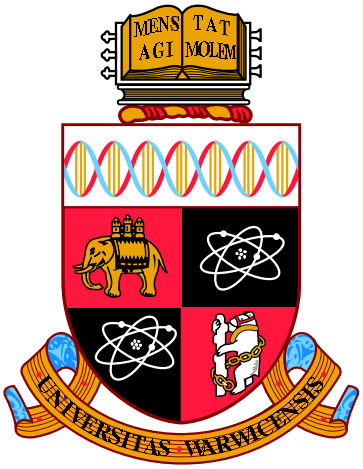

Essays in Debt Sustainability, Effects of Institutional Changes on Fiscal Policy in the Euro Area and Consumption Responses to a Shock in Public Salaries

by

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Declarations

This thesis is submitted to the University of Warwick in accordance with the requirements for the degree of Doctor of Philosophy. I declare that this thesis is my own work and has not been submitted for a degree at another university.

Chapter 1 of this thesis was jointly written as an ECB working paper with Cristina Checherita-Westphal during my stay in the Fiscal Policy Division of the European Central Bank. It contains data sourced from the ECB's statistical data warehouse, which were at that time, partially unpublished/confidential. Chapter 2 also uses some data from the ECB's statistical data warehouse. The use of ECB statistical data in these projects does not imply any endorsement from any part of the ECB in relation to the interpretation or analysis of the information. The views expressed are those of the authors and do not necessarily reflect those of the European Central Bank. Chapter 3 contains results based on the data provided by the Hungarian Academy of Science (HAS), confidential budget survey data from the Hungarian Central Statistical Office (HCSO) accessed at the Magyar Nemzeti Bank (MNB), and confidential employment data provided by Álmos M. Telegdy from his research project during my stay at the MNB. The use of ECB, HAS, HCSO and MNB statistical data in this chapter does not imply any endorsement from the ECB, HAS, HCSO or MNB in relation to the interpretation or analysis of the information.

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Abstract

The worst economic and financial crisis since the Great Depression in the 1930s, the Great Recession, followed by the Sovereign Debt Crisis (ESDC) in Euro area countries have revived interest in fiscal policy, and particularly in various topics related to its interactions with monetary policy in a monetary union. Despite a recent surge in theoretical and empirical work in this area, there are still many important questions that have not been explored and this thesis aims to fill this gap.

This thesis consists of three essays. Chapter one and chapter two focus on particular sets of questions that partially address newly emerging problems in the wake of the ESDC. Their common link is the existence of the Euro area and problems of national fiscal policies in this monetary union. Chapter three analyses effects of a government intervention in the form of an unexpected public sector salary increase.

The main focus of chapter one is on fiscal (debt) sustainability and the so-called fiscal fatigue hypothesis ('debt legacy'). For that purpose I firstly estimate a fiscal policy rule for Euro area countries, and test its robustness with various economic, financial and institutional determinants. Subsequently, the fiscal fatigue hypothesis is examined by estimating a non-linear specification of the same fiscal policy rule as suggested in the literature. In addition, I propose a simple linear debt rule for identifying the risk of fiscal fatigue.

In chapter two I analyse the fiscal policy behaviour of 'old' Euro area countries (EA-12) and three stand-alone EU countries (EU-3), given institutional constraints imposed on fiscal policy in the wake of the European integration process. To capture the changing nature of fiscal behaviour, I estimate a Bayesian time-varying parameter fiscal rule. Since fiscal harmonization is an important consequence of fiscal constraint, I also try to capture that effect by looking at the dispersion of country-specific Euro area fiscal behaviour and compare it with countries facing less strict fiscal constraints (EU-3).

The last chapter aims to shed some light on a government intervention (a quasi-natural experiment) represented by an unexpected increase of public employees' salary. Given the type of intervention, I can construct a 'natural' treated and a control group (private employees) and link them with data from a household budget survey. To compare their consumption behaviour, I estimate a regression model controlling for relevant economic and socio-demographic characteristics.

