Exchange Rate Instability and Economic Reform

with specific reference to Russian exchange rate reforms in the early 1990's

Michele Ca'Zorzi

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Department of Economics
University of Warwick
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THIS VOLUME HAS A VERY TIGHT BINDING

on all figures

Abstract

This thesis is concerned with the origins of exchange rate instability and the scope for economic reform. Several aspects of recent macroeconomic instability in Russia are discussed which, we argue, reveal the origins of this problem.

The first chapter combines currency substitution and price stickiness. It aims to account for the weakness of the real exchange rate and the net accumulation of foreign exchange, that so frequently characterise unstable economies. The essence of the discussion is that, when faced with severe tight controls on capital, agents are able to substitute foreign currency for local currency via the current account. The model has a simple dynamic structure, similar to the Dornbusch model.

The second chapter uses the Cohen and Michel procedure to extend the time inconsistency approach to an open economy, a-la-Dornbusch framework. A special loss function is used, but the same methodology may be applied to address other economic issues. When time consistency is assumed, future loose monetary policies are foreseen and hence have current consequences. We argue that the more the government has an inflationary instinct, the greater the experience of undervaluation and the fall in liquidity.

The third chapter builds on the work of the second. It is argued that even in this open economy, a-la-Dornbusch framework, the standard result holds: credibility is enhanced by delegating monetary policy to a conservative central banker. The economic consequences of this are twofold: a smaller real exchange rate undervaluation and a reduced fall in liquidity. In addition, we propose an extension of this analysis by letting currency substitution, between domestic and foreign assets, be the alternative assumption to perfect capital mobility. The assumption of currency substitution leaves largely unchanged the dynamic structure of the analysis, but gives rise to a quite different economic interpretation.

The fourth chapter describes the reasons why policy makers decide on restrictive foreign exchange policies. A currency substitution framework is used to highlight the consequences of foreign exchange leakages between official and black markets. The model is solved by applying the technique suggested by Dixit and Currie to determine the free variable as a function of the predetermined variables of the system.

A fifth chapter attempts to pull together the main arguments, and conclusions arising from these, which have been discussed throughout the thesis.

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Introduction

Horder (1997: 17) argues that "under the socialist system the main instrument for savings was domestic money". However, long spells of high inflation during the early 90's have turned Russia into, what may be described as, a "cashless society", (The Economist, 1997: 6) relying mainly on barter and foreign exchange. This has resulted in great economic instability giving rise to frequent criticism on how the Russian authorities handled the economy during that period. It is, therefore, the primary objective of this thesis to evaluate the early 90's Russian monetary policies and foreign exchange market reforms, exploring whether this economic instability, although unavoidable, could have been mitigated, and whether lessons can be drawn for countries in similar circumstances. In order to discuss this, the thesis will be organised in five chapters as follows:

In chapter 1, *Exchange Rate Undervaluation in the Absence of Perfect Capital Mobility: the Russian Case*, we first review the reasons why radical reformers, such as Yegor Gaidar and Boris Fedorov, were not in a position to halt the large monetary flow, which the Russian economy was witnessing. At the same time, there is a description of how, in a relative short time, Russia moved to a system of current account convertibility, liberalised prices and favourable retention rules, the purpose being to bring most of the economy back to legal channels.

This was certainly not an easy set of policies to carry out, considering the sudden breakdown of monetary control in the rouble zone and the extent to which official prices had been repressed. As pointed out by Bruno (1993: 16), current account convertibility is a risky option in an economy without inflation hedges, since "demand for foreign exchange reflects primarily a stock demand". We maintain that a currency substitution model is appropriate to describe the Russian economic environment.

The simple model developed here shows how, even in the absence of perfect capital mobility, a monetary expansion brings about the overshooting of the exchange rate. The economic insight of the model is the following: the weakness of the exchange rate improves the external position of the country, supplying the foreign exchange needed to satisfy economic agents' portfolio demands. The possession of foreign exchange as a store of value is sometimes called 'internal capital flight'. This is a common alternative to a real capital flight whenever capital account restrictions are in place. Both internal capital flight, and temporary real exchange rate weakness, are standard features of unstable economies, which rely on printing money for financing purposes. The model combines price stickiness and currency substitution, and can be reduced to a linear system of two differential equations.

In chapter 2, *Time Consistency in an Open Economy, a-la-Dornbusch,* two different models are presented:

1) the first, is the Barro (1983) seigniorage model, which offers an insight to high inflation, perfectly consistent with the hypothesis of the rationality of economic agents. It is an application of the time consistency framework. Despite the

commitment of a future tight monetary policy, economic agents understand the government's great difficulties for financing the budget and hence correctly foresee the real future monetary policies. Their response is to hold less money, so lowering the inflation tax. It is a one period model;

2) the second, is the Buiter Miller (1981) model, which emphasises the significance of the different speed of adjustment between the financial and the goods market. The time horizon is infinity. A key figure of the whole analysis is here presented: it is the phase diagram of the system of differential equations, expressed as a function of the real exchange rate, c and of real balances, l. The stable manifold of the system allows one to examine the overshooting of the exchange rate in the aftermath of a monetary shock.

The aim of this chapter is to integrate these two models in a common theoretical framework. The first problem to consider is how to make the time horizon of the two models compatible. This is solved by postulating a policy maker who minimises a quadratic discounted stream of costs over an infinite time period, subject to the Buiter Miller model. Thus, it is an optimal control problem.

After having calculated the standard optimal control solution, it is important to refer to the time consistency literature. In fact, the derived solution violates Belman's principle of optimality. So far this is the time inconsistent solution.

Thus, it becomes necessary to find an alternative way to calculate the time consistent solution. Our analysis refers to the Cohen and Michel (1988) article, where it is shown how standard control theory should be modified to obtain time consistent solutions in a dynamic framework with forward looking variables. The derivation of the time consistent solution, suggested by the Cohen and Michel technique, requires the assumption of a predetermined linear relationship between c and l. The application of this method allows one to reduce the number of state variables to only one, l.

The time consistent solution to the above problem, can be represented by a phase diagram entirely analogous to the one characterised by the Buiter Miller model. The crucial difference is that the growth rate of money is here endogenous. The exchange rate overshooting critically depends on the policy makers' aversion to inflation. The model therefore predicts that the greater the government's need to finance the deficit and to subsidise the debts of enterprises by printing money, the greater the real exchange rate jump. As a consequence, the analysis can justify the scale of the Russian undervaluation.

In chapter 3, *Exchange Rate Undervaluation and Institutional Reform*, our objective is to apply the previous analysis to the Russian undervaluation experience. Firstly, we maintain that it is important to verify whether the empirical data at our disposal gives some support to the theoretical analysis. There seems to be some evidence that the real exchange rate appreciation and fall in real balances had a common trend, thus giving empirical support to chapter 2.

This begs the question whether institutional reform would have been the appropriate response to the government's policy credibility problem. For example, recent literature has explored the possibility of a currency board system. There is also the well-known issue of monetary policy delegation. The standard result, that the optimal central banker should be conservative, holds here.

The really interesting point here is the possibility of extending the key Buiter Miller figure, to the context of monetary delegation. Our analysis reaches the conclusion that, if Russia had replaced Gerashchenko, by appointing a suitably conservative central banker, the adjustment path would have remained similar but less harmful. Enhanced credibility signifies both a smaller real exchange rate undervaluation, and a larger tax base for seigniorage.

Finally, we extend the currency substitution model developed in chapter 1, *Exchange Rate Undervaluation in the Absence of Perfect Capital Mobility: the Russian Case,* to the constraint of time consistency. It can be shown that, with monetary policy delegation, not only the exchange rate weakness is reduced, but so is also the overall stock of foreign exchange held by the private sector.

In chapter 4, *Internal Capital Flight in a Black Market Exchange Rate Economy* we explore the reasons why black market exchange rates develop and the likely consequences on the remaining macroeconomic system.

Russian radical reformers encouraged exporters to act through legal channels by easing the foreign exchange surrender rules. Over time, significant steps were made to ensure current account convertibility, and, in addition, there were no serious attempts to defend the rouble or to restrict current account convertibility after July 1992. This was certainly courageous.

In similar circumstances policy makers frequently prefer to keep the domestic currency artificially overvalued. This is the single most important factor originating a black market exchange rate, as the existing literature confirms.

We develop a stylised black market exchange rate economy. Frustrated demand spills over into the black market exchange rate. Exporters are compelled by law to supply dollars into the official market; however if there is a black market premium, they are ready to under invoice their revenues and divert dollars into the black market. Thus, even when retention rules are tight, internal capital flights are still possible, if the black market current account is positive. Net accumulation of foreign exchange is achieved with illegal means. For this reason it may be referred to as illegal internal capital flight.

Technically, we combine a currency substitution equation, an equation for the black market current account and finally, an equation for reserves. The model can be reduced to a non-linear system of differential equations. Subsequently, we solve the model by applying the technique suggested by Dixit (1980) and Currie (1985) to determine the free variable as a function of the predetermined variables of the system. This allows us to examine what the impact effect is of exogenous changes of both money supply and of the official exchange rate. As regards a monetary expansion, the analysis arrives at the standard result that a monetary expansion leads to a rise in the black market premium. Such a rise spurs exporters' willingness to divert more hard currency into the black market, hence satisfying the greater foreign currency stock demand

As regards an official exchange rate devaluation, we explore Morris' argument (1995) that this is likely to be a successful policy, if the country is a net receiver of foreign aid. On the other hand, if the country relies on an overvalued exchange rate as a implicit source of revenue, a devaluation has a negative fiscal impact, possibly undermining the stabilisation attempt.

Finally, in chapter 5 we attempt to summarise the main arguments which have been discussed throughout the thesis and to suggest further developments of this research.

Chapter 1

Exchange Rate Undervaluation in the Absence of Perfect Capital Mobility: the Russian Case

1.1 Russian Economic Background

1.11 An Overview on the Real Exchange Rate Weakness in Russia

In the early 90's currencies have typically been weak in the former USSR and Eastern Europe. While economists often recognise the dangers of having overvalued currencies, in terms of losses of export markets, which may never be recovered (Dornbusch, 1988: 80-107), they tend to be less concerned with the risks of undervalued exchange rates. Indeed, when the exchange rate is fixed to a nominal anchor, it is conventional wisdom to be cautious and initially choose a weak parity for the exchange rate. However, the extent and scale of the undervaluation phenomenon in Eastern Europe and Russia in the early 90's have been so impressive that their economic causes and consequences cannot be ignored. Bruno, for instance, suggested that in Poland in 1989, and in Czechoslovakia in 1990, the free exchange rate valued foreign exchange at roughly ten times more that the PPP parity, while in Russia in 1991-1992 the exchange rate reached the high peaks of 15 or 20 (Bruno, 1993: 16) times such a benchmark value. The large size of the Russian undervaluation in the early 90's is also broadly confirmed by the statistics gathered in a recently established journal, Russian Economic Trends (see Table 1.1), which monitors the progress of the Russian economy.

Table 1.1 Russian Real Exchange Rate

	Actual/PPP
1991	
December	33.3
1992	
January	11.1
February	9.1
March	7.1
April	5.9
May	4.3
June	3.6
July	3.8
August	4.2
September	4.8
October	6.7
November	6.7
December	5.3
1993	
January	4.6
February	4.8
March	4.6
April	4.6
May	4.6
June	4.6
July	3.4
August	3.1

(source: Russian Economic Trends[1], 1993: 25)

[1] It would be possible to add more data to this table. While the general trend remains a continuous appreciation of the real exchange rate, we prefer to exclude these data since the source for the PPP estimates is not the same as the one used in this table.

According to this series, in December 1991 the rouble valued even less than what suggested by Bruno, namely the outstanding figure of 33.3 times the estimated PPP number. According to the same series by January 1992 the rouble had partly recovered its value as the ratio between the actual and the PPP exchange rate fell to 11.1. The basic reason for this is that the Russian authorities in January 1992 started a process of radical reforms which included the liberalisation of several administrative prices. By looking at the monthly plot of inflation a large spike can be seen in January 1992 (see Fig. 1.1), which largely exceeded what most analysts had expected[2] (see Gomulka (1995: 332-333) and Horder (1997: 23-24) for a discussion on this issue).

The direct consequence to the large price jump is that the scale of the exchange rate undervaluation was immediately lowered. Nevertheless, 11.1 remains a very large figure for it means that the local currency valued less than 10 % of its purchasing power parity value! From January 1992 onwards the real exchange rate followed a more gradual trend of appreciation.

For reasons discussed later on in this chapter, the 1992 official data, while commonly employed to discuss the Russian performance, overestimates the size of the rouble undervaluation (see Goldberg, 1993: 852-864). There is no doubt, however, that the rouble was vastly undervalued, as is also confirmed by available black market data (Russian Economic Trends, 1992: 84).

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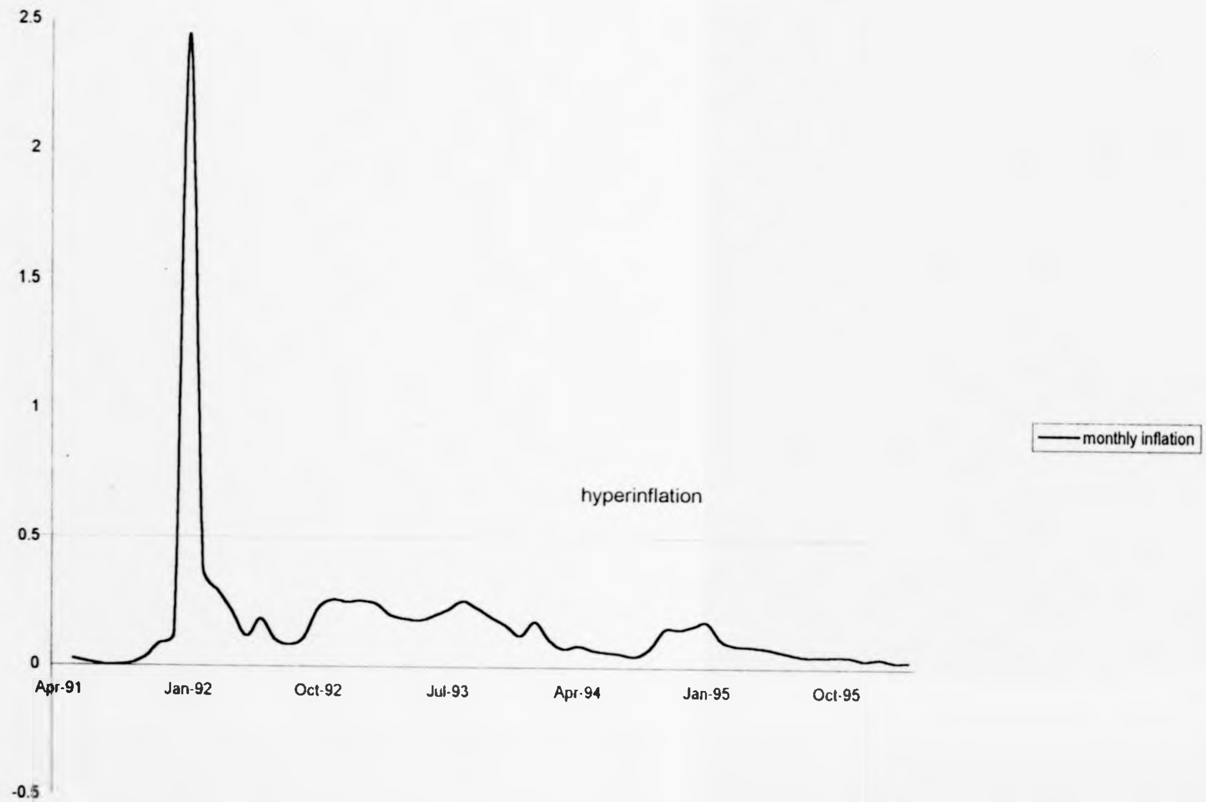
[2] In this thesis we have employed data from various issues of "Russian Economic Trends". With regard to computer software, we have relied on "Microfit" for estimation purposes while we have used "Excel 5" to represent time series. Furthermore, in the following chapters we carry out simulations analysis using "Mathematica". Finally, all the remaining diagrams are represented using "Freelance Graphics".

Fig. 1.1 Price Liberalisation



The weakness of the Russian exchange rate did not remain unnoticed by world economic investors as it provided the opportunity to acquire Russian assets at low prices. This is shown, for example, by the following extract taken from the Economist (1994: 94):

> To most people the Weimar Republic signifies economic collapse, social turmoil and, eventually, the rise of Hitler. Marc Faber, a Hong Kong-based investor, takes a different view. "the Weimar hyperinflation", he says, "provided the best buying opportunity for German shares this century". Mr Faber uses Daimler to prove his point. By November 1922, the company's market capitalisation was 980m paper marks. A single Daimlercar then cost 3m paper marks, so it would have been possible to buy the whole company for the price of only 327 of its cars. The opportunity was short-lived, however. In 1923 a speculative fury gripped the German stockmarket, which rose 15 times, measured in dollar terms. Mr Faber believes that Russian assets are now almost as undervalued as German ones were in 1922. He is not alone. In the first quarter of this year foreign portfolio investors put an estimated $400m into shares of Russian companies. Longer-term strategic investors have pumped in far more: over the past four years they have committed $ 11.6 billion

In addition to all the legal opportunities to buy Russian goods and assets cheaply, a massive exchange rate undervaluation prompted all kinds of illegal activities to flourish (see Goldman 1996: 117). Surrender rules, export licenses and quotas were supposed to hinder the underselling of national resources to foreigners, but rogue traders often managed to find ways to elude the existing tax system. As Aslund (1995: 150) says,

> "rogue traders were depriving Russia of its national wealth by selling raw material cheaply abroad. Undervoicing was chronic, often because the exporters did not own the products they exported to their own benefit. The call fo strict export controls was overwhelming."

To halt the damage caused by these frauds and by the general complexity of the system, Russian policy makers realised that it was necessary to progressively simplify foreign exchange rate rules and over time to complete all the necessary steps to attain current account convertibility. Above all, it was vital to carry out economic reforms which would encourage exporters to channel hard currencies through official markets.

1.12 The Prospects of Current Account Convertibility between the Final Years of the Soviet Union and the Start of Radical Reforms

It is well-known that during the years of Communism, currencies had not been convertible and all trade matters had been settled by the Council of Mutual Economic Assistance. The countries involved in such a system were: Czechoslovakia, Hungary, Poland, Bulgaria, Romania and the USSR. Trade was recorded bewteen the CMEA countries at the International Bank for Economic Cooperation in Moscow. Payments were carried out in national currencies and the common unit of accountancy was the Transferable Rouble. In practice exchange rates were established by political agreement, while to a large extent trade was bilateral as deficits between any two countries could not persist for long.

In short, the system was plainly biased against trade. The rationale for this pattern of trade was the communist notion that trade is not growth enhancing - through competition and variety - but essentially is only a necessity required by the different allocation of resources across countries. With the defeat of Communism, the concept that trade itself is an engine of growth revived, and convertibility, therefore, suddenly became an objective for all the CMEA countries.

As it is well known that the IMF regulation (Article 8 Section 2) explicitly requires current account convertibility with the following objectives:

1) to bring the correct price signals to the market

2) to increase the size of the market, reducing any existing monopoly power

3) to allow a wider consumption choice to consumers

4) to allow a greater choice of inputs to producers

As far back as November 1989, the Soviet Union had started moving in this direction by introducing currency auctions. As Goldberg (1992: 6) says "this marked the start of a period of exchange-rates movements that in principle would be driven by market forces". In theory, Soviet exporting enterprises could sell hard currency on a voluntary base. In practice, however, in 1989 surrender requirements rules were still extremely severe, as the fraction of foreign currency earnings which could be freely allocated in these markets was less than 10 percent. Thus, the early foreign-currency auctions which took place in the Soviet Union "have been characterized by a distinctive shortage of exporters willing to voluntary sell foreign exchange" (Goldberg 1992: 7). As a consequence, not only was it necessary to ration foreign exchange demand, but, in several circumstances, the Central Bank of Russia (CBR) had to intervene to defend the rouble by depleting its hard currency reserves.

Moreover, the Soviet Union was characterised by a system of multiple exchange rates which survived up until 1992. It was particularly complex: for each currency transaction a different exchange rate was applied which depended on both the region and the goods traded. Hence, it is not surprising that the Soviet economy - characterized by several exchange rates and a multitude of exemption rules - was liable to all kinds of frauds. In general, exporters were compelled to sell their foreign exchange at unfavourable prices, whilst some importers were given the opportunity to buy hard currency at exceptionally advantageous prices. All unsatisfied demand for hard currency inexorably spilled over into the black market. As exporters recognised the existence of this residual demand, they were more than willing to divert part of their hard gained currency into the parallel market.

Before long the Russian political scene was going to experience major changes which would step up the process of economic reform. On June 12 1991 Boris Yeltsin was in fact elected President of Russia and later in the same year, between the 19th and 21st of August, an abortive Communist coup took place, undermining Gorbachev's leadership. For some time the Soviet Union seemed to be on the brink of both social and economic collapse (Aslund, 1995: 52):

> "The severity of the acute financial crisis of 1991 can hardly be exaggerated. The Soviet budget deficit had risen to at least 20 percent of GDP, and it had skyrocketed out of control. International financing had been exhausted, and the USSR defaulted on its foreign payments in December 1991. The USSR suffered from a combination of high and rising inflation, and it endured massive shortages and long queues because of a huge monetary overhang."

Until then Russia had managed to prevent the outburst of a fully-fledged hyperinflationary process by strictly controlling administrative prices. However, it turned out to be impossible to halt large wage increases, as well as to control credit and social expenditure. Hence the Russian economy was suffering from a large monetary overhang which soon led the way to a dangerous supply collapse: prices, in fact, were low to the point that it had become hardly worthwhile for producers to keep up production or to sell goods in official stores. Furthermore, Russians started storing goods and, more and more frequently, buying and selling foreign currencies in black markets.

While credit to enterprises seemed to be boundless, money was becoming increasingly meaningless as it hardly served the purpose of buying consumption goods. Large enterprises, especially, were subject to soft budget constraints as "the state netted out debts between enterprises at the end of the year and offered cheap loans to cover those enterprises that had deficits" (Aslund 1995: 178). So they had no need to economize on real balances and no need to borrow at demanding 'commercial rates'. All balance sheets difficulties could be simply resolved by what Skidelsky and Halligan (1996: 28) have aptly defined as "phone call financing".

Clearly these policies could not be sustained for long. Two political developments in fact shook Russia in December 1991. On the 8th of December the USSR was abolished in accordance to the agreement signed in Belovezhsky by the leaders of Belarus, Russia and Ukraine. In the same month Yegor Gaidar was appointed as Minister of the Economy and Deputy Prime Minister of Russia and launched a set of radical reforms. Gaidar persuaded Yeltsin that it was absolutely necessary to eliminate as soon as possible the large monetary overhang by liberalising administrative prices. This policy needed to be matched by a substantial improvement in the government budget, reducing at least one of the main causes of inflationary pressure. Arms procurement, state investments and subsidies were immediately curbed. Several payments were also delayed: a policy which in the short run reduced the need to finance the deficit by printing money. Social expenditures were, on the other hand, not immediately targeted with the clear objective to reduce the political cost of reform. On the revenue side, the government decided not to establish personal taxes, as it was extremely hard for the bureaucratic establishment to collect them. Taxes needed to be primarily levied on large enterprises, because it was easier to monitor their payments. In January 1992 VAT was then introduced at a unified rate of 28 percent with the aim to add revenues to those from the already existing profit and payroll taxes.

Radical reformers wished to attain currency convertibility by replacing all the complex surrender requirements regulations, licenses, and multiple exchange rates with a much simpler system of tariffs (Aslund 1995: 11). However, they decided to liberalise foreign exchange markets with a gradual strategy as they were anxious of not being capable of collecting export and import taxes. Moreover, it proved very difficult to win over all the existing vested interests, which were particularly strong in the import sector.

1.1.3 Accomplishment of Current Account Convertibility in Russia

At the beginning of 1992 the Russian government decided to push forward foreign exchange market reforms with the intention to achieve current account convertibility. As regards the export sector, from January 1992 the system of multiple currency coefficients was abolished, but the following surrender rules were established: 40 percent of currency earnings would now be sold to the Hard Currency Board of the CBR at the extremely unfavourable rate of 55 roubles per dollar. An additional 10 percent would be surrendered to the Central Bank's Stabilisation fund "at what was supposedly the commercial rate which was fixed at 100 roubles per dollar" (Aslund 1995: 148). All the remaining hard currency could be either deposited in Russian bank accounts or built up to buy imports or, as final alternative, sold in the free market exchange rate, in Moscow through currency auctions which regularly took place twice a week. The clear objective was to develop an official currency market while maintaining the revenue for the state from the exporting sector.

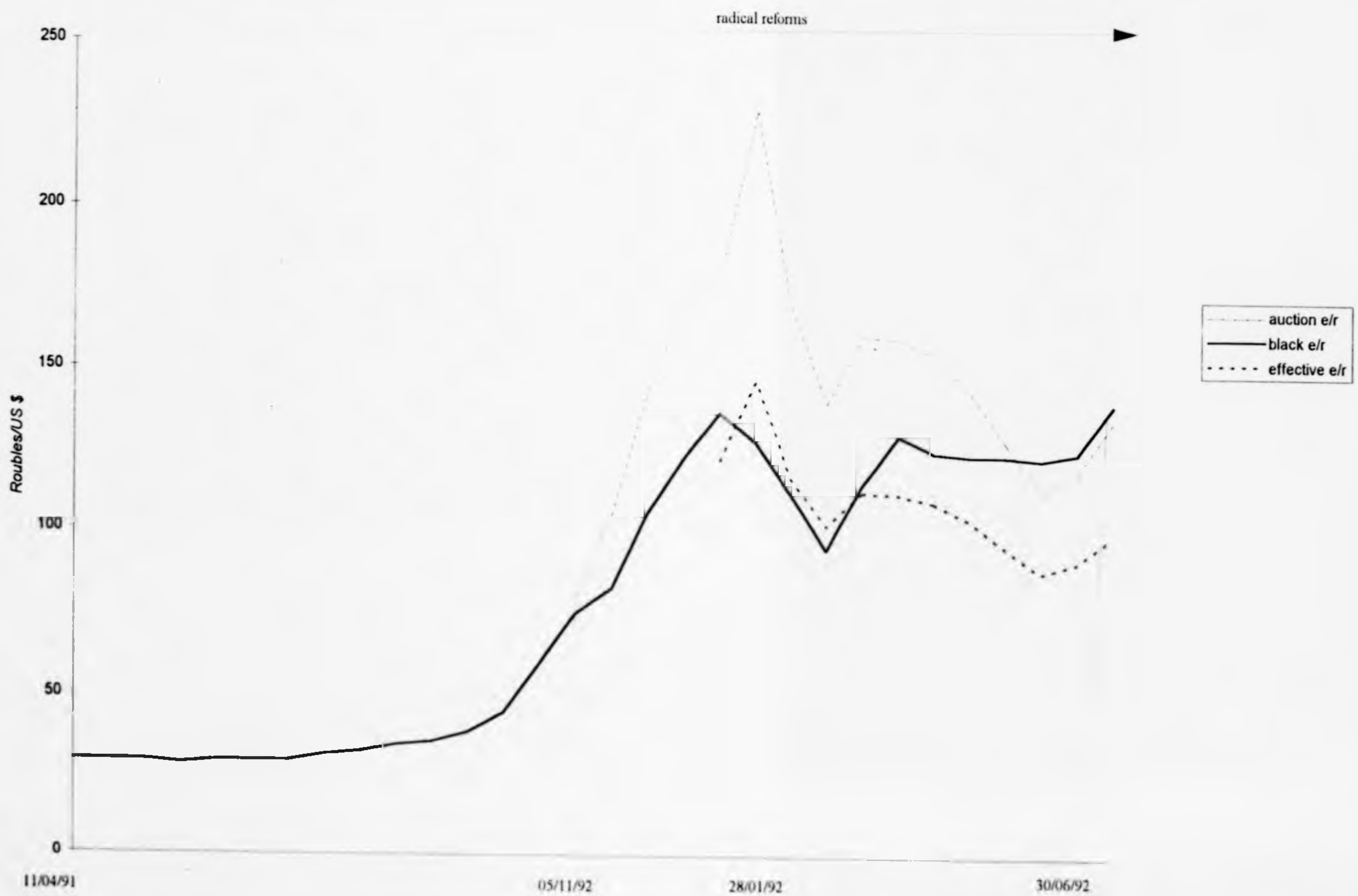
As regards the import side "so-called centralized imports persisted for vital goods, with a multitude of highly subsidized currency coefficients." (Aslund 1995: 148). Residents were entitled to acquire foreign exchange on these official markets as long as they possessed a regular import certificate (Russian Economic Trends, 1992 1.1: 32).

Although regulations had become more favourable, exporters were still reluctant to proceed through legal channels. As a matter of fact, during the first currency auctions the foreign exchange market remained, as a rule, very 'thin' - the whole weekly turnover on the main market in Moscow did not exceed $ 15 million. At first sight this seems odd, considering that during the first half of 1992 in these auction markets the dollar was sold at exceptionally high prices, well above the corresponding black market values (see Fig. 1.2). Note, for example, that the auction exchange rate peaked on the 28th of January 1992 at 230 roubles to the dollar while on the same day the black market exchange rate was valued at the much smaller rate of 128 roubles to the dollar'

However, if an effective exchange rate series is defined which accounts for the existing surrender rules[3], the spread between official and black market prices

[3] The effective exchange rate, V' was calculated as follows
$V' = 0.4 \cdot 55 + 0.10 \cdot 100 + 0.5 \cdot A$ where A is the auction rate

Fig. 1.2 Auction, Black and Effective Nominal Exchange Rates in Russia before the July 1992 Reforms



becomes much smaller (see Fig. 1.2), thus explaining why exporters were still reluctant to channel foreign exchange transactions through legal markets.

Another good explanation for the rouble weakness in these auction markets is that exporters were not compelled to sell a half of their earnings. In view of the highly inflationary climate, they generally preferred to deposit foreign exchange into Russian bank accounts. For this reason, it was the Central Bank of Russia which had in several circumstances to provide the necessary resources to ensure that auction markets would take place.

