAM and derived from official national sources.[211] The first three columns display French ad

[211] See Chapter 4.

valorem tariff rates applied to imports from the EC, the Rest of the world and Morocco. The next column shows the Moroccan tariff rates[212]. The next two columns display percentage shares of tariff revenues across sectors and although these appear to be similarly distributed in the two countries their value relative to total government fiscal revenues are very different. The last column shows French export subsidy rates.[213]

Table 7-3 Ad valorem estimates for French - Moroccan import protection 1990 (percentages)

		Tariff Rates				**Tariff Revenues**		**Exp.Subsidies**
Of		---------- France ----------			Morocco	France	Morocco	France
Against:		EC	ROW	Morocco	All Partners			All Partners
1	Food Crops	0.5	2	4	22	1	3	17
2	Estate Crops	3.5	12	20	61	1	0	10
3	Other Primary	0.0	1	1	31	1	5	9
4	Energy	0.0	13	10	45	17	22	6
	All Primary	0.4	9	9	38	19	30	12
5	Milling Conf	0.0	18	45	70	1	2	28
6	Food Product	0.1	11	19	20	4	2	20
7	Beverages Tobacco	0.1	70	98	54	2	1	6
8	Textiles	0.0	8	2	26	0	5	1
9	Apparel	0.0	26	10	48	11	2	0
10	Leather	0.0	35	13	14	4	0	0
11	Wood	0.0	24	8	37	3	3	2
12	Paper	0.0	11	4	36	4	3	2
13	Quarrying Min	0.0	9	1	54	0	2	1
14	Metal Ind	0.0	3	0	31	0	7	0
15	Metal Obj	0.0	7	2	50	1	3	1
16	Equipment	0.0	5	1	19	2	6	0
17	Transp Mat	0.0	29	7	29	19	9	2
18	Electr Machine	0.0	11	6	41	16	10	2
19	Chemicals	0.0	13	4	34	6	11	0
20	Rubber	0.0	16	3	51	2	2	0
21	Other Ind	0.0	14	8	82	3	1	0
	All Manufactures	0.0	16	11	33	77	70	3
22	Transp Communic	0.0	0	0	0	0	0	39
23	Banking Insurance	0.0	13	14	0	3	0	40
24	Other Services	0.0	4	1	0	1	0	44
	All Services	0.0	6	2	0	4	0	41
	Economy-wide	0.0	13	10	33	100	100	9
	% Of total govern. Revenues					2	29	

Moroccan tariff revenues, in the base year SAM, represented almost one third of total fiscal receipts. In order to avoid budget problems, their reduction associated with trade

[212] It is possible to implement region specific tariffs also for Morocco, although this has not been done in the present version of the model. Due to the weight of French unrestricted trade with other European countries, the need to differentiate tariffs by region for the French case results evident.

[213] These rates are also calculated from the basic SAM data, and it has not yet been possible to disaggregate them by region of export destination. Besides, although services are only a small share of exports, they seem to enjoy too generous subsidies. Future versions of the model will try to improve on the subsidy measurement.

policy reform has to be coupled with compensating measures.[214] During the 1980's the Moroccan commercial policy was strongly oriented towards trade liberalisation. In 1983 import licences were required in all sectors, tariff rates were high and dispersed (some over 100%), and there were export licensing requirements and a state marketing board on exports of processed food products. By 1993 no imports required a license (other than for health or safety reasons), exports were free, and the monopoly of the state marketing board was abolished.[215] Although these policies produced positive results (especially in terms of export diversification), as displayed in Table 7-3, there were still considerable distortions in place. This does not seem to be the case for France where trade taxes represent only 2 per cent of its government tax income, so that, as documented later, their removal has limited effects.[216]

This could change quite dramatically when non-tariff barriers (NTBs) are included. Consider, for example, this type of barrier for two sensitive sectors: food and textiles[217]. For the former sector there are several types of restrictions: import calendars (for 14 categories of fruit and vegetables), reference quantities/tariff quotas (for sensitive fruit, vegetables and sea products), import levies (mainly on olive oil) and countervailing taxes (for some fruit and vegetables).

Figure 7-1: Number of days per year with countervailing taxes

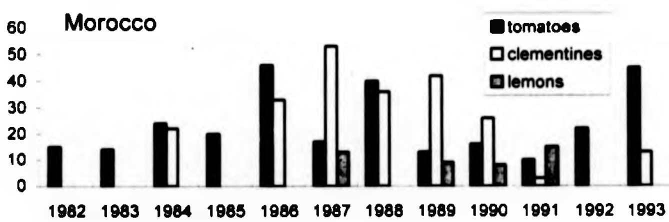
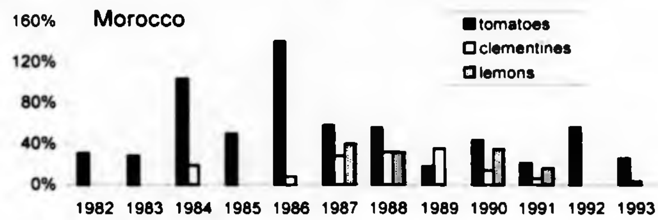


Figure 7-1 and Figure 7-2 display the number of days per year for which countervailing taxes were charged and the level of the taxes as percentage of entry prices

[214] As a reminder, in the model one closure rule requires fixed government savings so that household income taxes are shifted to offset exactly the decreasing tariff revenues.
[215] See Rutherford et al (1993), Mateus et al (1988) and official Ministry of Trade of Morocco (1995) for details.
[216] It should be noticed that in all the simulations, French trade reform includes both tariffs and export subsidies abatement.
[217] The following data are provided in Fontagné & Péridy (forthcoming).

in the EU for Moroccan imports. Clearly these taxes represent a true barrier for Moroccan exporters[218].

Figure 7-2: Countervailing taxes as a percentage of the entry price



For textiles the main non-tariff barriers are represented by voluntary export restraints (VERs). These were imposed by the EC in 1978 on trade from almost all-Mediterranean countries. Initially the level of the quota was above export potential but after 1984, with a rise in the quota allowance lower than that of exports expansion, the level of utilisation reached 141 per cent in 1988 (for France alone 216 per cent).

Moroccan NTBs towards European exports are present in various sectors and these are documented in other studies[219]. Unfortunately, owing to a lack of complete data on these instruments their inclusion in the current model has been postponed.

7.3 The EMMA model: an overview

This section presents a brief overview of the ***E**conomic **M**odel of the **M**editerranean **A**rea* (EMMA), leaving its detailed description to the next technical chapter. It consists of a two-country Computable General Equilibrium model that can be used in two main modes: comparative statics and recursive dynamics. I constructed and labelled the EMMA model for this thesis.[220]

Dimensions. The EMMA model consists of two detailed regional sub-models for France and Morocco. The main link between them is given by their bilateral trade which is fully endogenous (price and quantities are determined by the equilibrium conditions).

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[218] One solution they adopted was to build greenhouses so that their harvesting season would not coincide with that in Europe, when these taxes are levied. This obviously hinders their comparative advantage due to the excessive investment costs.

[219] See for instance Rutherford et al (1993).

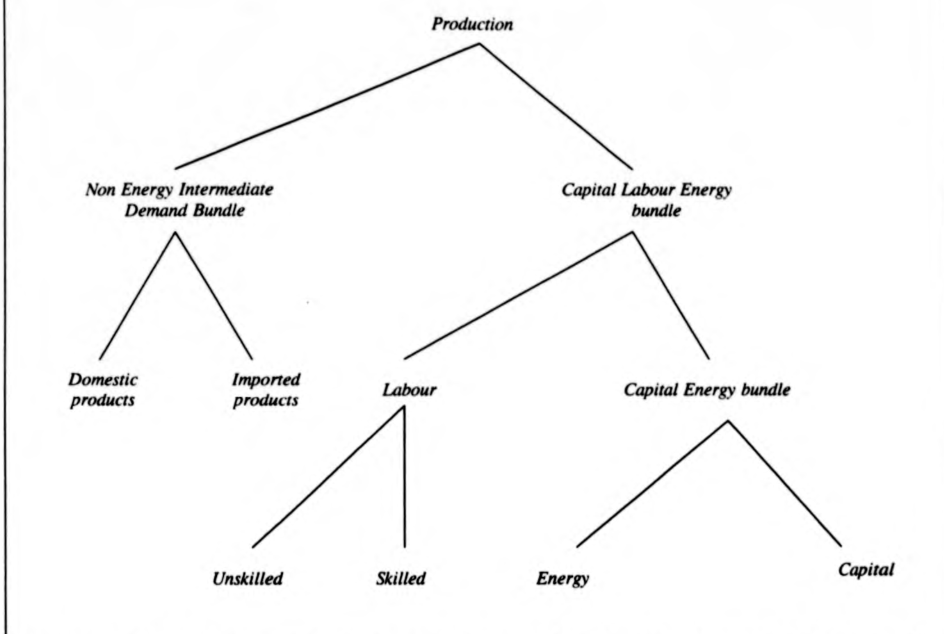
[220] I have to acknowledge unvaluable help and guidance from Dominique van der Mensbrugghe, author of numerous models at the OECD development centre. For more details see the technical appendix.

The other key dimension of the model is given by its sectoral disaggregation: the version used here details 24 sectors/commodities as shown in Table 7-1. Also the model examines supply and demand for one capital and four skill specific types of labour. Finally, the time horizon for the model goes to 2004 with equilibrium values reported for 5 solution periods (1992, 1995, 1998, 2001 and 2004).

Production. Standard assumptions are made for the production structure of the EMMA model: producers minimise costs under constant returns to scale technology and in a perfect competitive environment. Their inputs choices are modelled using a nested structure that is very similar to the one used in the previous chapter for the Environment and Trade model. This is reproduced in Figure 7-1. At the top-level output is a composite in fixed shares of value added and non-energy intermediate inputs. It is assumed that the latter are consumed in fixed proportion amongst themselves (Leontief input-output technology), though it is possible to substitute between domestic and imported goods. In the next level of the nested structure value added is separated in two components: a labour aggregate and a capital-energy bundle. The degree of substitutability here is determined by the CES elasticity. Further down, the capital-energy bundle is decomposed in its two parts and labour is split by skill level. Some degree of substitutability is assumed at this level.

The other components of final demand include: government expenditure, investment and variation of stocks. In the model it is assumed that aggregate real government expenditures and variation of stocks are fixed, and, according to the closure rule, aggregate real investment depends on savings. These aggregated variables are then mapped into commodity specific demands according to fixed shares derived from the SAM.

Figure 7-1: Production Structure



Note: CES substitution elasticities are differentiated by capital vintage, with higher elasticities for new capital. The values used here are the same as those shown in Figure 5-1(Note, though, that no substitution is possible at the top level of the nest.)

Trade. The main assumption here consists of modelling traded goods originating (destined) from (to) different regions as imperfect substitutes. This allows for cross-hauling and rules out the extreme cases of complete specialisation. In the case of imports this is captured using an Armington nested CES system. At a first level, for each commodity, demand is in terms of a composite good which is an aggregate of domestic and imported component. Then the imported component is further decomposed into its region-specific elements. Exports are treated in a symmetric fashion. Domestic producers optimally allocate their supply to domestic and international markets according to relative prices. This is achieved by means of a CET production possibility frontier.

Import demands and export supplies are thus price sensitive so that an increase in prices of one region with respect to other regions or domestic prices induces substitution. In the EMMA model a distinction is made between endogenous and exogenous regions. For the former, namely Morocco and France, border import prices of one country correspond to the export prices of the other and these are calculated as equilibrium prices in the model. For the exogenous region, the EC and the Rest of the World, the standard small country assumption holds, so that border imports or export prices are equal to (fixed) world prices.

Equilibrium. The market clearing condition for commodities simply sets domestic supply plus imports equal to domestic demand plus exports. The equilibrium conditions for factor markets are more complicated and vary in the dynamic and static version of the model. In the static version, it is assumed that capital stock is fixed. Labour supply is modelled in one of two extreme ways: perfectly elastic supply, implying a fixed real wage, or completely fixed supply[221]. Labour can freely move across sectors so that, for each skill, one economy-wide wage rate is computed. The variations in the dynamic version are examined below.

Closure. In addition to material balance and factor markets equilibrium, three additional macroeconomic "budget constraints" for the government account, the investment-savings account and the balance of payments account have to be satisfied in equilibrium. For the first it is assumed that real government savings are fixed and, given that also real expenditures are fixed, the household tax schedule is shifted to balance any loss or gain in other taxes (tariff and indirect taxes) revenues. This is equivalent to a lump-sum tax from or transfer to the household sector. Extended discussion on this particular closure rule is provided below in section 7.4.1.

The second closure rule concerns the savings-investment balance. In each sub- model investments are set equal to aggregate savings which result from the sum of household savings, the net government budget position (which is fixed in real terms) and foreign savings (fixed, see below). Increased demand for investment can therefore be satisfied only by a corresponding increased supply in savings.

Finally it is assumed that the trade balance is equal to the exogenous level of foreign savings. This implies that, following trade liberalisation, to finance the increased import demand the country has to expand its exports. This is possible, at rigid terms of trade (i.e. with fixed exchange rates), only if export sectors attract resources whose relative prices have declined due to structural adjustment in other sectors.

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[221] The factor markets closure rules as well as the investment-savings equilibrium condition reflect the macro aspects of a CGE model. In particular for the labour market see Harrigan, McGregor, Swales and Dourmashkin (1992), Maechler, A.M., and Roland-Holst (1995), McGregor, Swales, Yin (1996).

The last two closure rules, that of investment-saving and of external balance are considered the most appropriate to the study of the effects of trade reforms. In fact one limitation of this approach is the assumption of exogeneity of foreign savings and better modelling of foreign capital flows should be an objective of future extensions.

Dynamics. The recursive-dynamic structure of the EMMA model depends on three main features: factor accumulation, capital vintages and productivity growth. Each solution year in the period 1990-2004 is solved as a static equilibrium implying that there is no forward-looking behaviour in the model and that the link among static equilibria is fully given by transition equations that govern capital accumulation.

For each period of the dynamic version of the model, capital is differentiated into two vintages: old and new. Old capital is equal to the capital of the previous period minus depreciation (whose rate is constant over time) and new capital is equal to the previous period's level of investment. Labour supply increases at an exogenous rate usually corresponding to the population growth rate.

Productivity gains are determined by increases in energy, labour and capital efficiency 'shifters' in the production function. Labour and energy productivity growth is exogenously specified whereas capital efficiency is first endogenously calculated in the model base run and then fixed to that value in all subsequent simulations. In the base run regional GDP growth rates are exogenous and the instruments used to attain them are determined by the endogenously determined regional capital productivity changes. Then, during the simulations, GDP growth rates become endogenous and can increase or decrease with respect to the benchmark due to alterations in policy parameters. Clearly this implies that the policies considered in the experiments have no direct effect on productivity.

7.4 Mediterranean Integration. Policy description and Comparative Statics Results

Various factors contributed to the realisation by the European governments of the high negative externalities they would face with an inadequate development of the southern Mediterranean region. Earlier EU policy towards the Maghreb region led these countries to a narrow export specialisation, highly dependent on preferential trade agreements, and contested by emerging developing countries with lower labour costs.

Differences in income per capita between the two sides of the Mediterranean are very high, resulting in high migratory pressure. At the current unemployment rates and growth forecasts, European labour markets will not be able to accommodate a steady flow of migrant workers. Other global concerns include common environmental problems, or political instability and crime. As a result, the idea of a FTA in the region has emerged as the only solution compatible with this changing environment. It will be first implemented on a bilateral basis (each Mediterranean country vis-à-vis the EU), before being extended to a regional FTA, as Mediterranean countries will sign bilateral free trade agreements among themselves.

Technically a free trade area consists of the elimination of all trade barriers among participating countries, but it does not require that each country adopt a common trade policy (for example the same tariff rates) towards third countries. This in fact would be a requirement for the formation of a customs union. The three experiments performed here are based on the following distinct scenarios:

1. formation of a free trade area between France and Morocco[222];
2. creation of a customs union between these two countries;
3. full elimination of trade barriers.

By extending the removal of trade barriers to larger geographic groups, the degree of liberalisation increases from experiment 1 to 3. In fact the last experiment is performed to produce a reference scenario of completely free trade and, currently, it cannot be considered a viable policy. It should be noticed that all the simulations consider the joint reduction of tariff rates *and* French export subsidies. Moreover, between scenarios 1 and 2, French trade policy is not changed, as the customs union scenario consists of setting Moroccan tariffs on imports from the rest of the world equal to the French ones.

With the EMMA model in comparative statics mode, each of the three experiments has been performed under two different closures for the labour markets. In both cases labour is fully mobile across sectors. With the first closure, it is assumed that aggregate labour of each skill is in excess supply, thus the domestic economy-wide wage (by skill) is fixed, and aggregate employment adjusts to meet demand (in Table 7-4, Table 7-5, and Table 7-6 results for this closure are below the label "Flat labour supply"). Full employment is assumed for the second closure, so demand increases will only affect wage rates. Clearly these two closures represent extreme cases and the resulting estimates of the policy effect should be treated as bounds within which more realistic values will lie. The capital stock is held fixed throughout these static simulations.

7.4.1 Aggregate results

In the context of trade liberalisation, aggregate results are relatively easy to predict. The removal of import distortions through enhanced comparative advantage and expanded trade, promotes greater efficiency and increases welfare. The structural adjustments which the economies undergo is more uncertain, but, given that trade policy reform usually creates winners and losers it might be important for its sustainability in the long term to have some ex-ante detailed sectoral information on the possible outcomes. This will be discussed in the next subsection.

Assumptions on the adjustment mechanism in the labour market, the closure rule of the government budget and trade elasticities are the main factors affecting aggregate results, and especially welfare effects. In order to appreciate their influence, three separate tables present aggregate results under different combinations of the aforementioned factors.

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[222] This and the following policy options consider tariff reductions for all sectors and not the manufacturing subset as initially proposed in the Barcelona conference.