Chapter 1

Introduction

The Global Recession and the related Sovereign Debt Crisis in the Euro area (ESDC) have resulted in heightened volatility and uncertainty that have already persisted for several years, making them the most serious economic and financial disruptions since the Great Depression of the 1930s. Fiscal policy measures have been implemented in attempts to revive weak aggregate demand (via consumption spending) and economic growth, and to avoid repeating mistakes from the past. However, many of these measures have unexpectedly (soon) run out of steam. Conversely, fiscal policy has showed the other face that is related to its long-term effects (sustainability) as a result of large and increasing public debts across countries around the world. More recently, a mix of low real GDP growth, and low rates of inflation have compounded the problems. High private and sovereign indebtedness have placed serious and potentially long-lasting limits on economic activity and changed the economic and financial environment in many countries.[1]

Many developed countries, still facing grim economic outlooks have since responded with various non-standard monetary measures such as quantitative easing. Coupled with radical changes in financial intermediation, the standard economic and fiscal landscape that prevailed for several decades has also undergone significant transformation. Suddenly, bond yields and interest rates have approached not-for-a-very-long-time or never ever seen lows, and in some cases even entering negative territory, substantially reducing pressure on severely strained public finances.[2] However, having consumed all of its gunpowder, monetary policy became 'gridlocked' in the zero-lower-bound (ZLB) trap and thus gradually became ineffective. This rather extraordinary environment has led to the revival of a relatively

[1] For some early evidence see for example a series of McKinsey reports, such as Dobbs et al. (2015).

[2] Some evidence (mainly for euro area countries) can be found in Jobst and Lin (2016).

enduring discussion of roles and tasks attributed to monetary policy, and fiscal policy. In particular, as this discussion evolved over the years, fiscal policy has grown to again become one of the only available tools in policy-makers' pockets.[3] However, fiscal policy has now been seriously constrained, haunted by its own shadows.

This situation bares some resemblance to *Catch-22*, but is even more complicated and complex in the case of countries or member states of a monetary union. Having given up their monetary policy independence and exchange rate, fiscal policy and its toolkit is the only remaining domestically controlled tool that is useful for macroeconomic stabilization. Without any doubts, the role of fiscal policy has become much more important, and its on-going health deserves increased scrutiny.

This thesis consists of three essays that address some of the current fiscal issues that are outlined above. The link between Chapter 1 and Chapter 2 is the existence of a monetary union. Chapter 3 departs slightly to analyse the effects of a government intervention in a particular setting several years before the Great Recession, but with many surprising similarities to much later events. Macroeconomic stability, debt (fiscal policy) sustainability and the alignment of fiscal policy measures among member states are of key importance, both for the single monetary authority, and for the very existence of a monetary union. This has been repeatedly emphasised across a wide range of theoretical, empirical and policy-oriented publications by a range of well-known economists and institutions, including the European Commission, the ECB, the IMF or OECD. This introductory chapter will briefly review all three chapters and their main findings and contributions. I then conclude this introduction by summarising the main findings of all three chapters in greater detail. The last chapter of this thesis reviews main findings across all three chapters and offers some suggestions regarding possible extensions.

Chapter 1, titled, *'Fiscal Reaction Function and Fiscal Fatigue in the Euro Area'*,[4] investigates fiscal (debt) sustainability and debt related problems (fiscal fatigue) of Euro area member states. This is explored by estimating a fiscal policy rule (inspired by the Bohn, 1998's strand of literature), and examining its stability and robustness for these countries. The fiscal rule is a simple but powerful approach

[3] Either in the form proposed by classical public finance theory or in a more recent role aimed at macroeconomic stabilization in the (new) Keynesian public finances literature. The latter has particularly been subject to disputes since there seems to be a trade-off between short-run demand management and the (long-run) implications for sustainability of public finances, for an overview see Burger (2005).
See also regular publications of international organisations or numerous articles and books published recently by research institutions such as CEPR or NBER; further references can be found in Afonso and Toffano (2013) or Baldwin and Giavazzi (2016).

[4] This chapter was written jointly with Cristina Checherita-Westphal during my PhD traineeship at the ECB in 2014.

for assessing the fiscal sustainability of a country since it is not dependent on detailed microeconomic time series that may not be available, or estimates (educated guesses) of structural parameters that are often subject to criticisms.