The above discussion also clarifies why throughout the first half of 1992 the auction foreign exchange figures, as published in Russian Economic Trends, overestimate the undervaluation of the rouble. To put it briefly, exporters were not offered a good deal such as official numbers seem to suggest. This discussion also help explain why changes in legislation regarding surrender and retention rules affect the reliability and quality of official data.

Looking at the spread between the black and effective exchange rate (see Fig. 1.2), the black market premium was negative in the first few months of 1992. This suggests that at the outset of reform the Russian authorities were prepared to pay an implicit subsidy to exporters, with the objective of bringing foreign exchange transactions back to legal markets.

But soon after there was a return to a more standard situation of a positive black market premium. Goldberg (1993) has for example estimated that, if all the existing surrender rules and the prevailing currency auctions exchange rates are accounted for, in April 1992 the effective exchange rate was roughly equal to 106 roubles to the dollar, which compares to 125 roubles to the dollar offered on the black market (see Table 1.2).

Table 1.2 Comparison of Effective Exchange Rates on Transactions Before and After the July 1992 Reforms (roubles per dollar)

	Pre-unification		Post-unification	
	Black market	Legal Market	Black market	Legal Market
Exporters	125	106	145	135
Importers (excludes centralized imports priced at special budgetary exchange rates)	130	150	140	135

(source Goldberg, 1993: 862)

Her estimates are in line with ours (see Fig. 1.2) and confirm that in April 1992 exporters would have been better off by diverting hard currencies away from official markets[4].

On the import side from February 1992 exchange rates which applied to centralized imports were reduced to 'only' 25 and prices which applied were extremely favourable, ranging from 1.7 roubles per dollar to 70 roubles per dollar. As a consequence all other importers were rationed: in April this was achieved, for

[4] Goldberg chooses the April data because between May and June there was "heavy CBR intervention in foreign exchange markets" (footnote 13: 862)

example, by setting the exchange rate at 150 roubles per dollar, which was an even more expensive price than the 130 roubles required in black markets (see Table 1.2). Goldberg's conclusion is that before July 1992 there was still an incentive to exchange currencies on the black market exchange rate for both exporters and importers.

From July 1992 onwards surrender rules were substantially relaxed. Thereafter 50 percent of all earnings could be retained, while the remaining part had to be sold to the CBR (30 percent) and to the Russian currency market (20 percent) (Aslund, 1995: 148)[5].

These final changes turned out to be sufficient to unify the exchange rate for all goods traded - with the exception of centralized imports - and to establish current account convertibility: Goldberg estimated that this was achieved at the approximate rate of 135 roubles to the dollar (see Table 1.2). Over time the Moscow Interbank Foreign Currency Exchange (MICEX) became gradually more important in terms of weekly turnover, until finally currency auctions became a daily feature.

The basic objective of the above discussion has been to describe how, in a relative short time, Russia moved to a system of current account convertibility, liberalised prices and favourable retention rules, the purpose being to bring most of the economy back to legal channels. As a final remark to this section, it is important to note that the Russian authorities decided to preserve tight administrative controls with regard to capital account transactions. Experience with capital flights advised against even more radical foreign exchange reforms.

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[5] From July 1993 50 % of earnings could be retained, while the remaining part had to be sold to commercial banks

1.2 The Origins of Exchange Rate Instability in Russia

1.21 Preliminary Remarks

As we saw in section 1.1, there is overwhelming evidence that in the early 90's the rouble has been undervalued. Such an undervaluation has persisted, possibly even strengthened, when the Russian authorities decided to relax the existing retention rules and move to a system of current account convertibility.

It is not easy to identify the key aspects of currency weakness and to relate the Russian and other episodes of exchange rate undervaluation to a standard theoretical background. The first possible reference at our disposal is the overshooting literature, which says that, given perfect capital mobility, loose monetary policies are matched by undervalued exchange rates. The classic insight of this literature is that expansionary monetary policies reduce the attractiveness of the local currency, to the point that agents are no longer willing to hold it unless it becomes sufficiently cheap to compensate for the low nominal interest rate. Before attempting to develop a more formal analysis accounting for the Russian financial crisis, we think appropriate to first review the sources of monetary creation in Russia.

1.22 Sources of Monetary Creation in Russia

By all accounts it is certainly the case that Russia could not immediately halt the enormous growth in the rate of money supply. As Skidelsky and Halligan (1996: 15) have correctly pointed out there was "one source of money creation but four taps". The 'four taps' were the following:

a) the government budget deficit;

b) enterprise subsidies;

c) credits to commercial banks;

d) FSU Republics 'Technical Credits'

a) The Government Budget Deficit

Our discussion starts with the first obvious source of rouble creation: the Russian government budget deficit. From the very beginning of his mandate Gaidar realised that it was urgent to reduce the large government budget deficit which had reached, in 1991, the amazing figure of 30 percent of GDP. It was crucial to bring this figure down to a sustainable level in order to establish credibility in the government's policies. Gaidar's attempt was initially successful: during the first quarter of 1992 he surprisingly managed to attain a budget surplus approximately equal to 0.9 percent of GDP. It must be said that this result needs to be partly qualified inasmuch as it depended on the deferral of expenditures and commitments which sooner or later would have to be met. Nonetheless, these policies, probably for the first time, signaled to financial markets the will, if not the strength, to cope with tough unpopular decisions (Aslund, 1995: 189).

Despite all the good will, Gaidar - even if he had wanted to - could not prevent the widening of the so-called 'internal deficit'. The latter was more significant than the government budget deficit, as it also took into account the large expenditures, which the Russian state was subject to, derived from the frequent leveling out of enterprise debts. These policies were not, in fact, under the direct control of the government as it was the CBR which granted enterprise credit.

b) Enterprise Subsidies

A second source of rouble creation derived from the frequent recurrence of policy makers to enterprise subsidies. According to many commentators, this tendency started to get worse when Viktor Gerashchenko was appointed as chair of the CBR on July 17 1992. Gerashchenko believed that it was absolutely essential to prevent loss-making enterprises from collapsing. Henceforth his policies were essentially devised to assist these enterprises overcoming their chronic financial difficulties, with the intent of keeping the economy alive. However, the actual result was that the 'internal deficit' widened in the second quarter of 1992 to 7.8 per cent of GDP and reached the peak of 14.6 percent in the third quarter (Skidelsky and Halligan, 1996: 15). In the view of Skidelsky and Halligan, far from solving the financial difficulties of these enterprises, Gerashchenko's policies were quickly leading Russia to experience hyperinflation - generally defined as inflation greater than 50 percent per month. Skidelsky and Halligan also emphasised how the consequent wiping out of savings could possibly bring Russia near to a major collapse in demand.

c) Credits to Commercial Banks

Another element of macroeconomic instability depended on the fact that the growth rate of money supply was much larger than the growth rate of the monetary base. It is true that the CBR in the attempt to control the money multiplier required commercial banks to deposit 20 % of their assets, as it is common practice in Western economies. These banks could in fact borrow credit from the CBR at the refinance rate which was introduced in Russia for the first time. Nonetheless, as the real interest rate was extremely negative credit demand was huge and needed to be rationed. For that reason - at least in the early stage of transition - the money multiplier was mainly a political choice, influenced more by the strength of financial lobbies on CBR administrators than by the logic of financial markets (Aslund, 1995: 188). In quantitative terms, the CBR loans to commercial banks grew from R 134 bn on January 1 1992 to R 380 bn on May 1.

d) FSU Republics 'Technical Credits'

Up to now we have described all the internal reasons why in the early 90's Russia went through a phase of large monetary expansion. In addition there were also considerable external factors which further explain the reasons for the loss of monetary control. Williamson (1992: 14) described how this process developed:

> Under the ancien regime it did not matter very much that the central bank automatically monetized the deficits of the republic governments as well as the union government, because the union government kept its own deficit down and made sure that the republic governments did too. But the practice of automatic monetary emission was carried over to a situation where the union government was letting its own finances deteriorate and the republic governments were gaining a large measure of autonomy in their fiscal policy. Since most of the costs of monetary emission by any one republic spill over to the others under a common monetary system, while the benefits of the deficit spending accrue exclusively to the republic that runs a deficit, the system gave each individual republic an incentive to run a deficit even though the collective consequence was inevitably either repressed or open inflation.

When the reform government was appointed it must have been immediately clear to radical reformers how urgent it was to stop the progressive surge in the growth rate of money. As a first step Russia decided to establish control over the emission of rouble cash: thereafter cash would partly be used by the Russian Federation and partly 'lent' to other republics at a low real interest rate. As Williamson points out (1992: 15) these republics were therefore implicitly denied the opportunity "to share seigniorage in rouble creation".

However, the FSU central banks could still give credit to their enterprises which in turn could be used for buying Russian goods (Goldberg, Ickes and Ryterman, 1994: 302-303). At the beginning of 1992 the Russian federation established a correspondent account system which permitted the monitoring of but not to halt, this source of monetary growth. The system functioned as follows (Russian Economic Trends, 1992 1 1: 14)

> "The Central Bank established a correspondent account for the Central Bank of each former republic of the USSR, starting with an initial balance of zero. All banking transactions between republics were to be conducted through these accounts, thus making it possible for Russia to monitor which republics were running up large deficits based on excessive creation of rouble credits in their own republics".

According to Skidelsky and Halligan (1996: 21), at the time of the 1992 Gaidar administration, the IMF did not urge the Russian federation to dismantle the rouble zone, possibly because "it feared that Russia would repudiate the debts of the Former Soviet Union". While it would have been surely difficult to regain monetary control straightway, all the further delay meant was that the 'fourth tap' continued to be a damaging source of macroeconomic instability

1.23 The Model

While the immense growth of money supply is certainly at the root of the Russian financial crisis, we believe that the story suggested by the overshooting literature is not entirely satisfactory in the present context. As a rule we do not think that it is appropriate to assume perfect capital mobility for countries under a process of economic transition because at the early stages of economic transition, the convertibility of the capital account is typically limited, the purpose being to impede the development of large capital flights.

Bruno (1993) and Flemming (1993) have recently suggested a simple alternative story to account for the existence of widespread and persistent undervaluation in Eastern Europe and Russia which focuses on the current account rather than on the capital account. Bruno emphasized that market reforms in Eastern Europe and Russia were combined with a large degree of current account convertibility, while controls to capital account transactions were generally maintained.

The desire to establish the convertibility of the domestic currency and create a credible foreign exchange market has strong economic reasons, as we have previously described. Unsurprisingly, this is the policy which is also commonly advised by economic analysts with the clear objective to create proper price signals in the economy. Current account convertibility in Russia coincided with the abandoning, on the first of July 1992, of the previous chaotic system of multiple exchange rates, with the unification of the different exchange rates into one single floating rate (see section 1.13).

However, as emphasized by Bruno, current account convertibility may be dangerous in an economy without inflation hedges, as in this case "demand for foreign exchange reflects primarily a stock demand" (Bruno,1993: 16). If savers are offered negative real interest rates, as indeed in Russia, foreign exchange becomes the only credible inflation hedge and its demand easily rockets as residents desperately try to avoid the cost of inflation. Therefore, if demand for hard currency was to be satisfied in some way, a large devaluation of the exchange rate was necessary to improve the competitiveness of exporters, and to attract tourists, thus initiating a sustained inflow of dollars through the current account.

Flemming (1993: 80-83) similarly indicated how the lack of an inflation hedge encourages exporters to hold their foreign exchange. In Russia the process was not discouraged by the system as the existing retention rules allowed the legal possession of foreign exchange. We discussed in section 1.13 how these rules conceded that exporters could hold onto a certain fraction of their hard currency earnings; furthermore, a certain number of enterprises were exempted from these surrender requirements. Flemming correctly pointed out that the existing legal inflow of dollars required a trade surplus and in turn an undervalued real exchange rate. The possession of foreign exchange as a store of value is called by Flemming "internal capital flight". This is a common alternative to a real capital flight whenever capital account restrictions are in place.

We have tried in this paper to formalise the idea of Bruno and Flemming in a simple theoretical context and to develop a model which captures and describes the huge changes in the real exchange rate. As mentioned above, for countries in transition the assumption of capital account convertibility and perfect capital mobility is unrealistic and hence we prefer to choose the alternative notion of currency substitution. Following the large literature initiated with the papers by Calvo and Rodriguez (1977) and Krugman (1979), we relax the assumption of perfect arbitrage between domestic and foreign assets. Conversely, we assume that consumers have a portfolio of domestic and foreign assets, and demand a given proportion between domestic assets and foreign assets which depend on the difference between their expected rate of return.

In order to keep the analysis simple, we rule out the existence of a bond market, as in the currency substitution literature, and assume the existence of only two assets: domestic and foreign currency. This may be reasonable for a country at an early phase of stabilisation, such as Russia, because the budget deficit is in great part financed by credit from the central bank, and not by bonds. It is only more recently that the Russian government has attempted to finance a fraction of its deficit through open market operations.

The classic currency substitution literature, however, is not always perfectly suitable to analyse countries in transition. In Krugman's model (1979), for instance, purchasing power parity is assumed, although this is not realistic in the context of the massive undervaluation experienced in Russia, Eastern Europe and Ukraine. The analysis of Calvo and Rodriguez (1977) does not suffer from this drawback, as the assumption of purchasing power parity is relaxed. In their model they postulate instantaneous price flexibility in the non-tradable sector, while, in this theoretical model, we prefer to maintain, as in the Dornbusch (1976) type of models, the assumption of a greater rigidity of the price level than the exchange rate

We try to combine together two different strands of literature, namely the original currency substitution literature and the notion of price rigidity of the Dornbusch model. We believe this allows us to analyse, although in a rather simplified framework, the impact of monetary policy on economies in transition.

The standard currency substitution assumption is that the ratio of money to the value of dollars depends negatively on the difference in the rate of returns of the two currencies (e.g. Calvo and Rodriguez, 1977: 620, Krugman, 1992: 314, Morris, 1995: 302). Given that in the present context we relax the assumption of purchasing power parity, the difference in the rate of return between the two types of currencies is not inflation but the rate of change in the exchange rate.

The exchange rate s is defined as the price of foreign currency, m is the quantity of money in the economy while x is the quantity of dollars. Therefore, we can formulate this convenient functional form,

1.1) $$m - s - x = -\lambda \frac{ds}{dt}$$

which describes to what extent, if agents anticipate a future devaluation of the exchange rate, their response is to reduce the proportion between money and dollars (valued in terms of domestic currency) in their portfolio[6].

[6] In this context it is implicitly assumed that desired money holdings are negatively related to the rate of change in the exchange rate and positively related to wealth $\frac{M}{P} = f\left(\frac{ds}{dt}\right)W$, where wealth is defined as the sum of real money balances and the real value of dollars, $W = \frac{M}{P} + \frac{SX}{P}$ (see, for example, Krugman, 1992: 314-316 and Morris, 1995: 302)

We also assume that prices, p, adjust sluggishly according to a typical Phillips curve dynamics,

1.2) $$\pi = \frac{dp}{dt} = \rho(s - p) + \eta$$

where a devaluation in the real exchange rate stimulates demand and initiates an inflationary process. Inflation also depends on expectations, proxied by the growth rate of money, η (core inflation).

The last necessary step to close the model is to specify a relationship for the supply of dollars. When the capital account is not convertible, the only source of foreign exchange is the revenue gained by exporters and the hard currency brought in by tourists. Hence, we assume, as in Krugman and in Calvo and Rodriguez models, that a positive rate of accumulation of foreign exchange in the domestic economy requires a trade balance surplus. "This follows from the assumption that foreign currency is the only internationally traded asset; if securities were included and allowed to be traded then the foreign exchange could be instantaneously acquired through sales of securities abroad" (Calvo and Rodriguez, 1977: 619).

In turn, the trade balance depends positively on the real exchange rate, and therefore,

1.3) $$\frac{dx}{dt} = \mu(s - p)$$

the rate of accumulation of dollars is a positive function of the real exchange rate

Equations 1.1), 1.2) and 1.3) complete the model whose structure is hence quite simple. In the steady state the inflation and devaluation rate match the growth rate of money and the amount of foreign exchange in the economy is fixed (i.e. the degree of dollarisation of the economy is constant):

$$\pi = \frac{ds}{dt} = \eta$$

$$\frac{dx}{dt} = 0$$

Furthermore, it can be seen from equations 1.2) and 1.3) that the real exchange rate, $s - p$ is the only variable affecting both inflation, π and the rate of accumulation of foreign exchange, $\frac{dx}{dt}$. Thus the determinant of the system is zero: this at first may seem a complicating feature of the model; on the contrary, it allows a reduction of the system from three differential equations to two equations hence simplifying the model without losing its basic insight.

To verify this let us consider that it is possible to formulate the rate of accumulation of dollars as in the following expression:

1.4) $$\frac{dx}{dt} = -\mu\rho^{-1}(\eta - \pi)$$

Henceforth, integrating equation 1.4) we determine that the amount of foreign exchange present in the domestic economy as a linear function of real balances:

1.5) $$x = -\mu\rho^{-1}(m - p) + A$$

where A is the constant of integration. Assuming for simplicity that the initial values of x, m, p are equal to zero:

$$x_0 = m_0 = p_0 = 0$$

it follows, as a consequence, that the constant of integration is also equal to zero:

$$A = 0$$

The next step of the analysis is to define the real exchange rate as:

1.6) $$c = s - p$$

which also implies that the rate of change of the real exchange rate is equal to:

1.7) $$\frac{dc}{dt} = \frac{ds}{dt} - \pi$$

It now becomes straightforward to reduce our model into a system of two differential equations:

1.8) $$\begin{bmatrix} \frac{dx}{dt} \\ \frac{dc}{dt} \end{bmatrix} = \begin{bmatrix} 0 & \mu \\ \lambda^{-1} + \lambda^{-1}\mu^{-1}\rho & \lambda^{-1} - \rho \end{bmatrix} \begin{bmatrix} x \\ c \end{bmatrix} + \begin{bmatrix} 0 \\ -\eta \end{bmatrix}$$

in terms of the two most relevant variables of the model, namely the stock of foreign exchange held by the private sector, x and the real exchange rate, c.

The steady state is characterised by the two following expressions:

1.9) $$x^* = \frac{\lambda}{1 + \rho\mu^{-1}}\eta$$

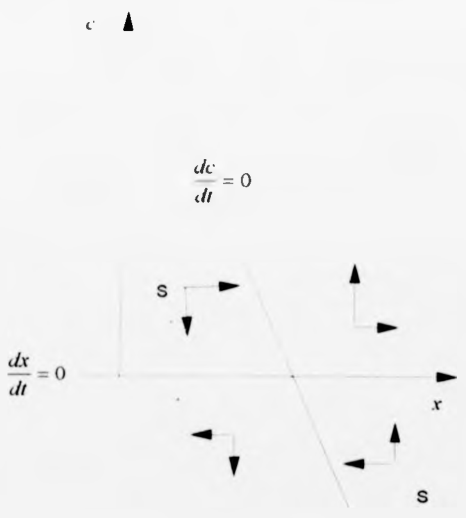
1.10) $$c^* = 0$$

The first of the two equations suggests that an increase in the rate of growth of money leads to a steady state increase in foreign exchange. While the second equation suggests that the real exchange rate eventually returns to its equilibrium value in the long run.

From the technical point of view the system is standard, as it is linear, the determinant is negative and the solution is unambiguously a saddle point. We can represent the dynamic system in two phase diagrams (see Fig. 1.3 and Fig. 1.4), which corresponds to the two alternative cases depending on whether the line of stability, $\frac{dc}{dt} = 0$ has positive or negative slope (Calvo and Rodriguez, 1977: 621-622).

Fig. 1.3 Dynamic Behaviour with $\lambda\rho > 1$

Fig. 1.4 Dynamic Behaviour with $\lambda\rho < 1$



In both cases the motion of x in the plane is obvious as long as we bear in mind that a net accumulation of foreign assets requires an economy with a positive real exchange rate, $c > 0$ (equation 1.3). On the same plane the direction of the arrows describe the dynamics of the real exchange rate, c.

Although the two pictures are different, they have the helpful common feature that for both the stable manifold SS is negatively sloped[7]. If we refer to ρ_s as the stable eigenvalue of the system and $\begin{pmatrix} 1 \\ \theta_s \end{pmatrix}$ as the stable eigenvector the solutions are then given by the following expressions:

1.11) $$x = \left(1 - e^{\rho_s t}\right)x^*$$

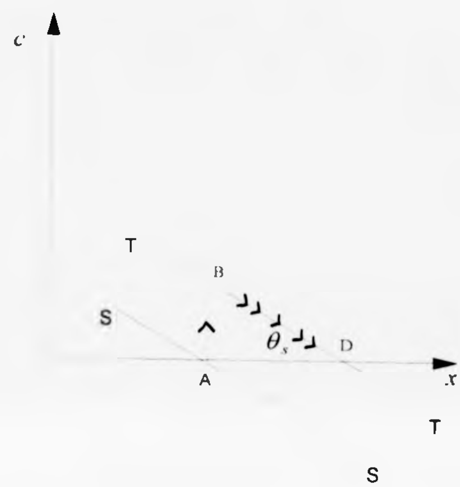
1.12) $$c = -e^{\rho_s t}\theta_s x^*$$

where the slope of the stable manifold is: $\theta_s = \frac{1}{\mu}\rho_s$

We can now examine what the effects are of a change in monetary policy and to verify whether our original insight was correct (see Figure 1.5). If there is a higher monetary expansion, one expects dollar holdings to increase, which requires the stable manifold to shift up to the right from SS to TT. But dollar holdings, x, is a sluggish variable, so the exchange rate, c, has to jump to guarantee the long run stability of the system.

[7] Hence in both cases the motion of the variables rule out the "undershooting" case

Fig. 1.5 Internal Capital Flight



Hence, the initial response of the real exchange rate to an unexpected monetary expansion is an instantaneous devaluation from point A to point B. The dynamics of the system also suggests that over time the economy will gradually slide from point B to reach point D, which is the new steady state.

From the above figure we see how this currency substitution story help shed light on the phenomenon described by Bruno and Flemming as internal capital flight. When the government decides to expand the growth rate of money, there will be an increase of inflation and of the rate of devaluation in the exchange rate in the steady state. As agents attempt to defend themselves from the forthcoming losses, their demand for foreign exchange increases, requiring a net accumulation of foreign assets. If this demand is to be satisfied, the real exchange rate must rapidly depreciate to attract tourists and favour exporters, and to remain weak for enough time to allow the process of dollarisation to continue until agents fully satisfy their portfolio demand for foreign exchange. Thus agents are able to to substitute for local currency into dollars not through capital account but via the current - which is what meant by saying that the capital flight is internal.

1.3 Adjustment of Real Exchange Rate, Liquidity and Dollar Holdings: the Russian Experience

It is the purpose of this section to examine whether the model is useful to illustrate the Russian economic experience In the light of the data problem attending the first few months and years of independence we resort largely to a graphical analysis.

At any rate econometric analysis would be difficult to use in a context such as this. In first place the stock of foreign exchange held by the private sector is not directly observable (Morris, 1995: 310). Also, during the period between the end of 1991 and July 1992, the Russian economy was subject to frequent changes in foreign exchange rules (see section 1.13)

Briefly summarising, the macroeconomic model presented in section 1.23 suggests that a higher rate of monetary growth brings about an immediate sizable deterioration of the real exchange rate. This allows for the increased demand for foreign currency to be progressively satisfied, via an improved trade balance

The real auction and black-market exchange rates for Moscow markets, based on Russian Economic Trends data, are presented in Fig. 1.6. The available sample period begins on April 1991[8].

For reasons discussed in section 1.13, we believe that auction data overestimates the weakness of the real exchange rate during the first half of 1992. Nevertheless, as it can be seen, the pattern for the two time series is similar.

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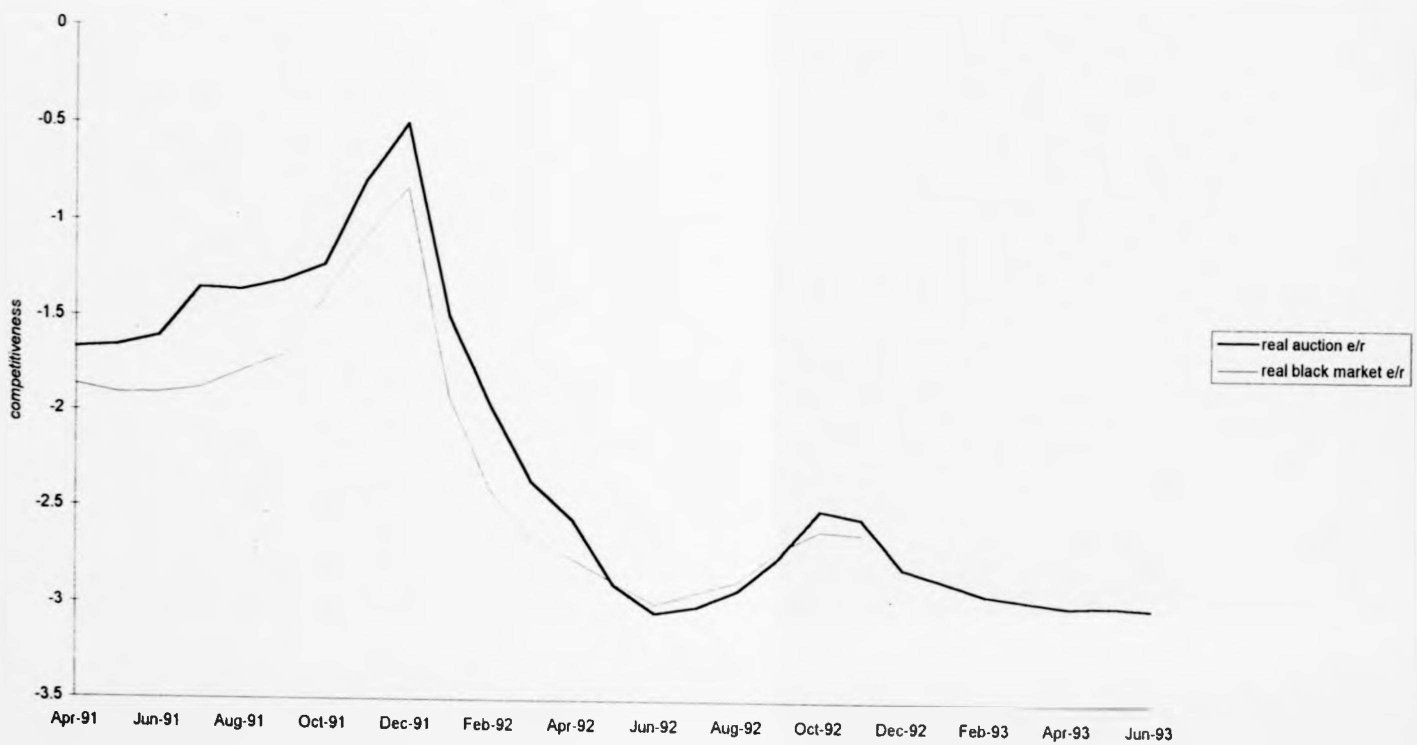
[8] A discussion on real auction and black-market exchange rates before April 1991 is found in Goldberg (1992 12-15) based on data from the Moscow publication *Commersant*

Fig. 1.6 Real Auction and Black Market Exchange Rates (logs)



Observe that the real value of the rouble sharply declined at the end of 1991. This lends support to the view that the loss of monetary control during the final months of the Soviet Union triggered the collapse of the Russian currency.

Thereafter in real terms the rouble steadily began to get stronger until it finally recovered more than it had initially lost. The real exchange rate appreciated particularly strongly, to start with, in January 1992. The reason for this can be accounted for by Gaidar's decision to liberalize prices in that same month, hence determining a one off jump in prices, with monthly inflation reaching up 245 % - well above the 50 % hyperinflation threshold (see Fig. 1.6). Since then the real exchange rate has undergone a more gradual process of appreciation, only temporary reversed each time financial markets perceived that policy-makers once more were losing control over monetary policy.

This sequence of events is broadly consistent with the model prediction that the real exchange rate should jump up just as soon as monetary policy is unexpectedly relaxed: under these circumstances economic agents revise up their inflationary expectations, switching further their portfolio investments towards hard currencies. Such a sudden new extra demand requires a supplementary depreciation of the exchange rate to allow the necessary inflow of foreign assets.

This is what presumably happened, for example, on July 17 1992 when Viktor Gerashchenko - already well known for his inclination to expansionary monetary policies - was appointed as chair of the CBR[9]. As Aslund (1995: 191) reports:

[9] In Goldman's words "In Russia, paradoxically, it was the prime minister who fought for monetary restraint, while the Central Bank director was determined to print up hoards of money so that he could fund the operations of the large state enterprises" (1996: 107).

"Soon thereafter it was decided to net out interenterprise arrears and cover the balance with state credits. In June, credit started flowing in all directions: to agriculture and industry; to other FSRs; and to the budget, because of increasing subsidies. The domestic budget deficit peaked during the third quarter at 14.6 percent of GDP on a cash basis. The money supply (M2) increased by no less than 28 percent per month during the five months from June to October 1992."

By carefully examining the time series presented in Fig. 1.6, we see how the real exchange rate again peaked up in October 1992. Thus, this empirical observation seems to be in line with the model prediction on exchange rate movements and, of course, more in general, with all the overshooting literature[10].

A different story, yet consistent with our model, took place on October 11th 1994 when the rouble suddenly collapsed by 28 %. The economic causes for such a harmful exchange rate plunge can be traced back to the previous summer when ministers had been incapable of holding out against the 'constant pleas' coming from both the influential agricultural and industrial lobbies (Financial Times, 1994a: 25). The following report (Russian Economic Trends, 1994 3.3: 32) is an apt description of subsequent events:

"The period from August to mid-October was one of sharp destabilization on the foreign exchange market. There were two underlying reasons for this development. Firstly, a loose monetary policy during the second quarter and secondly, a large, one-off centralized credit emission of R 13 bn around the end of July for agriculture supplies to the Northern territories and other state needs. This money started to exert pressure on the foreign exchange market in

[10] In a recent article Halpern and Wyploz (1995) convincingly argue how real exchange rates in a transition economy should revalue to match possible improvements in overall factor productivity. Their empirical results suggest that for most of the Eastern European countries the exchange rate was definitely weaker than the predicted equilibrium real exchange rate. This confirms the point emphasized by the overshooting literature that the exchange rate adjusts also for 'financial reasons' and not just because of changes in the real economy.