Table 7-4: Comparative statics - aggregate results (% difference from base run) – ***High Trade Elasticities – Fixed Government Savings***

		FLAT Labour Supply						VERTICAL Labour Supply					
		FTA		CUSTOM		FREE TRADE		FTA		CUSTOM		FREE TRADE	
		France	Morocco	France	Morocco	France	Morocco	France	Morocco	France	Morocco	France	Morocco
1	**EV**	0.05	-3.41	0.38	2.39	2.99	1.52	0.05	-4.00	0.36	-0.57	3.09	-1.42
2	**Real GDP**	0.02	0.51	0.03	4.42	0.97	5.34	0.00	-0.38	0.02	-0.31	0.13	-0.12
3	**Employment**	0.03	1.42	0.05	6.40	1.50	6.29	0.00	0.00	0.00	0.00	0.00	0.00
4	**Real wage unskill**	0.00	0.00	0.00	0.00	0.00	0.00	0.14	4.78	2.05	10.78	11.97	6.04
5	**Real wage skill**	0.00	0.00	0.00	0.00	0.00	0.00	0.08	21.68	0.51	49.54	6.60	20.34
6	**Real wage salaried**	0.00	0.00	0.00	0.00	0.00	0.00	0.05	4.45	-0.48	22.34	0.80	28.19
7	**Real wage other lab.**	0.00	0.00	0.00	0.00	0.00	0.00	0.08	1.02	-0.02	8.23	3.21	9.00
8	**Real wage informal**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.36	0.00	20.11	0.00	9.38
9	**Val.Added Wgt.Ave.**	0.00	0.00	0.00	0.00	0.00	0.00	0.07	3.91	0.02	19.31	3.37	22.17
10	**Employmt Wgt. Ave.**	0.00	0.00	0.00	0.00	0.00	0.00	0.07	3.92	0.11	14.79	3.75	13.90
11	**Rent**	0.13	2.29	-1.64	9.20	-4.49	11.28	0.03	-2.10	-1.76	-13.15	-9.99	-14.86
12	**CPI**	0.05	-2.61	-0.64	-7.77	-5.06	-11.51	0.04	-2.47	-0.68	-7.26	-5.59	-11.13
13	**Real Exchge Rate**	0.09	-0.97	-1.03	-1.28	-4.71	-2.43	0.08	-0.41	-1.09	1.26	-5.23	0.16
14	**Total M (value)**	0.28	13.25	-1.19	32.83	4.91	41.54	0.25	11.84	-1.28	23.54	3.25	29.88
15	**Total Ex (value)**	0.28	19.30	-1.19	47.81	4.92	60.50	0.25	17.25	-1.28	34.28	3.25	43.51
16	**Med M (value)**	50.81	111.81	76.03	56.90	38.70	27.36	48.29	110.23	62.42	51.61	29.11	21.84
17	**Med Ex (value)**	111.81	50.81	56.90	76.03	27.36	38.70	110.23	48.29	51.61	62.42	21.84	29.11
18	**Import Diversion**	0.46	42.32	0.71	8.81	0.29	4.87	0.44	42.79	0.59	11.05	0.23	3.01
19	**Export Diversion**	1.14	17.59	0.60	12.72	0.22	9.05	1.12	17.64	0.55	13.96	0.18	6.68
20	**Employ Adjustment**	0.02	1.70	0.24	5.83	1.47	6.06	0.01	1.67	0.23	3.30	1.29	3.43
21	**Capital Adjustment**	0.02	2.14	0.27	12.78	1.81	18.10	0.02	1.67	0.26	6.68	1.53	11.97
22	**Terms of Trade**	0.11	-3.14	0.05	-1.06	0.03	-1.04	0.11	-3.02	0.03	-0.47	0.02	-0.69
23	**Export price index**	0.17	2.50	0.08	1.22	0.01	-0.72	0.16	2.61	0.07	1.81	0.01	-0.40
24	**Import price index**	0.05	5.82	0.03	2.30	-0.02	0.32	0.05	5.81	0.04	2.28	-0.01	0.29
	Government Budget Closure (nominal values)												
25	**Households Dir Tax Rev**	0.38	47.05	-11.32	64.03	-47.96	92.04	0.38	52.54	-11.68	87.32	-50.43	115.22
26	**Ind. Tax Revenues**	0.20	-3.56	-1.77	-1.47	-10.56	-10.12	0.15	-4.30	-1.97	-5.63	-13.39	-14.63
27	**Tariff Rev**	-0.28	-51.89	-0.64	-86.20	-20.38	-118.47	-0.28	-53.29	-0.63	-88.85	-20.38	-118.47
28	**Exp. Subsid. Expend.**	-0.26	0.00	-7.28	0.00	-37.90	0.00	-0.25	0.00	-7.21	0.00	-37.90	0.00
29	**Gov Expend on goods**	0.25	-4.70	-2.61	-14.21	-14.00	-22.04	0.23	-2.04	-2.98	-0.79	-16.45	-6.36
30	**Gov Transfers**	0.21	-2.74	-2.81	-8.16	-22.30	-12.09	0.19	-2.59	-3.01	-7.62	-24.63	-11.69
31	**Surplus/Deficit**	0.08	-0.97	-1.03	-1.28	-4.71	-2.43	0.08	-0.41	-1.09	1.26	-5.23	0.16

Removing tariffs has quite different effects on consumers' welfare whether the government budget is held fixed, and increasing direct taxes on households' incomes compensates revenue losses, or it is left to vary to become an endogenous model result. In the first case, Equivalent Variation (EV) really measures the amount of net income (i.e. allowing for changes in tariff revenues) which would have to be given to the consumers at the initial prices to make them as well off as they would be at the new set of prices.[223]

By assuming fixed full employment (the case of a vertical labour supply function), the benefits of a more liberal trade regime are not reflected in employment changes, but only in more efficient reallocations of the existing labour force. With the hypothesis of a perfectly elastic labour supply (the case of a flat labour supply) these reallocations are enhanced through employment increases and this has beneficial effects on consumer welfare.

Finally, trade elasticities affect aggregate results by inducing stronger or weaker terms of trade changes. Two limiting cases are considered. In the first high elasticities of substitution in import demands are assumed. This is equivalent to a reduction in Moroccan exporters' market power in France (or that of French exporters in Morocco). As expected, this case registers lower terms of trade effects. When low trade elasticities are used, the implicit exporters market power produces stronger changes in the bilateral terms of trade.[224]

Table 7-4, with a fixed government's budget and high trade elasticities, probably represents the most plausible scenario. This table's results are commented first and then contrasted with the other two tables (Table 7-5 and Table 7-6).

Equivalent variation changes (see row 1) are influenced by the degree of liberalisation. In the case of France a direct relationship unambiguously appears: the more liberal the trade regime, the higher the welfare gains. For Morocco, the best solution seems to be a custom union with its northern partner. In this case welfare gains are maximised (or in the case of fixed resources, losses are minimised). This is due to two factors. Firstly, trade diversion is highest in the free trade area scenario and it drives up

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[223] See Vousden, N. (1990), page 224.
[224] The two limiting values for these elasticities are 8.00 and 1.50.

import prices worsening Moroccan terms of trade[225] and lowering welfare gains. This is evident in rows 16 through 19, which measure bilateral Mediterranean trade flows and diversion indices. Secondly, Moroccan welfare is higher in the custom union scenario with respect to the full free trade case, because of the "crowding-out" of government's savings on households' incomes in the latter case. In the free trade scenario tariff revenues go to zero and have to be replaced by higher direct taxes. Revenues from these taxes record the highest increase (they rise by 92 per cent with respect to the initial government's savings, see row 25) and thus affect households' disposable income.

Real GDP grows significantly only in the case of expandable employment (consider rows 2 and 3, and the first 6 columns) and this also explains the higher welfare gains recorded with this closure. In the case of fixed resources (fixed capital stock and vertical labour supply) GDP variations are very small and are attributable to factors' movements across sectors[226].

Factor price variations are again dependent on the assumption made for the labour markets. With excess labour supply, nominal wages vary by the same amount of the consumer price index (so that real wages in rows 4 to 8 remain unchanged), whereas rental rate responds to variations in capital productivity. In the case of full employment, increased labour demand depends on the pattern of structural adjustment in the economy and factor intensities in the various sectors. Wages and rent variations are then interpreted from the Stolper-Samuelson theorem and will be examined again in the detailed results section below.

Removing import protection induces real exchange rate[227] and domestic price depreciation (see rows 12 and 13). Cheaper imports compete with domestic goods and exert downward pressure on the consumer price index (CPI). Besides, the real exchange rate must depreciate to align domestic and international resource costs. One significant exception is worth mentioning: the real exchange appreciation in Morocco in the case of a custom union with fixed labour supply. This is due to the impressive real wage increase

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[225] It should be remembered that Moroccan-French bilateral trade prices are endogenous. When Morocco increases its import demand of French goods, due to a tariff reduction, French exporters can respond by increasing their supply, but they have to compete for resource use in the domestic and other international markets. This competition results in higher French export prices, which worsen Moroccan terms of trade.

[226] The model specification assumes inter-sectoral labour productivity differences, which are calibrated into a fixed wage distribution. This means that reallocating labour can decrease aggregate productivity per unit of resource cost, and especially so if labour is induced to migrate from lower to higher wage categories. For more detail see the technical specification in the next chapter.

[227] This is defined as the aggregate value added price index (see the technical chapter)

in the skilled occupational group, which records a very high intensity in Moroccan exports.

For both countries trade increases in all the simulations. It is possible to consider separately changes in total trade (rows 14 and 15) and in bilateral trade (rows 16 and 17). A clear picture of the trade diversion effects following the various policies is provided by the indices of import and export diversion (in rows 18 and 19).

These indices are defined as the normalised measure of the shifts in the composition of trade between the bilateral partner and the other regions (rest of the world and the EU). For example, the import diversion index is given by

$$\delta(M_0, M_1) = 100\frac{\left\| M_1\frac{|M_0|}{|M_1|} - M_0 \right\|}{\|M_0\|}$$

where $M_0 = (M_0^b, M_0^r)$ and $M_1 = (M_1^b, M_1^r)$ are the 2-tuple of bilateral, and EU and ROW (merged together) imports in the base and after the experiment, respectively, and $\|\cdot\|$ and $|\,|$ denote Euclidean and simplex norms.[228] These indices measure the percent of imports or exports diverted from one market to another; positive values indicate diversion into the Mediterranean region and away from the others.

For Morocco, the interpretation of these indices is straightforward. Trade diversion, stronger for imports than exports, is reduced according to the degree of liberalisation. The lowest level is reached with a fully free trade regime where only about 8 per cent of imports and 12 per cent of exports are diverted into the Mediterranean region. This residual diversion, puzzling in a completely unrestricted trade regime, is uniquely attributable to price effects in the Mediterranean region (see rows 23 and 24).[229]

For France, the policy-induced trade diversion effects seem to be quite modest. This obviously results from the initial limited France's trade dependence on its southern

[228] The export diversion index is defined analogously.

[229] Notice that in the current specification of the model, basically Morocco (France) faces a downward sloping demand for its exports to France (Morocco) and an upward sloping supply for its partner's import supply and it is impossible to rule out terms of trade effect. Brown (1987) signals that the magnitude of this effect, arising from the Armington assumption, may be quite large, suggesting that models using this assumption can seriously underestimate the gains from trade liberalisation.

partner. It should be noticed, though, that in the case of complete free trade a large proportion of imports and exports are *shifted* from the EU to the ROW region.[230]

The final sets of aggregate results worth noting are presented in rows 20 and 21 in a compact format of adjustment indices of capital and labour. These indices give an indication of the extent of the domestic resources reallocation consequent to the adoption of trade liberalisation and are measured in a similar manner to the trade diversion indices. For example, in the case of labour, as follows:

$$\lambda(L_0, L_1) = 100\frac{\|L_1 - L_0\|}{\|L_0\|}.$$

where $L_0 = (L_{0,i}, L_{0,j})$ and $L_1 = (L_{1,i}, L_{1,j})$ are the sectoral employment in the base and after the experiment, respectively, and $\|\cdot\|$ has the same definition. Clearly, the larger the value of these adjustment indices, the more resource reallocation and structural adjustment the economy undergoes.

Two main features are highlighted. Firstly, the results confirm that the smaller the size of the economy, the higher the trade dependency and the size of the initial tariffs, the larger will be the adjustment required after the policy shock. The highest levels of adjustments are reached for Morocco in the free trade experiment with perfectly elastic labour supply. In this case, more than 6 per cent and 18 per cent of total labour and capital move inter-sectorally.

Secondly, given the relatively low substitution elasticity among labour and capital, although some variations in the adjustment indices are observable between the two closures, they are not very significant and their ratio (not shown) is almost constant.

These results are contrasted with those presented in Table 7-5 and Table 7-6. The first of these tables collects aggregate results for the same three policy experiments under the assumption that trade elasticities are lower.

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[230] This effect is not visible in the aggregate tables but it is recorded in the sectoral results tables that follow. Besides, I use the term *shifted* and not *diverted* because in the case of free trade no preferences are accorded to any particular region. The ROW region trade shares increase at the expenses of the EU, but this is a correction of initial distortions (i.e. of the initial EU and Mediterranean preferences).

*Table 7-5: Comparative statics - aggregate results (% difference from base run) – **Low Trade Elasticities – Fixed Government Savings***

		FLAT Labour Supply						VERTICAL Labour Supply					
		FTA		CUSTOM		FREE TRADE		FTA		CUSTOM		FREE TRADE	
		France	Morocco	France	Morocco	France	Morocco	France	Morocco	France	Morocco	France	Morocco
1	EV	0.06	-2.64	0.96	-0.33	2.47	-0.86	0.06	-2.74	0.93	-1.70	2.53	-2.65
2	Real GDP	0.02	0.12	0.04	3.18	0.81	4.42	0.00	-0.10	0.03	0.10	0.13	-0.05
3	Employment	0.03	0.23	0.07	3.50	1.24	5.09	0.00	0.00	0.00	0.00	0.00	0.00
4	Real wage unskill	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.11	3.58	2.36	12.23	4.10
5	Real wage skill	0.00	0.00	0.00	0.00	0.00	0.00	0.09	5.36	0.95	16.21	5.83	18.84
6	Real wage salaried	0.00	0.00	0.00	0.00	0.00	0.00	0.06	1.75	-0.89	17.30	0.07	25.31
7	Real wage other lab.	0.00	0.00	0.00	0.00	0.00	0.00	0.10	-0.73	-0.07	4.36	2.44	6.83
8	Real wage informal	-0.04	0.00	0.81	0.00	4.41	0.00	0.00	0.24	0.00	11.28	0.00	9.63
9	Val.Added Wgt.Ave.	0.00	0.00	0.00	0.00	0.00	0.00	0.08	1.14	0.02	13.81	2.71	19.72
10	Employnt Wgt. Ave.	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.49	0.18	8.15	3.14	11.77
11	Rent	0.13	0.39	-2.35	4.18	-5.17	7.38	0.01	-0.83	-2.53	-11.08	-9.69	-14.99
12	CPI	0.04	-1.92	-0.81	-8.80	-4.41	-12.10	0.04	-1.88	-0.90	-8.27	-4.90	-11.55
13	Real Exchge Rate	0.08	-1.07	-1.41	-3.40	-4.59	-4.27	0.08	-0.88	-1.52	-1.24	-5.09	-1.48
14	Total M (value)	0.28	6.48	-1.37	23.40	3.39	33.89	0.25	6.17	-1.52	18.27	1.97	25.58
15	Total Ex (value)	0.28	9.43	-1.37	34.08	3.39	49.36	0.25	8.99	-1.52	26.61	1.97	37.25
16	Med M (value)	14.25	34.02	16.76	28.80	17.18	25.84	14.14	33.76	15.50	25.73	14.70	20.74
17	Med Ex (value)	34.02	14.25	28.80	16.76	25.84	17.18	33.76	14.14	25.73	15.50	20.74	14.70
18	Import Diversion	0.13	12.58	0.17	2.13	0.12	2.93	0.13	12.64	0.16	3.07	0.11	1.88
19	Export Diversion	0.34	2.93	0.31	8.60	0.22	14.35	0.34	3.15	0.28	5.85	0.19	10.94
20	Employ Adjustment	0.03	0.69	0.43	3.46	1.34	5.15	0.02	0.70	0.41	2.26	1.27	3.50
21	Capital Adjustment	0.03	1.18	0.48	11.16	1.73	17.28	0.02	1.06	0.47	7.17	1.52	11.89
22	Terms of Trade	0.12	-3.89	0.15	-4.74	0.11	-3.79	0.11	-3.83	0.12	-4.01	0.09	-3.06
23	Export price index	0.13	0.70	0.10	-1.74	0.04	-2.59	0.13	0.75	0.09	-1.15	0.04	-2.01
24	Import price index	0.01	4.78	-0.04	3.15	-0.07	1.24	0.01	4.77	-0.03	2.98	-0.05	1.09
	Government Budget Closure (nominal values)												
25	Households Dir Tax Rev	0.24	29.49	-20.38	61.83	-45.26	92.19	0.25	31.03	-21.07	77.91	-47.81	112.36
26	Ind. Tax Revenues	0.20	-3.50	-2.06	-7.60	-9.50	-14.40	0.15	-3.52	-2.43	-8.92	-12.03	-16.58
27	Tariff Rev	-0.21	-32.66	-0.57	-83.73	-20.38	-118.47	-0.22	-33.00	-0.59	-85.26	-20.38	-118.47
28	Exp. Subsid. Expend.	-0.28	0.00	-14.75	0.00	-37.90	0.00	-0.27	0.00	-14.66	0.00	-37.90	0.00
29	Gov Expend on goods	0.25	-3.58	-3.28	-16.86	-13.24	-23.69	0.22	-2.63	-3.96	-6.34	-15.67	-9.08
30	Gov Transfers	0.19	-2.02	-3.56	-9.24	-19.42	-12.71	0.15	-1.98	-3.95	-8.69	-21.57	-12.13
31	Surplus/Deficit	0.08	-1.07	-1.41	-3.40	-4.59	-4.27	0.08	-0.88	-1.52	-1.24	-5.09	-1.48

As already anticipated, this is equivalent to assuming that French and Moroccan exporters have some market power in the Mediterranean region. Given the lower regional import demand elasticities, exporters, serving the Mediterranean region, may increase their prices without triggering substitution for exports from other sources. From this it follows that terms of trade effects are much stronger and policy-induced trade diversion is lower (see rows 22, and 18 and 19).[231] With this low elasticity specification, welfare gains from trade liberalisation are severely reduced, especially for Morocco, which, by being more dependent on bilateral trade with France, suffers more intense imports price inflation (see row 24).[232] The remaining results (GDP, employment, and factors' prices) do not qualitatively differ between Table 7-4 and Table 7-5.