As a second step, the chapter also explores the so-called fiscal fatigue hypothesis for this group for EA countries.[5] Apart from the estimation of a non-linear model of debt à la Ghosh et al. (2013) for the EA sample, we propose a way of testing fiscal fatigue with a simple linear rule. Such a model can easily be implemented both in countries with limited availability of economic time series. This model can also be used as an early warning system in distressed countries, given the robustness of fiscal rule estimates across countries at different stages of economic development.

As the title *'Do Institutional Changes Affect Fiscal Policy Behaviour? Time-Varying Evidence from Europe'* illustrates, Chapter 2 analyses changes in fiscal policy behaviour triggered by institutional rules and regulations ('fiscal institutions') among twelve Euro Area (EA) members in comparison with three stand-alone EU members. These changes importantly include the most recent EU macro-fiscal regulations that were implemented in response to the ESDC. Fiscal policy is approximated with changes in primary balance, modelled within two types of fiscal rules: one that follows model-based sustainability literature (Leeper, 1991 or Bohn, 1998), the other resembling a monetary policy Taylor rule with microeconomic foundations (Kirsanova et al., 2005). This chapter then combines a time-varying parameter model estimation with Bayesian techniques (following the work of Kim and Nelson, 1999), and uses a novel quarterly dataset of fiscal and economic determinants over the period 1980q1–2015q4.

For the empirical analysis, individual countries are grouped by their debt levels (below 50% of GDP, between 50% and 80% and above), allowing for different levels of effort expected to be carried out so that debt development is kept under control (that is sustainable). Further, this chapter also investigates the (indirect) effect of fiscal institutional change on the harmonization of fiscal behaviour in the Euro area, and compares it with changes in the case of the stand-alone EU countries.

Chapter 3's title *'Consumption Responses to an Unexpectedly Large Shock in Public Salaries – Evidence From a Government Intervention in Hungary'* is at first sight somewhat distinct compared with the previous two Chapters, but is equally pertinent to fiscal policy. In this chapter I explore a government intervention that took place in Hungary in 2002 – a large unanticipated increase of public employees' salaries – (a quasi-natural experiment, in the notion of Fuchs-Schündeln and

[5] Since there are many definitions of fiscal fatigue, I follow Ghosh et al. (2013)'s definition that relates fiscal fatigue to the impossibility of adjusting primary balance such that it would stabilise the existing level of outstanding public debt.

Schündeln, 2015) and its effects on households consumption. Therefore, this analysis offers some very timely implications, since the majority of recent experiments have included changes in taxation, both randomized and pre-announced. Given the fact that only one side of the labour market is affected, it provides a natural classification of individuals subject to the intervention (treated group). In this chapter I am able to analyse the effects of the base salary increase on consumption responses among households by combining information obtained from employment surveys with budget surveys. The specific setting of a transition country trying to join the EU, combined with unexpected and rather large government intervention (salary increase), is a mix that is usually not observed. It complements the only existing study that uses this intervention to analyse wage spillovers between the private and public sector (see Telegdy, 2017). The findings, implications and conclusions of this chapter are particularly attractive for policy-makers deciding on various changes within the public sector or across sectors in an economy such as a reform of welfare or pension system.

1.1 Overview of Chapter 1

After the global economic and financial crisis, and euro area sovereign debt crisis, questions about fiscal sustainability in advanced economies have featured prominently in academic and policy debates. The large debt burden of most sovereigns has weighed on their economic outlook, further complicating the sustainability of public finances in the face of rising age-related payments, and the expected downward trend in potential GDP growth.