> August ; but the CBR managed to keep the situation under control with the help of massive dollar interventions. In September the pressure on the rouble continued and the CBR decided to let the exchange rate run faster than inflation and thus to allow the real exchange rate to find it new equilibrium level. This resulted in the jumps of the exchange rate on September 22 and 27-28. However, at the beginning of October the CBR lost control over the exchange rate and with reserves running low were unable to prevent 'Black Tuesday' on October 11, when the exchange rate fell by 28 %, jumping from R3000 to R4000 in one day."

The large devaluation of the rouble cannot be visually identified by looking at the monthly time series of the real exchange rate. The reason is that immediately after the rouble collapsed, Boris Yeltsin asked for the resignation of both Mr Sergei Dubinin, the Acting Finance minister and of, Viktor Gerashchenko, Chairman of the Central Bank. Such a quick response was seen, and understood by financial markets, as a signal that the President was truly determined to quickly reverse the summer expansionary macroeconomic policies. Without further delay, a number of economic measures were implemented with the clear intent to reduce the money multiplier. As a consequence - in line with the predictions suggested by our currency substitution model[11] - the next day the Russian rouble (Financial Times, 1994b: 18)

> "staged a startling recovery climbing 20 per cent against the dollar. Its rise prompted currency traders to break out into spontaneous applause on the floor of the Moscow Interbank Currency Exchange (MICEX)"

We have looked at the time paths for the real exchange rate. Now we focus on whether dollar holdings in Russia behaved as our story has suggested. Admittedly it is less easy to verify what was the stock of dollars in Russia during the early 90's. As we saw, according to our model dollar holdings rise in response to an increase in the

[11] In terms of Fig. 1.5, competitiveness first jumps up because of a higher monetary expansion from point A to point B only to jump back because of the sacking of the Central Bank governor

growth rate of monetary emission. It is, however, almost impossible to obtain reliable data about the actual dollarisation of the Russian economy as to a large extent private cash holdings depend on illegal flows. We have already emphasised, on the other hand, that it was legal to hold dollar deposits in Russian commercial banks (see section 1.13). These deposits could then be thought of as a proxy measuring the extent of dollar holdings in Russia (see Calvo and Vegh, 1992: 21). By plotting these data in the following Fig. 1.7 there seems to be some evidence that the stock of dollars in the Russian economy increased during the early years of radical reforms[12].

Unfortunately this proxy is critically influenced by changes in legislation rule regarding hard currency possession. Despite the 'statistical' unreliability of these data let us nevertheless cross plot competitiveness against dollar deposits in Russian commercial banks. As it can be seen from Fig. 1.8, there is some indication for the existence of a negative relationship between competitiveness and the stock of dollars in Russia. Observe, in fact, that the depicted path closely corresponds to the negatively sloped stable manifold SS previously derived from our model[13 14].

As a final cross check, let us complete our graphic analysis by examining whether the stock of dollars in Russia and real balances were really negatively correlated.

---

[12] Compare the trendline to equation 1.11

[13] The slope of this regression, equal to -0.45, is significant at the 1% level. As we have only 22 monthly observations, and given the quality of the data, it is not possible to carry out a correct cointegration analysis to verify whether this regression is spurious. Black market data cannot be employed because the sample period is too short

[14] Reality, of course, is much more complex than what is assumed in this simplified framework by all means one cannot simply say that the growth rate of money was increased from one constant rate to another higher rate. However, it would be possible to obtain the same picture with an anticipated time-dependent increase in the growth rate of money

Fig. 1.7 Dollar Deposits in Russian Commercial Banks

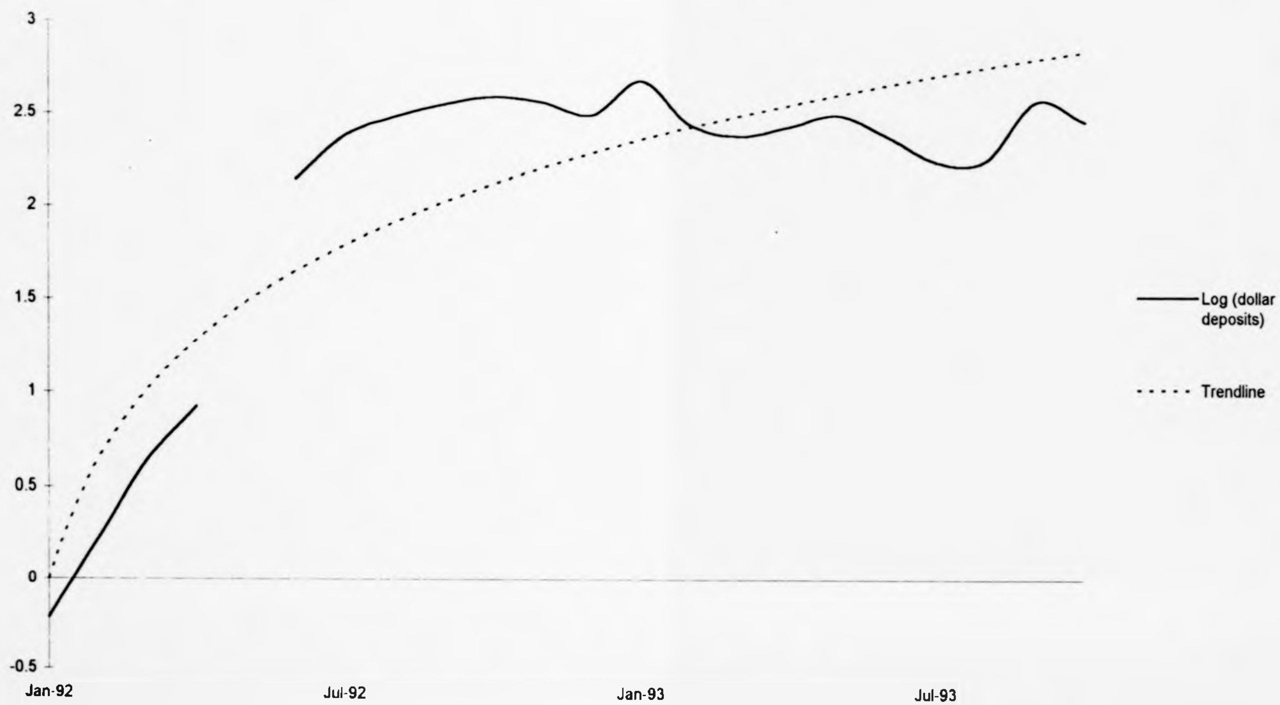
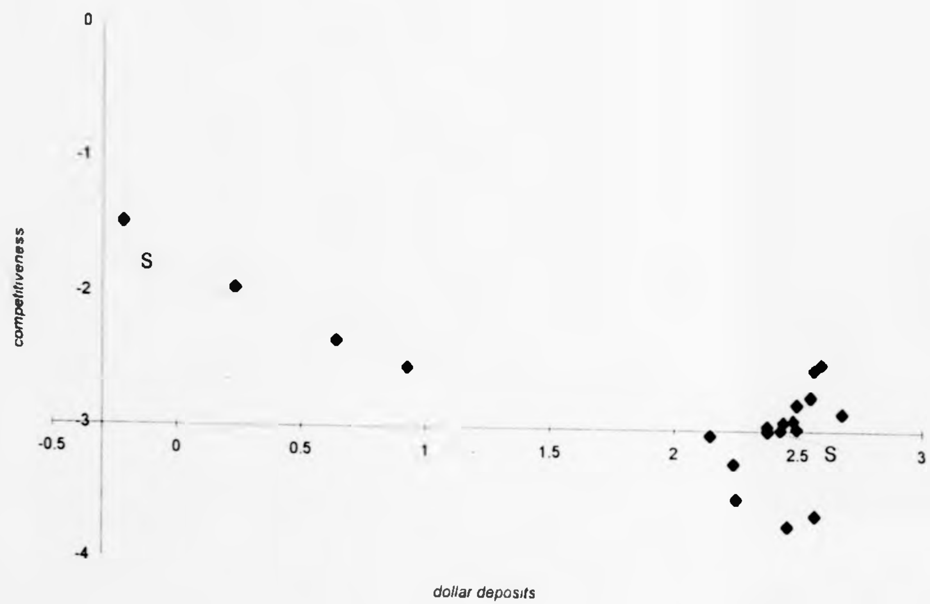


Fig. 1.8 OLS Regression between Competitiveness and Dollar Deposits (logs, January 92-October 93)



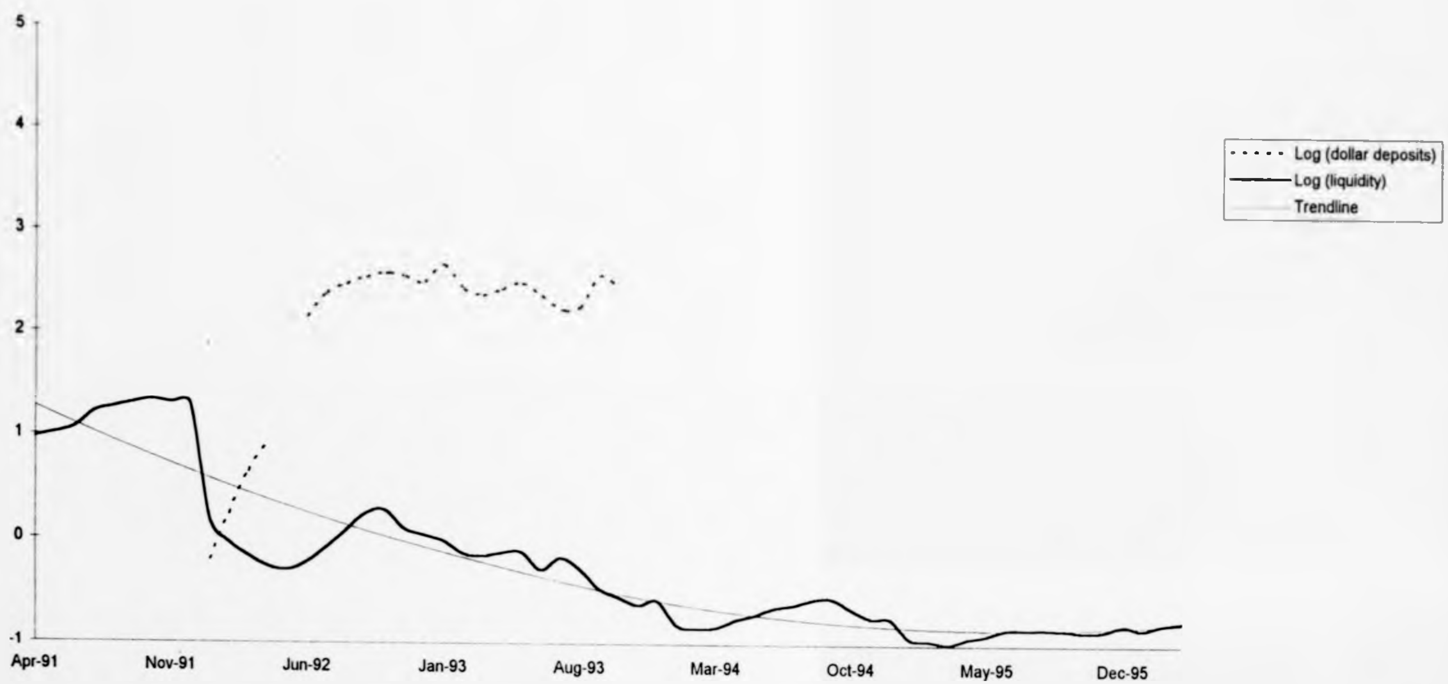
There is some - although not conclusive - indication that indeed economic agents associated dollar holdings increases to reductions in real balances (see Fig. 1.9). To further examine whether the model correctly explains the reasons for the Russian exchange rate undervaluation, it is appropriate to verify whether the Russian economy was actually characterised by a trade surplus. One point should be immediately clear: once again the available data are not fully reliable for several reasons. Firstly, because up to 1991 statistics were largely gathered and expressed relative to the Soviet Union economy; while conversely from 1992 onwards the control of statistical data became the responsibility of each republic. Consider how the simple change in national frontiers re-classified several transactions within the USSR as trade. Secondly, from 1992 all trade dealings were accounted in terms of dollars and no longer in terms of transferable roubles. Finally, and most importantly, official data did not take into account that exporters still had a strong incentive to divert hard currency revenues away from official exchange rate markets (Russian Economic Trends, 1994 3.1 'Special Report on Trade': 81). Nonetheless by examining these data, it appears that in the early 90's Russia was experiencing a visible trade surplus (Table 1.3).

Table 1.3 Russian Trade Balance in $bn

	1991	1992	1993	1994
export	53.2	41.6	46.3	49.4
import	45.1	37.2	34.3	39.6
trade balance	8.1	4.4	11.9	9.8

(Source Russian Economic Trends 1996 5.1)

Fig. 1.9 The Behaviour of Liquidity and Dollar Deposits



Back in 1990 the Russian economy had still a trade deficit. However, as a consequence of the collapse of the CMEA trade system, the Russian economy underwent a progressive fall in both exports and imports. Consider, to start with, that export revenues kept on falling in spite of extremely favourable terms of trade in the oil sector. According to Aslund (1995: 145) between 1990 and 1991, for example, exports fell roughly by 28 %. But imports fell even more rapidly as they plunged on that same year by 46 %! This could be partly explained by the recession but partly it was also the direct consequence of the USSR default on debt payments and of the sudden halt in foreign credit.

Thus, the above documented trade surplus seems to give some support to our model. Of course the real story is much more complex. To begin with Russia was experiencing a substantial deficit on services and therefore current account data were much less favourable than trade data. In addition, there is some evidence that in the early 90's Russia has been a net exporter of flight capital (Russian Economic Trends, 1996 5.1). To some extent, thus, Russia was experiencing an actual capital flight as well as the internal capital flight discussed by. Moreover the model does not take into account that Russia could partly rely on debt deferral which effectively lessened the need for an immediate trade surplus. All this granted, we nevertheless think that this model - especially when unofficial smuggling is accounted for - correctly captures the notion that the rouble had to be substantially undervalued to allow the necessary building up of hard currency stocks[15].

[15] Consider how the Russian Balance of Payments was equal to the following accounting identity:
Current Account Surplus = Capital Outflow+ Increase in Official Reserves - Debt Deferral + Internal Capital Flight
In our model implicitly we had accepted the simplifying assumptions that
Capital outflow - Debt Deferral + Increase in Reserves = 0 and, additionaly, that there was no deficit on services. Hence the result is
Trade Surplus = Internal Capital Flight

1.4 Export Taxes

In the previous paragraphs we described how the Russian economy experienced a great undervaluation of the exchange rate. The main thrust of our analysis was that the weakness of the rouble allowed the necessary accumulation of foreign currency in the presence of expansionary monetary policies. Emphasis has also been placed on how the exchange rate weakness was larger at the initial stage of economic adjustment. Henceforth the domestic economy was for some time exposed to foreign speculators and to corrupt bureaucrats "as there was an enormous incentive to gain access to products like oil and export them" (Goldman 1996:114; see also Aslund 1995: 150, The Economist (1994) and The Sunday Times "The Great Rouble Scam" (1994)).

Given such an economic background, at the start of reform the Russian political system was under considerable pressure to reinforce administrative controls on exports or, alternatively, to introduce export taxes. The reason was the widespread anxiety that the whole domestic economy would be re-oriented to foreign export markets at the expenses of the internal domestic market. Among all possible options the government was aware that export taxes were - if properly implemented - an excellent source of revenue for financing the budget deficit and for reducing monetary emission. It was then one of the main objectives of Russian radical reformers to progressively substitute the complex system of quotas and licenses with exports taxes.

As discussed earlier, Russian foreign exchange markets were liberalised with a gradual strategy: at the beginning of 1992 the government decided to abolish the existing chaotic system of multiple currency coefficients and to introduce implicit export taxes by imposing a renewed structure of surrender rules. Soon thereafter the authorities sought to impose explicit taxes as well (Aslund, 1995: 150):

> "A novelty for 1992 was that exporters had to pay export taxes (fixed in ECU). The export tariffs were supposed to tax most of the difference between the domestic price and the world price but these tariffs met with vehement opposition. Exporters sought exemptions and evaded export taxes on a broad scale. The number of exporters were too large to be monitored."

In the intentions of the legislator export taxes would thus maintain a wedge between domestic and foreign prices, especially in strategic sectors such as raw materials. Unfortunately the system proved on several occasions to be exposed to frauds and distortions, sometimes directly caused by legislative and bureaucratic confusion[16].

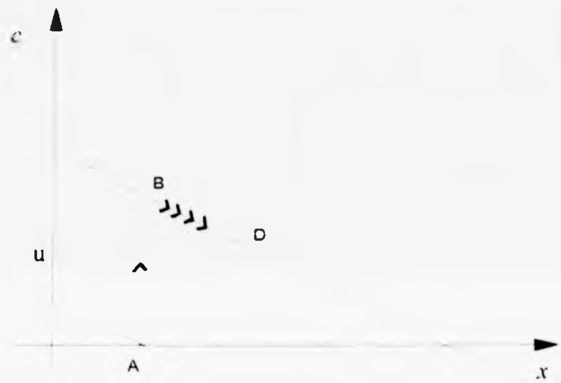
It is not easy to assess what was the size and the trend of this wedge. For example in July 1992 the export tax on raw materials was increased from 20 to 40 percent; but at the same time the surrender requirement rules were substantially reduced, hence the overall effective tax rate remained practically unchanged (Russian Economic Trends 1992 1.2). Consider also how in theory state enterprises of raw materials were not subject to export taxes but in practice all revenues ultimately ended up to the treasury (Aslund 1995: 150).

Empirical issues apart, in the early 90's the Russian economy was increasingly becoming characterised by (implicit or explicit) taxes on exports - to defend the availability of domestic goods and for state revenue purposes. Referring back to the model described earlier, let us now assume that the trade balance is not only a

[16] For example, Goldman (1996 243) says that "in mid-1993 the theoretical tax rate of the combined total of the different taxes levied on exporters exceeded 120 percent of profits"

positive function of the real exchange rate, c but it is also a negative function of export taxes, u.[17] A sketch solution is illustrated by the following Fig. 1.10:

Fig. 1.10 The Joint Effect of a Higher Rate of Monetary Expansion and an Export Tax on Competitiveness and Liquidity



Once again, suppose that political authorities decide on a higher monetary emission and on an increase in export taxation. This broadly captures the 1992 Russian experience. As before, the impact effect is a massive devaluation of the real

[17] If taxes are suitably defined, in algebraic form the model is:

$$\frac{dx}{dt} = \mu(s - p - u)$$

$$m - s - x = -\lambda \frac{ds}{dt}$$

$$\pi = \rho(s - p - u) + \eta$$

where the steady state is hence equal to $c = u$, $x = \dfrac{\lambda\eta - u}{1 + \rho\mu^{-1}}$

exchange rate with the economy jumping from point A to point B. Subsequently, the economy gradually tends to the new steady state, D, by sliding along the stable manifold: during that time period there is a net accumulation of foreign exchange while, contemporaneously, the real exchange rate undergoes a process of appreciation.

The interesting point of all this is that, under these circumstances, the real exchange rate does not converge to zero, since in the steady state a permanent wedge persists. This suggests that as long as the government maintains export taxes (or similarly import taxes) the nominal exchange rate does not return to its PPP value.

In light of the Russian experience, these considerations help explain the empirical observation that in recent years the rouble appreciated but remained quite far from its PPP value. According to official statistics (Russian Economic Trends 1995 5.1: 35), in fact, the rouble averaged approximately 2.88 in 1994 and 2.13 in 1995 times the estimated PPP value.

One has to add that the rouble strengthening somehow reduced the scope for taxing exports, as exporters started losing competitiveness in foreign exchange markets. Reductions in taxes, nevertheless, were not easy to accomplish given that the Russian government still needed to keep up revenues. The debate over export taxes was hence becoming one of the most important fields of economic discussion. The following report shows how the dismantling of export taxes was undoubtedly a slow and difficult process (Russian Economic Trends, 1995 4.2: 71):

> From October 1 export taxes were reduced on a number of exported commodities, the impetus behind this change was the appreciation of the

rouble which has hurt exporters of these commodities. The tax reduction cover a wide range of goods, but do not include key export commodities such as crude oil, natural gas, copper nickel. There are two reasons for this: firstly prices on international markets are now favourable for these commodities than they were 18 months ago, offsetting the impact o the rouble appreciation. Secondly, for fiscal reasons the government wanted to avoid decreasing export taxes on these goods. The export tax on oil is currently being debated, and the export tax written into the 1996 budget is 14 ECU per tonne (it was 20 ECU per tonne). Besides this the government plans to eliminate all export taxes on ferrous metals and chemical products by the end of the year, and to abolish export taxes for petroleum products (except for the heating oil) from December 1 1995. No changes are expected for export taxes on basic non-ferros metals

The process of reduction in export taxation has continued in recent times: not just because of the lobbying pressure coming from exporters but also because of the conditional deals agreed with the IMF. The IMF, in fact, urged Russia to progressively dismantle export taxes in order to expose its economy to the right price signals and to free it from all frauds and distortions[18]. According to our model the partial removal of export taxes should have determined a greater process of convergence of the rouble to its PPP values. The last data at our disposal suggests that in January 1996 the rouble was worth only 1.6 times the estimated PPP parity. This seems to be broadly consistent with the predictions of the model.

[18] For sake of simplicity we assumed an internal foreign exchange market characterised by a freely floating exchange rate without foreign exchange leakages. However, there are circumstances when foreign exchange leakages between two separate markets, the official and the informal, may turn out to be substantial. See Goldberg (1995: 167-187) and chapter 4 of this thesis for a formal account of a two-tier exchange rate model.

1.5 Hyperinflation and Seigniorage

The analysis presented so far is able to predict what are the consequences of an exogenous increase in the growth rate of money on the real exchange rate and on the stock of foreign exchange held by the private sector in a transition economy characterised by currency substitution. However, the real question to be addressed is whether monetary authorities of financially weak countries should choose a high growth rate of money supply or not.

It is a well known fact that in the Western world a very small fraction of public debt is money financed while, conversely, in several macroeconomically unstable economies seigniorage remains the only source of financement.

The government is in fact able to "extract resources by reducing the value of the outstanding stock of base money, so that the private sector has to save more in order to maintain its wealth" (Russian Economic Trends, 1993 2.1: 19). It has long since been recognised that the need to finance a large debt with seigniorage, rather than with the emission of bonds, is the main reason for the development of an hyperinflationary process.

The traditional literature on seigniorage, which initiated with the influential work of Cagan (1956) in the fifties, attempted to explain the reason why hyperinflation episodes might take place. According to this literature, hyperinflationary monetary policies should not be thought over as irrational for the reason that they are deliberately chosen by political authorities with the intent to increase seigniorage.

Henceforth the analysis seems to suggest that hyperinflation should be thought of as an unpleasant but necessary consequence to the desire of financing the budget with seigniorage.

In this paragraph we review the main argument of this literature by postulating a conventional money demand function which is assumed to depend negatively on the nominal interest rate:

1.13) $$m - p = -\lambda i$$

Suppose also that the real interest rate,

1.14) $$i^r = i - \pi^e$$

is constant and equal to zero

Seigniorage is then defined as the growth rate of money, η, multiplied by the real stock of money base:

1.15) $$Z = \eta \frac{M}{P}$$

and it is hence a function of both the growth rate of money and of expected inflation, π^e:

1.16) $$Z = \eta e^{-\lambda \pi^e}$$

In a stable economy where expected inflation, inflation and the growth rate of money are all equal:

1.17) $$\pi^e = \pi = \eta$$

seigniorage can then be formulated, for example, as a simple function of the growth rate of money:

1.18) $$S = \eta e^{-\lambda \eta}$$

which graphically has the Laffer curve shape: (Fig. 1.11)

Fig. 1.11 The Laffer Curve

Under the hypothesis of economic stability it is clear that the optimal growth rate of money which maximises seigniorage is equal to the inverse of the semi-elasticity of money demand:

1.19) $$\eta = \frac{1}{\lambda}$$

Clearly the increase in seigniorage is constrained insofar as the rise in the growth rate of money leads to a reduction in real money demand.

As a matter of fact there exists a large amount of literature on empirical estimation of the maximum seigniorage growth rate of money. For example, Budina et al. (1995) estimated the Cagan model to arrive at the conclusion that the optimal growth rate for the Czech Republic is about 20%.

In spite of all these considerations, Cagan has suggested that provided the government is ready to accept an unstable macroeconomic system, it can obtain a much greater segniorage than the maximum of the Laffer curve. The central notion of his analysis is that the government may take advantage of economic agents slow response to policy changes. Seigniorage may, in fact, reach any desired amount by sufficiently increasing the growth rate of money: the reason is that economic agents need time to reduce their money demand. For example, we previously showed how Russian real balances remained high for a long time, following a slow downward path. There are two reasons why velocity of money did not increase more rapidly: firstly, because people required some time to economise on cash holdings; secondly, state enterprises generally relied more on additional credits from the Central Bank rather than on trying to speed up payments procedures to shirk their working capital. The uncertain legal system also meant it was hard to collect payments, because there were no penalties for any delay (Aslund 1995: 5).

At some stage, however, Russian citizens managed to substantially reduce money demand[19]: at that point if the government decides to sustain the increase in seigniorage it has to keep on choosing a higher rate of monetary expansion. A vicious circle gets started in which the government keeps on increasing the growth rate of money, whilst at the same time money demand - which can be thought as the tax base of seigniorage - progressively shrinks. Cagan's analysis suggests that this is the plausible mechanism of how hyperinflation gets started[20].

Returning now to our currency substitution model, let us now calculate seigniorage, once more defined as:

$$Z = \eta\left(\frac{M}{P}\right)$$

Taking the logarithm of the previous expression we obtain the following:

1.20) $$z = \log \eta + m - p$$

which allows us to calculate seigniorage as a function of the rate of growth of money supply alone:

1.21) $$z = \log \eta - \rho\mu^{-1}\left(1 - e^{\rho t}\right)x^{*}$$

---

[19] In Russia enterprises started asking for prepayments

[20] The validity of Cagan's insight has been questioned by the more recent literature on seigniorage Buiter (1987 111-118) and Bruno e Fisher (1990 353-374), maintaining the formal framework of Cagan, with the difference of postulating "rational" rather than adaptive expectations, were able to show that the original results of Cagan are not robust Under rational expectations, in fact, the model suggests that a high level of seigniorage does not require hyperinflationary but rather hyperdeflationary monetary policies

If the only objective of the government were to maximise seigniorage in the steady state, the government would then choose the following growth rate of money:

1.22) $$\eta = \frac{1}{\lambda}\left(\frac{\rho + \mu}{\rho}\right)$$

The analysis of the model above hence suggests that for an economy without capital account convertibility, the rate of growth of money which maximises steady state seigniorage is higher than in the standard case[21]. However, for the special case of $\mu = 0$ the traditional solution is found again:

$$\eta = \frac{1}{\lambda}$$

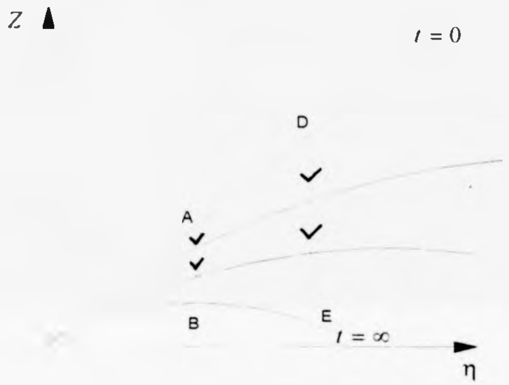
Here too, just as in Cagan's model, let us consider what are the consequences if the government unexpectedly chooses to increase the growth rate of money more than the optimal steady state level. From Fig. 1.12 it becomes intuitive how in the short run seigniorage, Z would be higher as the economy is at point D instead of being at point A. This has a long run cost in terms of seigniorage, as over time the economy slides to point E rather than to point B. But if the government has a large positive discount rate, it is not too concerned about it.

The ultimate consequence - sooner or later - is that seigniorage falls because of the progressive reduction of real balances. Hence, Cagan's analysis suggests that to

[21] In this currency substitution context the consequence to a net inflow of foreign assets is the larger demand for cash

sustain the level of seigniorage the government has to keep on choosing a higher rate of monetary expansion and to allow an hyperinflationary process to take place.

Fig. 1.12 Short-Run Incentive to a Higher Rate of Monetary Growth



Let us now describe what happens with our currency substitution model if the government unexpectedly keeps on increasing the growth rate of money to sustain seigniorage. As it can be seen from Fig. 1.13 each time the growth rate of money is increased the stable manifold moves upwards. The exchange rate remains undervalued - by jumping up to points as B and E. The undervaluation of the exchange rate allows economic agents to find relief from the hyperinflationary process with a continuous accumulation of foreign assets. The economy thus becomes progressively dollarised to the point when it is virtually impossible to extract seigniorage (Fisher, 1982: 295)

Fig. 1.13 The Consequences of High Seigniorage on Internal Capital Flight

There is one important final observation to make: all the above considerations, inspired by Cagan's analysis, implicitly assume that economic agents are not able to foresee the government's intention to repeatedly increase the rate of monetary expansion. In other words economic agents are assumed to be naive. The first question which needs to be asked in the next chapters then is: what would have happen if economic agents were instead rational? and a second one, closely related to the Russian experience, is: was it really the best possible option to appoint a Central Banker, as Gerashchenko, whose priority was not to fight against inflation but rather to subsidize loss making enterprises?

1.6 Final Remarks

In this chapter, there is a description of how, in a relatively short time, Russia moved to a system of current account convertibility, liberalised prices and favourable retention rules, the purpose being to bring most of the economy back to legal channels. Certainly, this was not an easy set of policies to carry out, considering the sudden breakdown of monetary control in the rouble zone and the extent to which official prices had been repressed.