The last table to be commented on, Table 7-6, collects interesting findings for the simulation experiments when a different closure for the government budget is implemented. The attention is focused on rows 25 to 31, which show per cent changes in the government's budget variables[233]. The following equation represents the government's budget closure rule.

$$P^{GDP}\overline{S}_g = H^{TAX} + \sum_i \left(Y_i^{INDTAX} + Y_i^{TARIFF} - Y_i^{ESUBS}\right) - P^G X^{TotG} - P^{CPI} G^{TRA}$$

initial savings in nominal terms are on the left hand side (and are found in row 31); these are equal to the difference of direct household tax revenues (H^{TAX} and row 25), indirect tax and tariff revenues (Y^{INDTAX} and Y^{TARIFF}, and rows 27 and 27), minus expenditures on export subsidies, goods and services and transfers (Y^{ESUBS}, X^{TotG} and G^{TRA} multiplied by relevant price indices, and rows 28, 29 and 30).

[231] One notable exception is given in the case of a FTA for Morocco. This was already commented above (see page 209 and footnote 225).

[232] This problem of underestimation of trade liberalisation gains (due to excessively high terms of trade changes) was already signalled above in footnote 229.

[233] For all the variables in rows 25 to 31, these changes are expressed as percentage variations with respect to the base year initial government's savings.

*Table 7-6: Comparative statics - aggregate results (% difference from base run) – **High Trade Elasticities – Endogenous Government Savings***

		FLAT Labour Supply						VERTICAL Labour Supply					
		FTA		CUSTOM		FREE TRADE		FTA		CUSTOM		FREE TRADE	
		France	Morocco	France	Morocco	France	Morocco	France	Morocco	France	Morocco	France	Morocco
1	EV	0.03	1.61	-0.13	9.16	0.77	11.82	0.03	1.40	-0.14	8.32	0.87	10.86
2	Real GDP	0.02	0.06	0.06	3.77	1.08	4.36	0.00	-0.68	0.01	-0.77	0.13	-0.76
3	Employment	0.03	1.98	0.09	7.06	1.69	7.38	0.00	0.00	0.00	0.00	0.00	0.00
4	Real wage unskill	0.00	0.00	0.00	0.00	0.00	0.00	0.13	14.54	2.08	26.22	12.04	26.33
5	Real wage skill	0.00	0.00	0.00	0.00	0.00	0.00	0.07	22.52	0.65	52.02	7.25	24.58
6	Real wage salaried	0.00	0.00	0.00	0.00	0.00	0.00	0.05	1.18	-0.38	16.85	1.27	20.57
7	Real wage other lab.	0.00	0.00	0.00	0.00	0.00	0.00	0.07	6.82	0.12	17.19	3.83	20.98
8	Real wage informal	-0.04	0.00	0.64	0.00	5.04	0.00	0.00	-1.47	0.00	12.30	0.00	0.43
9	Val.Added Wgt.Ave.	0.00	0.00	0.00	0.00	0.00	0.00	0.06	2.77	0.14	17.26	3.87	19.33
10	Employnt Wgt. Ave.	0.00	0.00	0.00	0.00	0.00	0.00	0.07	7.72	0.22	20.65	4.22	21.62
11	Rent	0.13	3.03	-1.65	9.94	-4.46	12.08	0.03	-0.14	-1.93	-10.10	-10.71	-10.91
12	CPI	0.04	-2.07	-0.64	-7.30	-5.04	-11.05	0.04	-1.70	-0.70	-6.28	-5.62	-10.04
13	Real Exchge Rate	0.08	-0.62	-1.03	-1.01	-4.69	-2.30	0.07	-0.12	-1.10	1.42	-5.25	0.11
14	Total M (value)	0.27	11.41	-1.13	30.34	5.17	37.63	0.24	10.21	-1.26	21.18	3.32	26.64
15	Total Ex (value)	0.27	16.62	-1.14	44.19	5.17	54.80	0.24	14.86	-1.27	30.85	3.33	38.80
16	Med M (value)	49.72	105.90	74.65	50.76	37.63	20.91	46.82	104.32	60.35	43.90	27.03	14.54
17	Med Ex (value)	105.90	49.72	50.76	74.65	20.91	37.63	104.32	46.82	43.90	60.35	14.54	27.03
18	Import Diversion	0.45	41.25	0.70	7.62	0.28	5.91	0.42	41.53	0.57	9.12	0.21	4.65
19	Export Diversion	1.08	18.90	0.54	14.07	0.15	7.39	1.06	18.53	0.47	15.02	0.11	5.65
20	Employ Adjustment	0.02	2.69	0.26	5.91	1.72	5.71	0.01	1.88	0.25	2.83	1.37	2.35
21	Capital Adjustment	0.02	2.68	0.31	12.51	2.03	16.93	0.02	2.38	0.30	7.07	1.69	11.41
22	Terms of Trade	0.10	-2.88	0.04	-0.82	0.03	-0.92	0.10	-2.75	0.02	-0.15	0.01	-0.52
23	Export price index	0.16	2.59	0.07	1.29	0.01	-0.74	0.16	2.71	0.07	1.90	0.00	-0.38
24	Import price index	0.05	5.64	0.03	2.13	-0.02	0.18	0.06	5.62	0.05	2.05	-0.01	0.14
	Government Budget Closure (nominal values; expenditures reductions have positive signs)												
25	Households Dir Tax Rev	0.56	-0.24	-5.38	2.44	-23.04	1.20	0.54	-0.11	-5.81	2.63	-25.62	1.32
26	Ind. Tax Revenues	0.18	-3.90	-1.87	-2.27	-10.92	-11.59	0.14	-4.84	-2.14	-6.83	-14.02	-16.59
27	Tariff Rev	-0.28	-51.85	-0.64	-86.49	-20.38	-118.47	-0.28	-52.94	-0.64	-88.96	-20.38	-118.47
28	Exp. Subsid. Expend.	-0.25	0.00	-7.31	0.00	-37.90	0.00	-0.24	0.00	-7.22	0.00	-37.90	0.00
29	Gov Expend on goods	0.23	-3.71	-2.62	-13.32	-13.92	-21.13	0.21	-2.50	-3.01	-2.10	-16.46	-8.53
30	Gov Transfers	0.19	-2.18	-2.82	-7.67	-22.21	-11.61	0.17	-1.79	-3.06	-6.60	-24.74	-10.54
31	Surplus/Deficit	0.28	-50.11	4.87	-65.34	19.70	-96.12	0.25	-53.60	4.70	-84.46	19.08	-114.67

With fixed real government's savings (as in Table 7-4 and Table 7-5) when tariff revenues (and for France, export subsidy expenditures) are reduced, due to liberalisation policies, household direct taxes are accordingly increased.[234] In the free trade scenario, Moroccan consumers' direct taxes double as a percentage of the government's initial savings (see row 25 in Table 7-4); clearly this affect households' welfare. On the contrary, French consumers benefit from export subsidy expenditure contraction.

Contrast this with the results in Table 7-6. Here, with endogenous government's savings, household taxes do not compensate any revenue losses, which instead directly affect the government's budget. Now row 31 shows what happens to the government's budget following a policy shock: the Moroccan government loses important revenues whereas the French one gains by reducing its support to exports. These losses and gains, by not being transferred to private agents, do not affect their welfare. EV estimations are now much higher for Morocco and quite reduced for France.

7.4.2 Sectoral results

In a disaggregated CGE model such as EMMA sectoral results are essential in the analysis of the real structural adjustment and reallocations occurring in response to policy change. For it is individual sectors that seek import protection, and aggregate real income or equivalent variation measures do not usually play a decisive role in the formulation of trade policy. In order to implement sustainable reforms, it is then crucial to have detailed information on sectoral adjustments and other trade-offs not discernible at the aggregate level.

Table 7-7 shows sectoral information on real GDP, real consumption, labour and capital demands, imports and exports inside and outside the Mediterranean region for the Custom Union and the full liberalisation (Free Trade) experiments. Results are shown as percentage differences from the initial equilibrium.

For France, the results suggest that a customs union with Morocco would have very little structural impact. Although trade with its partner would increase significantly with

[234] Notice that row 31 (in all the three tables) records changes in government's nominal savings with respect to the base run. Given the fixed real savings assumption, in Table 7-4 and Table 7-5, row 31 values

respect to the benchmark (and notice that the highest positive variations do indeed coincide with those sectors enjoying the highest initial protection, see Table 7-3), this would still represent a low proportion of French total trade, and the registered trade diversion effects would be of minor importance.

The picture changes when considering full liberalisation (Free Trade). In this case most manufacturing industries increase their production, whereas primary sectors and food processing show a reduction. This is mainly a response to increases in domestic and foreign demand for the expanding sectors and substitution with cheaper imports for the decreasing ones. Accompanying the output expansion is a growth in employment. Capital, due to its low substitutability with labour, is reallocated according to labour expansion.[235] As long as trade is considered, remarkable shifts are noticeable between the EC and the ROW regions. With the full elimination of trade preferences for the EC and the Mediterranean regions, imports from and exports to the ROW become competitive. It is in fact this shift towards more efficient markets sources (or more profitable destinations) that generates welfare gains.

Morocco undergoes a remarkably larger structural adjustment, the difference with respect to France is especially strong for the custom union scenario. Almost half of its sectors are contracting and the other half are expanding. The specialisation towards traditional comparative advantage sectors, already signalled in chapter 5, is apparent. *Food products*, *textiles*, *apparel*, and *chemicals* (phosphates) register significant increases in gross production and exports.[236]

Particularly interesting in this case is the extent of capital and labour reallocation. As illustrated in Table 7-4, in the perfectly elastic labour supply closure, capital returns go up whereas they decrease with the fixed labour supply closure. With expanded employment, the dominating effect is the increase in capital productivity and this explains the rise in its price. With fixed labour and capital supply, factors rewards will depend on the sectoral adjustment brought about by changes in relative prices. As implied

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coincide with the variation in the government's savings price index, which is assumed to be equal to the GDP price index (of row 13).

[235] Some sensitivity analysis has been carried out with changes in the elasticity of substitution of labour and capital, and the results confirm this observation.

[236] These are also the sectors with the highest gross product to export ratios, see column 9 in Table 7-2.

by the Stolper-Samuelson theorem if relative prices of capital intensive goods decrease with respect to those of labour intensive goods, then the rental rate is expected to fall with respect to wages.

Table 7-7: Sectoral results (Perfectly elastic labour supply - figures in percentages)

	CUSTOMS UNION										FREE TRADE									
	Real XP	Real Cons	LD	KD	Ec M	Row M	Med M	Ec E	Row E	Med E	Real XP	Real Cons	LD	KD	Ec M	Row M	Med M	Ec E	Row E	Med E
FRANCE																				
Food Crops	-1	0	-1	-1	-3	-3	14	11	-69	-9	-12	0	-12	-12	-15	-2	8	-39	-39	9
Estate Crop	1	0	0	1	-6	-6	98	8	-48	122	-6	1	-6	-6	-21	49	64	-17	-17	93
Other Primary	0	0	0	0	0	0	8	10	-46	9	1	-1	1	1	-2	8	25	-14	-14	30
Energy	1	0	1	1	-1	-1	31	13	-28	82	-2	3	-2	-2	-49	36	-12	-4	-4	27
Milling Conf	-2	0	-2	-2	-1	-1	228	21	-83	58	-14	-1	-14	-14	-34	147	189	-55	-55	41
Food Product	-1	0	-1	-1	-2	-2	129	16	-72	-10	-7	0	-7	-7	-26	69	110	-40	-40	-13
Beverages Tobacco	-1	0	-1	-1	-2	-2	864	14	-29	496	-6	5	-6	-6	-82	1145	413	-9	-9	67
Textiles	3	0	3	3	0	0	42	7	-3	72	14	2	14	14	-20	51	26	26	26	30
Apparel	2	1	2	2	-5	-5	96	5	1	79	3	7	3	3	-62	142	32	18	18	69
Leather	2	0	2	2	-2	-2	67	5	2	51	-2	9	-2	-2	-72	199	-4	14	14	25
Wood	1	0	1	1	-2	-2	55	5	-7	161	-1	4	-1	-1	-54	154	1	9	9	35
Paper	1	0	1	1	-2	-2	34	5	-8	73	3	3	3	3	-34	57	17	13	13	33
Quarrying Min	1	0	1	1	-2	-2	13	4	-2	122	7	3	7	7	-17	60	8	20	20	86
Metal Ind	5	0	5	5	0	0	8	7	6	27	43	3	43	43	1	33	17	63	63	31
Metal Obj	1	0	1	1	-1	-1	21	5	-5	82	10	3	11	10	-15	44	18	22	22	64
Equipment	2	0	2	2	-2	-2	24	5	1	31	18	3	18	18	-19	17	24	35	35	27
Transp Mat	1	0	1	1	-1	-1	59	7	-9	113	12	8	12	12	-60	206	8	26	26	27
Electr Machine	1	0	1	1	-1	-1	52	7	-10	54	9	4	9	9	-39	43	35	17	17	31
Chemicals	3	0	3	3	-1	-1	50	6	4	71	20	5	20	20	-32	78	42	39	39	27
Rubber	2	0	2	2	-2	-2	23	5	1	127	15	4	15	15	-30	129	8	34	34	67
Other Ind	2	0	2	2	-2	-2	29	5	2	153	7	5	7	7	-47	55	6	21	21	116
Transp Communic	-2	0	-2	-2	-1	-1	8	29	-91	-58	-6	0	-6	-6	-5	-4	11	-59	-59	-31
Banking Insurance	-1	0	-2	-1	-1	-1	76	28	-91	-60	-7	1	-7	-7	-34	78	56	-62	-62	-34
Other Services	0	1	0	0	-2	-2	20	29	-93	-65	1	3	1	1	-18	12	17	-61	-61	-39
MOROCCO																				
Food Crops	-1	1	0	-2	75	75	-9	-2	-2	14	-2	1	-1	-3	71	71	9	7	7	8
Estate Crop	7	1	9	7	178	178	122	-23	-23	98	4	1	6	3	273	273	93	-10	-10	64
Other Primary	3	2	4	2	0	72	9	11	11	8	36	1	38	35	0	78	30	59	59	25
Energy	-29	2	-29	-30	39	39	82	-29	-29	31	-40	2	-39	-40	59	59	27	-33	-33	-12
Milling Conf	-6	2	-6	-6	141	141	58	-67	-67	228	-12	2	-12	-12	240	240	41	-58	-58	189
Food Product	17	2	17	16	-2	-2	-10	16	16	129	17	2	17	15	15	15	-13	39	39	110
Beverages Tobacco	9	2	10	8	-55	-55	496	0	-84	864	-4	1	-3	-5	168	168	67	0	-66	413
Textiles	32	1	33	31	41	41	72	81	81	42	17	1	19	16	32	32	30	85	85	26
Apparel	46	3	47	44	0	-27	79	0	81	96	22	2	23	20	0	98	69	0	137	32
Leather	9	2	10	8	-81	-81	51	-3	-3	67	3	1	4	1	35	35	25	38	38	-4
Wood	4	2	4	2	6	6	161	26	26	55	-11	2	-10	-12	59	59	35	25	25	1
Paper	-3	3	-2	-3	19	19	73	27	27	34	-3	2	-2	-3	50	50	33	55	55	17
Quarrying Min	-5	2	-4	-5	117	117	122	20	20	13	-4	2	-4	-4	161	161	86	37	37	8
Metal Ind	-18	3	-18	-18	11	11	27	15	15	8	-14	2	-14	-14	11	11	31	37	37	17
Metal Obj	-8	3	-7	-8	78	78	82	34	34	21	-7	2	-6	-8	105	105	64	54	54	18
Equipment	6	3	7	5	11	11	31	0	49	24	13	2	13	11	20	20	27	0	87	24
Transp Mat	13	2	14	12	-47	-47	113	40	40	59	2	2	3	0	27	27	27	87	87	8
Electr Machine	5	3	5	4	0	0	54	48	48	52	7	3	8	6	42	42	31	108	108	35
Chemicals	30	3	31	29	-4	-4	71	80	80	50	56	3	57	55	19	19	27	156	156	42
Rubber	-7	3	-6	-8	31	31	127	24	24	23	-9	2	-8	-10	98	98	67	43	43	8
Other Ind	-27	4	-26	-28	94	94	153	0	-15	29	-28	3	-28	-30	180	180	116	0	18	6
Transp Communic	8	2	9	8	0	35	-58	19	19	8	13	1	15	12	0	6	-31	35	35	11
Banking Insurance	5	3	6	4	0	31	-60	-7	-7	76	7	1	8	6	0	2	-34	17	17	56
Other Services	7	3	8	6	0	21	-65	36	36	20	9	2	10	8	0	-14	-39	60	60	17

Examining the pattern of output changes and of capital intensities, in Table 7-2[237] and Table 7-7, it can be seen that three of the four most capital intensive sectors of the Moroccan economy (in order: *energy*, *metal industries*, *beverages and tobacco* and *leather product*) are all contracting.

These sectors in fact release the necessary capital for the expanding sectors which are in areas of higher comparative advantage: *textiles*, *apparel*, *food products*, phosphates (in *other primary* and *chemicals*), *estate crops*.