This chapter deals with the topic of fiscal sustainability by employing a so-called 'fiscal reaction function' (FRF) to euro area economies (EA-18) for the period 1970–2013. In this framework, we empirically test whether euro area governments abide, on average, by (weak) sustainability constraints, that is, whether they tend to ensure higher budget surpluses when their debt ratio increases (so-called model-based sustainability, see D'Erasmo et al., 2015). Our dataset is adjusted for government support to the financial sector, which has been sizeable in some cases at the height of the euro area sovereign crisis. This allows us to avoid peaks in primary deficits that would otherwise unduly reflect fiscal loosening and induce high data volatility. We also propose a novel concept to investigate fiscal fatigue for the euro area sovereigns. This is based on the estimated coefficient (associated with debt) of the fiscal reaction function that is often used to benchmark the realism of primary balance projections in the context of debt sustainability simulations.

Using various dynamic panel techniques, we find evidence that euro area sovereigns abide, on average, by (weak) sustainability constraints. The primary balance improves by about 0.03–0.05 for every 1 percentage point increase in the debt-to-GDP ratio after controlling for other relevant factors. We show that the FRF estimates are rather robust across various specifications, time periods and the exclusion of individual countries. We also conduct a series of country-specific robustness checks and find that responses do not extensively differ. With regards to other determinants of stronger fiscal positions (higher primary surpluses), we also find evidence for political factors (non-election years), improved external positions (support for the twin deficits hypothesis), and lower interest payment burden, *inter alia*. After controlling for the economic cycle (size of output gap), the positive reaction of primary surpluses to higher debt strengthened over the crisis, and seemed to have acted as a disciplining device, as compared to the preceding period. We do not find strong evidence for a stable cyclical behaviour (stabilisation) function of fiscal policy across the euro area countries.

The second contribution of the chapter proposes a novel approach to measuring fiscal fatigue. This simple measure allows the classification of countries based on their actual fiscal behaviour with few assumptions. Hence, one can measure the extent of fiscal fatigue for individual euro area countries by comparing the simulated primary balance paths in the context of debt sustainability analyses with each country's track-record, adjusted for the change in debt ratios by the estimated FRF coefficient. If the projected fiscal path, say as an average for a period of 5 or 10 years, is better than the country's performance in the past, adjusted for the change in the debt level, then the sovereign may be signalled as being at risk of fiscal fatigue. Such risk would need to be further investigated to determine more concrete country-specific risks. We provide illustrative examples for the application of this approach to the euro area countries in our sample. We also investigate an alternative estimation of the fiscal fatigue hypothesis using a non-linear FRF as proposed in Ghosh et al. (2013), but do not find sufficiently robust support for the euro area sample.

1.2 Overview of Chapter 2

While the first chapter explicitly considers problems of debt sustainability, this chapter emphasises the importance of fiscal policy in a single monetary policy environment, as a means of responding to country-specific shocks coming primarily from differences in business cycles across member countries (asymmetric shocks). This emphasis on fiscal policy is contrary to commonly used monetary policy approaches that deal with common (symmetric) shocks such as currency fluctuations. In this case, (fiscal, debt) sustainability is important because of two reasons: firstly, to guarantee macroeconomic stability (providing the government with necessary room to cope with asymmetric shocks, and for coordination with monetary policy), secondly, in the finance-fiscal sense, where sustainable (sound) fiscal policy is a key condition for the stability of domestic financial institutions (see Bénassy-Quéré, 2016).[6] These reasons call for the existence of rules or 'fiscal institutions' that can help to maintain sustainable (sound) fiscal policy, and prevent member states from free-riding in a single currency environment. However, such (fixed) rules would require efficient mechanisms (tools) to enhance their credibility and mitigate moral hazard problems since there is often a temptation to avoid them under limited enforceability (moral hazard).

In this chapter I analyse the effects of institutional changes on fiscal policy in Europe ('rules of fiscal game'), focusing on the 'old' members of the Euro area (EA-12) and three stand-alone EU countries (EU-3).[7] Recent changes in the regulatory framework have made it substantially faster and easier to impose (pecuniary) sanctions on EA members if they do not comply with various forms of regulation of fiscal matters. However, non-EA members subject to the same regulation may 'only' (non-binding) face recommendations without de facto sanctions.[8] This may of course affect the effort that individual countries devote to meeting such a regulatory framework, and how they respond to its modification. Therefore, I firstly investi-

[6] The literature has suggested that a loop exists here: a worsening of fiscal policy behaviour is reflected in the prices of sovereigns' debt instruments, with negative effects on banks' balance sheets, profitability and potential need to provide state guarantees. However, such a scenario would consequently put an additional layer of pressure on already distressed public finances (the so-called 'Diabolic loop', see Acharya et al., 2014; Brunnermeier et al., 2016).