The essence of the discussion proposed in this essay is that when faced with severe tight controls on capital, agents are able to substitute for local currency into foreign valuta via the current account - which is what is meant by saying that capital flight is internal. This helps shed some light on why in the early 90's the Russian foreign exchange markets have experienced a time of great turbulence

The currency substitution approach here developed yields two interesting insights, which are both broadly consistent with the Russian experience: the first is the weakness of the exchange rate, which basically reflects a large huge stock demand for foreign exchange; the second is the improvement in the external position of the country, which triggers the necessary accumulation of foreign exchange.

The model combines price stickiness and currency substitution, and can be reduced to a linear system of two differential equations. Most important of all, from a formal perspective, is that the dynamics of the model are simple, allowing one to extend this research while maintaining the same theoretical framework[22]. In the following chapters of the present thesis, joint examination of several macroeconomic themes, such as price stickiness, currency substitution and time consistency, provides additional insights for the Russian experience of undervaluation.

In this essay we have also investigated the role of export taxation. The Russian authorities were aware that export taxes were an excellent source of revenue for financing the budget deficit, and considering the great weakness of the real exchange rate, the imposition of these taxes appeared to be particularly attractive.

Using our basic model, we have arrived at the intuitive conclusion that, as long as the government maintains export taxes, the nominal exchange rate does not converge to its PPP value. Over time, however, the currency strengthening reduces the scope for taxing exports, as the export sector starts losing competitiveness in foreign exchange markets.

Finally we have reviewed Cagan's explanation of why financially weak countries may decide on a high rate of monetary expansion. The key notion of this research is that the government may take advantage of economic agents slow response to policy changes. When a country prints money to finance a large deficit, the government has to repeatedly increase the growth rate of money, and allow a hyperinflationary process to take place. In a situation such as the one described here, a further consequence of this is the progressive economy dollarisation. It should be said, however, that this analysis implicitly supposes a naive response of agents to changes

[22] In the following chapters we show how a natural extention of the Dornbusch model, the Buiter Miller model, has a dynamic structure which is very similar to the currency subtitution model just presented. This feature proves to be helpful, because it shows how the absence of perfect capital mobility changes the economic insight but not the dynamic properties of the overshooting literature.

in policy instruments. To provide additional insights to the research presented so far, we intend therefore to include, in the course of this thesis, the time inconsistency constraint to this analytical framework.

Chapter 2

Time Consistency in an Open Economy, a-la-Dornbusch

2.1 Introduction

That expectations of the future monetary policies play a key role in determining the evolution of macroeconomic variables has long since been recognised by economic theorists. This is especially true for macroeconomically unstable countries that rely largely on money financing, because in such circumstances there is an excellent motive for choosing a high rate of monetary expansion.

The aim of the present essay is to assess the behaviour of the real exchange rate, inflation and liquidity in an open economy setting characterised by financial markets with rational expectations. With rational expectation, loose monetary policies in the future have important current consequences. As will become clear later on, the key conclusions of this study broadly apply to Russia's recent experience of macroeconomic instability. However, as our exercise is primarily theoretical, it can similarly provide interesting insights on several other financially distressed countries.

Our discussion starts by referring the reader to section 1.5 of *Exchange Rate Undervaluation in the Absence of Perfect Capital Mobility: the Russian Case*, where we had briefly reviewed the standard hyperinflation analysis. Our understanding of Cagan's model is that hyperinflationary monetary policies are interpreted by such theory as a deliberate choice of a government whose objective is to take advantage of money demand slow response in order to increase seigniorage. Implicitly, henceforth, this approach either assumes that expectations are adaptive or, alternatively, that money demand adjusts according to a process of partial adjustment.

As a rule, however, agents who operate in an unstable economic environment are all too conscious of the possible costs of holding real balances. They are certainly aware that the government may choose an inflationary monetary policy to finance the deficit with seigniorage.

This essay proceeds as follows. In the next section 2.2 we will focus on an alternative interpretation of hyperinflation, suggested by Barro (1983), which is consistent with the hypothesis of rational expectations. The main economic insight of this literature is that an important aspect of macroeconomically unstable economies is given by the lack of credibility of policy makers. Under this setting economic agents foresee whether policy makers are prepared to accept high inflation in order to earn a large seigniorage. Despite the commitment of a future tight monetary policy, economic agents take into account of the great difficulties for financing the budget and hence correctly foresee the real future monetary policies: consequently their response is to reduce money demand, as soon as possible.

We present a simplified version of Barro's model which is capable of capturing the above described economic insight. We will see that this is yet another application of the time inconsistency analytical framework. As in the standard time inconsistency literature, the gist of the matter is that credibility can be enhanced by delegating control of monetary policy to a conservative central banker. Greater credibility allows, in fact, a reduced need to economise on real balances.

However, Barro's model is particularly simple because it assumes a closed economy and a constant real interest rate. To be able to apply such analysis to the Russian economic experience, it is therefore necessary to investigate these issues in an open economy setting.

With this objective in mind, in section 2.3 we formally review the classical Dornbusch literature. This highly influential work has emphasised the significance of a different speed of adjustment between the financial and the goods market. The exchange rate is indeed assumed to be a forward looking variable, which adjusts immediately by anticipating the future monetary policies that the government will adopt. Conversely real balances are assumed to be a sluggish variable. We believe that this correctly captures the Russian economic experience for the following two reasons:

1) on one hand, it seems rather likely that financial markets were able to anticipate the early 90's expansionary monetary policies. It was not, by all means, hard to foresee that the 'four taps' - which we discussed about in section 1.22 - would continue to determine large increases in money supply;

2) on the other hand, we also clarified, that for both people and enterprises, some time was necessary to economise on real balances (Horder, 1997: 37). Some commentators have also pointed out how, considering the Russian inflationary climate, the adjustment of real balances turned out to be extraordinary slow.

Purpose of section 2.4 and of the remainder of this essay is to combine the ideas presented in section 2.2 and section 2.3 in a unique theoretical framework. In general, the time inconsistency problem has been analysed, either in the context of a closed economy, or of a Mundell-Fleming open economy. We propose applying a methodology which allows us to study the time inconsistency analysis in the context of an open economy a-la-Dornbusch, characterised by a forward looking variable, as the exchange rate, and a sluggish variable as real balances. We believe that this more complex and interesting dynamic framework allows us to enhance our economic understanding of macroeconomically unstable economies.

The insight of our modelling exercise proves to be valuable, and can be broadly compared to the Russia's recent experience in the early 90's. The analysis suggests that the optimal time inconsistent solution adopted by a government in great financial difficulties is to implement an expansionary monetary policy whilst promising a future rigorous monetary policy.

This was probably the case for Russia in the early 90's, as is documented in Russian Economic Trends. Due to the great difficulties in financing the budget deficit, the growth rate of the money supply remained out of control; but, nonetheless, the government kept on promising that public expenditure and the growth rate of money would soon be reduced. For example, in 1993 the newly appointed minister of finance and deputy prime minister, Boris Fedorov, managed to persuade Viktor Gerashchenko to set credit targets, which pledged a progressive decline in the growth rate of the money supply. While to some extent this policy was successful, unsurprisingly, these credit targets proved to be over-optimistic (see Skidelsky, 1996: 4, Aslund, 1995: 7, Russian Economic Trends, 1993 2.3).

If the promise of tight future monetary policies is credible, three objectives are contemporaneously achieved: firstly seigniorage remains high, because of the expansionary nature of monetary policy; secondly, the exchange rate remains stable for financial markets anticipate tight monetary policies; thirdly, for the same reason, economic agents realise that there is a reduced necessity to economise on real balances.

Nevertheless, under the more likely hypothesis that the government announcement is not credible, financial markets are able to foresee that the government is not going to choose a rigorous monetary policy.

With rational financial markets, the exchange rate is able to anticipate the real monetary policies that the government will implement and hence remain extremely weak. The analysis can therefore explain why a country in great financial difficulties, with a non credible government, is generally characterised by a weak real exchange rate.

To attain these results we have applied some interesting mathematical techniques. While it is extremely simple to calculate the time inconsistent and the time consistent solutions in the traditional closed economic set up, it is certainly more complex in a dynamic framework a-la-Dornbusch. The purpose of the remainder of this essay is to derive both the time inconsistent and time consistent solution under this economic set up. Rather surprisingly, the time consistent solution - which is empirically the most relevant - turns out to be extremely simple. Later in chapter 3, *Exchange Rate Undervaluation and Institutional Reform,* we will discuss to what extent these results correctly describe the Russian economic experience. Above all, in chapter 3 we will concentrate on the policy message of this analysis: it turns out, in fact, that according to our model, the Russian process of economic adjustment would have been very different - and more favourable - if there had been, instead of Viktor Gerashchenko, a more conservative central banker.

From a technical point of view, the existence of a price dynamics and an exchange rate dynamics requires that the solution paths of the macroeconomic variables depend on a system of differential equations. Hence, the minimisation of the government loss function becomes a problem of optimal control. A further complication arises from the assumption that there exists a different speed of adjustment between the exchange rate and the price level.

As we will later discuss, the solution derived with the standard optimal control is the time inconsistent solution (see section 2.5). Consequently it is not possible to apply standard control theory to find the time consistent solution. Cohen and Michel (1988) have nevertheless shown how to proceed under these circumstances: to obtain solutions which satisfy the time consistency constraint, in a dynamic framework with forward looking variables, it is sufficient modify slightly standard control theory (see section 2.6)

Once derived, both the time inconsistent and the time consistent solutions, we will then be able to calculate the loss level associated with each. Such a procedure allows us to verify the standard result that it would be desirable, from a theoretical point of view, to attain for the time inconsistent solution. In practice, however, the best available strategy is to devise a monetary arrangement which allows us to reach a suitable approximation to the time inconsistent solution.

2.2 The Barro Model: Hyperinflation as Lack of Credibility

In the first essay of this thesis we suggested how the classic interpretation of hyperinflation critically relies on the assumption that monetary authorities deliberately increase seigniorage to take advantage of money demand slow response. According to this economic theory, the government is always capable of money financing the deficit: granted that this pushes up inflation, and, if currency substitution is assumed, the stock of foreign exchange held by the private sector as well (see section 1.5). We discussed how, implicitly, Cagan's approach either postulates that economic agents are not rational or, alternatively, that economic agents are subject to a process of partial adjustment of money demand.

In this present section, just as in Barro (1983), we focus upon an alternative interpretation of hyperinflation. Economic agents are supposed to be rational and hence be able to forecast the real intentions of the government. According to this approach, hyperinflation episodes are best explained by the lack of credibility of the government.

The economic insight of his research is the following: the government has an incentive to announce a low inflation rate to persuade economic agents to expand their money demand. Money demand is, in fact, the tax base of seigniorage.

Yet, the government does not have the incentive to keep faith with its commitment as it would thereafter choose an expansionary monetary policy to secure higher seigniorage.

In analogy to the traditional time inconsistency analysis, however, economic agents are assumed to be able to foresee the real intentions of the government. So their response is to reduce immediately their money demand to lower the forthcoming economic loss[1].

For the present purposes let us now introduce a simplified analysis of this model. Assume a closed economy in which money demand is a negative function of the interest rate:

2.1) $$m - p = -\lambda i$$

and the real interest rate is constant:

2.2) $$i^r = i - \pi^e$$

and equal to zero.

Following Barro's analysis, let us also assume that expected inflation is a constant:

2.3) $$\frac{d\pi^e}{dt} = 0$$

The latter equation greatly simplifies the model from a technical point of view while preserving its main economic insights. As a direct consequence, the inflation rate and the growth rate of money are equal:

2.4) $$\pi = \eta$$

Suppose also that the government minimises the following loss function, which

---

[1] Namely, the inflation tax

depends positively on inflation, π and negatively on seigniorage, Z

2.5) $$L = ae^{\pi} - bZ$$

where a and b are the two weights respectively associated to inflation and seigniorage.

Clearly it is possible to express the loss function in terms of inflation and expected inflation as follows:

2.6) $$L = ae^{\pi} - b\pi e^{-\lambda\pi^{e}}$$

Consider now that the government chooses the inflation rate with the objective to minimise its loss:

2.7) $$\frac{dL}{d\pi} = 0$$

and we therefore derive the government reaction function

2.8) $$\pi = \log\left(\frac{b}{a}\right) - \lambda\pi^{e}$$

At this stage of the analysis we are in a position to examine all the various alternative solutions. Suppose, for example, that the government announces a zero growth rate of money with the objective to encourage a greater money demand. Suppose, in addition, that economic agents consider this commitment as reliable:

2.9) $$\pi^{e} = 0$$

If the government keeps faith with its announcement, seigniorage remains at zero; whereas if the government chooses a positive inflation rate, seigniorage is conversely positive. As a result, there is a definite incentive for the government to cheat and to set the following inflation rate:

2.10) $$\pi^f = \log\left(\frac{b}{a}\right)$$

which would bring about a seigniorage equal to

2.11) $$Z^f = \log\left(\frac{b}{a}\right)$$

Since in this scenario economic agents make a mistake, we can label this as the fooling solution[*].

In analogy to the traditional time inconsistency literature, it seems more likely that economic agents foresee the government desire to tax liquidity. If, this time, expected inflation is equal to the actual outcome:

2.12) $$\pi^e = \pi$$

money holdings would be reduced and so would be the tax base available to the government.

It is important to note that the rationality of economic agents changes the intentions of

[*] To be precise this is not exactly the fooling solution. The optimal solution to the government would be to promise an inflation rate equal to minus infinity while choosing an inflation rate equal to plus infinity

the government. To verify this, let us calculate the time consistent inflation rate:

2.13) $$\pi^{tc} = \frac{\log\left(\frac{b}{a}\right)}{1+\lambda}$$

and the associated level of seigniorage

2.14) $$Z^{tc} = \frac{\log\left(\frac{b}{a}\right)}{1+\lambda} e^{-\frac{\lambda}{1+\lambda}\log\left(\frac{b}{a}\right)}$$

Considering the reduction of the tax base, we find that the government prefers to choose a smaller inflation rate, since it is less beneficial to adopt a high inflation policy:

2.15) $$\pi^{tc} < \pi^{f}$$

The reduction of the inflation rate is of course good news; however, the consequent loss in seigniorage must be taken into account as well[3]:

2.16) $$Z^{tc} < Z^{f}$$

Overall, economic agents rationality has a negative impact on the economic system as the time consistent loss level increases:

2.17) $$L^{tc} > L^{f}$$

---

[3] Both the growth rate of money and money demand are smaller

From the economic point of view, the most interesting aspect of the Barro model is that it explains why the inflation rate might be very high in a country which has severe financial difficulties, as Russia certainly had. If the weight associated to seigniorage in the loss function, b, is a large number, the time consistent inflation rate is high (see equation 2.13). The reason is that the government is ready to accept a high inflation rate to earn a good level of seigniorage. For example, Russian monetary authorities seemed to be, for long time, much more concerned about large enterprises closing down rather than of high inflation (see section 1.22). Time consistent economic agents were therefore probably able to correctly anticipate that the credit flow to enterprises was not soon going to be halted.

Barro's analysis finally suggests that the solution to the policy credibility problem is to delegate the control of monetary policy to an independent and conservative central banker, since its anti-inflationary stance brings about a rise in money demand. The expansion in money demand is, in fact, crucial to secure seigniorage at a low inflation rate.

We maintain that the model successfully describes the effects of a non credible government, and why there is a case for appointing a conservative central banker. The government intention to finance the deficit by printing money is the root of the time consistency problem. Plainly, however, Barro's model is not perfectly suitable to describe the Russian economy: firstly, because it supposes a closed economy while exchange rate fluctuations in those circumstances would have had a relevant role; secondly because it does not seem to us a good description of the Russian economy to assume that real balances could be quickly adjusted. Consider, moreover, how the model just described is not properly dynamic since expectations are constrained to be constant.

The purpose of the remainder of this essay is to propose a similar study in a dynamic open economy framework. We will apply a methodology which allows us to extend the time inconsistency literature in the context of an open economy a-la-Dornbusch. We believe that the main conclusions to be drawn on the real exchange rate and liquidity shed some light on Russia's economic experience in the early 90's. However, to begin with, we need to review the exchange rate overshooting literature.

2.3 The Dornbusch Literature

This section reviews the open economy macroeconomic literature a-la-Dornbusch which is going to be, subsequently, the dynamic framework of our analysis.

It is well known how the Dornbusch model has succeeded in extending the IS LM analysis to the case where prices are not fixed. However, the most relevant aspect of such work has been to emphasise the significance of the different speed of adjustment between the financial and the goods market.

Consider, to begin with, how the sluggishness of the price level implies that monetary policy has a real effect on the interest rate. Yet, if perfect capital mobility and risk neutrality are assumed, the rate of return on domestic and foreign bonds should be equal. Thus the distinctive feature of the Dornbusch model is that the exchange rate immediately adjusts to avoid a spread between the rate of return of domestic and foreign bonds.

Suppose, for example, that the government decides to adopt an expansionary monetary policy. The domestic currency would become unattractive for two different reasons: on one hand the interest rate paid on domestic bonds would fall, on the other hand an expansionary monetary policy would tend to weaken the exchange rate

To encourage domestic and foreign investors to hold domestic bonds, the exchange rate, therefore, must devalue at once, up to the point that it becomes reasonable to expect a future appreciation of the exchange rate. Hence, the model predicts that a change in monetary policy leads to the overshooting of the exchange rate.

The traditional Dornbusch model (1976) examines what the impact effect is of a change in the level of money supply on the exchange rate. However, it is not really suitable to examine changes in the rate of growth of money supply[4]. For this reason we review the Buiter and Miller (1981) analysis which extends the Dornbusch model to the case where the growth rate of money is positive.

Similarly to the Dornbusch model, it is a small open economy model which assumes floating exchange rates, perfect capital mobility, sticky prices a-la-Dornbusch, rational financial investors and risk neutral speculators. As shortly will become clear, the Buiter and Miller model is able to preserve and extend the original economic insight of the Dornbusch model.

The demand side of the model has the typical IS LM structure, the supply side is given by a Phillips curve relationship while the open economy is driven by the arbitrage equation[5]

We present here a slightly simplified version of the Buiter Miller model, characterised by the following log-linear equations:

2.18) $$m - p = -\lambda i + \mu \bar{y}$$ (LM curve)

2.19) $$y = -\gamma(i - \pi) + \sigma(s - p + p^*)$$ (IS curve)

2.20) $$\pi = \phi(y - \bar{y}) + \eta$$ (Phillips curve)

2.21) $$\frac{ds}{dt} = i - i^*$$ (Arbitrage equation)

[4] A further implicit simplification of the model is to assume that trade unions expected inflation to be equal to zero. Emphasis is given to the rationality of financial markets

[5] One feature, which distinguishes this model from Cagan's model, is that the real interest rate is not constant but a function of the monetary policy adopted

List of Symbols

m	logarithm of the nominal money stock
p	logarithm of the price level
p^*	logarithm of the foreign price level
y	logarithm of domestic income
$\bar{y}$	logarithm of permanent income
η	rate of growth of money and core inflation
i	domestic interest rate
i^*	foreign interest rate
s	logarithm of the exchange rate

where all parameters $\lambda, \mu, \gamma, \sigma, \phi$ are positive.

Equation 2.18) is derived by assuming equilibrium in the money market. Real money demand negatively depends on the opportunity cost of holding money, i and positively on permanent income, $\bar{y}$[6].

Output is determined by demand which in turn is supposed to be a negative function of the instantaneous real interest rate, $i - \pi$, and a positive function of competitiveness, $s - p + p^*$ (equation 2.19).

A Phillips curve type of mechanism generates inflation: inflation is, in fact, assumed to be positively related to the gap between real output and permanent income, augmented by core inflation, which can be interpreted as the trade union expected inflation (equation 2.20). For the present purposes we maintain the Buiter and Miller

[6] It is simple to extend the model so as to allow money demand to depend on flexible output, rather than on permanent income

restrictive hypothesis that core inflation has only a backward component: hence we suppose that it is equal to the rate of growth of money supply[7].

The last equation of the model is the uncovered interest rate parity, whereby the existence of risk neutral speculators with perfect foresight ensures that domestic and foreign assets have the same rate of return (equation 2.21). Of course, this requires that any exchange rate depreciation of the domestic currency must be matched by a positive interest rate differential.

As permanent income, foreign prices and the foreign interest rate are all constants, we can set them equal to zero.

$$\bar{y} = p^{*} = i^{*} = 0$$

By defining l as real money balances,

2.22) $$l = m - p,$$

and c as competitiveness,

2.23) $$c = s - p,$$

we can reduce the model into a linear system of differential equations as below:

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[7] It is possible to define core inflation in various different ways. For instance, in their original article Buiter and Miller (1981: 156-159) argue that generally a delay occurs before a change in the rate of growth of money supply affects expected inflation. Moreover, they suggest how to alter the specification of the core to capture this delay. Conversely, it is also possible to postulate that core inflation not only has a backward looking but also a forward looking component. We maintain that the original article by Buiter and Miller closely matches the Dornbusch analysis in the sense that the focal point is the forward looking nature of financial markets.

2.24) $$\frac{dl}{dt} = \frac{-\phi\gamma\lambda^{-1}l - \phi\sigma c - \phi\gamma\eta}{\Omega}$$

2.25) $$\frac{dc}{dt} = \frac{-\lambda^{-1}l - \phi\sigma c - \eta}{\Omega}$$

where Ω is defined as:

2.26) $$\Omega = 1 - \gamma\phi .$$

Inflation can therefore be expressed in terms of l, c, η, as here below:

2.28) $$\pi = \frac{\phi\gamma\lambda^{-1}l + \phi\sigma c + \eta}{\Omega}$$

The model is characterised by one forward looking variable c, one predetermined variable l and a control variable η. Moreover the growth rate of money, η, is exogenous while the assumption of saddle point stability is sufficient to ensure the existence of a unique stable solution[x].

The main economic insight of the Dornbusch model still holds. Suppose, for example, that the government decides for an expansionary monetary policy (see Fig. 2.1).

In the very short run, real balances are fixed while the exchange rate jumps on the new stable manifold of the system, labelled on Fig. 2.1 as TT. The impact effect of a monetary expansion is hence a jump of the economy from point A to B. Thereafter, a slow process of convergence along the stable manifold brings the economy to its new steady state, D.

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[x] The implied restriction to the parameters is $\Omega > 0$

Fig. 2.1 The Consequences of an Expansionary Monetary Policy

As expected, the economic insight of the model is in line with the Dornbusch analysis. The model suggests that a rise in the growth rate of money brings about a temporary real exchange rate depreciation. Moreover, economic agents progressively manage to economise on real balances. Rather surprisingly the above presented figure is going to be relevant again later on when we will postulate time consistent agents and an endogenous growth rate of money (section 2.6). As will become clear at that time, this feature allows us to simplify and improve the economic understanding of our model[9].

[9] In *Exchange Rate Undervaluation and Institutional Reform* we will be able to verify how, from an empirical point of view, this figure seems to be a fairly accurate description of the Russian transition process.

2.4 The Model

Our objective in this essay is to apply the existing techniques to extend the time inconsistency analysis in the context of a dynamic open economy a-la-Dornbusch. As already mentioned, we believe that this more complex and interesting dynamic framework allows to enhance our understanding of the macroeconomic environment of unstable economies.

Assume that the government controls the growth rate of money supply, η,[10] with the intent to minimise the following quadratic discounted stream of costs:

2.29) $$L = \frac{1}{2}\int_t^{\infty}\left(a\pi^2 + (\eta - \tilde{\eta})^2\right)e^{-\xi t}dt$$

where π stands for inflation, η is the rate of growth of money supply, $\tilde{\eta}$ is the target rate of growth of money supply and ξ is the discount rate.

To begin with, as in the standard time consistency literature, a high inflation rate is assumed to be harmful: hence the weight a in the loss function is supposed to be positive.

In an economic setting similar to Russia, the other top priority is to have a sufficiently expansionary monetary policy to help finance the deficit and issue subsidised credits: hence we assume that the government chooses a positive target growth rate of money $\tilde{\eta} > 0$ to ensure the collection of seigniorage[11 12].

[10] In the present analysis we leave aside the difficulty of measuring and controlling money supply aggregates.

[11] If we included seigniorage in the loss function, the model would become non-linear. Indeed, one possible extension to the present analysis may be to investigate the implications of such a non-linearity. But this would require to study the applicability of the Cohen and Michel technique to non-linear

Therefore our analysis extends the Buiter and Miller model to the case where the growth rate of money is no longer exogenous but is rather endogenously determined as the solution to the above minimisation problem.

While it is extremely simple to calculate the time inconsistent and the time consistent solutions in the traditional closed economic set up, this is certainly more complex in a dynamic framework a-la-Dornbusch.

The classic Hamiltonian analysis allows one to determine the optimal path for the control variable (in our case the growth rate of money supply, η) at time $t = 0$. However, it has been shown by various authors (see for example, Kydland and Prescott (1977), Lucas and Sargent (1981), Calvo (1978a), Driffill (1982)) that the solution derived by standard control theory is the time inconsistent solution. In fact, it is possible to verify that in general the solution which is optimal at the beginning, is no longer so at a later stage: hence the government does not have the incentive to implement the original plan. If the solution does not remain optimal over time, it is said to violate Bellman's principle of optimality.

The essay proceeds as follows. First the time inconsistent solution is derived in section 2.5. Second, it is necessary to find alternative ways to calculate time consistent solutions (i.e. solutions which satisfy the principle of optimality of

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systems of differential equations. In addition, it is important to note that liquidity is not subject to jumps in the present context. On the basis of this, if the government seeks to reach a desired target for seigniorage, $\bar{Z}$, it just needs to implement a sufficiently expansionary monetary policy, η. A constant target for seigniorage would require a target growth rate of money which has to be function of time. Here, for sake of simplicity, we content ourselves to assume a constant target growth rate of money.

[12] With sluggish liquidity, at each moment in time the greater η, the greater seigniorage Z. For this reason, the growth rate of money could be thought as a proxy for seigniorage. To avoid a target for seigniorage, the following alternative loss function may be used $L = \frac{1}{2}\int_t^{\infty}\left(a\pi^2 - 2\eta\right)e^{-\delta t}dt$. The main economic insights of the model would remain, by and large, the same.

Bellman). Our analysis refers to the theoretical articles by Cohen and Michel (1988), Miller and Salmon (1984) and Currie and Levine (1986), where it is shown how standard control theory should be modified to obtain time consistent solutions in a dynamic framework with forward looking variables. One early application of the time inconsistency problem in a similar dynamic environment can be found in Miller (1985), further developed in Miller and Salmon (1990)[13].

[13] Their analysis is different from ours for two reasons. The first is that in their loss function, as in the traditional time consistency literature, includes inflation and unemployment while here, as the analysis refers to transition or underdeveloped countries, the loss function includes inflation and the growth rate of money. In our model, instead of having the classic trade-off between inflation and unemployment, we have the more obvious trade-off between inflation and monetary growth. The second reason is that the Miller and Salmon model does not include a specification for money demand while we adhere to a more standard open economy model. This turns out to be crucially important, as our model has the interesting feature that the steady state for monetary growth and inflation is not invariant (as in Miller and Salmon), but it is crucially affected by the type of solution considered. The steady state itself, and not just the dynamic path, depends on whether the solution is time inconsistent or time consistent, and changes with the appointment of a central banker or with the choice of a feedback solution.

2.5 Time Inconsistent Solutions

The aim of this section is to calculate the time inconsistent solutions for the growth rate of money and inflation. To this end, we derive the standard solution to the optimal control problem by setting up the appropriate Hamiltonian to our minimisation problem:

2.30)

$$H = 1/2\left[a\pi^2 + (\eta - \tilde{\eta})^2\right]e^{-\beta t} + h_1\left(\frac{-\phi\gamma\lambda^{-1}l - \phi\sigma c - \phi\gamma\eta}{\Omega}\right) + h_2\left(\frac{-\lambda^{-1}l - \phi\sigma c - \eta}{\Omega}\right)$$

where h_1 and h_2 are the shadow prices associated to the predetermined variable l and the forward looking variable c. The first order conditions are given by the following equations:

2.31) $$H_\eta = 0$$

2.32) $$H_l = -\frac{dh_1}{dt}$$

2.33) $$H_c = -\frac{dh_2}{dt}$$

By defining the current value shadow prices as:

2.34) $$q_1 = h_1 e^{\beta t}$$

2.35) $$q_2 = h_2 e^{\beta t}$$

it is possible to derive the optimal growth rate of money:

2.36)

$$\eta = \frac{-a\phi\gamma\lambda^{-1}l - a\phi\sigma c + \Omega q_2 + \Omega^2\bar{\eta}}{\left(a + \Omega^2\right)}$$

and to express the system of equations in the following standard linear matrix form:

2.37)

$$\begin{bmatrix} \frac{dl}{dt} \\ \frac{dq_1}{dt} \\ \frac{dq_2}{dt} \\ \frac{dc}{dt} \end{bmatrix} = \frac{1}{a+\Omega^2} A_1 \begin{bmatrix} l \\ q_1 \\ q_2 \\ c \end{bmatrix} + \frac{1}{a+\Omega^2} b_1$$

where

2.38)

$$A_1 = \begin{bmatrix} -(u+\Omega)\phi\gamma\lambda^{-1} & -(\phi\gamma)^2 & -\phi\gamma & -(u+\Omega)\phi\sigma \\ -u\left(\phi\gamma\lambda^{-1}\right)^2 & (u+\Omega)\phi\gamma\lambda^{-1} + \left(u+\Omega^2\right)\xi & (u+\Omega)\lambda^{-1} & -u\phi^2\sigma\gamma\lambda^{-1} \\ -u\phi^2\sigma\gamma\lambda^{-1} & \left(u+\Omega^2\right)\phi\sigma + \Omega\phi^2\gamma\sigma & \left(u+\Omega^2\right)\xi + \Omega\phi\sigma & -u(\phi\sigma)^2 \\ -(u+\Omega)\lambda^{-1} & -\phi\gamma & -1 & -\phi\sigma\Omega \end{bmatrix}$$

and

2.39)

$$b_1 = \begin{bmatrix} -\phi\gamma\Omega\bar{\eta} \\ -u\phi\gamma\lambda^{-1}\bar{\eta} \\ -u\phi\sigma\eta \\ -\Omega\eta \end{bmatrix}$$

The steady state solutions are given by:

2.40) $$\begin{bmatrix} l^* \\ q_1^* \\ q_2^* \\ c^* \end{bmatrix} = -A_1^{-1} b_1$$

For the reason that prices are sluggish but not fixed, the steady state real exchange rate returns to equilibrium - as in the standard Buiter and Miller model -:

2.41) $$c^* = 0$$

The unique solutions for l, q_1, q_2, c are determined by applying the saddle path restriction to the above system. If we define the stable eigenvalues as ρ_1 and ρ_2 and the stable eigenvectors as:

2.42) $$\chi = \begin{pmatrix} 1 \\ \chi_1 \\ \chi_2 \\ \chi_3 \end{pmatrix} \qquad \vartheta = \begin{pmatrix} 1 \\ \vartheta_1 \\ \vartheta_2 \\ \vartheta_3 \end{pmatrix}$$

the solutions are then equal to:

2.43) $$l = N_1 e^{\rho_1 t} + N_2 e^{\rho_2 t} + l^*$$

2.44) $$q_1 = \chi_1 N_1 e^{\rho_1 t} + \vartheta_1 . N_2 e^{\rho_2 t} + q_1^*$$

2.45) $$q_2 = \chi_2 N_1 e^{\rho_1 t} + \vartheta_2 N_2 e^{\rho_2 t} + q_2^*$$

2.46) $$c = \chi_3 N_1 e^{\rho_1 t} + \vartheta_3 N_2 e^{\rho_2 t} + c^*$$

where it is possible to determine the two constants, N_1 and N_2 by taking into account the two following constraints. The first is the initial condition for real balances,

2.47) $$l(0) = l_0$$

and the second is the optimality condition,

2.48) $$q_2(0) = 0$$

which states that the shadow cost of the real exchange rate has to be zero at time $t = 0$ [14].