For brevity, a similar table with sectoral results for the fixed labour supply case has been omitted. The only point worth noting is that the results for this latter case do not qualitatively differ from those displayed by the perfect elastic supply; the same reallocative forces (tariff reduction and comparative advantage) are still responsible for the structural adjustment the economies undergo.

Both aggregate and sectoral results confirm expectations about the ranking of France and Morocco in terms of welfare effects and adjustment. Morocco benefits more than France given its size and trade dependency. Clearly the advantages increase with the degree of liberalisation, although higher adjustment costs are incurred. As far as comparative statics results are concerned, the best option, for Morocco, in terms of the combination of positive effects, balanced adjustment costs, and political feasibility seems to be represented by a custom union treaty.

7.5 Dynamic simulations and results

7.5.1 The benchmark scenario

Applied general equilibrium models are not forecasting tools, so the 1990-2004 benchmark scenario for the Mediterranean economies studied here is not intended as a realistic prediction, but simply as a scenario in which current economic policies parameters remain unaltered. This ***B**usiness **a**s **U**sual* (BaU) scenario is obtained by making assumptions about the future behaviour of those variables that govern the

[237] Capital intensity is indirectly measured in columns 6 and 7, the lower the value the higher the capital contribution.

dynamics of the model, namely: factors and productivity growth rates. During the dynamic calibration of the model the labour growth rate in efficiency units is set exogenously together with a *target* real GDP growth rate while the *instrument* is the capital productivity growth rate.

In a simplified version[238], the two crucial equations used in the dynamic calibration of the capital productivity growth rates take the following form. Real GDP is defined as the sum of factor demands in efficiency units:

$$Y_t = \lambda^L{}_t L_t + \lambda^K{}_t K_t \tag{1}$$

and grows according to an exogenous rate g_Y :

$$Y_t = (1 + g_Y)^n \, Y_{t-n} \tag{2}$$

By imposing λ_t^L (labour productivity) and λ_t^K (capital productivity) equal to 1 in the base year, and assuming exogenous growth rates for the labour force (g_L) and labour productivity ($g_{\lambda L}$), it is possible to re-write equation (1) as follows:

$$(1 + g_y)^n Y_{t-n} = (1 + g_{\lambda L})^n (1 + g_L)^n L_{t-n} + (1 + g_{\lambda K})^n K_{t-n} \tag{3}$$

During dynamic calibration equation (3) is solved for $g_{\lambda K}$, the capital productivity growth rate. This is then fixed during the other experiments, and GDP growth rate g_Y becomes an endogenous result of equation (2).[239] This procedure, which is standard in calibrating recursive dynamic CGE models[240], does not guarantee that the model has a strictly defined steady state. This means that not all the variables (Y_t, L_t and K_t) grow at the same rate, as shown in Table 7-8. In fact, by exogenously setting both labour force and productivity growth rates independently, a basic restriction for such a steady state is deliberately not respected. An alternative would be to choose the labour force growth rate and to calculate the labour productivity growth rate according to the relationship:

[238] For the exact version see the following technical chapter.
[239] With no shocks and by fixing the capital productivity growth rate thus calculated, the model will exactly recalculate the GDP growth chosen during the dynamic calibration.
[240] See Ballard et al. (1985).

$$(1+g_{AL})=(1+g_y)/(1+g_L)$$

The BaU assumed growth rates are summarised in Table 7-8 together with the capital productivity values resulting from the dynamic calibration.

Table 7-8: Growth rates in the recursive dynamics

	1992	1995	1998	2001	2004	1992	1995	1998	2001	2004
			France					Morocco		
Labour force	0.005	0.005	0.005	0.005	0.005	0.010	0.010	0.010	0.010	0.010
Labour productivity										
Skilled workers	0.005	0.005	0.005	0.005	0.005	0.010	0.010	0.010	0.010	0.010
Unskilled workers	0.015	0.015	0.015	0.015	0.015	0.020	0.020	0.020	0.020	0.020
RGDP	0.020	0.025	0.027	0.025	0.025	0.045	0.045	0.045	0.045	0.045
Depreciation	0.045	0.055	0.055	0.055	0.055	0.035	0.045	0.045	0.045	0.045
Capital productivity	0.016	0.037	0.035	0.027	0.023	0.025	0.030	0.031	0.035	0.032

The labour force rate is assumed to be uniform across skills and equal to the national population growth rates[241]; labour productivity rates are differentiated by skill and by region; and real GDP growth rates are simple trend extrapolations of past growth rates. The table also shows the assumed region-specific capital stock depreciation rates. In addition to the data shown here, the assumptions on government and foreign savings also influence the dynamic behaviour of the model. For simplicity, and consistent with long run equilibrium, it has been assumed that French and Moroccan governments will have a balanced budget by the year 2004, and that foreign savings are fixed to the initial values shown in the SAM for 1990.[242]

Trade liberalisation policies can have multiple effects on growth performance. Firstly, they can improve *allocative efficiency* by affecting relative prices and can make investment goods cheaper. Secondly, as pointed out in an extensive literature, more liberal trade can have positive effects in terms of increased *technical efficiency* or productivity. The best-known attempts to link outward orientation and productivity are based on 'X-efficiency', economies of scale, capacity utilisation, increased competition,

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[241] These are taken from World Bank international statistics.

[242] These particular assumptions on government and foreign savings might seem a bit restrictive in a growth model. In fact, liberalisation is usually accompanied with increased foreign capital inflows. Their inclusion would probably generate larger growth gains, but the purpose of the following simulations is to measure the isolated effect on growth of liberalisation policies alone. See text below and footnote 244.

and technological catch-up.[243] Finally, these policies might trigger virtuous circles by attracting more foreign capital.[244] In the EMMA model, given the closure rules chosen for its recursive dynamics mode (in particular setting aggregate investment equal to aggregate savings), and given the *exogeneity* of productivity changes, only the first effect is properly taken into account.[245] In practice, as already demonstrated in the comparative statics section, by changing relative prices, Mediterranean economic integration induces a more efficient allocation of resources and expands incomes. More savings become available and they can be devoted to larger investment. This might be magnified if the relative price of investment goods has been reduced.

It could also be possible to exogenously change productivity growth rates. For example, to mimic endogenous growth effects, labour productivity can be exogenously increased during a trade liberalisation experiment. This has been done for a few simulations, although not reported here. As expected, the main effect is to enhance growth and incomes. This effectively shows that the results reported in the main text, i.e. with no productivity effects, should be considered as a sort of lower bound.

In fact, in the next section the growth effects of the usual three policy scenarios will be examined by focusing mainly on the changes in real investment and its price.

7.5.2 Rationale for the experiments and simulations description

Greenaway and Morrissey , and Kreuger[246] identify three core areas of disagreement over policy reform. First, the magnitude of change required is unknown; second, it is difficult to specify the range of reforms necessary and in what order they should be implemented; third, there is little agreement on the appropriate speed of reform. These issues are also linked to administrative capacity and credibility. This section contrasts two different ways of implementing the trade liberalisation reforms described above, in order to try to shed some light on the different consequences that the speed and

[243] Among the various papers on trade and growth explicitly referring to Morocco are those by M. Haddad (1991) and Clerides, Lach and Tybout (1996).

[244] See, for Morocco, Haddad and Harrison (1992).

[245] In this sense, the model presented here is *not* a model of endogenous growth.

[246] See Greenaway and Morrissey (1993) and Kreuger (1992) page 253.

magnitude of policy change can have on GDP growth and structural adjustment, thus achieving the second main objective of this chapter, as stated in the introduction.

In essence, each of the three alternative policy scenarios of free trade area formation, custom union creation and full free trade will be implemented in two variants. The first consists of gradual proportional across the board reduction of the initial tariffs (and subsidies). The second variant implements an initial change to uniform tariffs and then, in subsequent periods, their gradual reduction. The uniform tariff and subsidy chosen for all sectors are equivalent to the trade weighted average of the initial rates[247].

Table 7-9 details the changes in the policy parameters performed in the six simulations. It is possible to see that the overall shock (from 1990 to 2004) of policies 1 to 3 is equivalent to the comparative statics experiments. Policies 4 to 6, although they reach the same final year's value[248] of the other three, are implemented differently. In the first round (1992) tariffs are set equal for all sectors to the shown values and then reduced accordingly. An exactly equivalent procedure has been followed for export subsidies.

The motivation for attempting these particular simulations stems from an examination of the proposals the Moroccan government presented to the European Community and to the WTO[249]. Among the various issues discussed in those documents are the reciprocity of the trade reforms and the sequencing of liberalisation across sectors. Two major concerns of the Moroccan side are the effects of a freer access to the European markets for its agricultural goods and the shock to the domestic manufacturing industries once these sectors are open to trade. Without explicitly attempting liberalisation of particular sectors before others, the policy experiments essentially consist of a special kind of sectoral sequencing in the trade reform and show which are the expected aggregate effects.

[247] These uniform rates can be read on the last row (labelled "economy-wide") of Table 7-3. Interestingly, an attempt to calculate the revenue neutral tariff (subsidy) rate yielded a result very close to the average one. In other words, implementing the uniform average tariff has almost no consequences for government revenues. In contrast such a policy should be less liable to rent seeking, have much lower administrative costs and, as shown below, it improves allocative efficiency.

[248] The only exception is for the final year's tariff rates of policies 2 and 4: in fact in the former Moroccan tariffs on ROW imports are equal to the French tariffs but are not uniform across sector as in policy 4.

[249] See Royaume du Maroc. Ministère de l'Agriculture (1994), and Royaume du Maroc (1994).

Table 7-9 Dynamic trade policy simulations: reduction coefficients and uniform rates values

Tariff of:	on imports from	1990	1992	1995	1998	2001	2004
		Type of policy					
		1. FTA					
Morocco	France	1.00	0.90	0.75	0.50	0.25	0.00
Morocco	Row	1.00	1.00	1.00	1.00	1.00	1.00
France	Morocco	1.00	0.90	0.75	0.50	0.25	0.00
France	Row	1.00	1.00	1.00	1.00	1.00	1.00
		2. CUSTOM					
Morocco	France	1.00	0.90	0.75	0.50	0.25	0.00
Morocco	Row	1.00	0.75	0.50	0.25	=French tariff	=French tariff
France	Morocco	1.00	0.90	0.75	0.50	0.25	0.00
France	Row	1.00	1.00	1.00	1.00	1.00	1.00
		3. FREE					
Morocco	All	1.00	0.90	0.75	0.50	0.25	0.00
France	All	1.00	0.90	0.75	0.50	0.25	0.00
		4. FTA uniform					
Morocco	France	1.00	1 x 0.33	0.75 x 0.33	0.5 x 0.33	0.25 x 0.33	0.00
Morocco	Row	1.00	1.00	1.00	1.00	1.00	1.00
France	Morocco	1.00	1 x 0.10	0.75 x 0.10	0.5 x 0.10	0.25 x 0.10	0.00
France	Row	1.00	1.00	1.00	1.00	1.00	1.00
		5. CUSTOM uniform					
Morocco	France	1.00	1 x 0.10	0.75 x 0.10	0.5 x 0.10	0.25 x 0.10	0.00
Morocco	Row	1.00	1 x 0.33	0.75 x 0.33	0.5 x 0.33	0.25 x 0.33	1 x 0.05
France	Morocco	1.00	1 x 0.10	0.75 x 0.10	0.5 x 0.10	0.25 x 0.10	0.00
France	Row	1.00	1.00	1.00	1.00	1.00	1.00
		6. FREE uniform					
Morocco	All	1.00	1 x 0.10	0.75 x 0.10	0.5 x 0.10	0.25 x 0.10	0.00
France	Morocco	1.00	1 x 0.10	0.75 x 0.10	0.50 x 0.10	0.25 x 0.10	0.00
France	Row	1.00	1 x 0.05	0.75 x 0.05	0.50 x 0.05	0.25 x 0.05	0.00

The difficulty of establishing a clear theoretical result provides further motivation for carrying out a numerical simulation of these two different tariff reduction procedures. Greenaway and Morrissey[250] argue that the general principle guiding tariff liberalisation is to reduce all tariffs proportionally. Economic theory is less clear about the welfare effects of differential tariff reductions although, if goods are net substitutes, it is argued to be generally beneficial to reduce the highest tariffs and increase the lowest tariffs. This last result is discussed in Falvey and Kim (1992), where they state that the adjustment in individual tariffs will be welfare improving in the following cases: (i) a cut in the highest ad valorem tariff of a good that is a net substitute for all other goods; (ii) an increase in the lowest ad valorem tariff, including any zero tariffs, of a good that is a net substitute

[250] See Greenaway and Morrissey (1993) page 259.

for all other goods; (iii) a reduction (increase) in the tariff of a good that has a higher (lower) tariff than its net substitutes, and a lower (higher) tariff than its net complements..

Falvey and Kim assert that results (i) and (ii) form the basis for the popular "concertina" approach to trade liberalisation, but they warn that little concern appears to be expressed over determining whether the net-substitutes requirement is satisfied.[251] Clearly the uniform procedure described in Table 7-9 for policies 4 to 6 can be considered as an approximation to the "concertina" approach just described.

Further complications in the empirical study of implementing a uniform tariff structure arise in presence of additional distortionary policy measures (indirect taxes and export subsidies in the Moroccan-French case). Mitra (1986) and Dahl, Devarajan and van Wijnbergen (1986) study, with static CGE models, the conditions for an "optimal"[252] tariff structure in a second best framework for India and Cameroon respectively. One interesting result[253] is the sensitivity of the "optimal" tariff structure to the degree of policy distortion assumed to remain. Essentially when indirect taxes are set to zero the resulting "optimal" tariffs are highly uniform[254], however when they move into second best world (where production taxes are present) then tariff rates vary widely across sectors.

These considerations suggested testing a further *variant* of policies 4 to 6 of Table 7-9, namely to set, by the year 1992 onwards, uniform indirect taxes for all sectors equal to the average rate calculated from the base SAM. It should be noted that these uniform production tax rates are not very high; they are equal to 6.6% and 7.0% for France and Morocco, respectively. In fact, this new version does not produce qualitatively different results, rather it enhances the effects of the previous version (with no uniform indirect taxes). As expected, the uniform *tariffs-and-indirect-taxes* variant, through greater efficiency gains, registers higher growth rates than the *tariffs-only* variant. For brevity,

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[251] See Falvey and Kim (1992) pages 914. On the theory of piecemeal tariff reform see Lopez and Panagariya (1992) and other references therein.
[252] The optimality criterion is represented by the maximisation of the utility of the representative consumer.
[253] In Dahl, Devarajan and van Wijnbergen (1986).
[254] See table 2 in Dahl, Devarajan and van Wijnbergen (1986).

and because this case is closer to the actual proposed policy reforms, only the uniform *tariffs-and-indirect-taxes* version results have been reported below.[255]

A final observation is necessary before proceeding to the description of the simulation results. The long-term growth implications of alternative trade strategies are of clear interest to policy makers, but as already stated in the previous section, the model used here will only partially capture policy effects on growth. It remains heavily dependent about the assumptions made on the exogenous variables (factor growth, productivity, depreciation, and expectations). One way of testing the robustness of the following results would be to undertake extensive sensitivity analysis on crucial parameters and, maybe also, to attempt different modelling approaches. This is left to future research and is therefore not carried out here.

7.5.3 Experiments results

Table 7-10 below reproduces the main results of the dynamic simulations. For each policy (proportional tariff reduction for *F*ree *T*rade *A*rea (*FTA*), *CUSTOM* union, *FREE* trade and uniform *tariffs-and-indirect-taxes* reduction version) real GDP growth rates, real investment, investment and GDP prices are presented as percentage differences with respect to the base year. It should be noticed that all the effects reported here are permanent.

In order to highlight the differences between the policies the results in Table 7-10 are reproduced graphically in Figure 7-1 to Figure 7-10 in the annex at page 232.

Not surprisingly, even in these dynamic simulations Morocco registers larger effects than France in terms of all the variables considered. More open trade regimes seem to boost growth in the southern Mediterranean country by up to almost 4% (in the final year) of the base run growth rate in the proportional free trade experiment, and by more than 5% in the uniform version of the same policy. Clearly, the removal of the distortionary effect of tariff dispersion in the uniform policies helps to reach higher growth levels. In terms of GDP growth, the relative small difference between the custom union and full free trade policy options is partially confirmed.