[7] This group of countries includes: Austria, Belgium, Finland, France, Germany, Greece, Luxembourg, Ireland, Italy, the Netherlands, Portugal, and Spain. Greece became an EU member in 1981, Spain and Portugal in 1986, Austria and Finland in 1995. The EU-3 group of countries consists of: Denmark, Sweden, and the United Kingdom. These countries did not belong to the original group of six member states ('founders') either: Denmark and the United Kingdom became EU members in 1973, and Sweden in 1995.

[8] The most 'serious' sanction would be related to the temporary suspension of the use of various EU funds, such as those for structural adjustment.

gate whether changes in the EU-wide institutional environment had any effects on fiscal behaviour during the decades long European integration process. Apart from examining the effects of the pre-Euro integration (Maastricht Treaty) and the first years of the Euro (Stability and Growth Pact), focus is paid to an original analysis of the effects of crisis-related institutional changes on fiscal regulation (coordination) in the post-2010 period, the Fiscal Treaty in particular.

The second question looks at the accompanying effect of institutional changes in the EU, and specifically analyses how individual regulatory changes affecting the institutional environment have shaped the harmonization (increased similarity) of national policy-making and fiscal policy behaviour. In particular, one can think that the very last series of institutional changes (the so-called Fiscal Compact within the Fiscal Treaty) will most likely see national fiscal policies behave in a similar way, increasing the risk of negative (undesirable) demand spillovers across EA members, in line with the arguments of Holland and Portes (2012) and other studies.

In order to answer both research questions, I create a novel quarterly dataset covering the period (1980q1–2015q4), comprising of fiscal variables for the aforementioned groups of EA-12 and EU-3 countries.[9] For this purpose, I use an approach that combines both the Kalman filter and Bayesian methods (see Bańbura et al., 2015; Giannone et al., 2015). The dataset covers all the main stages in the integration process, starting with those in the late 1980s up until the most recent changes in the wake of the ESDC.[10] This dataset is an important first contribution since it complements a dataset available for Spain (see De Castro et al., 2014) and the Euro area (see Paredes et al., 2014), and consequently extends the possibilities for researchers to analyse fiscal policy at a higher frequency.

Given the fact that governments can unexpectedly modify their behaviour as a consequence of varying internal and external incentives and/or shocks can result even in abrupt changes of policy variables. Budgetary balance is a key variable for policy-makers (mainly government) since institutional settings may change fiscal measures, and in turn affect budgetary outcomes. This dynamic calls for an approach that appropriately considers both aspects. Therefore, I draw upon a modelling strategy that is similarly used to explore monetary policy – a proxy for fiscal policy behaviour is a fiscal rule providing a link between the key fiscal variable (pri-

[9] It complements available quarterly fiscal series from Eurostat that for most of the countries start either in 1999q1 or 2002q1 for flow variables (balances), or in 2000q1 for stock variables (debt).

[10] Mainly these: the Delorse Report, the pre-EMU period (Maastricht period), the creation of the Stability and Growth Pact (1996), the Euro launch (1999), fiscal sustainability problems of EMU countries and a modification of fiscal rules (2005), and the EU Sovereign Debt Crisis and institutional response (2011–2012).

mary balance) and a set of its fiscal policy determinants (primarily public debt).[11] Two rules are considered since there is no single universal fiscal rule: one in line with Leeper (1991) and Bohn (1998) ('macro-fiscal rule', macro debt sustainability), and the other resembling a Taylor rule proposed by Kirsanova et al. (2005) (micro-based 'optimal rule'). I accordingly estimate both fiscal rules using a time-varying parameter (TVP) model combined with Bayesian techniques.