Given equations 2.36) and 2.28), we derive the time inconsistent paths for both the growth rate of money and inflation: hence it becomes possible to calculate the associated loss by solving integral 2.29). Moreover, it is also possible to prove that both paths in the steady state converge to the following value[15]:

2.49) $$\pi = \eta = -\frac{l^*}{\lambda}$$

To get a deeper understanding of our analysis let us now examine a numerical example by assigning some specific values to the parameters of the model and, moreover, by choosing an initial condition for real balances (Simulation A). For the parameters which are in common with the Buiter Miller model let us precisely choose

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[14] See Cohen and Michel (1988: 267) and Miller and Salmon (1984: 73).
[15] Equation 2.49) holds in the standard Buiter Miller model (1981) as well. Both the time inconsistent inflation rate and the time inconsistent growth rate of money converge to minus the steady state value of real balances divided by the semi-elasticity of money demand, λ, (i.e. the slope of the money demand equation).

the same values which the authors themselves suggested to be plausible (1981: 171). As will become clear later on, the crucial parameter value is the interest sensitivity of money demand, λ , here assumed to be equal to two $(\lambda = 2)$. In the Phillips curve a one percent increase in income above permanent income is supposed to cause a half percent point rise in inflation for a given level of growth rate of money $\left(\phi = \frac{1}{2}\right)$. The elasticity of demand, with respect to the exchange rate, and the semi-elasticity of demand, with respect to the real interest rate, are also set equal to a half $\left(\sigma = \gamma = \frac{1}{2}\right)$. We also set a target annual growth rate of money supply equal to two $(\overline{\eta} = 2)$, a five percent annual discount rate $(\xi = 0.05)$, a weight for inflation in the loss function equal to two $(a = 2)$ and the initial value for real balances equal to zero $(l_0 = 0)$

Thus we have all the information required to derive the time inconsistent solutions for inflation, monetary growth and the exchange rate. Henceforth, we can calculate the associated loss:

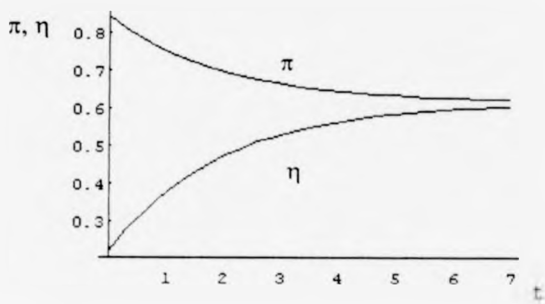
2.50) $$L^{o} = 28.3568$$

The shape of the optimal time inconsistent path is crucially affected by the initial value of real balances. As in this specific case we have chosen - in view of the large monetary overhang in Russia - a relatively 'high' initial value for real balances $(l_0 = 0)$, in the process of adjustment, real balances must fall to the steady state value $(l^* = -1.24)$: this in turn requires having a temporary positive gap between inflation and monetary growth

2.51) $$\pi - \eta = -\frac{dl}{dt}$$

Our insight is confirmed by plotting the optimal time inconsistent paths for monetary growth and inflation as a function of time (see Fig. 2.2):

Fig. 2.2 Time Inconsistent Paths for Monetary Growth and Inflation



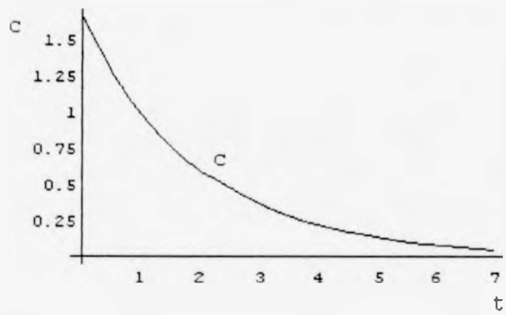
At time $t = 0$ the optimal growth rate for money supply is approximately equal to 0.22, while the inflation rate is higher and equal to 0.84. The discrepancy between the two paths disappears as they progressively convergence to the steady state $(\pi = \eta = 0.619666)$.

One reason why the inflation rate is higher than the rate of monetary expansion is that the real exchange rate, e, is temporary undervalued. To be precise, in our example the real exchange rate overshoots to 1.66 before falling back to its equilibrium value, 0 (Fig. 2.3).

The weakness in the real exchange rate has an inflationary impact, because it stimulates demand via an improvement in the current account[16].

[16] Moreover, since the real exchange rate appreciates during the process of adjustment, the real interest rate is negative, $\frac{de}{dt} = i - \pi < 0$ and, naturally, this has also an inflationary impact, because demand is stimulated via an increase in investment.

Fig. 2.3 Time Inconsistent Path for the Real Exchange Rate



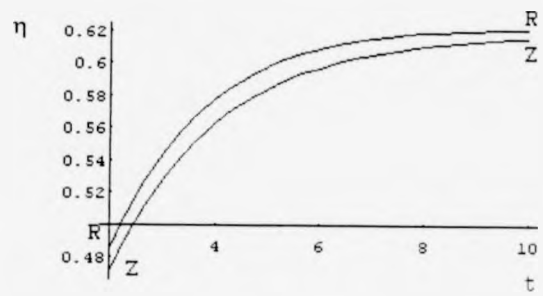
As previously discussed, the optimal paths drawn in Fig 2.2-2.3 do not satisfy the principle of optimality: if financial markets are rational these paths do not have any empirical relevance.

There is a simple way to verify that the initially planned policy is time inconsistent. Let us suppose, for instance, that the government actually implements the planned monetary policy from time $t = 0$ to $t = 2$ and only then realises that it is possible to reduce the loss by choosing a new path for the growth rate of money.

Plotting the 'new' and the 'old' path from time $t = 2$ onwards (Fig. 2.4), if we had time consistency, the two paths would be identical. Instead, the new path for monetary growth (RR) is always above the old path (ZZ).

Hence, we can verify that our initial economic insight was correct. While at time $t = 0$ the optimal policy for the government is to announce a conservative monetary policy for fear of the inflationary impact of the exchange rate, at time $t = 2$ the government has the incentive to expand the growth rate of money more than it had previously announced.

Fig. 2.4 Violation of Belman's Principle of Optimality



As this incentive does not only exist only when $t = 2$ but in any moment in time, financial markets learn how the government behaves and hence revise their expectations accordingly[17].

[17] The above depicted path RR puts in evidence why the government is tempted to cheat. It corresponds to the fooling solution in a dynamic set up

2.6 Time Consistent Solutions

The objective of this section is to derive and plot the time consistent solutions to our optimisation problem. We assume that financial markets agents are rational and hence, when they form expectations of future monetary policy, they anticipate that the government may not have the incentive to follow the monetary policy previously announced at $t = 0$. We have shown with the example of Simulation A that financial markets would make a mistake if they were to expect the 'conservative' monetary policy announced by the authorities (and plotted in Fig. 2.2). The announcement of a tight future monetary policy, in fact, serves the purpose of defending the exchange rate to reduce the inflationary pressures[18], but the government does not have the incentive to adhere to such a plan. Thus economic agents need to revise their expectations of future monetary policy. They are not 'fooled' only if they anticipate the true monetary policies chosen by the government and if the latter remain optimal at any moment in time. As in the time-inconsistent analysis, the solution should also be stable and thus converge to the steady state.

To derive the solution for the control variable which satisfies the properties of time-invariancy and stability we apply the method proposed by Cohen and Michel. The main result of their paper is that given a linear quadratic loss function, the time consistent solution for the forward looking variable is a predetermined linear function of the state variables with constant parameters. Since the forward looking variable is predetermined, its value is no longer influenced by any 'false promise' that the government might make. As suggested by Miller, Salmon and Sutherland (1991: 144), the parameters could be thought as measuring private expectations.

[18] By announcing a future (relatively) conservative monetary policy the overshooting of the exchange rate is smaller, reducing therefore its inflationary impact.

Cohen and Michel emphasised how once the forward looking variable is assumed to be a predetermined linear function of the state variable with unknown parameters, the optimal time consistent solutions can be calculated with standard control theory. The unknown parameters are determined only subsequently to ensure both the fulfillment of the predetermined expectations and the stability of the system.

Applying the technique to our problem we assume that the real exchange rate is a linear function of the state variable l, where the unknown parameters are labelled as α and κ:

2.52) $$e = \alpha + \kappa l$$

The real exchange rate therefore cannot be controlled by the government and in all respects 2.52) is a new constraint added to the loss minimisation process. Given 2.52), the only remaining state variable which the government effectively influences is real balances, l.

The appropriate Hamiltonian is, hence, now equal to:

2.53) $$H = \frac{1}{2}[a\pi^2 + (\eta - \bar{\eta})^2]e^{-\delta t} + h\left(\frac{dl}{dt}\right)$$

where h is the costate variable. Expanding the Hamiltonian by substituting equation 2.28) and equation 2.24), we derive the following expression:

2.54)

$$H = \frac{1}{2}\left[a\left(\frac{\phi\gamma\lambda^{-1}l + \phi\sigma(\alpha + \kappa l) + \eta}{\Omega}\right)^2 + (\eta - \bar{\eta})^2\right]e^{-\delta t} + h\left(\frac{-\phi\gamma\lambda^{-1}l - \phi\sigma(\alpha + \kappa l) - \phi\gamma\eta}{\Omega}\right)$$

As in standard control theory, the first order conditions are determined by imposing the following conditions:

$$2.55)\qquad H_{\eta} = 0$$

$$2.56)\qquad H_{l} = -\frac{dh}{dt}$$

By defining the current value multiplier as:

$$2.57)\qquad q = he^{\vartheta}$$

the two first order conditions are equal to

$$2.58)\qquad a\left(\frac{\phi\gamma\lambda^{-1}l + \phi\sigma(\alpha + \kappa l) + \eta}{\Omega}\right)\frac{1}{\Omega} + \eta - \tilde{\eta} - \frac{\phi\gamma}{\Omega}q = 0$$

$$2.59)\qquad a\left(\frac{\phi\gamma\lambda^{-1}l + \phi\sigma(\alpha + \kappa l) + \eta}{\Omega}\right)\left(\frac{\phi\gamma\lambda^{-1} + \phi\sigma\kappa}{\Omega}\right) - \left(\frac{\phi\gamma\lambda^{-1} + \phi\sigma\kappa}{\Omega}\right)q = -\frac{dq}{dt} + \xi q$$

From 2.58) the optimal growth rate of money can be expressed as

$$2.60)\qquad \eta = \frac{-a\phi\gamma\lambda^{-1}l - a\phi\sigma\alpha + \phi\gamma\Omega q + \Omega^{2}\tilde{\eta}}{a + \Omega^{2}}$$

Given equations 2.21), 2.25), 2.58) and 2.59) the system is reduced in matrix form to:

2.61)
$$\begin{bmatrix} \frac{dl}{dt} \\ \frac{dq}{dt} \\ \frac{dc}{dt} \end{bmatrix} = \frac{1}{a+\Omega^2} A_2 + \frac{1}{a+\Omega^2} b_2$$

where A_2 is defined as:

2.62)

$$A_2 = \begin{bmatrix} -a\phi\gamma\lambda^{-1} & -(\phi\gamma)^2 & -a\phi\sigma - \Omega\phi\sigma \\ -a\phi\gamma\lambda^{-1}\left(\phi\gamma\lambda^{-1} + \phi\gamma\lambda^{-1}\right) & (a+\Omega)\left(\phi\gamma\lambda^{-1} + \phi\sigma\kappa\right) + \left(a+\Omega^2\right)\xi & -a\phi\sigma\left(\phi\gamma\lambda^{-1} + \phi\sigma\kappa\right) \\ -a\lambda^{-1} - \Omega\lambda^{-1} & -\phi\gamma & -\phi\sigma\Omega \end{bmatrix}$$

and b_2 as:

2.63)
$$b_2 = \begin{bmatrix} -\phi\gamma\bar{\eta} \\ -a\left(\phi\gamma\lambda^{-1} + \phi\sigma\kappa\right)\iota\bar{\eta} \\ -\Omega\bar{\eta} \end{bmatrix}$$

The steady state solutions are

2.64)
$$c^* = 0$$

$$l^* = -\left(\frac{\Psi}{\Psi + a\left(\xi\lambda + \gamma\phi + \kappa\lambda\phi\sigma\right)}\right)\lambda\bar{\eta} < 0$$

$$q^* = -\frac{(a+\Omega)\lambda^{-1} l^* + \Omega\bar{\eta}}{\phi\gamma}$$

where Ψ is defined as:

2.65) $$\Psi = \xi\lambda\Omega + \gamma\phi + \kappa\lambda\phi\sigma$$

As in the time-inconsistent case, the steady state real exchange rate converges to zero. Furthermore, steady state real balances are negative and depend on the weight a in the loss function[19].

The assumption of stability of the system and self-fulfillment of private expectations are necessary to determine the unknown coefficients. Since the real exchange rate, c, and the shadow price, q, are forward looking variables, while real balances, l, is sluggish, to have saddle stability the system should have one negative eigenvalue. By defining $\nu_s < 0$ as the stable eigenvalue of the system and $\begin{bmatrix} 1 \\ \varphi \\ \kappa \end{bmatrix}$ as the stable eigenvector, the solutions are equal to

2.66) $$l = (l_0 - l^*)e^{\nu_s t} + l^*$$

2.67) $$q = \varphi(l_0 - l^*)e^{\nu_s t} + q^*$$

2.68) $$c = \kappa(l_0 - l^*)e^{\nu_s t}$$

and the 'true' relationship between competitiveness and real balances is

2.69) $$c = \kappa(l - l^*)$$

[19] Given the Buiter and Miller structure of the model, it seems intuitive that the higher the concern for inflation, the greater steady state real balances need to be

Given rational time consistent expectations, the predetermined parameters can be computed by assuming that financial markets correctly anticipate this relationship. Clearly, from equation 2.52) and 2.69) the coefficient α must be equal to

2.70) $$\alpha = -\kappa l^{*}$$

Less straightforward is how to determine the other predetermined coefficient, κ^*. Nevertheless, to have convergence, the following condition must be satisfied,

2.71) $$\frac{1}{a+\Omega^2} A_2 \begin{bmatrix} 1 \\ \varphi \\ \kappa^* \end{bmatrix} = v_s \begin{bmatrix} 1 \\ \varphi \\ \kappa^* \end{bmatrix}$$

where κ^* appears both in the square matrix A_2 and in the stable eigenvector, $\begin{bmatrix} 1 \\ \varphi \\ \kappa^* \end{bmatrix}$.

With the system of equations 2.71) it is possible to find the signs of the following parameters,

$$\kappa^* > 0$$

$$\varphi > 0$$

showing that the stable manifold has a positive slope

It is also possible to evaluate the precise value of the negative eigenvalue, v_s and hence of the parameters κ^* and φ with the procedure that we now describe. Since 2.71) is a three equations linear system with three unknowns, κ^*, φ and v_s, by substituting κ and φ the value of the stable eigenvalue, v_s, can be found as the solution to a fourth degree equation in v_s. It turns out that there is a unique negative solution for v_s, while there are three positive solutions which are not acceptable.

The solutions for the time consistent inflation rate and for the time consistent growth rate of money are equal to,

2.72)
$$\pi = \frac{\left(\Omega\phi\gamma\lambda^{-1} + \Omega\phi\sigma\kappa + \phi\gamma\varphi\right)\left(l_0 - l^*\right)e^{v_s t} - \left(a + \Omega^2\right)\lambda^{-1}}{a + \Omega^2}$$

2.73)
$$\eta = \frac{\left(-a\phi\gamma\lambda^{-1} - a\phi\sigma\kappa + \Omega\phi\gamma\varphi\right)\left(l_0 - l^*\right)e^{v_s t} - \left(a + \Omega^2\right)\lambda^{-1}}{a + \Omega^2}$$

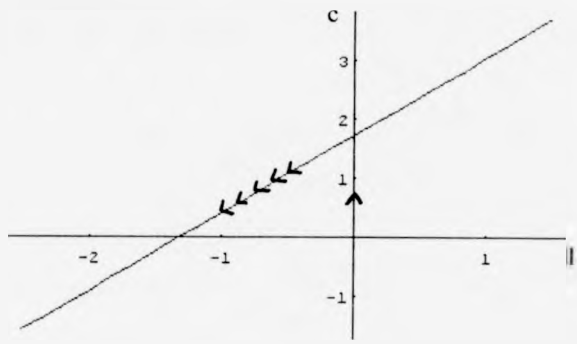
and can be plotted. In the steady state inflation and monetary growth are equal, and equation 2.49) still holds.

$$\pi = \eta = -\frac{l^*}{\lambda}$$

even if the steady state value for real balances, l^*, is now endogenously determined.

Although the analysis so far carried out has been, to a large extent, technical the derived time consistent solution is fairly simple. For example, our simulation analysis suggests that the time consistent stable manifold looks as the following figure (see Fig. 2.5).

Fig. 2.5 The Impact and Long-Run Effect of a Time Consistent Monetary Policy



It is important in first place to point out that the solution is general and would therefore have been very similar if different parameters had been chosen. But what seems particularly interesting to us is the perfect analogy between Fig. 2.5 and the phase diagram characterising the Buiter and Miller model (Fig. 2.1), despite the following different features:

a) there is a government which needs to print money to finance the deficit;

b) monetary policy is endogenously devised to achieve this purpose;

c) financial markets anticipate the future monetary policies;

At first sight that the time consistency constraint has not modified the Buiter and Miller key figure may come as a surprise. To shed some light on this, it is sufficient to see how the logic of the overshooting literature still applies here. Financial markets do not form expectations by relying on promises which the government might make but rather by foreseeing what the government is prepared to do. With rational expectations, the future expansionary monetary policies are anticipated. As a consequence, a large sudden depreciation of the exchange rate is necessary to sustain the initial level of money demand.

If the starting point is a monetary overhang, thereafter liquidity follows a downward process of convergence to its new steady state. One of the aims in the next essay will be examining whether Fig. 2.5 is broadly supported by the available Russian data

Further simulation analysis also shows how the size of the initial real exchange rate jump is a negative function of the weight, α. Therefore the model predicts that the greater the government's need to finance the deficit and to subsidise enterprises debts by money financing, the greater the real exchange rate jump. On the basis of this argument, the present analysis can broadly justify the scale of Russia's recent experience of undervaluation.

Concluding this discussion, let us refer to the time consistency literature which says that if it were possible to attain the time inconsistent solution, overall loss would be smaller. As a cross check, it is possible to verify that, in our simulation, loss is higher with time consistent expectations $\left(L^{c} = 28.3931\right)$ than with time inconsistent expectations $\left(L^{n} = 28.3568\right)$. Even in this framework, 'rationality' leads to a worse performance of the economy. Some possible solutions to the time consistency problem, are discussed in the forthcoming essay.

2.7 Final Remarks

In this chapter we have applied the Cohen and Michel procedure to study the time inconsistency problem in a dynamic open economy a-la-Dornbusch. A special loss function was used for the present purposes, but the methodology here developed is general and may be applied to address other economic issues. To this end, it is sufficient to modify the loss function while maintaining the basic structure of the Buiter and Miller model.

Leaving aside the technical aspects, what we believe to be the most interesting outcome of this essay is that the Buiter and Miller key figure remains valid, despite the different features of the model analysed here. On this occasion the real exchange rate initial response depends on the government's credibility with regards to future monetary policies. The more the government cares about an expansionary monetary policy, the greater the real exchange rate jump.

For a financially weak country, as Russia certainly is, the message is simple but important: a large experience of undervaluation may be justified by a lack of confidence in the government. Establishing credibility is therefore crucial to hinder a collapse of the currency.

A key objective of the forthcoming chapter, *Exchange Rate Undervaluation and Institutional Reform*, is to examine whether a different monetary arrangement helps to overcome the policy credibility problem. Using the same analytical framework, we show the consequences, for example, of appointing a central banker, who is less keen on expansionary monetary policies than the government. The basic insight is that the exchange rate remains stronger because financial markets anticipate future conservative monetary policies. Formal analysis suggests that it is possible to improve on the time consistent solution by reaching a suitable approximation to the time inconsistent solution.

In the same chapter we also propose a natural extension of the model by letting currency substitution, between domestic and foreign assets, be the alternative assumption to perfect mobility of financial capital. As pointed out earlier, the hypothesis of currency substitution seems to be more appropriate for countries at the early stages of economic transition.

Chapter 3

Exchange Rate Undervaluation and Institutional Reform

3.1 Introduction

The present essay applies the research that we developed so far to the Russian undervaluation experience. Our first aim is to examine whether the analysis is a good description of the empirical data at our disposal; it is also our objective to investigate whether there are any policy suggestions brought out from this study.

The main feature of the model developed in *Time Consistency in an Open Economy, a-la-Dornbusch* is that the financial markets understand the real intentions of policy makers regarding future monetary policies. While velocity of money is supposed to be a sluggish variable, the real exchange rate is conversely supposed to be forward looking. If the government lacks credibility, the exchange rate response is hence to devalue at once. The greater the government's need to finance the deficit by printing money, the greater the real exchange rate jump. Therefore the analysis seems to account for the outstanding scale of the rouble undervaluation, considering the precariousness of the Russian financial standing in the early 90's. A further peculiarity of the model is that, over time, economic agents learn to economise on real balances.

In short, the model suggests that the adjustment process should proceed along a path which closely resembles the stable manifold depicted in Fig. 2.5. To find out whether there is any empirical evidence for this relationship in section 3.2 we cross plot monthly data of the real exchange rate and of real balances. Once we establish that the study is - at least to some extent - supported by the available data, we attempt to carry our study a step forward: our ultimate objective is, in fact, to explore whether there are any lessons to be learned to ease the policy credibility problem.

Our analysis is similar in motivation to that of Horder (1996: 20), which also emphasises how the performance of the Russian economy heavily depended, along with structural factors, on the choices of the authorities in charge. For example, we discussed in *Exchange Rate Undervaluation in the Absence of Perfect Capital Mobility: the Russian Case* how in the early 90's - either for tenacious belief or personal interest - Russian monetary authorities kept on clearing out enterprise debts, in particular the chairman of the CBR, Viktor Gerashchenko, was emphatically defined by the Economist as the 'worst central banker ever' for his remarkable inclination towards expansionary monetary policies. Various commentators have indeed emphasised how Gerashchenko's actions had a negative influence on the performance of the Russian economy.

There are special occasions in history, when a country, in great financial difficulties, has a short-lived opportunity to implement the necessary economic reforms. Let us suppose that the leaders decide to take on the task. Once these reforms are implemented, it may become difficult however to defend them - either for the lack of sustained political consensus or for the reaction of vested interests. That is why to design policies that can hold out against calls for reversal is very important.

For example recent literature has paid great attention to the programme adopted by the Estonian government, which has consisted on the introduction of a currency board system, in July 1992. As is well known, discretionary monetary policy is not possible with a currency board because domestic currency is issued only against foreign exchange at a fixed exchange rate. Hanke, Jonung and Schuler (1993) argue that if a currency board had been established in Russia, policy makers would have been forced to embark on a programme of financial discipline. By contrast, we tend to agree more with the doubts raised by Humpage (1996) and Horder (1996) on the feasibility of such a scheme in Russia. Potential objections might be imagined to the appropriateness of a fixed exchange rate scheme in the circumstances that Russia had. Though the key objection is, in our view, that a currency board system would have compelled the Russian government to depend exclusively on non-inflationary financing.

Could Russia renounce the large seigniorage revenues that according to several analysts were higher than 30% of GDP in 1992? This seems quite unlikely, if we keep in mind that not just the government, but several enterprises and most of the banking system relied on this source of financing (see section 1.22)[1]. In addition,

[1] More likely to succeed was the programme adopted by Russia in 1995, which combined a fixed exchange rate system to the monitoring of Net Domestic Assets, defined as monetary base minus net international reserves. According to Skidelsky and Halligan (1996: 18) "The IMF decided that the current programme should employ the concept of NDA, the usual analytical framework within which to peg a currency, as additions to reserves offset monetary growth. The important point is that if the government prints rubles and uses them to buy hard currency, NDA does not grow, even though the domestic money supply has increase". With such system, collection of seigniorage is still possible, but constrained by the fixed exchange rate regime. This policy is however subject to reversal.

financial markets would have not probably given much credit to the promise of a monetary policy consistent with zero seigniorage[2].

The reader may refer to Horder (1996), among other commentators, for a comprehensive discussion about other solutions that can help promote economic stability, such as conditional assistance, reform of the political process, and currency reform[3].

What this essay gives special attention to, is the solution proposed by the time inconsistency literature. As shown in section 3.3 our model reaches the standard conclusion that Russia would have been better off by appointing a suitably conservative central banker. As we have assumed an open economy a-la-Dornbusch, financial markets are able to foresee a tighter monetary stance in the future. On the basis of this, our analysis reaches the conclusion that optimal monetary delegation would have eased the policy credibility problem in Russia, with the following important consequences:

1) in first place, the size of the Russian real exchange rate undervaluation would have been smaller,

[2] Humpage (1996) has raised this point by asking the following question: "without budgetary, banking and market reforms, could a Russian currency board reduce the time inconsistency problem?"

[3] Goldman (1996: 116-117) criticism of Gaidar, for not having implemented a currency reform in 1992, has given rise to much controversy. According to Skidelsky and Halligan (1996: 22-23) "Goldman does not discuss the feasibility of implementing a successful currency reform in the conditions which the reformers faced: the lack of preparation for such reform, the recent failure of two previous efforts, the lack of information about the extent of monetary overhang, the complications of the ruble zone, and above else, the acute food shortage which meant that getting food back into the shops was the most urgent priority." Similarly, Horder (1996: 24) underlines how a currency reform does not help improve the policy credibility problem of the government for the reason that "monetary confiscation might reduce people's confidence in money even further, causing prices to rise in any case or necessitating even greater monetary reform. In addition monetary reform would not have changed the basic incentives to cause higher inflation in the future"

2) in second place, economic agents would have decided to economise less on money holdings[4].

Optimal monetary delegation turns out to be, in fact, a suitable approximation to the ideal time inconsistent solution. Comparing the latter with the currency board system adopted in Estonia, the important difference is that monetary policy delegation still allows the government to collect some seigniorage.

Finally, in section 3.4 we briefly review an alternative monetary arrangement, namely the setting up of an optimal feedback rule for monetary policy. As it turns out, this latter option allows us to approximate the time inconsistent solution better than an optimal central banker. Some doubts, of course, remain on whether it is feasible to establish a feedback rule which the government cannot suddenly render null and void, at his own discretion.

Despite the plausibility of this analysis, there is one feature of the model which, in our view, does not adequately describe the true Russian economic experience. As was pointed out in chapter 1, it is not entirely satisfactory to assume perfect capital mobility for a country which undergoes a process of economic transition. Under these circumstances policy makers generally do not allow capital account convertibility as they attempt to prevent a harmful capital flight[5].

For this reason we felt the need in chapter 1 to develop a slightly more complex model: the starting point was to relax the assumption of perfect arbitrage between domestic and foreign assets and to choose instead the alternative notion of currency

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[4] Therefore the steady state tax base for seigniorage would have remained larger.
[5] As regards the Russian experience, we discussed how even current account convertibility turned out to be a difficult achievement.

substitution. We maintain that this kind of analysis gives a satisfactory explanation for the rouble undervaluation in the early 90's and for the simultaneous increase in the stock of foreign exchange held by the Russian private sector. In this economic setting foreign exchange is essentially required as an inflation hedge. When economic agents expect an expansion in the growth rate of money, they attempt to defend themselves from the forthcoming losses by switching their portfolio to foreign exchange. If this demand is to be satisfied in some way, the real exchange rate must therefore depreciate at once to allow the necessary hard currency inflow, by attracting tourists and making exports more competitive.

The objective of section 3.4 is to add the time consistency constraint to this currency substitution model. The most interesting aspect of this exercise is to verify how the government's lack of credibility brings about an excessive undervaluation of the exchange rate combined to an excessive net accumulation of foreign exchange. In conclusion, the analysis suggests that, even in this different economic setting, the appointment of a conservative central banker remains a satisfactory response to the time consistency problem. Such an arrangement, in fact, allows the policy maker to reduce both the exchange rate undervaluation and internal capital flight. The greater credibility of a conservative central banker persuades economic agents to lessen their demand for hard currency as a store of value. Hence, the exchange rate undervaluation has to be less extreme.