[255] The main drawback of this version is that the terminal values (in the year 2004) for policies 1 to 3 and

Table 7-10 Dynamic simulations: main results (% differences from base run)

	FRANCE					MOROC				
	1992	1995	1998	2001	2004	1992	1995	1998	2001	2004
Real GDP										
Base run	2.00	2.50	2.70	2.50	2.50	4.50	4.50	4.50	4.50	4.50
FTA	0.00	0.00	0.01	0.01	0.01	-0.20	-0.22	-0.21	0.23	0.69
CUSTOM	0.04	-0.08	-0.26	-0.47	-0.51	-0.46	0.27	1.02	3.05	1.89
FREE	0.20	-0.08	-0.42	-0.95	-1.07	-0.16	0.30	1.47	3.18	4.05
uFTA	1.19	0.93	0.34	-0.69	-1.04	5.18	2.40	0.96	1.08	1.37
uCUSTOM	2.41	1.56	0.03	-1.64	-1.97	2.58	2.41	1.91	3.40	3.85
uFREE	4.59	2.91	0.13	-2.70	-3.20	2.77	2.66	2.63	4.13	5.04
Real Investment										
Base run	247.972	291.496	300.752	326.757	355.961	6.587	7.924	8.675	9.477	10.638
FTA	0.00	0.00	0.00	0.01	0.01	0.12	0.40	0.84	1.19	1.28
CUSTOM	-0.12	-0.33	-0.57	-0.64	-0.62	1.09	2.42	4.07	3.58	4.07
FREE	-0.34	-0.98	-1.72	-1.74	-1.47	0.60	2.01	4.41	6.39	7.21
uFTA	0.29	0.57	-0.55	-0.97	-1.13	1.75	2.69	2.85	3.16	3.20
uCUSTOM	1.31	0.85	-1.21	-1.85	-1.90	0.15	2.75	5.47	7.72	6.27
uFREE	3.11	1.58	-2.01	-3.12	-2.82	0.03	3.25	6.11	8.55	9.47
Investment Price										
Base run	0.9998	1.0021	1.0049	1.0063	1.0077	1.0057	1.0085	1.0222	1.0410	1.0538
FTA	0.00	0.01	0.03	0.05	0.06	-0.21	-0.77	-1.88	-3.00	-3.37
CUSTOM	-0.13	-0.38	-0.71	-0.88	-0.95	-2.34	-5.06	-7.95	-7.34	-7.63
FREE	-0.53	-1.79	-3.77	-5.29	-5.85	-1.16	-3.79	-7.71	-10.58	-11.49
uFTA	0.48	0.96	0.86	0.74	0.67	-1.39	-3.01	-4.09	-5.23	-5.59
uCUSTOM	0.91	1.12	0.35	-0.23	-0.44	-0.54	-4.42	-8.97	-12.30	-9.95
uFREE	1.49	0.74	-2.21	-4.52	-5.38	-0.28	-5.15	-9.70	-13.00	-14.01
GDP Price										
Base run	1.0308	1.1039	1.1805	1.2538	1.3255	1.0485	1.1275	1.2293	1.3513	1.4724
FTA	0.01	0.02	0.05	0.08	0.10	0.03	0.03	-0.12	-0.42	-0.58
CUSTOM	-0.19	-0.56	-1.00	-1.24	-1.31	-0.21	-0.46	-0.65	-1.02	-1.35
FREE	-0.59	-1.93	-3.88	-5.25	-5.75	-0.16	-0.51	-0.91	-1.19	-1.56
uFTA	0.02	-0.39	-0.74	-1.01	-1.15	-1.02	-2.17	-2.25	-2.52	-2.66
uCUSTOM	0.55	-0.30	-1.57	-2.43	-2.73	-0.73	-2.42	-2.85	-3.14	-3.88
uFREE	1.23	-0.58	-4.00	-6.46	-7.37	-0.86	-3.02	-3.48	-3.75	-4.08

Note: "u..." policy simulations reproduced here are those with uniform indirect taxes.

For France the experiments show a reduction (up to -3% in the worst case) of GDP growth rate to be correlated with more liberal trade. In order to explain this reduction it is necessary to consider the other variables of Table 7-10.

As stated at the outset of this section the growth of capital stock, through investment, is the main endogenous mechanism influencing real GDP growth performance. The crucial equation is the investment-saving closure equation reproduced below:

$$P^{I} I^{TOT} = S_h + S_g + P^{SAFE} S_f + Y^{DEPR} - \sum_i PA_i X_i^{ASTOCK}$$

the left hand side measures current value for aggregate investment as the product of real investment (I^{TOT}) and its price index; this value must be equal to the current value of

4 to 6 will not be exactly equal.

aggregate savings: the sum of household, government and foreign savings. In the dynamic simulation real government savings starting at positive values for both France and Morocco go to zero by the year 2004, and foreign savings are fixed in real terms to the base year value[256], thus households' real savings, its price[257], government's savings price[258] and the investment price are the endogenous variables determining capital accumulation and growth.

From the above equation, it is expected that, with the same level of current savings, a reduction in investment prices would produce increased real investment. Indeed in the case of Morocco investment grows (quite dramatically for policy 6 uFREE) and becomes also cheaper. A full analysis of the investment price reduction would be based on the following decomposition:

$$\partial P^{I} = \alpha_{d}\,\partial P_{d} + \alpha_{m}\,\partial P_{m}(1+\tau) + \alpha_{m}\,P_{m}\,\partial \tau$$

the variation in the price of investment depends on changes of the domestic price of investment (P_d), the import price (P_m) and the tariff rate (τ). Clearly the policy change directly affects the tariff, but domestic and imports prices for Morocco and France are also expected to change as a result of the policy shock[259] and these changes affect the price of investment.

In the case of France though, reduced investment prices do not occur alongside increased real investment. This is explained by noting the reduction in the price of GDP (the government savings price) which more than offsets the investment price contraction. The GDP price decreases due to the liberalisation process and lowers government savings (in current values). This reduction is only partially compensated by the increase in households' savings (in current value). Furthermore, given the balanced budget closure for the government account, tariff revenues losses, occurring during the trade liberalisation, are compensated by increased households' direct taxes. This further exerts downward pressure on households' disposable incomes and private savings.

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[256] Given that the price of foreign savings is the numeraire of the model and it is fixed at 1, it is equivalent to define foreign savings either in real or current terms.
[257] Equal to the consumer price index; see comments in the technical specification of the model.
[258] This is equal to the price of GDP (i.e. equivalent to the GDP deflator).
[259] Import prices from the ROW region are fixed (small country assumption).

Another interesting feature of these experiments is represented by the marked difference between the uniform and proportional policy results. This difference is remarkable not only for the final year but also in all the intermediate years. This is easily explained by the reallocation that uniform policies require in the first round. This benefits Morocco but also France. In fact for all the simulations, French real GDP is slightly lower than in the base run, and yet, because of the higher growth rates in the early period, GDP is higher with uniform rather than proportional policies.

A sound policy recommendation would be to implement uniform tariffs at an early stage and then reduce them. This seems to confirm the orthodoxy of the trade reforms of the World Bank structural adjustment programs: more uniform tariffs across sectors is seen as a means of simplifying the system, reducing the spread of effective protection rates, resources misallocation and the opportunities for rent seeking activities.[260] The first best policy would probably be to set policy parameters to their long run optimal levels as soon as possible. In fact if factor and commodity prices adjust instantaneously between activities, the appropriate speed of liberalisation would be a trivial issue.[261] In practice any change in policy is likely to generate adjustment costs both in terms of output foregone while resources are "idle" in the process of moving between sectors and in the resources actually absorbed in this movement. Adjustment costs will depend on the extent of inter and intra industry adjustment. Thus an indirect measure of adjustment costs can be seen in the factor adjustment indices defined above (see page 211).

Table 7-11 (reproduced graphically in Figure 7-9 and Figure 7-10) displays two different types of normalised ratios. The first, the ratio of labour adjustment indices to real GDP growth rates, is calculated as follows:

$$I_{1,t} = \frac{\lambda\ (L_{t-n}, L_t)}{g_{y,t}},$$

This ratio is shown in the base run rows. I_l is a normalisation of the labour adjustment index with respect to GDP growth rate, it gives an indication of the share of total labour that moves inter-sectorally per unity of GDP growth rate. For instance in France for the

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[260] See Greenaway and Milner (1993) page 173.
[261] See Falvey and Kim (1992) pages 919.

first year of the simulation (1992), for each percentage point in GDP growth rate, 0.54 per cent of total labour moves to new sectors.

The second index is calculated as an elasticity and is equal to the first index computed for an experiment and divided by the base run one:

$$I_{2,t} = \frac{I_{1,experiment,t}}{I_{1,base-run,t}}$$

The resulting values are shown in the rows for each simulation. If a simulation registers a value equal to 1, it means that both the GDP growth rate and the adjustment index are increased (or decreased) in the same proportion with respect to the base run.[262]

Table 7-11: Labour Adjustment index as a ratio of real GDP growth

		1992	1995	1998	2001	2004
				France		
I_1	**Base Run**	0.54	0.75	0.67	0.69	0.70
I_2	**FTA**	1.00	1.00	1.00	1.00	1.00
I_2	**CUSTOM**	0.98	0.99	0.98	0.99	1.00
I_2	**FREE**	0.95	0.96	0.90	0.93	0.99
I_2	**uFTA**	1.46	1.16	0.98	0.99	1.00
I_2	**uCUSTOM**	1.60	1.15	0.91	0.95	1.00
I_2	**uFREE**	1.80	1.15	0.79	0.86	0.97
				Morocco		
I_1	**Base Run**	0.87	1.28	0.99	0.70	0.70
I_2	**FTA**	0.99	0.98	0.95	0.94	0.97
I_2	**CUSTOM**	0.94	0.94	0.89	0.95	0.97
I_2	**FREE**	0.98	0.96	0.92	0.95	0.95
I_2	**uFTA**	1.08	1.04	0.95	0.93	0.96
I_2	**uCUSTOM**	1.14	1.01	0.88	0.89	1.05
I_2	**uFREE**	1.20	1.00	0.90	0.92	0.93

Clearly in this type of CGE model, higher GDP values (and higher growth rates) are a direct consequence of increased allocative efficiency Therefore many of the values in Table 7-11 are expected to be close to 1. Yet, a closer inspection of these tables reveals another interesting feature. In the early rounds (1992 and 1995) there is a tendency for the uniform policies to be costlier, in terms of labour adjustment, then their proportional counterparts. Uniformity produces higher growth with non-linearly augmenting adjustment costs. This is partially reversed in the second half of the period, especially for Morocco.

Although further investigation is necessary to confirm the validity and robustness of these measurements, they give a preliminary indication of the likely balance between increased growth and adjustment associated with different types of policy. Being credibility a crucial success factor for trade policy reforms, policy makers should be cautious not to being forced to reverse a blunt pro-growth policy due the too large resources reallocation involved.

7.6 Conclusion

As stated in the introduction this chapter had two primary objectives: to estimate the effects of trade policy reforms currently planned for the Mediterranean area and to extend the discussion of the sequencing issue of trade reform by looking at the problem of the order of liberalisation of production sectors.

The first objective has been met by constructing a detailed two-country CGE model and using it to appraise the effects of trade liberalisation in three main scenarios: a custom union, a free trade area and a benchmark case of full liberalisation. The evidence obtained from the model results indicates that removing trade barriers may produce considerable gains. Their magnitude is proportional to the initial level of protection, trade dependency and size of the economy involved. Extensive discussions of the effects of different closure rules and trade elasticity on aggregate results as well as a detailed examination of sectoral adjustments complete the analysis of the first part.

To study the effect of differential liberalisation of the current account a dynamic version of the two-country CGE model has been constructed. This was then used to compare the effects on growth and adjustment costs of different sequencing scenarios. The results confirm that increased growth shown by policies implementing more extensive liberalisation (the uniform policy scenarios) is derived from the stronger allocative efficiency they induce, but that it is also accompanied by higher adjustment costs. An elasticity-type of index has been devised as a summary measure of the trade-

[262] This measure is similar to the emission elasticity shown in the Trade and Environment chapter.

offs between increased growth and larger adjustment costs associated with different types of policy.