That allows me to see the observed values of primary balance that result from 'behavioural changes', in the estimated coefficients of its key determinants such as government debt and business cycle. Moreover, I am able to trace these outcomes without explicitly specifying an impact period, while also minimizing some other problematic aspects related to the standard estimation of fiscal rules (such as structural breaks).

I show that the effects of institutional changes on national fiscal policies were rather heterogeneous over the entire sample period, corresponding to differences in debt levels across EA countries. I do find only weak effects related to the Maastricht Treaty, and in contrast to the literature emphasising the effect of Maastricht rules, my findings provide only limited support to the usual explanation (a significant change in behaviour). However, the implementation of the Pact and the race to adopt the single currency amongst the frontrunners corresponded with a high share of countries responding to the Pact's limits (nine out of twelve). Similar to the literature, I do find some support for its modification in 2005 (for most of the medium and high debt countries). Since the dataset covers the outset of the ESDC and a series of more recent reforms (the Fiscal Treaty in particular), my exploration of these changes reveals that less than half of the countries responded to the most recent changes.[12] In the 'control' group of three stand-alone EU countries, few show some response to the Maastricht Treaty, while in the case of the most recent changes, their responses are ambiguous.[13]

In the case of harmonization of national fiscal policies, my results for EA-12 confirm a reduction of dispersion, approximated with the standard deviation of time-varying fiscal (debt) responses over the entire period. However, this conclusion hides

[11] Primary balance does not only represent the results of the current action, or past active or passive behaviour reflected in public debt, but also represents economic conditions (business cycles), trade flows and various other determinants.
Primary balance is a tool that comprises of all governmental actions that affect both revenues and expenditures less interest payments over a period of time (usually one year).

[12] The Fiscal Pact was formally enforced from January 2013, but granted signatories a period of one year to implement the necessary amendments at the national level. For EA participating countries, it therefore only became binding for the first time from January 2014.

[13] As expected since they have not signed some or all (the UK) of the newly introduced institutional amendments.

a rather heterogeneous transition since the 1980s. First, dispersion was increasingly larger before the Maastricht period, and was followed by a decline, and another increase during the early years of the Euro area. Subsequently, around the onset of the ESDC, there was an increase in the harmonization of fiscal policies, which continued almost until the end of our sample period. The dispersion in the case of stand-alone countries was lower in absolute terms, compared with EA-12, but similar to that of EA-10. Nevertheless, there are some similar patterns visible, with only a negligible increase during the Euro period (1999–2009), followed by an increase and rather small reduction of dispersion. I conclude the text with a discussion of the consequences of harmonized fiscal responses. In particular, there seems to be a strong need for further changes in intra-EA fiscal policy arrangements, either as modifications to the existing mechanisms or as an additional level of fiscal coordination at the supranational level. That would alleviate pressures on members facing idiosyncratic shocks.

1.3 Overview of Chapter 3

There is a natural interest to analyse individuals or households and their consumption behaviour, particularly in the case where the flow of individuals' (households') primary (labour) and/or secondary (non-labour) income is subject to expected or unexpected changes. This information is particularly important for policy making decisions with regards to modifications or reforms of direct or indirect taxation, welfare systems, and pension systems (see Jappelli and Pistaferri, 2010 or Fuchs-Schündeln and Schündeln, 2015). This is further reflected in the recent surge in studies providing empirical evidence on expected changes in income and their corresponding effects on consumption. For instance, a number of studies explored the effects of government interventions in the aftermath of post-2000 events such as 'September 11', and an even greater number explored the effects of the Financial crisis and the Great Recession. Nevertheless, many empirical studies have been unable to document the effects of (*a*) unexpected (unanticipated) income changes and (*b*) large (unanticipated) permanent income shocks.

In this last chapter I try to fill in this gap investigating how a government intervention, represented by an exogenous shock to households lifetime resources, impacted on consumption in a quasi-natural experiment setting (in terms of Fuchs-Schündeln and Schündeln, 2015's terminology). The government intervention was an unanticipated and unexpectedly large increase in the basic salary pay (50%) across employees in the Hungarian public sector in 2002, and reached as many

as 90 percent of workers in the public sector.[14] Because of the features of this intervention, an approach similar to Jappelli and Padula (2014) can be followed in order to study the effects at the household level, instead of analysing individuals and their incomes. This allows me to compare household heads that are directly exposed to the government intervention, with those that are not, assuming that a variation in consumption responses is driven by a realization of the income shock.[15] Since this government intervention targeted only public employees, I will consider households of public employees as the treated group, and contrast this to a control group of households of private employees and other types of public workers.