3.2 Empirical Relationship between Competitiveness and Real Balances in Russia

The present section examines whether the empirical data at our disposal give some support to the theoretical analysis developed up to now. To reach this objective we employ monthly data, gathered from a recently established journal, Russian Economic Trends. As before e, stands for the logarithm of the real exchange rate while l for the logarithm of real balances[6]. As discussed in *Exchange Rate Undervaluation in the Absence of Perfect Capital Mobility: the Russian Case*, these data are not entirely reliable for the following two reasons:

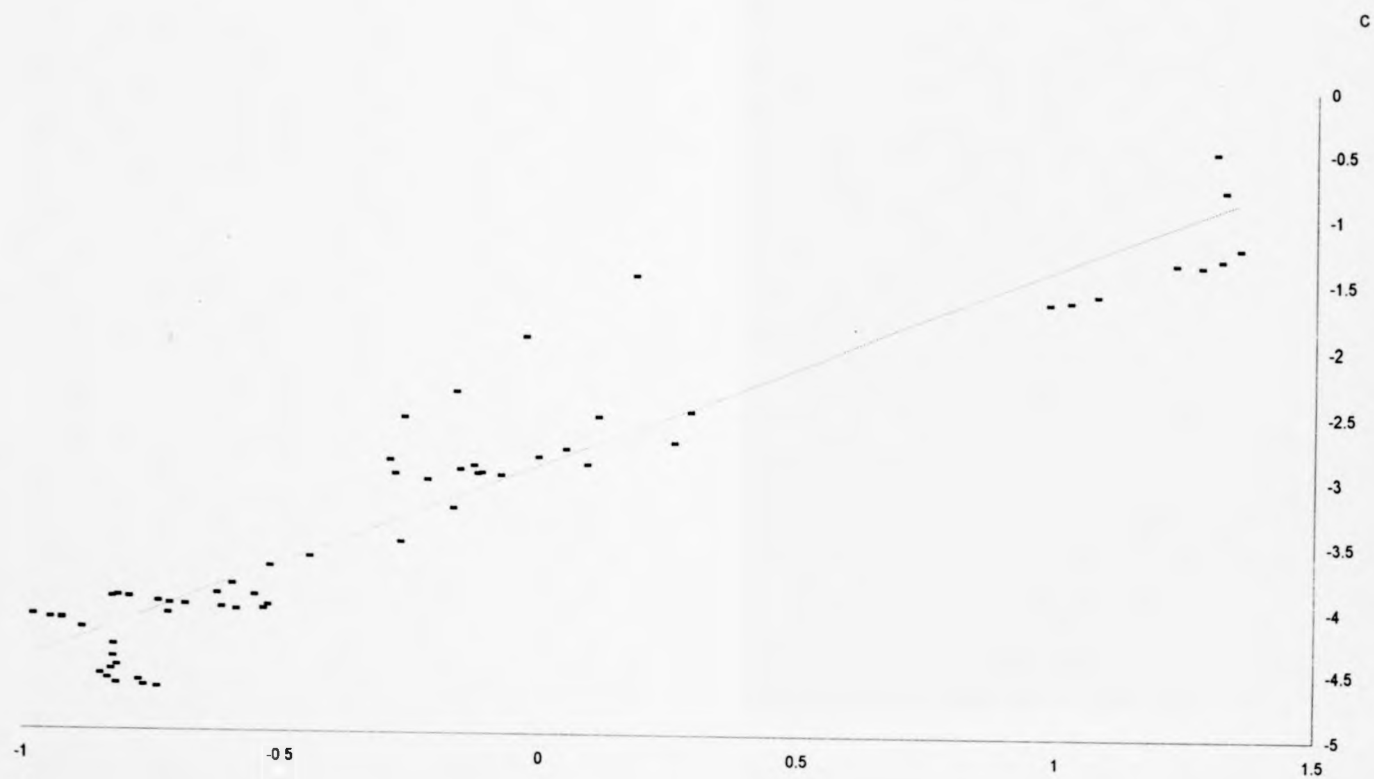
1) in first place, official foreign exchange markets have been, at least in the early 90's, very 'thin', as exporters were not willing to surrender hard currencies. As a matter of fact, foreign exchange supplies partly depended on the CBR deployment of reserves;

2) in second place, the rouble exchange rate was also critically influenced by all the complex surrender and exemption rules.

If, despite all these considerations, we plot the real exchange rate, e and real balances, l the following figure is obtained (Fig. 3.1).

[6] The nominal exchange rate is the monthly weighted average value in the Moscow Interbank Foreign Currency Exchange, money supply is M2, the price level is the CPI value. All variables are taken from Vol. 5 1 1996. Finally, the real exchange rate is defined as the fraction between the nominal exchange rate and domestic prices.

Fig. 3.1 OLS Regression between Competitiveness and Liquidity (April 91 - March 96)



which is remarkably similar to Fig. 2.5. Estimating an OLS regression we derive,

$$e = -2.92 + 1.52l$$

where both parameters are significant at the 1% level in terms of t ratio. The slope of this relationship can incidentally be compared to the value which we had previously calculated in Simulation A $(k = 1.31853)$[7].

It is not our intention to overplay the statistical significance of the above figure. While both variables have the same order of integration, the Engle-Granger procedure denies the existence of a cointegrated vector, at least for the case where the variables are expressed as logarithms. When, on the contrary, the real exchange rate and real balances are estimated in levels there is some evidence that a long run relationship between the two variables does exist - the residual of the regression is in fact integrated of order 0 at the 5% significance level.

In view of the data problems discussed here, we also explore whether the key Buiter Miller model economic insight is relevant for the Russian experience. According to this analysis, when expansionary monetary policies are expected, the real exchange rate has to be initially weak and recover thereafter to compensate for the low real interest rate[8]. As far as Russia is concerned, we believe that this is broadly consistent with our model. As suggested by Aslund, at the beginning of the adjustment process (Aslund, 1995:182):

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[7] It is also possible to establish a negative relationship between the black market exchange rate and real balances. We would obtain an almost identical visual pattern to Fig. 3.1 and, here as well, the parameters of the regression would be significant at the 1% level. This is not surprising, considering that both the official and the black market series have a similar trend (see Fig. 1.6). We have already discussed how throughout the first half of 1992 the official foreign exchange figures, as published in Russian Economic Trends, overestimate the undervaluation of the rouble. On the other hand the available black market sample series is much shorter - April 91 - November 92.

[8] Consider that $\frac{de}{dt} = i - \pi$

"the whole concept of commercial borrowing was alien to the socialist mind. In the old system, credit had been fairly automatic for big state enterprises, and much of enterprise investment had been funded through the state budget".

Large enterprises did not even need to borrow at demanding commercial rates as the CBR would deal with their debts. Of course all this could not possibly last for long. Soon managers had to learn to cope with rising real interest rates. While this took place, the real exchange rate gradually approached its estimated PPP value.

One further point should be emphasised. Several commentators have indeed recognised that, in line with our model Russian real balances adjusted slowly, at least relative to the highly inflationary climate. Of course, this is not surprising as time is generally necessary for economic agents to economise on cash holdings and for enterprises to speed up payments procedures.

If, however, we carefully inspect Fig. 3.2 there has been one exception to this general rule: Russian real balances suddenly collapsed in January 1992. To understand why this happened, recall that at the end of 1991 Russia was subject to price controls. For this reason, real balances continued to increase artificially, determining a lower interest rate and weaker exchange rate. When in January 1992 Gaidar finally decided to liberalise several administrative prices, a considerable reduction of the existing monetary overhang, and a sudden strengthening of the real exchange rate, were inevitable[7]. Our model does not describe all these events because it simply postulates a sluggish, but still flexible, price level. If temporary price controls were to be included, the analysis would account for the January 1992 fall in real balances. Nonetheless it would also become, at the same time, much more complex.

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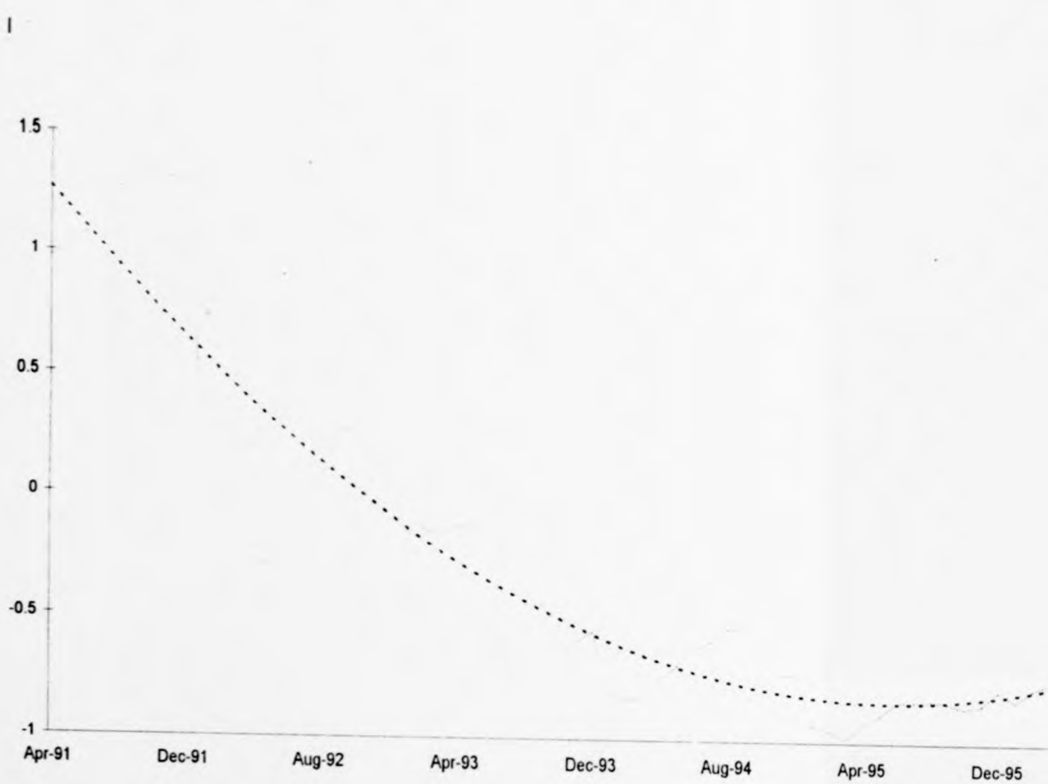
[7] The jump in the price level was essentially due to credit rather than to cash emission and hence for some time the Russian economy experienced a cash crisis.

Fig. 3.2 The Behaviour of Liquidity in Russia



3.3 Delegation of Monetary Policy to a Central Banker

Following the large amount of literature on the time consistency issue, the question to be posed is whether it is possible to improve on the time consistent solution by appointing an independent central banker (Rogoff, 1985). At the present stage of the analysis this has become a simple task to achieve. Let us, in fact, suppose that monetary policy is delegated to a central banker, who has the same loss function of the government but has a different weight for inflation equal to $\bar{a}$. The procedure which should be followed to determine the new time consistent paths is entirely analogous to the one that we examined in section 2.6. By simply substituting a with $\bar{a}$ in the loss minimisation process, we instantly find the correct solutions to our problem, similarly labeled as:

$$\bar{v}_s, \bar{\kappa}, \bar{\varphi}, \bar{l}, \bar{q}, \bar{c}, \bar{\pi}, \bar{\eta}$$

The associated loss is then derived by calculating the following expression[10]

3.1) $$L = \frac{1}{2}\int_0^\infty \left[a\bar{\pi}^2 + (\bar{\eta} - \tilde{\eta})\right]e^{-\theta t}dt$$

Here it is possible to examine how the solution paths change when monetary policy is assigned to a central banker. Above all, it is possible to verify whether the time consistency problem can be dealt with.

[10] The central banker perceives a higher loss equal to

$$L = \frac{1}{2}\int_0^\infty \left[\bar{a}\bar{\pi}^2 + (\bar{\eta} - \tilde{\eta})\right]e^{-\theta t}dt$$

To reach these objectives let us return to the same numerical example that we examined in *Time Consistency in an Open Economy, a-la-Dornbusch* (Simulation A). In Table 3.1 we report the results of our simulation, which are obtained by varying the degree of central banker aversion to inflation. For each different weight given to inflation, $\bar{a}$ we firstly derive the stable eigenvalue, $\bar{v}_s$, as the only negative solution to a fourth degree equation; we subsequently derive the slope of the stable eigenvector $\begin{pmatrix} 1 \\ \bar{\varphi} \\ \bar{\kappa} \end{pmatrix}$ and we, finally, calculate the time consistent paths for the endogenous variables, the associated loss, L and the steady state for real balances, $\bar{l}\,*$ and for inflation, $\bar{\pi}\,*$.

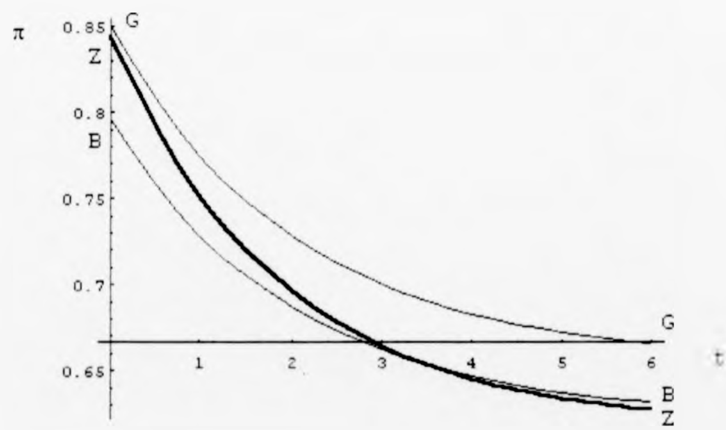
Table 3.1 The Consequences of Monetary Policy Delegation as a Function of the Central Bank Preferences

$\bar{a}$	$\bar{v}_s$	L	$\bar{l}\,*$	$\bar{k}$	$\bar{\varphi}$	$\bar{\pi}\,*$
0.01	-0.723657	98.2477	-3.95955	1.67935	0.003466	1.97978
1	-0.535966	80.7609	-1.97585	1.39578	0.12872	0.987927
2	-0.49172	28.3931	-1.3113	1.31853	0.156672	0.655565
2.16	-0.487628	28.359	-1.24414	1.31116	0.159223	0.622071
3	-0.472133	28.9077	-0.98097	1.28285	0.168768	0.490484
5	-0.454001	31.0749	-0.65235	1.24897	0.179773	0.32617
100	-0.42336	39.3077	-0.03857	1.1897	0.198195	0.019283

Among all the possible weights, $\bar{a} = 2$ is a special case, because the central banker has exactly the same preferences of the government and it is hence the 'government' time consistent solution, as was derived in section 2.6. In analogy to the classic time consistency literature, we verified that loss is higher with time consistent expectations ($L = 28.3931$) than with time inconsistent expectations ($L = 28.3568$). The first aspect to focus on is whether it is possible to improve on the time consistent solution by delegating monetary policy to a 'conservative' central banker. In our simulation, for example, the optimal central banker is indeed 'conservative' because he (or she) has a weight for inflation which is greater than 2, as it is equal to 2.16. If the optimal central banker is appointed, the loss is in fact reduced to 28.359, closer to the target of 28.3568 associated to the time inconsistent solution.

The second aspect to consider is to understand why loss diminishes by appointing an optimal central banker: for this reason we plot the time inconsistent (ZZ), the time consistent (GG) and the optimal central banker (BB) paths for inflation (Fig. 3.3)[11].

Fig. 3.3 The New Dynamics of Inflation with an Optimal Central Banker



[11] The time inconsistent paths are drawn as thicker lines for visual clarity

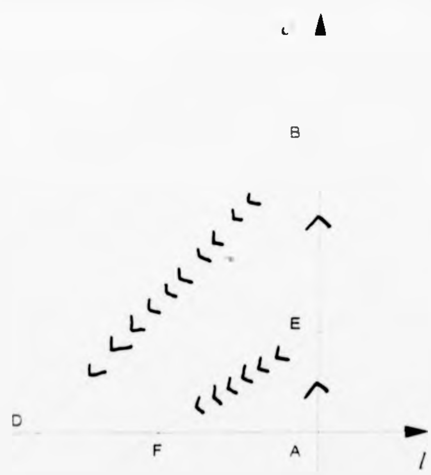
The interesting aspect of Fig. 3.3 is that the government time consistent path for inflation (path 'GG') is always above the corresponding time inconsistent path (path 'ZZ'). This is precisely what we expected, given that economic agents with time consistent expectations are able to foresee that the government wishes to inflate the economy more than it had first announced. As a consequence, there is a role for an optimally conservative central banker, because the corresponding solution path for inflation is lower (path 'BB'): an optimally conservative central banker is in fact capable of reducing the inflationary bias induced by the government's lack of credibility.

A first issue to address is the following: if the difference between the various solutions is quite small, then it becomes hardly worthwhile to appoint a central banker. Indeed, in our simulation the difference between the central banker solution and the time consistent solution is noteworthy, but not huge: for example, inflation is initially 5.5 per cent smaller with the optimal central banker than with the time consistent solution, with the difference progressively falling to 3.4 per cent. We leave to Appendix A & B to show how the larger the discount rate, ξ, and the semi-elasticity of money demand, λ, the stronger the case for appointing a conservative central banker. In Appendix C we also consider the special case where the discount rate is assumed to be equal to zero: in such a particular case, even if the time consistency problem does not disappear, monetary policy delegation turns out to be the wrong response.

A second important issue to concentrate on is the following: any evaluation error regarding the true preferences of the central banker may prove to be extremely costly. If, for example, the appointed central banker turns out to be a 'monomaniacal inflation fighter'[12] with a weight to inflation equal to $\overline{a} = 5$, the inflation path is extremely deflationary: thus it approximates rather poorly to the time inconsistent path and loss surges to 31.0749[13].

Consider how the main economic insight of the whole analysis, so far presented, can be summarised with just one figure. To show this we plot both the time consistent and the optimal central banker solutions, taking as coordinates the real exchange rate, c and real balances, l (see Fig. 3.4). Basically Fig. 3.4 is nothing more than an extension of the key Buiter Miller figure (Fig. 2.1) to a time consistency framework.

Fig. 3.4 Comparison between the Time Consistent and the Optimal Central Banker Solution: a Less Remarkable Undervaluation



[12] Term adopted in Blanchard (1989: 610).
[13] Conversely, in the traditional time consistency analysis it is shown that, in the absence of supply shocks, the more anti-inflationary the central banker, the lower the loss.

The time consistent adjustment path, which we looked at in the previous chapter, is labelled on Fig. 3.4 as BD. On the same figure we also plot now the stable manifold associated to the optimal central banker, here labelled as EF.

In section 3.2 we verified how in the early 90's the Russian adjustment process was effectively characterised by a simultaneous strengthening of the real exchange rate and a progressive fall in real balances. In terms of policy, our model seems to suggest that if only Russia had chosen an optimally conservative central banker, the adjustment path would have been still similar but less harmful. The Russian economy would have jumped to a point E, instead of B, and at the end of the adjustment process it would have reached steady state F, instead of D. In other words this analysis suggests that if a more credible central banker than Gerashchenko had been in control of monetary policy, financial markets would have correctly forecast the greater efforts to reduce monetary expansion. For this reason the real exchange rate undervaluation would have been less remarkable and so would have been the reduction of money holdings[14].

As a final consideration to this section consider what would have happened, for example, if a radically conservative central banker had been appointed: while this would have surely meant a considerably reduced real exchange rate undervaluation, nonetheless the chosen growth rate of money supply would have not been enough to guarantee a sufficient amount of seigniorage. This seems to indicate that under economic circumstances similar to those Russia was coping with, a certain degree of exchange rate undervaluation should be accepted.

[14] In order to apply the analysis to the Russian economic experience, we chose, in view of the large monetary overhang, a relatively 'high' value for real balances $(l_0 = 0)$. if, on the other hand, the process of economic convergence had begun with economic agents being short of liquidity, the adjustment process would have then been characterised by an 'overvalued' exchange rate (see Appendix D)

3.4 Alternative Monetary Arrangement: Optimal Feedback Solution

As described in the previous section, one way of dealing with the government lack of credibility is to delegate control of monetary policy to a conservative central banker. In such a way, it is possible to reach a suitable approximation to the ideal, but not attainable, time inconsistent solution.

The classic alternative to monetary policy delegation is to choose a feedback rule for monetary policy. Even in this theoretical framework, we can confirm the standard result that a properly chosen feedback solution is able to approximate the time inconsistent solution better than a conservative central banker.

To show this, assume that the growth rate of money is set as a linear function of the state variable, l,

3.2) $$\eta = \omega_1 + \omega_2 l,$$

and that the two parameters, ω_1 and ω_2 are constants.

The Buiter and Miller model is then reduced to the following system of differential equations:

3.3) $$\begin{bmatrix} \frac{dl}{dt} \\ \frac{dc}{dt} \end{bmatrix} = \frac{1}{\Omega}\begin{bmatrix} -\left(\phi\gamma\lambda^{-1} + \phi\gamma\omega_2\right) & -\phi\sigma \\ -\left(\lambda^{-1} + \omega_2\right) & -\phi\sigma \end{bmatrix}\begin{bmatrix} l \\ c \end{bmatrix} + \frac{1}{\Omega}\begin{bmatrix} -\phi\gamma\omega_1 \\ -\omega_1 \end{bmatrix}$$

Moreover, we determine that the steady state value for real balances is still negative,

3.4) $$l^* = -\frac{w1}{\lambda^{-1} + w_2}$$

and the steady state real exchange rate returns to equilibrium,

3.5) $$c^* = 0 .$$

If we impose the assumption that the forward looking variable jumps on the stable manifold, the solutions are then equal to the following equations:

3.6) $$l = (l_0 - l^*)e^{\rho_s t} + l^*$$

3.7) $$c = \theta_s(l_0 - l^*)e^{\rho_s t}$$

where ρ_s is defined as the stable eigenvalue of the system and $\begin{pmatrix} 1 \\ \theta_s \end{pmatrix}$, as the stable eigenvector. Defining Γ as:

3.8) $$\Gamma = \frac{\phi\gamma\lambda^{-1} + \phi\sigma\theta_s + \omega_2}{\Omega}$$

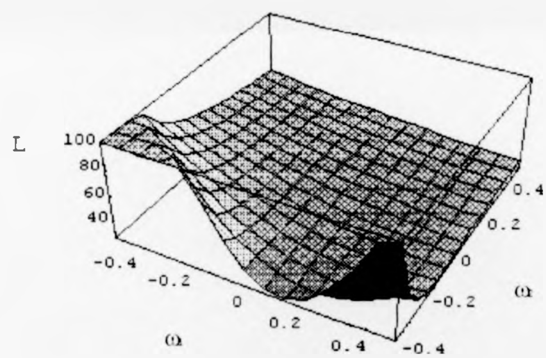
inflation and monetary growth can be shown to be equal to:

3.9) $$\pi = \Gamma(l_0 - l^*)e^{\rho_s t} - \lambda^{-1} l^*$$

3.10) $$\eta = \omega_2(l_0 - l^*)e^{\rho_s t} - \lambda^{-1} l^*$$

Let us now assess whether is possible, for the same parameter values of Simulation A, to improve on the time consistent solution with an optimal feedback rule. To each set of parameters, ω_1 and ω_2, a different solution path corresponds for inflation and monetary growth and a different loss level, L. Loss can hence be plotted as a function of the these two parameters, ω_1 and ω_2:

Fig. 3.5 Three-Dimensional Plot of Loss as a Function of the Two Parameters of the Feedback Rule



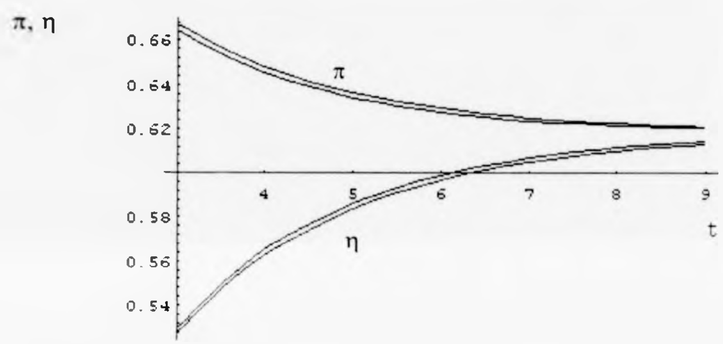
For the parameters above chosen, the three dimensional function has a minimum at the following values.

$$\omega_1 = 0.1888$$

$$\omega_2 = -0.3483$$

which determine the optimal feedback rule. We can verify that the corresponding solution paths for inflation and the growth rate of money (Fig. 3.6) are a very good approximation to the time inconsistent paths,

Fig. 3.6 Resemblance between the Optimal Feedback Rule and the Ideal Time Inconsistent Solution



For this reason, it is not surprising that loss is reduced to 28.3569, getting closer to the level which corresponds to the time inconsistent solution.

Table 3.2 Short Summary of Solutions

	Government Solution	Optimal Central Banker Solution	Optimal Feedback Solution	Time Inconsistent Solution
Loss	28.3931	28.359	28.3569	28.3568
Steady State Inflation	0.6556	0.6221	0.6185	0.6197

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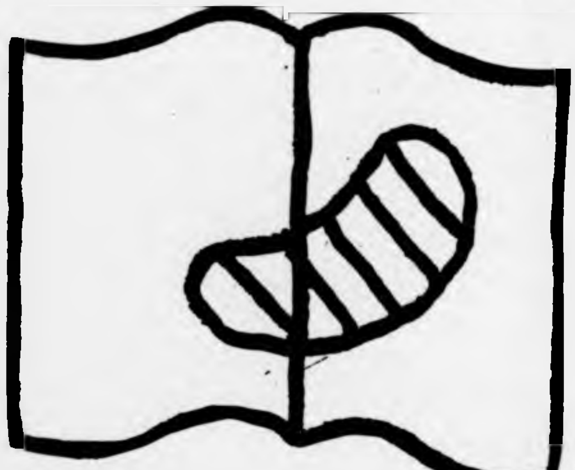


The approximation to the time inconsistent solution has improved for the reason that when a feedback rule is chosen it is possible to control two weights, ω_1 and ω_2, while when a central banker is appointed only one, $\bar{\alpha}$[15]. Some doubts, of course, remain on whether it is really feasible to establish a feedback rule which the government cannot suddenly render - when the right time comes - null and void[16].

---

[15] Associated to each $\bar{\alpha}$ a pair of parameters ϖ_1 and ϖ_2 corresponds. We verified that the solutions determined with the Cohen and Michel technique for any $\bar{\alpha}$ [illegible] solutions determined with ϖ_1 and ϖ_2 are identical

[16] Such issue is beyond the purposes of our thesis

3.5 Currency Substitution Extension

Up to now we have emphasised how the need to print money for financial purposes raises a time consistency issue concerning the control of monetary policy. The main economic argument is that the financial markets of a country which relies on seigniorage to finance its debt is able to foresee that the government has an incentive to promise a future rigorous monetary policy, but not to honour its commitment. This ability to anticipate the real policy tends to weaken the exchange rate.

Henceforth, the important message of the model in terms of policy is that macroeconomically unstable countries, as for example Russia in the early 90's, would be better off by delegating monetary policy control to a conservative central banker. The basic economic insight is that the greater credibility of the central banker strengthens the exchange rate, dampening hence both demand pressure and inflation.

To get to these conclusions we examined the time consistency problem in the dynamic framework of a Dornbusch open economy. Our approach has been to extend the Buiter and Miller model by assuming that monetary policy was no longer exogenous but was rather endogenously determined by the government as the solution to a loss minimisation problem.

However, among all the assumptions of the Dornbusch literature there is one which requires perfect capital mobility. As previously mentioned, this hypothesis does not seem entirely plausible for countries in great financial difficulties. The key argument is that, in these circumstances authorities, generally adopt restricting measures with the objective to impede the development of flight of capital.

For this reason we believe that it is preferable to begin with the alternative assumption of currency substitution between domestic and foreign assets.

Given the above considerations, let us go back to the currency substitution model that we examined in *Exchange Rate Undervaluation in the Absence of Perfect Capital Mobility: the Russian Case*. We discussed how its general structure appears at first quite complex because it involves three different variables - the real exchange rate, e, real balances, l and stock of foreign exchange, x. However, it has proven to be possible to simplify the model without losing its basic insight. The reason is that two variables, real balances, l and stock of foreign exchange, x have the distinctive feature of being negatively correlated.

From an economic point of view this seems to be fairly reasonable: when economic agents switch their wealth away from money holdings, hard currencies are precisely what they are most likely to invest in.

From a mathematical point of view this relationship is described by the following equations (see chapter 1):

3.11) $$\frac{dx}{dt} = -\mu\rho^{-1}\frac{dl}{dt}$$

3.12) $$x = -\mu\rho^{-1}l$$

The logical implication of all these considerations is that the model that we presented in chapter 1 can be, for the present purposes, expressed as a function of the real exchange rate, c and of real balances, l :

3.13)
$$\begin{bmatrix} \frac{dl}{dt} \\ \frac{dc}{dt} \end{bmatrix} = \begin{bmatrix} 0 & -\delta \\ -\lambda^{-1}\left(1+\mu\delta^{-1}\right) & \lambda^{-1}-\rho \end{bmatrix} \begin{bmatrix} l \\ c \end{bmatrix} + \begin{bmatrix} 0 \\ -\eta \end{bmatrix}$$

The crucial and surprising feature is that, although the model starts from the hypothesis of currency substitution, it has nonetheless a dynamic structure which is extremely similar to the one of the Buiter and Miller model (compare 3.13 with 2.24 & 2.25).

This is an extremely helpful property: as a direct result it becomes absolutely straightforward to endogenise monetary policy in perfect analogy to the way this was accomplished in *Time Consistency in an Open Economy, a-la-Dornbusch*. It is therefore possible to examine what are the consequences of the government's lack of credibility on the stock of foreign exchange held by the private sector in a different economic setting, characterised by currency substitution.

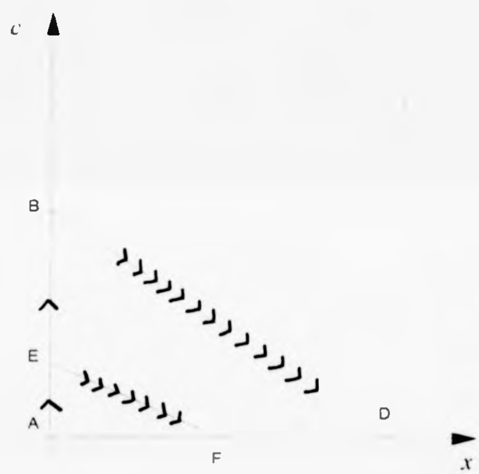
Suppose that the government minimises once again the following loss function:

2.29)
$$L = \frac{1}{2}\int_0^\infty \left(a\pi^2 + (\eta - \bar{\eta})^2\right)e^{-\theta t}dt$$

subject to the system of differential equations 3.13).