7.7 Annex: Dynamic simulation figures

Figure 7-1: % Differences in GDP growth rates - France

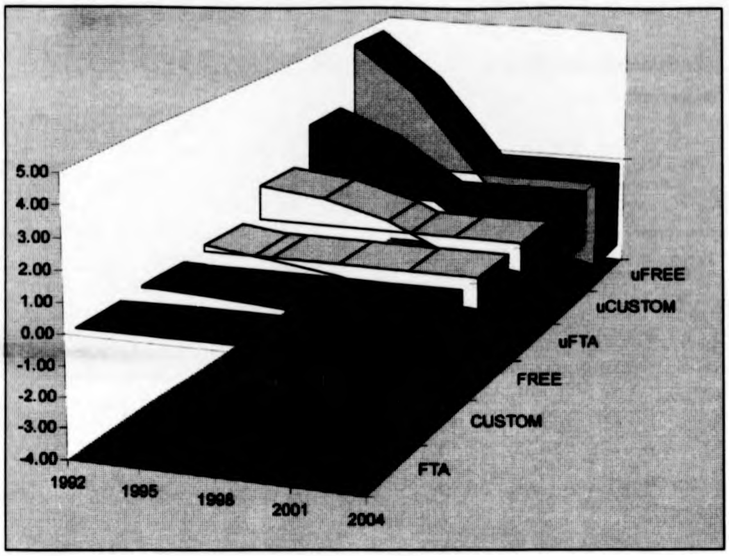


Figure 7-2: % Differences in Real Investment - France

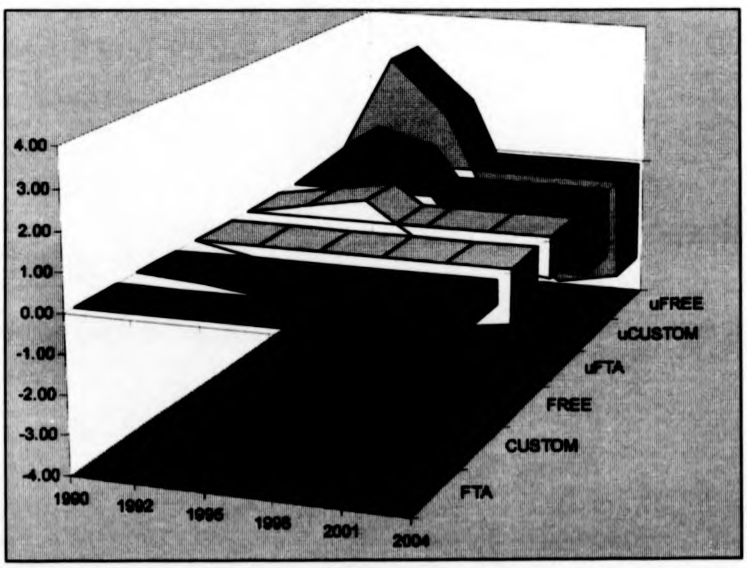


Figure 7-3: % Differences in Investment Price - France

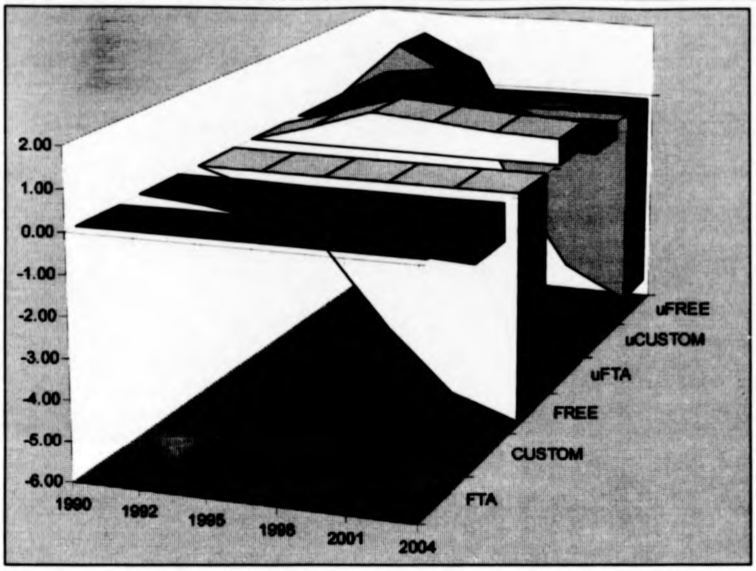


Figure 7-4: % Differences in GDP Price - France

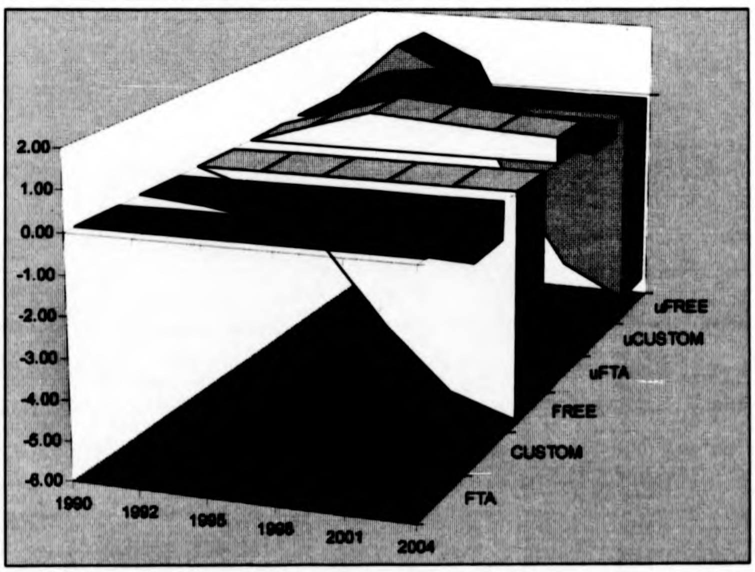


Figure 7-5: % Differences in GDP growth rates - Morocco

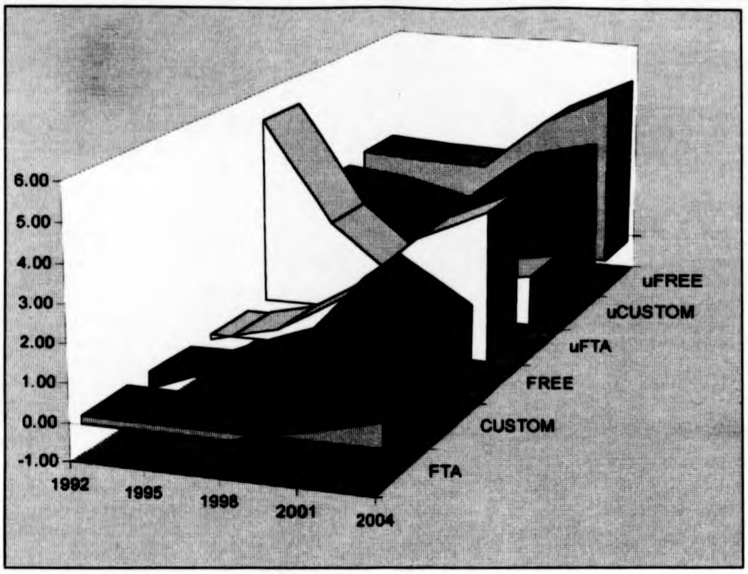


Figure 7-6: % Differences in Real Investment - Morocco

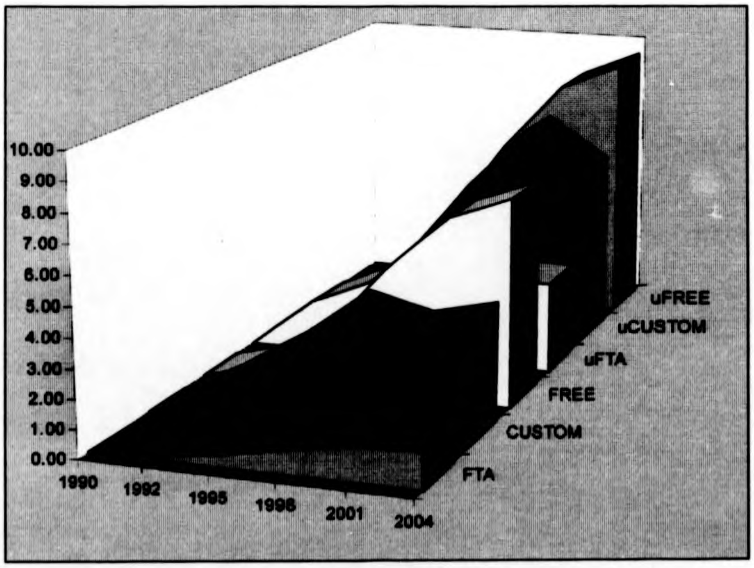


Figure 7-7: % Differences in Investment Price - Morocco

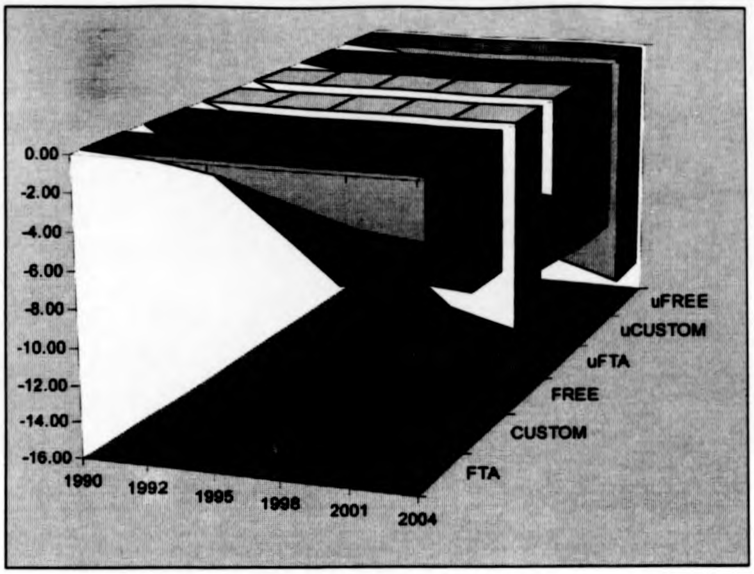


Figure 7-8: % Differences in GDP Price - Morocco

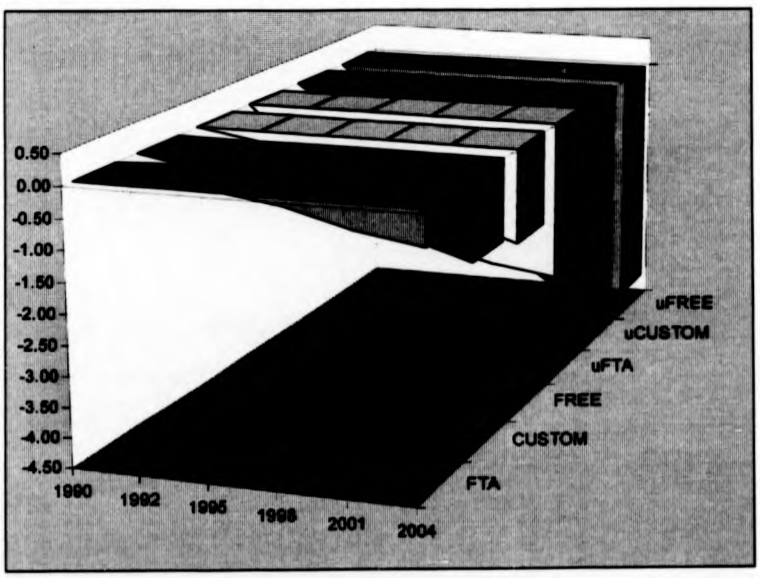


Figure 7-9: Labour adjustment elasticity index (I_2) - France

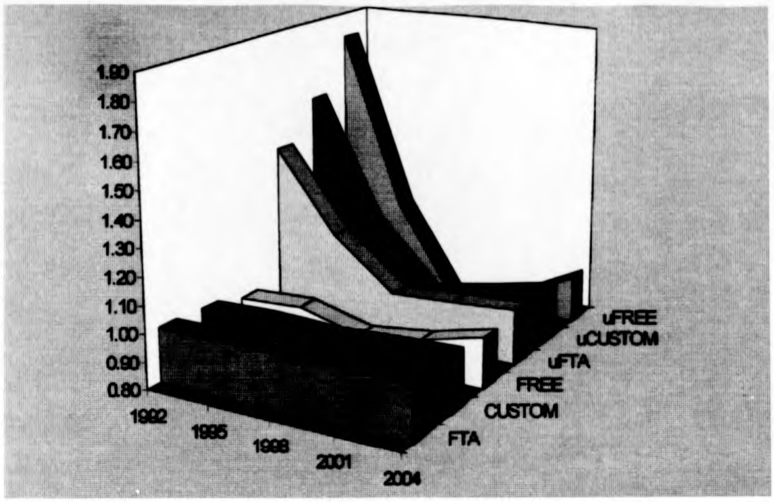
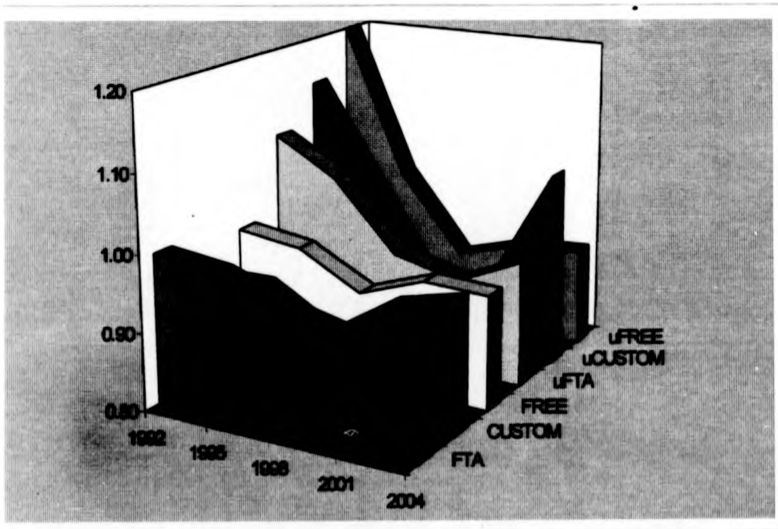


Figure 7-10: Labour adjustment elasticity index (I_2) - Morocco



8 Appendix: The EMMA model specification

8.1 Introduction

This appendix is organised in a similar manner of the previous technical chapter (chapter 6). To avoid repetitions, it describes in details only those equations, which are specific to the EMMA model, and it refers to chapter 6 for those equations, which are the same in the EMMA and Environment and Trade models.

An overview and main characteristics of the EMMA model have been already presented in the previous chapter. Although EMMA has been explicitly constructed for this thesis, it has some relationships with an earlier global model.[263] There are though significant differences between the earlier model and EMMA. The earlier model is a global model whereas EMMA is a multi-country model and does not include the 'world', as an integrated, endogenous block. Thus the main changes in adapting the former model have been in the trade block and in the closures. A high degree of spatial disaggregation for import sources and export destinations, absent in the global model, is included in EMMA.

The detail for the labour markets has been improved and their closures have been modified. In EMMA two alternatives are explored: a flat labour supply curve, implying excess supply and infinite elasticity, and a vertical labour supply, implying full employment and zero elasticity of supply. A policy of minimum wages, relevant for both France and Morocco, has been implemented and tested in the model, although the results are not reported here and will form part of future research projects. In essence, it has been assumed that for a particular skill (or sector) a fixed real (or nominal) minimum wage was imposed. If an experiment (for example trade liberalisation) has a deflationary effect on wages, the consequences for the protected skill are as follows: in France, it

[263] In particular EMMA replicates the standard parts (CES production functions, CET export supply and Armington CES import demand functions) of any multi-sectoral general equilibrium model, for which no original approach is claimed here. The reference global model was developed primarily by D. Van der Mensbrugghe and D Roland-Holst while I was consultant at the OECD.

simply creates unemployment[264], whereas in Morocco, people losing their job in the protected market move to the informal economy thus depressing the informal wage.

In EMMA the production structure includes energy as a separate production factor. This is for two reasons. First, it renders EMMA's results more comparable with those of the previous model; secondly, although this might not be relevant in the French - Moroccan case, many trade interactions between the southern and northern shores of the Mediterranean occurs in the energy sector.[265]

Finally the recursive dynamics structure of the Moroccan trade and environment model, used in the previous chapters, has been adapted to the current two-country model transforming EMMA from a static to a dynamic model and allowing the analysis of policy sequencing.

8.2 *Dimension, variables and parameters of EMMA*

The remainder of this section introduces the dimensions of the EMMA model and provides a full list of the model variable and parameters. There are four main dimensions: sectors, labour skills, regions, and time. Some of these broad dimensions are split into sub-dimensions (or subsets to use the GAMS terminology).

Sectors

The base data set is constructed around a 24-sector database, derived from the French-Moroccan SAM presented previously. The sectors are defined in Table 8-1. The usual indices are shown under each table title. In the case of multiple indices, they are simply synonyms (or aliases) for each other. Table 8-2 provides the definition of the regions. Table 8-3 defines the labour skill dimension. Table 8-4 defines the time dimension.

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[264] Unemployment benefits can be easily included in the model, thus introducing a new policy instrument. These can then be distributed back to households or, as in the new French employment program policies, distributed to production sectors through indirect tax reduction.
[265] In fact I started working on the model before completing the construction of the France-Morocco SAM but having in mind the crucial European imports of oil from Mediterranean developing countries.

Table 8-1: **Sectoral Definition of EMMA**

(i,j)

1.	Food Crops	13.	Quarrying mining
2.	Estate Crops	14.	Metal industries
3.	Other Primary	15.	Metal products
4..	Energy	16.	Motors and equipment
5.	Milling	17.	Vehicles and other transportation equipment
6.	Food processing	18.	Electrical equipment & appliances
7.	Beverages and tobacco	19.	Chemicals
8.	Textiles	20.	Rubber and plastic products
9.	Apparel	21.	Other manufacturing
10.	Leather products	22.	Transport and communication
11.	Wood products	23.	Banking and insurance
12.	Paper	24.	Other Services

Table 8-2: **Regional Definition of EMMA**

(r,r')

1.	France	3.	Rest of Europe
2.	Morocco	4.	Rest of the World

Table 8-3: **Labour Skills in EMMA**

(l)

1. Unskilled labour
2. Skilled labour
3. Salaried labour
4. Other labour (independent workers, employers)

Table 8-4: **Time Definition of EMMA**

(t)

0.	1990
1.	1992
2.	1998
3.	1995
4.	2001
5.	2004

The following indices are also used in the equations and in the model definition:

k This index represents the consumer goods. Consumer goods are essentially identical to producer goods except for the energy good. (Under the current definition of sectors, there is only one energy good)

e This index represents the energy good. In the current version there is only one energy good, but in future versions it could index the different types of energy.

v This index represents the capital vintage. It has two dimensions which take either the value *Old*, or the value *New*.

The variables and parameters definitions follow.

__Variables__

Factor demands

L^{Ad}	Sectoral aggregate labour demand
L_g^{Ad}	Government sectoral aggregate labour demand
L^{d}	Sectoral demand for labour skill *l*
Kv^d	Capital demand by vintage
K_g^{d}	Government capital demand
χ_v	Capital- output ratio

Composite Factor demands

Q^{KEL}	Capital, labour and energy aggregate in production (top nest)
Q^{KE}	Capital and energy aggregate in production (2nd nest)
E^P	Demand for the energy bundle (by vintage)

Factor supplies

Pop	Population
K	Capital stock
L_l^S	Labour supply
γ^I	Growth rate of investment

Volumes

C_k	Consumer spending on non-energy commodities
C_{Energy}	Consumer spending on energy
C_g	Government spending on goods and services
E^I	Investment demand of aggregate energy
E^G	Government demand of aggregate energy
X^{AP}	Intermediate demand (at the Armington Level)
X_e^{AP}	Energy demand (by fuel *e*)
X^{AC}	Consumer spending (at Armington level)

X^{AG}	Government demand (at Armington level)
X^{AI}	Investment demand (at Armington level)
X^{ASTOCK}	Stocks change (at the Armington level)
XA	Aggregate Armington demand
$M^{r'}$	Bilateral trade flow matrix (imports of country r from country r')
X^{D}	Domestic demand (of domestic production)
X^{M}	Domestic demand for aggregate imports

Real Macro Variables

XPv	Aggregate vintage output
X^{RGDP}	Real GDP
X^{totG}	Government total expenditures
G^{TRA}	Government real transfers (to households)
I^{TOT}	Total Investment
I^{STOCK}	Total Stock change

Nominal variables

S_h	Households savings
S_g	Government savings
S_f	Foreign savings
Y^{*}	Supernumerary income
Y^{d}	Disposable income
Y^{DEPR}	Depreciation allowance
Y	Total factorial income
Y^{INDTAX}	Indirect taxes revenues
Y^{TARIF}	Tariff revenues
Y^{ESUBS}	Export subsidies expenditure
H^{TAX}	Households direct taxes

Prices

P^{C}	Consumer price (on non-energy commodities)
P^{EC}	Consumer price (on energy)
P^{EI}	Investment price (on energy)
P^{EG}	Government price (on energy)
P^{EP}	Production price (on energy)
P^{I}	Price index of aggregate investment
P^{STOCK}	Price index of aggregate stock change
P^{SAVF}	Price of foreign savings
P^{GDP}	GDP price index
P^{G}	Government total expenditure price index
P^{CG}	Government goods expenditure price index
P^{CPI}	Consumer Price Index
PA	Armington price
PXv	Unit cost by vintage
PX	Output price excluding indirect taxes
PP	Output price including indirect taxes
P^{KEL}	Aggregate (CES dual) price of the Q^{KEL} bundle
W^{A}	Sectoral price of aggregate labour

W_g^A	Government sectoral price of aggregate labour
P^{KE}	Price of the Q^{KE} bundle
$R^{Old,New}$	Vintage specific sectoral rental rate of capital
R_g	Government rental rate of capital
R^A	Economy-wide rental rate of capital
R^R	Relative sectoral rental rate on old capital
$PE^{r,r'}$	Border price for imports of country r from country r'
P^M	Import price (including taxes and subsidies) of aggregate imports
P^E	Export price (including taxes and subsidies) of aggregate exports
P^D	Domestic sales price of domestic production

Parameters

Production coefficients

a	Input-output coefficients
a^K	Share parameter for Capital (in the disaggregation of Q^{KE} bundle)
a^{KEL}	Share parameter for Q^{KEL} in aggregate output
a^{KE}	Share parameter for the Q^{KE} bundle (in the disaggregation of the Q^{KEL} bundle)
a^{LS}	Share parameter for skill (in the disaggregation of aggregate labour)
a^L	Share parameter for aggregate labour (in the disaggregation of the Q^{KEL} bundle)
a^E	Share parameter for the Energy bundle (in the disaggregation of Q^{KE} bundle)
a^{EP}	Share parameter for specific fuel in aggregate energy demand
σ^L	Inter labour elasticity of substitution (in labour demand)
σ^{KE}	Elasticity of substitution between capital and aggregate energy
σ^{KEL}	Elasticity of substitution between capital-energy bundle and aggregate labour
σ^{EP}	Inter energy elasticity of substitution (in production)
λ^K	Capital efficiency factor for demand
λ^L	Labour efficiency factor in labour demand
ω_{li}	Sectoral wage premium matrix

Consumption

μ	ELES parameter (marginal propensity)
θ	ELES parameter (subsistence minima)
σ^{EC}	Inter energy elasticity substitution (in consumption)
a_k^C	Consumption mapping matrix
a^{EC}	Energy share in consumption

Government

a^{GG}	Share parameter for goods expenditure (in the disaggregation of aggregate government expenditure X^{GOV_i})
a^{GK}	Share parameter for capital payments (in the disaggregation of aggregate government expenditure X^{GOV_i})
a^{GL}	Share parameter for labour payments (in the disaggregation of aggregate government expenditure X^{GOV_i})

ρ^{g}	Elasticity of substitution between different types of expenditures in aggregate government spending
σ^{Eg}	Inter energy elasticity of substitution (in government expenditure)
a^{GE}	Share parameter for aggregate energy government consumption (in the disaggregation of C_g)
a_e^{GE}	Share parameter for specific fuels Investment goods (in the disaggregation of E_g)

Investment and stocks change

σ^{EI}	Inter energy elasticity of substitution (in investment)
a^{I}	Share parameter for non-energy Investment goods (in the disaggregation of I^{TOT})
a^{EI}	Share parameter for aggregate energy Investment goods (in the disaggregation of I^{TOT})
a_e^{EI}	Share parameter for specific fuels Investment goods (in the disaggregation of E^{I})
a^{STOCK}	Share parameter for Stocks change (in the disaggregation of I^{STOCK})

Trade

$\tau^{r'r}$	Tariff rates (region specific)
$\varepsilon^{r'r}$	Export subsidy rates (region specific)
α^{m}	Share parameter for aggregate imports (Armington 1st nest)
α^{d}	Share parameter for domestic demand (Armington 1st nest)
α_i^{e}	Share parameter for aggregate exports (CET 1st nest)
α_i^{d}	Share parameter for aggregate domestic sales (CET 1st nest)
$\Phi_i^{r,r'}$	Share parameter in the decomposition of aggregate imports (Armington 2nd nest)
$\Theta_i^{r'r}$	Share parameter in the decomposition of aggregate exports (CET 2nd nest)
σ^{m}	CES Armington elasticity of substitution (between imports and domestic production)
Λ^{m}	CES Armington elasticity of substitution (between imports from different regions)
σ^{t}	CET elasticity of substitution (between exports and domestic sales)
Ω	CET elasticity of substitution (between exports from different regions)

Miscellaneous

λ^{EC}	Energy efficiency factor for consumption
λ^{EP}	Energy efficiency factor for production
λ^{EI}	Energy efficiency factor for investment
λ^{ESTOCK}	Energy efficiency factor for stocks change
λ^{EG}	Energy efficiency factor for government consumption
δ	Depreciation coefficient
τ^{p}	Indirect tax rate

8.3 Model blocks

8.3.1 Household Consumption

Household expenditure behaviour is modelled in EMMA in exactly the same way as in the Environment and Trade model. The only two differences of the EMMA specification consist of the absence of an index for the household types (EMMA has only one representative consumer), and of the introduction of an energy efficiency parameter.[266] The basket of consumer goods is somewhat different from the sectoral definition of producer commodities. All energy goods are grouped in one basket and disaggregated by fuel type at a second stage. In other words, at the first stage, consumers maximise over all non-energy goods and a single energy bundle.