With the same mathematical techniques employed in *Time Consistency in an Open Economy, a-la Dornbusch*, it is possible to derive the time inconsistent, time consistent and the optimal central banker solutions. Consider how the economic insight of such analysis can be summarised by the following figure.

Fig 3.7 Optimal Monetary Policy Delegation in an Economy without Perfect Mobility of Financial Capital



Given our initial conditions, the economy starts off at point A. Suppose, to begin with, that the government is in control of monetary policy. Once again, the government has the incentive to promise a tight monetary policy but time consistent financial markets foresee that the government is unlikely to keep faith with this commitment. Since financial markets expect an inflationary monetary policy, they increase their foreign exchange demand to defend themselves from the forthcoming losses. As a result, demand for foreign exchange largely exceeds the supply of foreign exchange available in the domestic economy.

The implication is that the real exchange rate must devalue at once - jumping from point A to point B - to allow the necessary net accumulation of foreign exchange, by attracting tourists and making exporters more competitive. The real exchange rate has to remain weak for some time to allow the process of internal capital flight to continue until financial agents are able to fully satisfy their portfolio demand of foreign exchange. On Fig. 3.7 the economy gradually slides from point B to point D, which is the new steady state of the system.

On the other hand, consider what happens if monetary policy is delegated to an optimal central banker. Time consistent economic agents still expect an inflationary process but a smaller one: hence they reduce foreign exchange demand. As a consequence the real exchange rate needs to devalue less, because the net accumulation of foreign exchange has to be not as great. The economy jumps now from point A to E, before gradually sliding to F[17]. Henceforth, by appointing a conservative central banker the overshooting effect and internal capital flight are reduced.

[17] An interesting point of this analysis is that when internal capitla flight increases contemporaneously liquidity must fall. Therefore this currency substitution model can also be graphically represented with Fig 3.4. For this reason, it is perfectly consistent with the evidence shown in section 3.2.

3.6 Final Remarks

Economies in great financial difficulties, such as Russia, are frequently characterised by a large undervaluation of the exchange rate. To shed some light on this, we have extended the logic of the Dornbusch model to a time consistency framework, emphasising how expectations of future monetary policies play a decisive role. As far as Russia is concerned, there seems to be some evidence which broadly supports this theoretical analysis.

This begs the question whether institutional reform would have been the appropriate response to the government policy credibility problem. Recent literature has explored, for example, the possibility of a currency board system.

The key policy implication we have explored in this chapter is whether it would have been possible to ease the Russian policy credibility problem by appointing a conservative central banker. Indeed, the standard result that monetary policy delegation successfully enhances the credibility of a stabilisation programme holds here[18].

[18] However, it is important to keep in mind that it would have been harmful if Russia had appointed a too radically conservative central banker as the chosen deflationary monetary policy would not have generated an adequate amount of seigniorage. In addition, there is another reason why the central banker should not be too conservative. If monetary policy is in fact delegated to a radically conservative central banker, time consistent financial agents foresee future restrictive monetary policies: hence the exchange rate response is to revalue at once. Inevitably the greater strength of the exchange rate has a recessionary effect on the economy, harming the export sector. As a matter of fact until now we have ignored the importance of output, since our discussion has largely focused on the seigniorage issue. From a technical point of view, it is possible to capture the above economic insight by extending the Kydland and Prescott model to a sticky price open economy setting - with the same mathematical techniques adopted so far. Let us suppose that the government minimises one of the two following loss functions

A) $$L = \frac{1}{2}\int_t^{\infty}\left(a\pi^2 + (y-\tilde{y})^2\right)e^{-\vartheta t}\,dt$$

B) $$L = \frac{1}{2}\int_t^{\infty}\left(a\pi^2 - 2y\right)e^{-\vartheta t}\,dt$$

What is very interesting, in our view, is the possibility of extending the key Buiter Miller figure to the context of monetary delegation. Our study reaches the conclusion that if Russia had replaced Gerashchenko by appointing a suitably conservative central banker, the adjustment path would have remained similar but less harmful. Enhanced credibility signifies both a smaller real exchange rate undervaluation and larger liquidity (see Fig. 3.4).

Furthermore, we have proposed in this chapter an extension of the model by letting currency substitution, between domestic and foreign assets, be the alternative assumption to perfect mobility of financial capital. This framework provides some interesting economic insights, which seem to broadly describe the Russian stabilisation process. While the dynamic structure of the model remains largely similar - being consistent with the empirical evidence of a negative relationship between competitiveness and liquidity - the economic interpretation is considerably different.

Here, the weakness of the exchange rate basically reflects a large huge stock demand for foreign exchange. Even more important is that economic agents are able to substitute for local currency into foreign currency, not through capital account, but via the current account, which is what is meant by saying that capital flight is internal. Finally, the research that we have developed here yields the following interesting result: the appointment of a conservative central banker in Russia would have also meant a reduction in internal capital flight (see Fig. 3.7).

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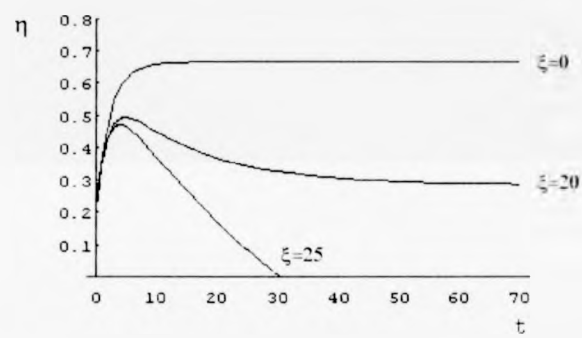
subject either to the Buiter and Miller model (presented in section 2.3) or to the currency substitution model (presented in sections 1.2 and 3.5). The next step is to derive the time inconsistent, time consistent and optimal central banker solution. The second loss function turns out to be the easier of the two, as the stable eigenvector coefficient, φ, is always equal to zero. It also turns out that this allows one to proceed analytically rather than with simulations.

Appendix A

The Impact of the Discount Rate

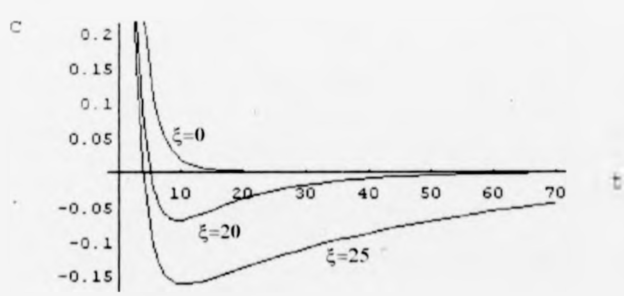
In this appendix we wish to investigate what role is played in our analysis by the discount rate, ξ. A priori, we expect that the larger the discount rate, the greater is the incentive to distort the future to improve the present economic performance. To verify whether this is the case we plot the optimal time inconsistent monetary policy, for different values of the parameter ξ, while maintaining the other parameters as in Simulation A. For example, in Fig. A1 we chose ξ to be equal to 0, 20, and 25.

Fig. A1



As expected, the greater the discount rate the greater the distortion of the steady state. For example, if the discount rate is as large as 20, the time inconsistent monetary growth converges to 28.6 per cent and therefore the distortion is, roughly, equal to 38 per cent. The value of the discount rate also affects the shape of the real exchange rate as depicted in Fig. A2:

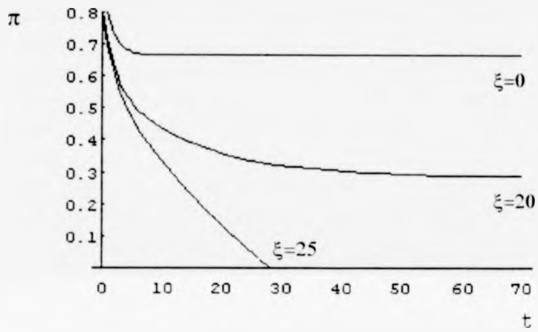
Fig. A2



With a large discount rate, the real exchange rate is relatively strong for most of the process of adjustment, as it correctly anticipates the future recessionary monetary policies.

Finally, in Fig. A3, we plot inflation, which depends both on the optimal growth rate of money, through core inflation, and on the real exchange rate, through the effect of competitiveness on demand:

Fig. A3



With a large discount rate we expect the problem of time inconsistency to be more important, as a large distortion reveals itself to be unrealistic with the elapsing of time. Repeated simulation analysis indeed confirms that the greater the discount rate, the greater the gap between the time inconsistent and the time consistent paths[19]. Hence it becomes more important to appoint a conservative central banker, or, alternatively, to establish a tight feedback rule. Simulation analysis in fact confirms that the larger the discount rate the more conservative the optimal central banker and the tighter the feedback rule need to be[20].

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[19] This confirms the result by Miller, Salmon and Sutherland (1991 147) that "the discounting exacerbates the inefficiency of the time consistent policy"

[20] Let us suppose, for example, that the discount rate increases from $\xi = 0.05$ to $\xi = 0.1$ It can be shown that the gap between the time inconsistent and the time consistent solutions becomes larger Simulation analysis confirms that the higher discount rate, the more conservative the optimal central banker should be in this particular case the weight on inflation must be equal to $a = 2.28$ (Table A1)

Table A.1

a	v	L	$l*$	$k*$	φ	π
0 01	-0 723634	57 9743	-3 95882	1 67932	0 003349	1 97941
1	-0 535544	17 5139	-1 95546	1 39506	0 12318	0 977729
2	-0 491377	14 8986	-1 29264	1 31791	0 149393	0 646322
2 28	-0 484316	14 8426	-1 17689	1 30516	0 153485	0 588446
3	-0 471855	15 0219	-0 96523	1 28234	0 16062	0 482617
5	-0 453804	15 9668	-0 64061	1 2486	0 170814	0 320304
100	-0 453804	15 9668	-0 64061	1 2486	0 170814	0 320304

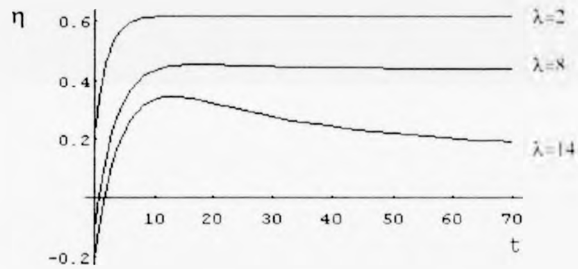
Appendix B

The Impact of the Semi-Elasticity of Money Demand

Another crucial parameter of the analysis is the semi-elasticity of money demand, λ. In the traditional Buiter and Miller model, the exchange rate overshooting is particularly sensitive to the semi-elasticity of money demand. For a given exogenous monetary policy, the larger λ is the greater the 'jump' of the exchange rate. In our analysis, however, the growth rate of money is endogenous and, hence, is also a function of the semi-elasticity of money demand.

We plot in Fig. B1, the optimal time inconsistent paths of the growth rate of money for three different values of the parameter λ, equal to 2, 8, and 14

Fig. B1



When λ is large, since the exchange rate is very sensitive to an expansionary monetary policy, the optimal monetary policy has to be relatively tight to avoid huge inflation. When λ is large, moreover, there is a great incentive for the government to distort the future, because the immediate benefit is considerable, due to the large overshooting effect.

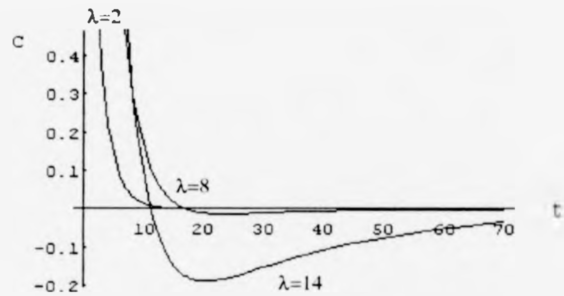
The larger the discount rate, the greater the scope for a central banker, or for a feedback rule, but the greater also the associated distortion of the steady state. With $\xi = 0.1$, for example, the distortion is roughly equal to 7 8 per cent with a central banker, and equal to 9 6 per cent with a feedback solution (see Table A2)

Table A2

	Government Soution	Optimal Central Banker Solution	Optimal Feedback Solution	Time Inconsistent Solution
Loss	14 8986	14 8426	14 8324	14 83195
Steady State Inflation	0 6463	0 588446	0 5699	0 5614

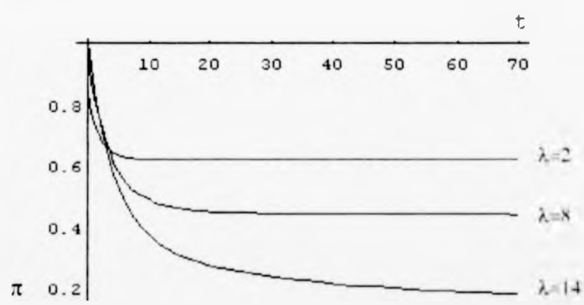
It is interesting how the real exchange rate is affected by the value of λ:

Fig. B2



The larger λ is, the more sensitive the exchange rate becomes to monetary policy, and hence, the overshooting effect increases, despite monetary policy being tighter. However, the larger λ is the more sudden the real exchange rate revaluation, since it anticipates the future distortion of monetary policy. The overall impact on inflation is pictured in Fig. B3:

Fig. B3



As in the case of a large discount rate, with a large semi elasticity of money demand, the time inconsistency problem becomes more serious, since the government does not have the incentive to deflate the economy as much as it had announced. Finally, simulation analysis suggests that the larger λ is the more conservative the central banker, and the tighter the feedback rule should be, to approximate the time inconsistent solution.

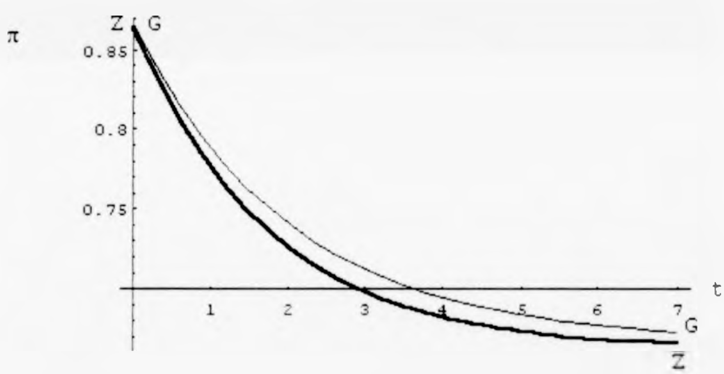
Appendix C

Do We Have a Time Consistency Problem if the Discount Rate is Equal to Zero?

We discussed in Appendix A how the larger the discount rate, the greater the scope for appointing a central banker or for choosing a tight feedback rule. It is interesting, therefore, to verify whether there is still a time inconsistency problem, if the discount rate is equal to zero.

In the following Simulation B, we keep the same values for all the parameters as in Simulation A, except that we now suppose the discount rate to be zero. Plotting the time inconsistent (ZZ) and the time consistent solution for inflation (GG), we obtain the following figure:

Fig. C1

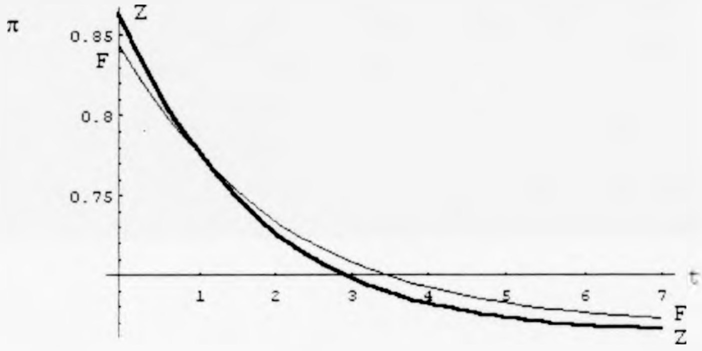


which is interesting for two reasons. The first is that the time consistent solution is again above the time inconsistent solution, suggesting that the government still has the incentive (although less than before) to inflate the economy more than it had initially announced. Thus we establish that, even when the future is considered to be as important as the present, the government still wishes to cheat. The second interesting aspect is that the time inconsistent solution converges to 0 666 and hence there is no distortion at all of the steady state. A distortion of the steady state, in fact, has to be avoided precisely because its infinite cost would not be discounted

In growth theory, a distortion of the steady state level of capital is only justified if the discount rate is positive. Similarly, in our model, the distortion of the steady state inflation is only justified when the discount rate is positive. The clear implication is that it is not appropriate to appoint a conservative central banker if the discount rate is positive, because it would bring about a permanent distortion of the steady state.

Nonetheless, it is still possible to reduce the time inconsistency problem by carefully choosing the feedback rule. In fact, with a feedback rule it is possible to control two weights, ω_1 and ω_2, and there are, hence, two degrees of freedom. Given a zero discount rate, one weight (i.e. one degree of freedom) is 'lost' to ensure that there is no distortion of the steady state. The other weight, instead, can be chosen to achieve a better approximation to the time inconsistent solution. Following this strategy for the parameters of Simulation B, we derive the optimal feedback solution. Plotting the feedback solution (FF) and the time inconsistent solution (ZZ) here below.

Fig. C2



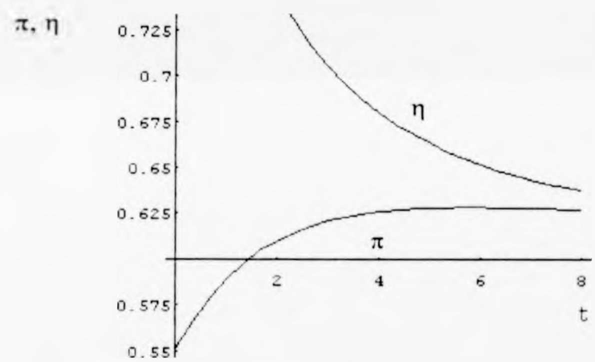
we see how the feedback solution is a good approximation to the time inconsistent solution

Appendix D

The Impact of the Initial Value of Real Balances

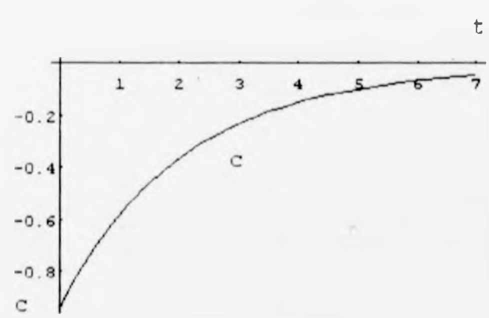
In Simulation A, the initial value of real balances was supposed to be equal to zero in view of the large monetary overhang in Russia. Conversely, let us now assume in the following Simulation C a 'low' initial value for real balances (equal to $l_0 = -2$), while keeping the same values we had before for all the remaining parameters. Since the steady state money real balances is unchanged at $l^* = -1.24$, it becomes necessary, this time, that real balances increase during the adjustment process. The implication is that there must be a 'negative' gap between inflation and monetary growth (equation 2.51). If we plot in Fig. D1 the optimal time inconsistent paths for both the growth rate of money and inflation paths, in fact we have:

Fig. D1



The first reason why inflation is below the growth rate of money is that during the process of adjustment the real exchange rate is 'overvalued', as shown in the following figure:

Fig. D2



The second reason for inflation to be below the growth rate of money is that the real exchange rate devalues in the process of adjustment, and hence the real interest rate is positive, dampening demand.

The conclusion is that the shape of the time inconsistent paths critically depends on the initial state of the economy. The real exchange rate is a particularly sensitive variable. If there is an initial monetary overhang, the exchange rate devalues (both in nominal and real terms), while, on the other hand, if there is an initial lack of liquidity, the exchange rate appreciates. A low initial value for real balances does not prevent, however, the time inconsistency problem to arise. The government, in fact, is still tempted to promise an unrealistically tight future monetary policy to encourage a stronger revaluation of the exchange rate aiming at reducing inflation. As before, the time consistent solution turns out to be more inflationary than the time inconsistent solution and thus it is again possible to better approximate the time inconsistent solution by appointing a central banker or by establishing a feedback rule. The final surprising feature of the model is that the optimal central banker and the optimal feedback rule depend on the initial value of real balances. For example the optimal central banker has a weight for inflation equal to 2.13 while for Simulation A the optimal weight is 2.16 (see Table D1).

Table D1

a	v	L	l^*	$\bar{\kappa}$	$\bar{\varphi}$	$\bar{\pi}^*$
0.01	-0.723657	86.8805	-3.95955	1.67935	0.003466	1.97978
1	-0.535966	29.7308	-1.97585	1.39578	0.12872	0.987927
2	-0.49172	25.8732	-1.31113	1.31853	0.156672	0.655565
2.13	-0.488358	25.8514	-1.25618	1.31247	0.158756	0.628088
3	-0.472133	26.3977	-0.980968	1.28285	0.168768	0.490484
5	-0.454001	28.4463	-0.652353	1.24897	0.179773	0.326176
100	-0.423336	36.1724	-0.038566	1.1897	0.198195	0.019283

Chapter 4

Internal Capital Flight in a Black Market Exchange Rate Economy

4.1 Introduction

This essay singles out the reasons why black market exchange rates develop and what are the likely consequences on the remaining macroeconomic system. The analysis has so far largely ignored the possibility of foreign exchange leakages between official and black markets. It is worth noting that to include two exchange rates, foreign assets and leakages in one single model has a cost in terms of techniques and economic tractability. For this reason, the task of specifying a formal framework for discussing the effects of monetary and exchange rate policies on the black market premium, was left to this final essay.

Our motivation for this study derives from the empirical observation that several unstable economies with high inflation policies are characterised by foreign exchange leakages. The essay proceeds as follows. Section 4.2 highlights, first, the economic rational for the restrictive foreign exchange policies that cause the emergence of black markets. Second, in section 4.3 we briefly review some of the economic insights provided by the existing literature. Finally section 4.4 presents a stylised black market exchange rate model.

Our discussion starts from the following consideration: as is recognised by the existing literature, one important factor originating a black market exchange rate is the policy makers attempt to keep the domestic currency artificially overvalued. This has been, for example, the experience of several African and Latin American countries in the past.

Whatever the reasons for this policy may be, one thing should be immediately clear: it is neither convenient nor sustainable to maintain in the long run an overvalued exchange rate unless current account convertibility is restricted. To show this, assume without loss of generality that the foreign currency considered is the dollar and define the exchange rate as the price of foreign currency. Let us subsequently represent demand and supply for foreign currency as a function of the real exchange rate (see Fig. 4.1). Dollars are demanded from importers, who need to buy foreign goods and supplied by exporters selling the foreign currency gained abroad[1]

[1] In general the slope of the supply curve is ambiguous but if the domestic country is small it will be positively sloped (Williamson, 1991: 192-200).

Fig. 4.1 Demand and Supply in the Foreign Exchange Market

When the exchange rate is kept at an overvalued level demand for dollars exceeds supply. If the country does not experience generous capital inflows, the authorities can sell foreign reserves to satisfy, as a temporary measure, the excess in dollar demand[2]. However, this depletion of foreign reserves cannot last forever and it ultimately becomes necessary to impose some form of exchange rate restrictions in the official markets (Culbertson, 1989:1908). Thus, these economies are typically characterised both by limited current account and no capital account convertibility.

[2] Capital flows may sustain the domestic currency, but at a certain point if the trade balance continues to worsen, the fear of a possible devaluation is likely to prevail

A direct consequence of the lack of convertibility is that unsatisfied demand for hard currency spills over into the black market. Such a demand has a double nature (Dornbusch and Kuenzler, 1993:107):

> "First, the rationing of foreign exchange by quotas, licenses, absolute restrictions, or special exchange rates gives rise to a demand for foreign exchange to finance illegal imports and outlays abroad. Second, there is a portfolio demand for foreign exchange that needs to be satisfied in a black market if the government does not sell foreign exchange for that purpose, but economic agents want to hold foreign assets."

Once exporters recognise the existence of this residual demand they may be willing to divert part of their foreign exchange into the parallel market. Trade misinvoicing is of course awarded with a black market premium. Thus, exchange rate black markets have a 'social' function because they allow economic agents to satisfy their foreign exchange demand.

In connection to this last consideration recall what we discussed in *Exchange Rate Undervaluation in the Absence of Perfect Capital Mobility: the Russian Case*. The accumulation of foreign exchange as a store of value in that essay was described as 'internal capital flight'. Such name was used for the reason that internal capital flight is a common alternative to real capital flight whenever capital account restrictions are in place. As an example we described in that essay Russia's economic experience. We suggested that the accomplishment of current account convertibility in July 1992 and the simultaneous development of flexible (interbank and auction) exchange rate markets meant that hard currency demand could be satisfied, for the most part, through legal means.

However, whenever policy makers decide to restrict current account convertibility as well as capital account convertibility, hard currency demand turns to black markets. In other words black markets provide an ultimate mechanism for foreign exchange accumulation. This process could be thought as yet another kind of internal capital flight, with the difference that this time foreign exchange is channelled illegally.

4.2 Economic Rational for Restrictive Foreign Exchange Policies

Before going into the details of the analysis it is natural to try to understand why governments adopt restrictive policies that cause the emergence of black markets. One straightforward reason why the authorities may be tempted not to allow current account convertibility is the need of revenue. Multiple exchange rates, for example, are often devised with this intention. What policy makers do, is to select a set of overvalued exchange rates, which apply to exports, at the same time as to ration the demand-side of foreign exchange markets. Import rationing can be achieved either by devising a system of licenses or by selling foreign exchange at unfavourable prices.

In both cases the consequence is a strong incentive for importers to operate through illegal markets. For example, we described in section 1.12 that the Soviet Union has been characterised by a complex system of multiple exchange rates, which lasted up until January 1992. Therefore it is not surprising that in those years black markets for foreign exchange held a quite significant role.

Revenues may also be earned by the state without requiring a multiple system of exchange rates but just by keeping the official exchange rate overvalued whilst rationing foreign exchange demand. A strong exchange rate, indeed, acts like an implicit tax on exports. For oil exporting countries this may be a considerable source of revenue.

For example, in Russia during the pre-unification period, between January and July 1992, the structure of surrender requirements guaranteed the Russian authorities a significant revenue. The reason is that the export sector was subject to an overvalued 'effective exchange rate' whilst the import sector, except for centralised imports, was offered foreign exchange at unfavourable prices (see section 1.13 and Table 130). In addition, the Central Bank of Russia provided the necessary resources to ensure that auction markets would take place in several circumstances. Therefore a supplementary source of revenue for the state depended on the spread between the auction rate, at which foreign exchange was sold, and the effective exchange rate, which applied to exports (see Fig. 1.2). In short, during the pre-unification period there was a clear incentive to exchange currencies on the black markets.

We have already suggested that one of the aims of Gaidar's reforms was to encourage exporters to act trough legal channels both by lessening the foreign exchange surrender rules and by establishing current account convertibility. After the July 1992 foreign exchange reforms, the more favourable surrender rules and the further development of auction and interbank markets allowed hard currency stock demand to be, to a great extent, satisfied through legal means. Over time, the black market exchange rate premium became a less significant variable in Russia[3]

Apart from the revenue motivation, there may be additional explanations for an overvalued exchange rate, even though overvalued exchange rates may be extremely

[3] To keep the analysis simple the model presented in chapter 1 assumed current account convertibility while neglecting foreign exchange leakages. Moreover, in section 1.4 we investigated the role of export taxation. Briefly summarising, we developed a dual exchange rate model, which did not admitted foreign exchange leakages. By contrast in this essay we take into account the possibility of foreign leakages.

dangerous[4]. Let us now review some of the economic circumstances when this may take place[5]:

a) Nominal Anchor

To begin with, sometimes it is the monetary authorities explicit policy to fix the exchange rate or to establish a crawling peg in the hope of importing low inflation and credibility from abroad. This, indeed, is a typical response of countries experiencing a process of hyper-inflation. If, however, wages and prices fail to adjust, a quick appreciation of the real exchange rate might develop, putting the entire export sector at risk. If there are no capital inflows, as soon as the country runs out of reserves, the monetary authorities are forced to either devalue or restrict currency convertibility. With regard to this, there is indeed an ongoing debate on whether the exchange rate should be a policy tool to achieve real targets or whether it should be the nominal anchor in stabilisation attempts. This debate was for example reviewed by Corden (1993).

b) Expansion in Domestic Demand

An increase in government spending may induce households to spend more on imports. Exporters have the incentive to bring back some of their exports into the domestic market. As a consequence the old exchange rate becomes overvalued.

[4] As pointed out by Dornbusch (1988), if the overvauation of the exchange rate persists for only few years the entire exportable sector may well be at risk, especially if exportables are easy to substitute. This is the case when exports are goods characterised by a low technological input.
[5] The analysis broadly follows Dornbusch (1988).

c) Oil Import Price Increases

If oil imports become more expensive, the domestic country reacts by reducing oil consumption. The overall effect on demand for dollars therefore depends on import elasticity, but in general the demand for dollars increases and as a result the domestic currency is overvalued.

d) Loss of Export Revenue

This may happen either when there is a recession abroad or when the price of one important export good falls. The direct consequence is that exporters supply less dollars to the foreign exchange market, and inevitably, the currency becomes overvalued.

e) Attempt to Hinder an Exchange Rate Collapse

In the previous essays we described how countries in great need of seigniorage may be characterised by a very weak official exchange rate for the reason that economic agents correctly foresee future loose monetary policies. Under these circumstances foreign exchange demand has a portfolio component as well. The exchange rate weakness allows an enhanced competitiveness of the exporting sector matched by the required hard currency inflow. Policy makers typically become anxious about the extent of the exchange rate undervaluation: often their response is to keep the official exchange rate artificially strong either through foreign exchange market intervention or by limiting the degree of convertibility of domestic currency. Once more frustrated demand for hard currency is then diverted to black market exchange rates, especially so if the authorities persist with highly inflationary monetary policies. The exchange rate undervaluation ends up being transferred from the official to the black exchange rate market.

f) Exchange Rate as an Instrument of Commercial Policy

Sometimes exchange rates and rationing are used as instruments of commercial policy to favour specific categories of importers over others[illegible]. In particular, importers of consumer goods are often penalised in the belief that a process of industrialisation starts off by favouring the acquisition of capital goods.

g) Corruption

Finally, officials and bureaucrats may have an interest in maintaining a two-tier exchange rate system, as they are likely to have easy access to cheap dollars through the official market and make an easy profit by selling them on the parallel market.

[illegible] This is sometimes accomplished with a system of multiple exchange rates

4.3 Some Interesting Ideas from the Existing Literature

The number of papers on the black market exchange rate is quite impressive, even if most of them have been published separately and the issue has generally failed to have an important role in standard economic textbooks. Our general impression is that although several themes are common to most of the literature there is not as yet a unique and fully satisfying methodology. The reason can probably be accounted for by the great difficulty of modelling in a formal framework two exchange rate markets where both cheating and convertibility rules hold a vital role. In our view, key papers of the existing literature are the four following articles: Dornbusch et al. (1983), Pinto (1989), Morris (1995) and Agenor and Flood (1992).

The classic paper remains the article by Dornbusch et al. The question the authors try to answer is relatively simple: what happens in a black market economy when money supply is expanded?

To tackle this question the authors need to postulate how money demand behaves. The great contribution of such authors to the black market literature is to assume that even in such economic setting there is currency substitution between domestic money and foreign money. To be more precise, economic agents are supposed to demand a given proportion between domestic and foreign assets, which in turn depends on the difference between their expected rate of return. The thrust of the Dornbusch et al. analysis is that the ratio between domestic money and foreign currency is constant in the steady state; domestic residents are hence prepared to hold a higher level of money balances only if they can accumulate foreign currency as well. A short run increase in the black market premium allows a net accumulation of foreign currency, as exporters and tourists increase their inflow of dollars into the black market[7]. The solution to this model is that a money expansion leads to a short run increase in the premium and an increase in internal capital flight.

More recently the debate has shifted to a different question: what happens when the authorities attempt to unify the two exchange rates and liberalise trade by allowing current account convertibility of the currency? (e.g. Pinto (1989), Morris (1995), Agenor and Flood (1992)). On several occasions, developing countries have carried out attempts of this kind, at times under the direct pressure of international institutions as the IMF or the World Bank. In these circumstances a devaluation of the exchange rate seems to be the best policy to improve the macroeconomic environment of a black market economy. A devaluation is, in fact, meant to reduce the black market premium, possibly unify the two exchange rates and finally start off a process of trade liberalisation.

However matters are not always so simple. Section 4.2 has highlighted that changes to the official exchange rate may have important fiscal implications. On several circumstances the need of revenue can explain why the governments of countries in great financial difficulties keep the exchange rate overvalued and maintain foreign exchange restrictions. On the basis of this, Pinto (1989: 322) suggests that the reversal of these policies may require an increased need of money financing to compensate for the

[7] Dornbusch et al. (1983) ignore the impact of money supply on the price level and on reserves.

loss of revenue. It follows that an inflationary process begins, critically undermining the stabilisation attempt:

> "The basic idea is simple: the fiscal deficit is financed partly by the revenues from the government's purchase of foreign exchange with the overvalued domestic currency, which serves as a tax on exporters. Gross revenue from the premium is an increasing function of the size of the wedge between the official and black market exchange rates. Unifying the official and black market rates obliterates this wedge so that the related revenues vanish. So, unless real government spending is simultaneously lowered or other compensating tax revenue raised, the fiscal deficit will widen. Given the time needed for fiscal reform and the limited menu of tax instruments available, the most likely outcome is that this additional deficit will be monetized, raising inflation."

A more recent study by Morris (1995: 296) has shown, however, that foreign exchange liberalisation could have the opposite effect. There are some special circumstances when an official exchange rate devaluation has a positive fiscal impact on the government budget and hence reduce current inflationary pressures. Morris argues this to be the case, for example, if the country is a net receiver of aid. In support of his view, he refers to his own experience as Economic Advisor for Uganda's Ministry of Planning and Economic Development:

> "In Uganda, external inflows of foreign capital easily outweigh debt obligations. Governments receive a large proportion of resources in 'program aid' - grant or concessionary loans which provide foreign exchange to the Government to sell to the private sector, often for productive inputs, sometimes even for consumer goods. The local currency counterpart of these program aid funds then goes to support the Government budget. The budget then stands to gain from devaluations of the budget. The budgetary situation of Uganda seems typical of many African countries."

The essential point of his discussion is that the government of Uganda was a net seller of foreign exchange to the private sector. On similar circumstances a devaluation of the exchange rate acts like an implicit tax on the private sector. The policy message of this study seems to be that foreign aid helps unstable economies remove their foreign exchange restrictions.

Morris' paper is also interesting from a technical point of view, because it develops an equation for the black market current account that we later make use of. Naturally the amount of dollars on the black market rises if the black market current account is positive. The amount of dollars on the black market is crucial because it measures the stock of foreign exchange held by the private sector and hence the extent of internal capital flight.

Agenor and Flood (1992) have developed a formal analysis about the consequences of exchange rate unification. Their model provides an interesting equation for reserves as a function of the black market premium. They suggest that reserves diminish in the official market if the black market premium rises. The greater the premium, the more exporters have an incentive to under invoice their exports and divert their reserves into the black market. In a stabilisation process the dynamic of reserves is extremely important, as when they rise it becomes easier to improve the convertibility of the currency[8]

[8] It is no longer strictly necessary to start with a large quantity of reserves at the beginning of the adjustment process

4.4 The Model

In this section our aim is to attempt to develop a stylised black market exchange rate model. Suppose that the economy is characterised by the contemporaneous existence of both an official and a black market exchange rate. Suppose, in addition, that dollar demand is rationed in the official exchange rate market, either because of an overvalued exchange rate or because of import quantity restrictions. Frustrated demand spills over into the black market. Exporters are compelled by law to supply dollars into the official market; however if there is a black market premium, they are ready to under invoice their revenues and divert dollars into the black market. Similarly, foreign tourists have an incentive to sell dollars into the black market. In this economic setting the current account is therefore only partially convertible. Moreover let us assume that authorities do not allow capital account convertibility for the plausible fear of a real capital flight.

Technically, we combine together a currency substitution equation, the Morris equation for the black market current account (modified) and the Agenor and Flood equation for reserves. The model can be reduced to a non-linear system of three differential equations. Subsequently we solve the model by applying the technique suggested by Dixit (1980) and Currie (1985) to determine the free variable (the black market exchange rate) as a function of the predetermined variables of the system. This allows us to examine what the impact effect is of exogenous changes of both money supply and of the official exchange rate on the black market premium.

These are the variables in the model:

Variable in Logs	***Variable in Levels***	
m	M	*money supply*
p	P	*price level*
x	X	*dollars in the black market*
s^b	S^b	*black market exchange rate*
s^0	S^0	*official exchange rate*
r	R	*level of reserves*
p^T	P^T	*price of tradables*
p^N	P^N	*price of non tradables*
w	W	*wealth*
d	D	*domestic credit*
$\overline{d}$	$\overline{D}$	*Exogenous component of domestic credit*

where the parameters are all positive unless otherwise stated.

1.11 Black Market Current Account

To start with it is necessary to postulate a black market current account equation. Before we arrive at this let us first go back to the issue whether capital flights can take place in a black market economy. With perfect capital mobility, the standard development of capital flights is, of course, perfectly legal: at some stage capital account outflows become so large that they need to be financed with current account surpluses - something that in turn requires tough adjustment policies. But in an economy, as the one just described, capital account convertibility is not permitted. Illegal accumulation of foreign exchange is, however, still possible if the black market current account is positive.

In short, the black market current account equation measures the increase in internal capital flight. It is, in fact, not relevant how intensely residents demand foreign currency: if the quantity of dollars in the black market remains constant any extra demand would only push up the price of dollars, all in all preventing capital flights - incidentally this is precisely how a dual exchange rates economy works when the commercial and financial exchange rate markets are successfully kept separate.

The question now is how dollars, x can be accumulated in a black market. One way this could be achieved is by domestic residents selling their assets to foreigners. To a large extent, however, this depends on whether the legal framework and the economic environment encourage foreign firms to buy such assets. The only other way foreign exchange can increase in the parallel market is if exporters and tourists divert hard currency supplies from the official market to the black market. This diversion depends positively on the premium $s^b - s^0$, where s^b is defined as the black market exchange rate and s^0 as the official exchange rate. Yet one must consider that there is also a loss of dollars from the black market. Rationed importers buy dollars from the black market. Black market imports depends negatively on the black market premium, $s^b - s^0$ (Dornbusch et al., 1983: 29) and on the stock of private wealth, W (Morris, 1993: 9).

At this stage of the analysis we can now specify a black market current account equation as follows:

4.1) $$\frac{dx}{dt} = \phi\left(s^b - s^0\right) - \left\{\sigma g[W] - \varphi\left(s^b - s^0\right)\right\} \qquad g'[W] > 0$$

The quantity of dollars in the black market rises if the diversion of exporters and tourists from the official market[9] $\phi\left(s^b - s^0\right)$ exceeds the quantity of dollars bought by importers $\left\{\sigma g[W] - \varphi\left(s^b - s^0\right)\right\}$

Wealth is defined as the sum of money balances M and the value of dollars in domestic currency $S^b X$ divided by the price level:

$$W = \frac{M + S^b X}{P}$$

Having postulated a black market current account equation it is now necessary to specify a money demand equation.

4.12 A Currency Substitution Equation for a Black Market Economy

The standard currency substitution literature suggests that economic agents compare assets on the basis of their expected rate of return. As described in *Exchange Rate Undervaluation in the Absence of Perfect Capital Mobility: the Russian Case*, with this

[9] Morris assumes that supply of foreign exchange on the black market is exogenous; we maintain that it is more sensible to assume that the black market premium is relevant.

theory the assumption of perfect arbitrage between assets is relaxed. It is, in fact, argued that demand is not so sensitive to minimum changes in the expected rate of return. Conversely, it is assumed that the ratio in the stock level of two assets depends on the relative rate of return of the two assets. For example, in the classic article by Calvo and Rodriguez (1977) - where PPP is postulated - the ratio of money supply and foreign assets depends on the level of domestic inflation.

It is possible to write a similar expression for a black market economy. The difference in the rate of return between domestic and foreign money is given by the rate of depreciation of the exchange rate in the black market economy (Dornbusch et al. 1983: 27).

Consider moreover how the less reliable domestic currency is, the greater the demand for foreign currency. Thus an increasing black market premium indicates a growing unreliability of the domestic currency, possibly due to a worsening in the level of rationing in the official market. This aspect is for example outlined by Frenkel (1990: 162):

> "we assume that stock demand for foreign assets depends positively on the premium which could be the result of several factors: the more the black market rate exceeds the official rate, the higher could individuals perceive the risk of the government adopting additional restrictive measures; as a consequence, they seek to change the structure of their wealth towards foreign assets. A higher premium in the black market may also have the effect that foreign currencies take over functions of money, in which case individuals would also want to change the structure of their portfolio accordingly".

It is then plausible to formulate the following currency substitution equation:

$$4.2)\qquad \frac{M}{S^b X} = e^{-\kappa_1 \frac{d}{dt} s^b} e^{-k_2 \frac{S^b - S^0}{S^0}}$$

where the ratio between nominal money and the domestic value of dollars is a decreasing function of both the rate of change of the black market exchange rate and of the premium itself. A special case, frequently seen in the black market literature, is to suppose that money demand is not sensitive to changes in the premium[10]: $\kappa_2 = 0$.

The above relationship 4.2) can be rewritten in logarithmic terms as:

$$4.3)\qquad \frac{ds^b}{dt} = -k_1^{-1} e^{-s^b} \left(m - s^b - x + k_2 e^{s^b - s^0} - k_2\right)$$

and, together with the flow equation 4.1), is the driving force of the model[11].

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[10] In such a situation, a change in the official exchange rate does not affect money demand

[11] Agenor and Flood (1992: 928) prefers not to employ a currency substitution equation but to utilise the following arbitrage equation between domestic and foreign bonds: $i = i^* + \frac{ds^b}{dt} - \mu(s^b - s^0)$. This expression is correct when the repatriation of the principal on foreign bonds is achieved through the black market while the repatriation of interest receipts is achieved through the official market. Eliminating the interest rate with a money demand equation, it is possible to get an expression not dissimilar from our own, however, we question its theoretical validity as it seems unlikely that in a black market economy foreign interest payments are received through the official market. Such expression is generally used in the dual exchange rate literature, where of course it makes more sense (Flood and Marion 1983). The positive aspect is that it allows the author to greatly simplify the analysis

4.43 The Complete Model

Having presented the key features of the analysis, we now present the complete model. The equations, expressed in logarithmic terms, are as follows:

4.3) $$\frac{ds^{b}}{dt} = -k_1^{-1} e^{-s^{e}} \left(m - s^{b} - x + k_2 e^{s^{e} - s^{0}} - k_2 \right)$$

4.1) $$\frac{dx}{dt} = (\phi + \varphi)\left(s^{b} - s^{0}\right) - \sigma g\left[e^{m-p} + e^{s^{b} + x - p}\right] \qquad g' > 0$$

4.4) $$m = v\left(r + s^{0}\right) + (1 - v)d$$

4.5) $$d = \gamma h\left[s^{0}\right] + \psi \bar{d} \qquad \gamma < or > 0 \qquad h' > 0$$

4.6) $$p^{I} = \theta s^{0} + (1 - \theta)s^{b}$$

4.7) $$p = \eta p^{I} + (1 - \eta)p^{N}$$

4.8) $$\frac{dr}{dt} = -\phi\left(s^{b} - s^{0}\right)$$

There follows a brief description of each equation

4.3) is the currency substitution equation.

4.1) is the black market current account equation.

4.4) defines money supply as a weighted average between reserves, r valued in domestic currency and domestic credit, d;

4.5) postulates that domestic credit not only has an exogenous component, $\bar{d}$ but depends also on the official exchange rate, s^{0}. We have already pointed out that a devaluation of the official exchange rate has an impact on money supply. To be precise, a devaluation of the official exchange rate has an impact on the growth rate of money supply but for sake of simplicity our analysis avoids adding another differential equation. Let us suppose, to start with, that like in Pinto a devaluation of the official exchange rate has a negative fiscal impact and hence the money supply expands to meet this extra deficit. In this case γ is positive. Conversely, imagine that foreign aid is large, as suggested by Morris. Governments receive grants and financial support for specific projects in foreign currency. When they sell foreign exchange to the private sector these governments reduce their deficit and the need to expand money supply. In this case γ is negative[12];

4.6) defines the price of tradables as a weighted average of the black market exchange rate and the official exchange rate (Agenor and Flood, 1992: 927-928). This is based on the hypothesis that trade occurs both via the official market exchange rate and via the black market (Goldberg, 1995: 172);

4.7) defines the price level as a weighted average of tradable and non tradable prices. Since our aim is to examine the effect of a real devaluation, suppose that non tradable prices do not adjust [13];

4.8) controls the dynamic of reserves. The greater the black market premium, the more exporters are encouraged to under invoice reserves and transfer them into the black market (Agenor and Flood, 1992: 928)[14 15]

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[12] To consider the special case when money supply is exogenous we just need to impose the restriction $\gamma = 0$. This is a frequent assumption in the black market literature (for example Goldberg, 1995: 171).

[13] A special case, analysed by Agenor and Flood (1992: 928), is to define the price level as the price of tradables $(\eta = 1)$. Such a case, however, rules out the possibility of having a steady state real exchange rate devaluation. Under this hypothesis the effects of a devaluation are of a short run nature.

[14] Since the currency is not fully convertible a positive premium, ε may be sustainable without a loss of reserves in the official market. If, however, the premium is greater than ε, the restrictions are not

4.4.4 The Steady State

The government is capable of controlling two instruments: the exogenous component of domestic credit, $\bar{d}$ and the official exchange rate, s^{o}. Suppose for simplicity these variables are adjusted with unanticipated 'jumps', but the rate of growth of each remains equal to zero.

Consider, first of all, that reserves are constant in the steady state: thus the black market exchange rate has to converge to the official rate. Bearing in mind that the price of tradables is defined as a weighted average of the two exchange rates, the following identity then holds in the steady state:

$$p^{T} = s^{b} = s^{o}$$

Consider, moreover, that a change in the exogenous component of money supply, $\bar{d}$, does not affect the steady state proportion of wealth that economic agents wish to hold in terms of domestic money. Of course, the reason is that the black market exchange rate is stable in the steady state:

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sufficient to avoid a loss in reserves because of increased export smuggling. Following Agenor and Flood (1992: 928) in the present analysis we assume - without loss of generality - $\varepsilon = 0$.

[15] We have already mentioned that the official exchange rate is an implict tax on the export sector. A possible extension to the present analysis would be to split the official exchange rate by including an export tax as in Goldberg (1995: 171).

$$\frac{ds^b}{dt} = 0$$

In short any increase in $\bar{d}$, unless matched by a devaluation of the official rate, brings about a long run corresponding fall in reserves. Therefore the money supply remains unchanged in the steady state. At a later stage of the analysis we discuss what the impact effect of a change in domestic credit is on the economic system.

Consider next how a devaluation of the official exchange rate leads to an equivalent long run devaluation of the black market exchange rate[16]. Moreover a devaluation of the official exchange rate leads to both a reduction in foreign assets, x, and an increase in money supply, m:

$$\frac{dx^*}{ds^o} < 0 \qquad \frac{dm^*}{ds^o} > 0$$

These two movements re-establish the long run ratio between money supply and the value of dollar, which is required from the currency substitution specification. In particular the foreign assets' fall can be interpreted as an 'internal capital flight' reduction.

[16] The empirical black market literature focuses on whether the black market exchange rate and the official exchange rate possess a common trend. For empirical evidence and further economic insight, see, for instance, Baghestani and Noer (1993).

We have already summarised the debate between Pinto and Morris on whether foreign exchange reforms cause a higher rate of inflation. Our study is similar in motivation to that of Pinto and Morris but the sustainability of economic reform is here judged in terms of reserves. An increase in reserves, indeed, facilitates the opening up of trade and the removal of existing exchange rate restrictions. In our analysis we find that the overall effect of a devaluation on steady state reserves depends critically on γ:

$$\frac{dr^*}{ds^0} < 0 \quad (\text{if } \gamma \text{ is large}) \qquad \text{bad news case}$$

$$\frac{dr^*}{ds^0} > 0 \quad (\text{if } \gamma \text{ is small}) \qquad \text{good news case}$$

This seems to us an appealing result: γ is the coefficient that captures the fiscal impact of the foreign exchange reform on the government budget. The larger γ is, the more domestic credit must increase to service an additional deficit. When γ is sufficiently large, the consequent monetary policy entails a long run fall in reserves. When on the contrary γ is small, reserves rise in the steady state[17].

In sum, the model indicates that if an overvalued exchange rate acts like an implicit mean of taxation, an official exchange rate devaluation is not an easy policy to implement. In these circumstances, in fact, the fall in reserves may hamper possible attempts to liberalise trade. A large inflow of foreign aid, by contrast, helps the authorities move forward with the liberalisation of foreign exchange markets.

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[17] There is also a wealth effect, thus explaining why the cut-off point is not zero

4.45 Reducing the Model into a System of Differential Equations

The next step is to reduce the model into a non linear system of differential equations. Linearising the model around its steady state a system of the following form is obtained (Currie, 1985: 31):

$$\begin{bmatrix} \dfrac{d(x-x^*)}{dt} \\ \dfrac{d(r-r^*)}{dt} \\ \dfrac{d(s^b-s^{b*})}{dt} \end{bmatrix} = A \begin{bmatrix} x-x^* \\ r-r^* \\ s^b-s^{b*} \end{bmatrix} \tag{4.9}$$

where:

$$A = \begin{bmatrix} -a_1 & -a_2 & \pm a_3 \\ 0 & 0 & -a_4 \\ a_5 & -a_6 & \pm a_7 \end{bmatrix} \qquad a_i > 0$$

Consider how in our analysis the black market exchange rate is a free variable while assets and reserves are both predetermined. The black market exchange rate is a free variable because, in analogy to the overshooting literature, it can be interpreted as a forward looking variable. Given the great volatility and responsiveness to shocks of the black market exchange rate, this seems to us plausible. On the contrary the level of reserves, r cannot change discretely because capital account transactions are forbidden. The lack of capital account convertibility prevents, all in all, the possibility of speculative attacks. Reserves are lost only when there is an increase in the black market premium, which spurs exporters to divert more hard currency into the black market. Hard currency in the black market is also supposed to adjust sluggishly (see both Dornbusch et al and Morris on this).

As suggested by Dixit (1980) and Currie (1985) the system will be stable and uniquely determined if the number of unstable eigenvalues is equal to the number of free variables, i.e. if the system is characterised by one positive and two negatives eigenvalues.

As the determinant is positive there can be either three positive eigenvalues or two negative and one positive. Let us rule out the case where the eigenvalues are all positive as the system would be, under this hypothesis, globally unstable.

Dixit (1980) and Currie (1985) have shown how it is necessary to proceed in order to determine the free variable as a function of the predetermined variables of the system. To this end we first need to postulate that the free variable jumps onto the stable manifold[18].

If x is the vector of free variables and Z the vector of predetermined variables - both expressed in terms of deviations from the steady state - this relationship will be given by:

4.10) $x = -M_{22}^{-1}M_{21}Z$

[18] See Dornbusch et al., footnote 3, 29

where M is the matrix of eigenvectors (Dixit, 1980: 4, Currie 1985: 27) defined as:

4.11) $MA = \Lambda M$

and partitioned as:

4.12) $M = \begin{bmatrix} M_{11} & M_{12} \\ M_{21} & M_{22} \end{bmatrix}$

It is now possible to derive the relationship linking the black market exchange rate to the predetermined variables of the system:

4.13) $s^b - s^b* = -m_3^{-1}\begin{pmatrix} m_1 & m_2 \end{pmatrix}\begin{pmatrix} x - x* \\ r - r* \end{pmatrix}$

where $\begin{pmatrix} m_1 & m_2 & m_3 \end{pmatrix}$ is the unstable eigenvector, equal to

4.14) $\begin{pmatrix} m_1 \\ m_2 \\ m_3 \end{pmatrix} = \begin{pmatrix} \dfrac{a_5}{\lambda_u + a_1} \\ \dfrac{-(a_6\lambda_u + a_6 a_1 + a_2 a_5)}{\lambda_u(\lambda_u + a_1)} \\ 1 \end{pmatrix} \qquad \begin{matrix} m_1 > 0 \\ m_2 < 0 \\ m_3 > 0 \end{matrix}$

The stable manifold is hence equal to the following plane[19]:

4.15) $$s^b - s^b{}^* = -m_1(x - x^*) - m_2(r - r^*)$$

It is finally possible to examine the impact effect of a change in the exogenous variables. At time $t = 0$ we can determine the black market premium:

4.16) $$s^b[t_0] - s^0 = -m_1(x[t_0] - x^*) - m_2(r[t_0] - r^*)$$

We have previously described how in response to an increase in the exogenous component of domestic credit there is long run fall of reserves while foreign assets remain unchanged:

$$r[t_0] > r^* \qquad\qquad x[t_0] = x^*$$

Thus 4.16) suggests that the impact effect of an increase in domestic credit is a rise in the black market premium:

$$s^b[t_0] > s^0$$

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[19] To derive 4.15) it is also possible to proceed as follows

$$\begin{bmatrix} A_1e^{\rho_s t} \\ A_2e^{\rho_s t} \\ A_3e^{\rho_u t} \end{bmatrix} = \begin{bmatrix} \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ m_1 & m_2 & m_3 \end{bmatrix} \begin{bmatrix} x - x^* \\ r - r^* \\ s^b - s^b{}^* \end{bmatrix}$$

where ρ_s are the stable eigenvectors and ρ_u is the unstable eigenvector of the system. Since saddle stability requires $A_3 = 0$, the knowledge of the unstable eigenvector is sufficient to derive 4.15)

Such response immediately starts off a process whereby exporters are encouraged to cheat the system, so that official reserves fall until the economy gets back to equilibrium[20].

Consider also what happens when the government proceeds with a devaluation in the official exchange rate. If the country is a net receiver of foreign aid and, at the same time, does not rely too much on implicit export taxation (i.e. if γ is small) a devaluation leads to a long run increase in reserves:

$$r[t_0] < r^*$$

We have also mentioned that a devaluation also leads to a fall in foreign assets:

$$x[t_0] > x^*$$

Using 4.16, we arrive at the conclusion that the impact effect is a fall in the black market premium:

$$s^b[t_0] < s^{b}$$

In sum, if γ is small a devaluation of the official exchange rate starts a process in which reserves increase. This process begins with an immediate fall in the black market premium, which encourages exporters to channel reserves through the official market. Foreign aid helps make sustainable a process of foreign exchange liberalisation.

[20] If the growth rate of $\overline{d}$ is positive the loss in reserves is permanent and so is the black market premium

4.5 Final Remarks

Throughout this chapter we have explored the reasons why black market exchange rates develop and the likely consequences on the remaining macroeconomic system. In similar circumstances, policy makers frequently keep the domestic currency artificially overvalued. This is the single most important factor originating a black market exchange rate, as the existing literature confirms. We have looked into some of the reasons why policy makers may decide on an overvalued exchange rate. Among these the need of revenue plays a very important role: revenue may be earned by the state simply by keeping the official exchange rate overvalued and rationing foreign exchange demand. A strong exchange rate, indeed, acts like an implicit tax on exports.

The policy advice that international institutions generally offer is to reduce money supply and devalue the official exchange rate. With regard to the impact of money supply, the analysis arrives at the standard conclusion that a money supply expansion leads to a short run increase in the black market premium. Such an increase rise spurs exporters to divert more hard currency into the black market, hence satisfying the greater hard currency demand. A more stable economic environment is, therefore, vital for reducing internal capital flight.

With regard to the official exchange rate, a devaluation is meant to reduce the black market premium, possibly unify the two exchange rates and finally starting off a process of trade liberalisation. Recent black market literature has, however, recognised that this may not always be so simple to accomplish. The public may understand that a devaluation of the exchange rate has a negative fiscal impact, leading to an increased need to expand the money supply. This chapter is essentially a first attempt to examine how reserves behave in these circumstances. Reserves are very important: an increase in them helps the opening up of trade and the removal of existing exchange rate restrictions. Our model arrives at the conclusion that when an overvalued exchange rate acts like an implicit tax, reserves fall in the steady state, hence hampering possible attempts to liberalise trade.

Finally, we have also explored in this chapter Morris' notion that foreign aid changes the fiscal structure of the government budget. Let us suppose the government receives grants and financial support for specific projects in foreign currency, which is thereafter sold to the private sector, a devaluation of the exchange rate would act as a tax on the private sector and hence have a positive fiscal effect. According to our model, this process begins with an immediate fall in the black market premium, which in turn encourages exporters to channel reserves through the official market. This increase in reserves helps sustain the process of foreign exchange liberalisation.

Chapter 5

Conclusions

This Ph.D. thesis could be been as a first attempt to reconcile ideas, generally analysed in separate frameworks, in a unique and relatively simple context. Several important economics issues, such as currency substitution, price stickiness, time inconsistency and black markets have been discussed with specific reference to Russian exchange rate reforms in the early 1990's.

At the end of each chapter we have drawn together the main ideas explored in the chapter. In this final chapter, an attempt will be made to pull together all the ideas and conclusions that have been discussed throughout the thesis.

A common theme to all four chapters has been the following: foreign exchange demand as a store of value is the driving force in times of extreme economic instability. Policy makers, indeed, may try to hamper this demand but there are no simple ways to attain this objective. When foreign exchange demand is rationed, this demand is likely to find alternative channels.

Thus if policy makers do not impose any restrictions on the ability to invest abroad, foreign exchange demand turns to the capital account. With perfect mobility of financial capital, the Dornbusch literature is the appropriate theoretical context for this analysis. From a technical point of view, we have presented the Buiter Miller version of this model, highlighting some of the interesting insights of this literature. We have shown, for example, how the exchange rate dynamics are closely connected to the behaviour of the domestic interest rate.

Furthermore, if policy makers decide to impose complete capital controls, foreign exchange demand may turn to the current account. With financial autarky, we have argued that a currency substitution model, which assumes sluggish adjustment of liquidity, is a suitable framework. According to this approach, an undervalued exchange rate improves the external position of the country, supplying the foreign exchange needed to satisfy economic agents' demand. Favourable surrender rules, on one hand, auction and interbank markets, on the other, allow foreign exchange demand to be satisfied through legal channels. The stock of foreign exchange, which the private sector gradually builds up, has been referred to as internal capital flight here.

Even if the above two approaches yield very different economic insights, a useful feature is that their analytical structure is almost identical. As a direct consequence of this, we have shown that the real exchange rate and liquidity behave similarly, both in the case of perfect capital mobility and in the case of financial autarky. In addition, these two models may be thought of as being complementary, as they describe two different economic phases in the evolution of one country: over time, internal capital flight is likely to become a less relevant phenomenon, while the importance of the domestic bond market is likely to grow.

The similar dynamic framework of these two models has another interesting implication: it allows the examination of the time consistency problem in an almost identical manner. Applying the Cohen and Michel technique, we have examined the consequences of the policy credibility problem for countries which print money in order to finance the budget. Similar conclusions for both models have been reached concerning the impact of delegating monetary policy on the real exchange rate and liquidity. As long as the loss function is suitably specified, the same methodology may be applied to address other economic issues not explicitly considered here. Future research may explore, for example, the current effects of a future European Central Banker who has different preferences about inflation than those of the national monetary authorities. A two country Buiter Miller model, subject to the time consistency constraint, may possibly shed some light on the economic consequences of this on output, inflation and the real exchange rate.

Finally, when policy makers decide to restrict current account convertibility, as well as capital account convertibility, foreign exchange demand turns, to black markets, as a final option. An internal capital flight process is always possible, although on this occasion it takes place through illegal channels.

The present analysis has not included the time consistency constraint to this economic framework. An interesting, but probably not simple, extension would be to apply the Cohen and Michel technique to this economic context as well. This would presumably highlight the role played by credibility in black foreign exchange markets.

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