Table 8-5: **Household Consumption**

(8-5.1) $$Y^{*} = Y^{d} - Pop\sum_{k'} P_{k'}^{C}\theta_{k'}$$

(8-5.2) $$C_{k} = \theta_{k} Pop + \frac{\mu_{k}}{P_{k}^{C}} Y^{*}$$

(8-5.3) $$S_{h} = Y^{d} - \sum_{k} P_{k}^{C} C_{k}$$

The next stage maps household demand in terms of consumer commodities into demand for produced commodities, this is trivially determined for the non-energy commodities. Equation (8-6.1) in Table 8-6 determines the Armington consumer demand for non-energy commodities. The matrix *ac* is simply a matrix of 0's and 1's, mapping the non-energy goods indexed by k' to the same non-energy good mapped by *nf*.

[266] Each agent in the economy (producers, consumers, and other final demand accounts) has a demand for an energy bundle. The CES structure of energy demand, which includes the efficiency parameter, is the same for all agents, however, the share and substitution parameters are allowed to differ.

Table 8-6: **Transformation of Consumption into Produced Goods**

(8-6.1) $X_{nf,k}^{AC} = a_{nf,k}^{C} C_k$

(8-6.2) $X_e^{AC} = a_e^{EC} \dfrac{C_{Energy}}{\lambda^{EC}} \left(\dfrac{\lambda^{EC} P^{EC}}{PA_e} \right)^{\sigma^{EC}}$

Equation (8-6.2) determines the demand for the fuel components of the energy aggregate. The formula includes an energy efficiency factor for consumption.

8.3.2 Consumer Prices

In this section consumer prices are determined starting from the most disaggregated level. Table 8-7 describes the (CES) prices of the consumer goods which are determined from the Armington prices. The following equations replicate the price equations of the Environment and Trade model with the exception of the energy efficiency factor.

Table 8-7: **Consumer Prices**

(8-7.1) $P^{EC} = \left[\sum_e a_e^{EC} \left(\dfrac{PA_e}{\lambda^{Ec}} \right)^{1-\sigma^{Ec}} \right]^{\frac{1}{1-\sigma^{Ec}}}$

(8-7.2) $P_k^C = \sum_{nf} a_{nf,k}^{C} PA_{nf}$

(8-7.3) $P_{Energy}^{C} = P^{EC}$

(8-7.4) $P^{CPI} = \dfrac{\sum_k P_k^C C_k}{\sum_k P_{k0}^C C_k}$

Equation (8-7.1) in Table 8-7 defines the CES dual price, *PEc*, for the energy bundle in consumption[267]. Equation (8-7.2) maps the Armington price to the consumer price for non-energy goods, where the index k' runs over the non-energy commodities. Equation (8-7.3) simply transfers the price of the energy bundle into the consumer price vector. Finally, Equation (8-7.4) defines the consumer price index.

8.3.3 Production

The production inputs choice in EMMA is modelled as in the Environment and Trade model, i.e. as a nested structure with different degrees of elasticity of substitution (CES) at the different levels. A graphical description of the production structure is given in Figure 7-1.

The main difference here is that the top level in the nest is a *Leontief* structure in non-energy intermediate inputs and an aggregate bundle designated by Q^{KEL}. The Q^{KEL} bundle is an aggregate of capital, labour, and an energy bundle, as before. Table 8-8 provides the top level demands for the non-energy intermediate inputs and the Q^{KEL} bundle.

Table 8-8: **Top Level Production Nest**

(8-8.1) $X^{AP}_{nf,j} = \sum_{v} a_{nf,jv} XPv_{jv}$

(8-8.2) $Q^{KEL}_{jv} = a^{KEL}_{jv} XPv_{jv}$

X^{AP} is intermediate demand (at the Armington level, i.e. before disaggregation into import demand and demand for domestically produced commodities). The index *nf* identifies elements pertaining to the set of non-energy commodities. In Equation (8-8.1) aggregate intermediate demand is determined directly (i.e. summing over vintage), since non-energy intermediate demand is not dependent on the vintage. The matrix *a*, is the

[267] Note that in the current version the energy bundle includes only one commodity. Thus, its difference from the non-energy bundle consists only of the energy efficiency factor. In future versions though, the energy consumption bundle could easily be decomposed in different type of energy sources (see the trade-environment model of the previous chapter)

matrix of input-output coefficients for non-energy intermediate inputs, and XPv represents aggregate sectoral output for each vintage. Q^{KEL} represents the capital, labour, energy bundle, and it is determined using a fixed coefficient function, with a^{KEL} being the share parameter.

At the next stage in production, the Q^{KEL} bundle is split into aggregate labour demand on the one hand L^{A}, and the Q^{KE} bundle on the other. This is done exactly in the same way of the Environment and Trade model (see relevant equations in chapter 6).

The next level of the CES nesting disaggregates the Q^{KE} bundle into the energy bundle on one side, and capital demand on the other side (see the relevant equations in chapter 6).

The last two bundles to decompose are: aggregate labour and the energy bundle. This is again done as in the Environment and Trade model (see the relevant equations in chapter 6[268]).

8.3.4 Production Prices

Given the Leontief specification for the top nest of the production structure, the only difference of the EMMA model with respect to the previous one is in the equation that defines the unit cost of production by capital vintage, PXv_{jv}. In Equation (8-9.1), note that PXv_{jv} is also a CES dual price for the special case when the substitution elasticity is 0.

Table 8-9: Unit Production Cost

(8-9.1) $PXv_{jv} = \sum_{nf} a_{nf,jv} PA_{nf} + a_{jv}^{KEL} P_{jv}^{KEL}$

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[268] The current version of EMMA uses a single energy nesting, i.e. the decomposition of the energy bundle into the fuel components requires only one CES function. The index *e* represents the fuel commodities in the sectoral disaggregation.

8.3.5 Equilibrium in Factor Markets

Since there are no changes for the capital markets we refer to the relevant section in chapter 6 for the equations determining the equilibrium for capital demand and supply, and this section describes the determination of labour market equilibria.

There are as many labour markets as there are labour skills. Labour supply in the EMMA model is determined in one of two extreme versions: either excess supply is assumed (i.e. real wage is fixed, which is equivalent to imposing an infinite elasticity to the supply curve) or full employment (labour supply is fixed with zero elasticity).

Table 8-10: **Equilibrium on the Labour Market**

(8-10.1) $$W_l = P^{CPI} W_{0,l}$$

(8-10.2) $$L_l^s = L_{g,l}^d + \sum_i L_{i,l}^d$$

The two possible closures are alternatively determined by Equation (8-10.1) or Equation (8-10.2). The former simply sets the fixed real wage, and employment will be determined via demand. Equation (8-10.2), the case of fixed labour supply, is a market clearing condition and determines the equilibrium wage rate on the labour markets.

8.3.6 Determination of Vintage Output

The equations of this section determine the optimal allocation of production across vintages and exactly reproduce the equations of the same section of the technical specification of the Environment and Trade model. The optimal allocation is derived from the capital/output ratio. This depends on all the prices in the nested CES structure and since in EMMA the top nest presents zero elasticity of substitution, the only equation showing some difference is Equation (8-11.1) which calculates the optimal capital/output ratio.

Table 8-11: **Allocation of Domestic Production Across Vintages**

(8-11.1) $$\chi_i^v = a_{jv}^{KEL} a_{jv}^{KE} \left(\frac{P_{jv}^{KEL}}{P_{jv}^{KE}} \right)^{\sigma_{jv}^{kel}} \frac{a_{jv}^k}{\lambda_{jv}^k} \left(\frac{\lambda_{jv}^k P_{jv}^{KE}}{R_{jv}} \right)^{\sigma_{jv}^{ke}}$$

8.3.7 Income Distribution

EMMA has only one representative household which receives most of its income from value added. Other sources of income include depreciation allowance, and transfers from the government.[269] Table 8-12 lists the equations determining household income.

Table 8-12: **Household Income and GDP Statistics**

(8-12.1) $$Y_t^{DEPR} = \delta \ R_t^A K_t$$

(8-12.2) $$Y = \sum_l W_l \left[\omega_{lg} L_{lg}^d + \sum_l \omega_{li} L_{li}^d \right] + R_g K_g^d + \sum_v \sum_i R_{iv} Kv_{iv}^d - Y^{DEPR}$$

(8-12.3) $$Y^D = Y - H^{TAX} + P^{CPI} \ G^{TRA}$$

(8-12.4) $$X^{RGDP} = \sum_l W_{l,0} \left[\omega_{lg} \lambda_{lg}^L L_{lg}^d + \sum_l \omega_{li} \lambda_{li}^L L_{li}^d \right] + R_{g,0} K_g^d + \sum_v \sum_i R_{iv,0} \lambda_{iv}^K Kv_{iv}^d$$

(8-12.5) $$P_t^{GDP} = \frac{Y_t + Y_t^{DEPR}}{\sum_l W_{l,0} L_{li}^s + K_t^s}$$

Equation (8-12.1) defines the depreciation allowance on the total capital stock of the previous period.[270] Y^{DEPR} is the value of the depreciation allowance, δ is the depreciation

[269] Note that in the Environment and Trade model transfers and factor payments from and to the ROW were explicitly considered. Here their net value has been simply aggregated to the foreign saving value.

rate (defined on the aggregate capital stock, but region specific), and R^A is the economy-wide rental rate. Equation (8-12.2) defines total household income. It is the sum of payments to production factors (including payments by the government), less depreciation. Y is total household income. Equation (8-12.3) determines household disposable income, Y^d. Y^d is equal to aggregate income, less direct taxes, H^{TAX}, plus transfers from government to households, G^{TRA}. G^{TRA} needs to be multiplied by a price in order to preserve the homogeneity of the model. The consumer price index, P^{CPI}, was chosen as the appropriate deflator.

Equation (8-12.4) defines real GDP, X^{RGDP}.[271] It is the sum of factor demand in efficiency units. Equation (8-12.5) defines the GDP deflator, P^{GDP}.[272] The GDP deflator is defined as the value of factor payments, divided by the sum of factor volumes.

Table 8-13 presents the government and investment closure rules. Equations (8-13.1) and (8-13.2) determine respectively the government's tax revenues from the production tax and the import tax. Equation (8-13.3) calculates government's expenditures for export subsidies. Note that in Equations (8-13.2) and (8-13.3) the regional indices are explicitly used. The tariff rates (export subsidies) are trading-partner specific, i.e. the tariff rate (export subsidies) is allowed to vary depending on the region of import. Also note that the "world" price of imports, is the trading partner's export price. This implies that there is no single world price for a commodity. The aggregate world price faced by a country will be a weighted average of the export prices of its trading partners. Finally, also note that the variable M represents the bilateral trade flow matrix for each commodity. Import volumes are read along a row, while export volumes are read down a column.

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[270] There are two variables representing the aggregate capital stock, K and K^s, each representing a different unit of account. K is in millions of 1990 USD and in the base year, represents the total value of the capital stock. K^s is also in millions of 1990 USD, but in the base year, it represents aggregate capital remuneration. The reason for using K^s is to be able to normalise the capital rental rate to the value 1 in the base year. A numerical example may clarify the difference. For example, in the US (in 1985), aggregate capital remuneration, as determined from the US national accounts, is $1,216 billion. The aggregate value of the capital stock is estimated to be $10,399 billion. Given the rental rate normalisation rule, the first number is used in the model as the base year value of the capital stock. If instead, the second number were used (or the true value were used), the imputed rental rate would be 0.117. In fact, it makes no difference, since it is only an indexing issue. However, it does make a difference when imputing the depreciation income, hence the use of K. (K is discussed again in the section on capital accumulation.)

[271] It is assumed that there is no change in the efficiency of capital in the government sector, though there is efficiency improvement in the use of labour.

Table 8-13: **Government Receipts and Saving**

(8-13.1) $$Y_i^{INDTAX} = \tau_i^P PX_i XP_i$$

(8-13.2) $$Y_{ri}^{TARIF} = \sum_{r'} \tau_i^{r'r} PE_i^{r'r} M_i^{r'r}$$

(8-13.3) $$Y_{ri}^{ESUBS} = \sum_{r'} \varepsilon_i^{r'r} PE_i^{r'r} M_i^{r'r}$$

(8-13.4) $$S_g = P^{GDP} \overline{S}_g$$

(8-13.5) $$S_g = H^{TAX} + \sum_i \left(Y_i^{INDTAX} + Y_i^{TARIFF} - Y_i^{ESUBS} \right) - P^G X^{TotG} - P^{CPI} G^{TRA}$$

The government closure rule is specified in Equation (8-13.4): government saving is fixed (in real terms). Government saving is simply the difference between government revenue and government expenditure and is determined by Equation (8-13.5). With exogenous government saving the household tax schedule is endogenous. Household taxes are determined by (inverting) Equation (8-13.5), i.e. H^{TAX} is the equilibrating variable to achieve the fixed government balance.[273]

Table 8-14: **Determination of Aggregate Investment (Exogenous Foreign Saving)**

(8-14.1) $$P^I I^{TOT} = S_h + S_g + P^{SAVF} S_f + Y^{DEPR} - \sum_i PA_i X_i^{ASTOCK}$$

(8-14.2) $$S_f = P^{SAVF} \overline{S}_f$$

Table 8-14 includes the equation for the closure of the saving and investment account. Domestic investment is equal to domestic saving plus a fixed level of foreign saving.

[272] All base year factor prices are equal to one, therefore, this implies that the denominator is evaluated in base year prices.

Under this rule, foreign saving does not react to regional changes in relative rates of return. In this case, the *value* of investment, $P^I \times I^{TOT}$, is determined by Equation (8-14.1). Aggregate fixed investment (in value) is the sum of saving, plus depreciation, less expenditures on stock building. Saving includes household saving, S_h, government saving, S_g, and foreign saving, S_f. Foreign saving is exogenous in each time period. Changes in stocks are represented by XA^{STOCK} (at the Armington level). The investment deflator, P^I, will be defined below. I^{TOT} represents the volume of real investment. Equation (8-14.2) defines the value of foreign saving using P^{SAVF} as a price index.

8.3.8 Investment and Stock Building

This section determines investment and stock building demand for goods and services. As described above, aggregate investment is determined by total savings. The volume of investment is disaggregated into final demand for goods and services using a fixed coefficient Leontief function. Energy is further disaggregated using the same nested structure as that used in production and consumption. Table 8-15 presents the equations for investment final demand for goods and services.

Table 8-15: **Final Demand for Investment Intermediate Inputs**

(8-15.1) $$X_{nf}^{AI} = a_{nf}^{I} I^{TOT}$$

(8-15.2) $$E^{I} = a^{EI} I^{TOT}$$

Equation (8-15.1) specifies the (Armington) investment derived demand for non-energy goods and services, where XA^I represents demand, and a^I are the Leontief fixed input coefficients. Equation (8-15.2) determines demand for the energy bundle, E^I, where a^{EI} is the input coefficient for aggregate energy demand in investment.

Table 8-16 lists the equations describing the disaggregation of the energy bundle into the fuel composites.

[273] In the reference scenario, government saving is held fixed at its base year level which implies that as a share of GDP, government saving (or the deficit), declines over time.

Table 8-16: **Demand for the Fuel Components in Investment**

(8-16.1) $$X_e^{AI} = a_e^I \frac{E^I}{\lambda^{E^I}} \left(\frac{\lambda^{E^I} P^{EI}}{PA_e} \right)^{\sigma^{E^I}}$$

Equation (8-16.1) decomposes the energy bundle into the fuel components. The CES share parameters are given by a_e^I, and the substitution elasticity is σ^{E^I}. The energy efficiency factor enters at this level of the energy nest.

The aggregate volume of stock building, I^{STOCK}, is exogenous in each period, and normally set to zero in some future year. Final demand for stock building is determined via a fixed coefficient function, including demand for the fuel composites, i.e. the substitution elasticity for splitting the energy bundle into fuel composites is equal to zero. Table 8-17 lists the equations of intermediate demand derived from stock building.

Table 8-17: **Demand for Intermediate Goods and Services, and Fuels, Derived from Stock Building**

(8-17.1) $$X_{nf}^{ASTOCK} = a_{nf}^{STOCK} I^{STOCK}$$

(8-17.2) $$X_e^{ASTOCK} = \frac{a_e^{STOCK}}{\lambda^{ESTOCK}} I^{STOCK}$$

Equation (8-17.1) determines (Armington) demand for non-energy goods and services, X^{ASTOCK}, derived from stock building, and Equation (8-17.2) defines derived demand for the fuel composites.

8.3.9 Investment and Stock Building Prices

In this section prices in investment and stock building are determined going from the bottom up. Table 8-18 describes the prices in the demand for investment goods.

Table 8-18: **Prices in Investment and Stock Building**

(8-18.1) $$P^{EI} = \left[\sum_{e} a_e^I \left(\frac{PA_e}{\lambda^{EI}}\right)^{1-\sigma^{EI}}\right]^{\frac{1}{1-\sigma^{EI}}}$$

(8-18.2) $$P^I = \sum_{nf} a_{nf}^I \, PA_{nf} + a^{EI} \; P^{EI}$$

(8-18.3) $$P^{STOCK} = \sum_{nf} a_{nf}^{STOCK} PA_{nf} + \sum_{e} a_e^{STOCK} \frac{PA_e}{\lambda^{ESTOCK}}$$

Equation (8-18.1) in Table 8-18 defines the CES dual price, P^{EI}, for the energy bundle. Equation (8-18.2) determines the aggregate price index of investment. Finally, Equation (8-18.3) defines the aggregate price of stock building, P^{STOCK}. It is the weighted sum of the intermediate input prices, with λ^{ESTOCK} being the energy efficiency factor in the stock building sector.

8.3.10 Government Expenditures

This section determines government expenditures on purchases of goods and services, as well as on labour and capital. Contrary to the other final demand sectors, government is assumed to demand factor services.[274] The top level government expenditure function is a CES function in capital, labour, and aggregate intermediate inputs. Final demand by the government is assumed to derive from the minimisation of the following cost function:

$$\min P^{Cg} C_g + R_g K_g^d + W_g^A L_g^{A^d}$$

subject to the production function:

[274] Note, however, that due to lack of data in the current data-set on labour and capital use in the government sector, government expenditures are only on goods and services. This simply means that, during the calibration of the model, the labour and capital shares of total expenditure are set to zero.

$$X^{TotG} = \left[a^{GC} C_g^{\rho^g} + a^{GK} K_g^{d\,\rho^g} + a^{GL} L_g^{Ad\,\rho^g} \right]^{1/\rho^g}$$

Equations in Table 8-19 provide the derived reduced form first order conditions for government demand for the three components of the CES expenditure function.

Table 8-19: **Government Demand for Goods, Services, Labour, and Capital**

(8-19.1) $$C_g = a^{GC} X^{TotG} \left(\frac{P^G}{P^{Cg}} \right)^{\rho^g}$$

(8-19.2) $$K_g^d = a^{GK} X^{TotG} \left(\frac{P^G}{R_g} \right)^{\rho^g}$$

(8-19.3) $$L_g^{A^d} = a^{GL} X^{TotG} \left(\frac{P^G}{W_g^A} \right)^{\rho^g}$$

Equation (8-19.1) determines aggregate intermediate demand for goods and services by the government, C_g. X^{TotG} represents the volume of government expenditure, P^G is the aggregate price of government purchases , P^{Cg} is the aggregate purchase price of goods and services, a^{GC} is the CES share parameter for goods and services, and ρ^g is the CES substitution elasticity. Equation (8-19.2) determines government demand for capital, K_g^d, where R_g is the rental rate on government capital. Equation (8-19.3) determines government's aggregate demand for labour, L_g^{Ad}.

The next level of demand disaggregates the C_g bundle into sectoral demand for non-energy goods, and the energy bundle. The energy bundle is further decomposed into demand for the fuel components.

Table 8-20: **Government Demand for Goods, Services, Energy, and Fuels**

(8-20.1) $$X_{nf}^{AG} = a^{GCnf} C_g$$

(8-20.2) $$E_g = a^{GE} C_g$$

(8-20.3) $$X_e^{AG} = a_e^{GE} \frac{E^G}{\lambda^{EG}} \left(\frac{\lambda^{EG} P^{EG}}{PA_e} \right)^{\sigma^{EG}}$$

Equation (8-20.1) determines (Armington) demand for non-energy goods and services, X^{AG}, using the fixed coefficients a^{GCnf}. Equation (8-20.2) determines demand for the energy bundle, E_g. Equation (8-20.3) determines the demand for the fuel components, by disaggregating the CES energy bundle.[275]

8.3.11 Government Prices

This section determines prices in government demand. As in all other economic sectors, it starts at the bottom with basic prices.

Table 8-21: **Prices in Government Consumption**

(8-21.1) $$P^{EG} = \left[\sum_e a_e^{GE} \left(\frac{PA_e}{\lambda^{EG}} \right)^{1-\sigma^{EG}} \right]^{\frac{1}{1-\sigma^{EG}}}$$

(8-21.2) $$P^{Cg} = \sum_{nf} a^{GCnf} PA_{nf} + a^{GE} P^{EG}$$

(8-21.3) $$P^G = \left[a^{GC} {P^{Cg}}^{(1-\rho^g)} + a^{GK} {R_g}^{(1-\rho^g)} + a^{GL} {W_g^A}^{(1-\rho^g)} \right]^{\frac{1}{1-\rho^g}}$$

[275] Aggregate government labour demand should still be disaggregated by skill type. This is easily derived with a CES conditional demand but it is not shown here since not used in the current model.

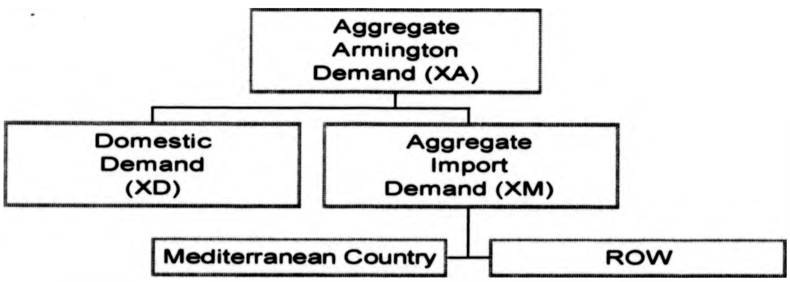
Equation (8-21.1) in Table 8-21 determines the price of the energy bundle, P^{EG}. The aggregate price of expenditures on goods and services, P^{Cg}, is given by Equation (8-21.2). The CES dual price of output, P^{G}, is given by Equation (8-21.3).

8.3.12 Trade Equations

Import Structure

The structure of import demand of EMMA and the Environment and Trade model are quite similar. Given the difference in the final demand specification the equation specifying the aggregate Armington demand across all agents is slightly different.

Figure 8-1: **Structure of Import Demand**



Apart from this difference the first level of the Armington nesting is exactly the same as the previous one. At the final level, agents minimise the cost of the aggregate import bundle, subject to an aggregation function over imports originating in each region of the model, namely the Mediterranean region and the Rest of the World.

Table 8-22 specifies the equation determining aggregate Armington demand, XA, i.e. the sum of Armington demand across all agents.

Table 8-22: **Armington Aggregate Demand**

(8-22.1) $$XA_i = \sum_j X_{i,j}^{AP} + X_i^{AC} + X_i^{AG} + X_i^{AI} + X_i^{ASTOCK}$$

The Armington price, PA, is determined in the exact same way of the Environment and Trade model.

In EMMA the next stage in the Armington decomposition is slightly different and the relevant equations are described below in Table 8-23.

Equation (8-23.1) determines the world trade flow matrix (in volume) for each commodity, $M^{r,r'}$. Reading along a row, it specifies import demand for commodity i in region r, originating in region r'. Summing down column r' determines aggregate export demand for region r'. The relevant import price, is the export price of the exporting region, augmented by a trading partner-specific import tariff. Equation (8-23.2) determines the aggregate import price of commodity i, which will be an average of the export prices of all the region's trading partners, tariff inclusive. Equation (8-23.3) fixes the price for a commodity imported from the Rest Of the World region (small country assumption).

Table 8-23: **World Trade and Import Prices**

(8-23.1) $$M_i^{r,r'} = \Phi_i^{r,r'} XM_i^r \left(\frac{PM_i^r}{PE_i^{r'}\left(1+\tau_i^{r,r'}\right)} \right)^{\Lambda_i^r}$$

(8-23.2) $$P_{i,r}^{M} = \left[\sum_{r'} \Phi_i^{r,r'} \left[PE_i^{r,r'}\left(1+\tau_i^{r,r'}\right) \right]^{(1-\Lambda_i^r)} \right]^{\frac{1}{1-\Lambda_i^r}}$$

(8-23.3) $$PE_i^{r,\text{"ROW"}} = \overline{PE}_i^{r,\text{"ROW"}}$$

Export Structure

In EMMA export supply is specified as in the previous model. The top level of the CET decomposition is therefore equal in the two models.

The final trade equations are instead peculiar to EMMA and they determine the second nest of the CET decomposition of exports. The regional disaggregation of exports is given in Equation (8-24.1), in which, clearly, the same symbol $M^{r',r}$ as before has been used with the indices transposed. $\varepsilon^{r',r}$ represents exports subsidies. Analogously equations (8-24.2) determines aggregate export price P^E inclusive of export subsidies.

Table 8-24: **Export Market Equilibrium**

(8-24.1) $$M_i^{r',r} = \Theta_i^{r',r} E_i^S \left(\frac{PE_i^{r',r}\left(1+\varepsilon_i^{r',r}\right)}{P_i^E} \right)^{\Omega_i^r}$$

(8-24.2) $$P_{i,r}^E = \left[\sum_{r'} \Theta_i^{r',r} \left[PE_i^{r',r}\left(1+\varepsilon_i^{r',r}\right) \right]^{(1+\Omega_i^r)} \right]^{\frac{1}{1+\Omega_i^r}}$$

8.3.13 Walras law and numeraire

In the EMMA model, Walras' law has been defined to be the equality of the trade balance to the (negative) of foreign saving. Equation (8-25.1) defines Walras' law.

Table 8-25: **Trade Closure**

(8-25.1) $$\sum_i \sum_{r'} PE_i^{r',r} M_i^{r',r} + P^{SAVE} S_t^r = \sum_i \sum_{r'} PE_i^{r,r'} M_i^{r,r'}$$

On one side of the balance sheet are exports, evaluated at world prices, and net foreign saving. On the other side of the balance sheet are the sum of imports evaluated at world prices (excluding tariffs). Due to Walras' law, one equation in each region is redundant, and Equation (8-25.1) is dropped from the model.

Any price in the model can be chosen as the numéraire. In the current version of the model, the foreign saving price index, P^{SAVF}, has been designated as the numéraire, and its value is always set to 1.

8.3.14 Aggregate Capital Stock and Productivity Growth

In this section are described the equations concerning the pre-determined exogenous variables, the energy efficiency factors, and the labour transition. The equations for the aggregate supply of capital, and for its productivity factor have been described in chapter 6.

Table 8-26: **Other Pre-Determined Exogenous Variables**

(8-26.1)	$Pop_t = (1+\gamma_t^p)^n Pop_{t-n}$
(8-26.2)	$X_t^{TotG} = (1+\gamma_t^y)^n X_{t-n}^{TotG}$
(8-26.3)	$G_t^{TRA} = (1+\gamma_t^y)^n G_{t-n}^{TRA}$

In Table 8-26, Pop_t is the population at time t. X^{TotG} is the level of total real government non-transfer expenditures (including goods, services, labour, and capital). G^{TRA} is the real level of transfers from government to households. Both X^{TotG} and G^{TRA} are assumed to grow at the same rate as the economy.

The energy efficiency factors are also exogenous and pre-determined leading to the following set of transition equations:

Table 8-27: **Energy Efficiency Factors**

(8-27.1)	$\lambda_{i,v,t}^{Ep} = (1+\gamma_{i,v,t}^{e,p})^n \lambda_{i,v,t-n}^{Ep}$
(8-27.2)	$\lambda_t^{Ec} = (1+\gamma_t^{e,c})^n \lambda_{t-n}^{Ec}$
(8-27.3)	$\lambda_t^{Eg} = (1+\gamma_t^{e,g})^n \lambda_{t-n}^{Eg}$
(8-27.4)	$\lambda_t^{Ei} = (1+\gamma_t^{e,i})^n \lambda_{t-n}^{Ei}$
(8-27.5)	$\lambda_t^{Est} = (1+\gamma_t^{e,st})^n \lambda_{t-n}^{Est}$

The annual autonomous energy efficiency factors are given by $\gamma^{e,p}$, $\gamma^{e,c}$, $\gamma^{e,g}$, $\gamma^{e,i}$, and $\gamma^{e,st}$ representing respectively the growth in energy efficiency in production, household consumption, government demand, investment demand, and stock-building demand. The energy efficiency factors in production are specific to both sector and vintage. The cumulative factors are given by the λ variables.

The transistion equations in Table 8-28 determine the changes in the labour supply curve and labour efficiency. Equation (16.6.1) simply shifts the labour supply curve out. The shift factor is the same as the population growth rate, but it could easily be made to differ. Equation (16.6.2) determines the labour efficiency factor. The growth in labour efficiency is exogenous and can be both sector and labour-type specific.

Table 8-28: **Labour Transition Equations**

(8-28.1)	$L^{S}_{l,t} = (1+\gamma^{p}_{t})^{n} L^{S}_{l,t-n}$
(8-28.2)	$\lambda^{l}_{li,t} = (1+\gamma^{l}_{i})^{n} \lambda^{l}_{li,t-n}$

9 Conclusion

This thesis should be viewed essentially as a collection of three academic papers. These correspond to chapters 3, 5, and 7. Given that each paper has its own set of conclusions, in this final chapter, rather than reiterate the main results, I go back to the initial questions that motivated my work and see what are the main contributions and integrating features and what may be the possible future extensions.

In a somewhat schematic fashion I identify twelve main points that make some original contribution to the economic literature. The sequence in which I briefly present them here simply follow the order of exposition in the thesis: there is no intention of listing them in order of importance.

Firstly, I provide a new valuable database for the Mediterranean region. This takes the form of a detailed, up to date and consistent two-country SAM for France and Morocco. I restricted the database to these two countries given that their economic relationships represents the broader links between the north and south of the Mediterranean quite well. I can proudly say that the value of this database is apparent from its inclusion in the GTAP public database of SAMs for computable general equilibrium analysis.

Secondly, based on this SAM I construct a fixed-price multiplier model initially, merely with a descriptive purpose in mind. In this way I offer some new empirical evidence relevant to the literature on the economic relationship between the north and south shore of the Mediterranean. I also undertake a comparison of the Mediterranean situation with that of NAFTA and identify similar patterns of dependence and specialisation in the less developed partners of these two groups. The simple and transparent analytical structure of the multiplier model highlights the main structural features of the economies under study, emphasising the major linkages between supply and demand, trade and production, factors and income distribution. I argue that building this type of model is relatively easy and the sort of results they offer may be very helpful in the construction of more complex CGE models. I have in mind, for instance, how much sectoral detail should be included in a CGE model, how many and which type of households and factors, or which important linkages deserve special modelling attention.

Thirdly, although CGE models are a natural evolution of earlier input-output and multipliers models, the two communities of researchers working with these two analytical tools have, with few exceptions, remained quite detached. They tend to use slightly different jargon, analyse distinct issues and publish results in specialised journals. By jointly presenting both types of models, this thesis attempts to fill a gap in the economic literature that neglects the close connections between these two modelling families.

The fourth feature of originality is in the formulation of a particular kind of sensitivity analysis. Instead of the usual elasticity sensitivity analysis that focuses on the curvature of demand and supply functions, I undertake a share sensitivity analysis by concentrating on the functions' intercept values. By measuring the variations in the size of the multipliers, I assess the sensitivity of the results to different ways of accounting for imports and conclude that results generated from data-intensive SAM formats, such as those with full distinct domestic and imported intermediates tables, do not differ appreciably from more statistically parsimonious formats. This proves to be quite important given that import functions in a CGE model are usually calibrated from the second type of formats.

The complete description of the Moroccan SAM assembly provides some guidelines in the process of database construction and is the fifth point of originality in this thesis. One of the most common obstacle researchers have to face is making sense of conflicting estimates from disparate government and other agency sources and by supplying accessible sources and methods for this and other difficulties I fill another gap in the applied economics literature.

A detailed quantitative assessment of the interdependencies between trade and environmental policies in Morocco is an additional novelty. I answer directly the initial questions of how trade liberalisation may affect the environment and which are the consequences on international competitiveness of implementing a stricter environmental protection policy. I do so by constructing and using a CGE model.

Three further points of originality can be emphasised. I use a CGE model with a very high level of detail. The model explicitly includes dynamic features. Emissions are generated through consumption rather than being linked to output levels. Therefore beyond the concrete application to Morocco, these characteristics make the trade and environment analysis different from earlier studies concerned with similar issues.

The tenth point is the application of a new multi-country model to the Mediterranean region. I have already signalled the geographic bias of applied general equilibrium analysis towards the North-American regional group in the literature to date. My applied study contributes a balance to this situation.

Apart from this geographic focus, the novelty of this analysis is also ascribable to the intrinsic characteristics of the model. It distinguishes, for both of the two countries expressly modelled, trade flows from and to different regions thereby permitting a study of different regional integration policies. Labour markets can be modelled in two limiting cases, making clear the possible sensitivity of the results to factor market adjustments. Experiments with different closure rules and trade elasticities are fully documented at the aggregate and detailed sectoral level.

The twelfth and final point is concerned with the particular use of the dynamic version of the multi-country model. By tackling directly the issue of the sequencing of tariff reduction across sectors within a dynamic applied general equilibrium analysis, I extend a literature largely devoted to either the theory of second-best and static piecemeal reform or to establishing whether to open first the current or the capital account. I devise a summary elasticity measure linking adjustment costs (approximated by labour displacements) to GDP growth rates and use it to show the possible trade-offs between growth with the adjustment costs of conservative liberalisation versus big-bang-like sequences.

A few suggestions for future research close the thesis. As far as the first paper is concerned, I would consider extending the share sensitivity analysis to a CGE context and maybe look at other intercepts, not only those of import functions.

I also realise the need for future research in two main directions for the trade and environment model. A clearer focus on issues of income inequality: the relation between poverty and environment degradation is a central question in the literature and a CGE approach might be fruitful. Additional investigation could also attempt to integrate two separate themes in environmental modelling, that of resource management (for example mining in the case of Morocco) and emission abatement. Both these themes have linkages with trade and growth in developing countries.

Finally, a crucial issue is only hinted at in the third paper and deserves more attention. In a world of increasingly mobile capital, characteristics of and interactions between labour markets will determine how countries will or will not take advantage of more liberal trade. A deeper understanding of the interactions between capital flows, labour adjustment and trade defines a challenging and important agenda for future research.

10 References

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