I then use a novel approach to identify treated households by calculating probabilities of working in the public sector over an exhaustive set of occupational categories from a novel individual dataset based on the repeated cross-section Hungarian household budget survey. This approach allows me to then use a regression framework to identify the consumption responses – (1) for levels of consumption and (2) average propensity to consume (APC) – of households driven by the exogenous change in their income, when controlling for relevant economic and socio-demographic characteristics. In this way, this chapter complements the only other study (Telegdy, 2017) that uses the same salary intervention to study public-private sector wage spillovers.

Given the structure of public sector employees' remuneration, a change in employees' base salary can be viewed as a change in the permanent component of their total (disposable) income. Standard consumption theory postulates that effects in the case of such an unexpected increase in income are associated with changes of consumption expenditures at the household level. Although I do find significant responses for subcomponents (durable and non-durable) of total consumption expenditure, I did not find significant changes in the case of total consumption (only for the other variable, APC). This may have been the result of a consumption boom on the heels of a change in a system of housing loan subsidies (and a partial re-direction of these funds to finance other non-housing related consumption expenditures).[16] As a result, many households in the early 2000s were left with

[14] Some employees were excluded such as workers in state-owned firms or employees in the judiciary.

[15] Although a 'natural' choice would seem to be the individual level, I followed this modelling approach because controls for some household characteristics are only observed at the household level in budget surveys.

[16] This strongly resembles Mian and Sufi (2015) story of the mid 2000 US credit crunch (mortgage-bubble) unfolding into the most severe economic crisis since the Great Depression, or Kumhof et al. (2015)'s alternative explanation that places more emphasis on income inequality and indebtedness. However, (*i*) Hungarian households could not re-mortgage their mortgages, (*ii*) it was not possible to obtain loans above the property valuation (not much above 60%, see MNB, 2002), and (*iii*)

higher actual levels of consumption expenditures as compared to their disposable incomes, and declining savings (assets). In my explanation, the potential for increasing household consumption was dampened, because households 'living above their means' used the additional income to consolidate their 'weak' balance sheets. This seems to be supported by some evidence showing a catching-up effect in consumption in subsequent years (2004 and 2005). Looking back in time, I argue that this unexpected income change, together with regulatory restrictions on housing loans may have unintentionally prevented the loan-driven-consumption *bonanza* that returned more severely in 2007.

there was not a general trend of rising housing prices in the country (apart from the capital and few other regions) before EU accession.

Chapter 2

Fiscal Reaction Function and Fiscal Fatigue in the Euro Area

2.1 Introduction[†]

> Sustainability is basically about good housekeeping. [...]a good indicator of sustainability is one which sends clear and easily interpretable signals when current policy appears to be leading to a rapidly growing debt to GNP ratio.
>
> [Blanchard et al., 1990, p. 8]

The global economic and financial crisis, and the Euro area Sovereign Debt Crisis (ESDC, henceforth) has brought heightened volatility and uncertainty in recent years. Questions about fiscal sustainability in advanced economies have featured prominently in academic and policy debates. In particular, the issue of early identification of the fiscal fatigue that may be associated with sizeable efforts to restore fiscal sustainability has gained prominence. The large debt burden of most sovereigns, coupled in many cases with high private indebtedness, has weighed on their economic outlook. This mix further complicates the sustainability of public finances in the face of high and rising ageing costs and related pressures on potential growth.

In the empirical literature, a concept inherently related to the operationalization of fiscal sustainability is the fiscal reaction function (FRF, henceforth), coined in the seminal paper of Bohn (1998). Applied to the US economy, the paper shows that a sufficient condition for sustainability is that the government reacts systemat-

[†] This chapter represents a slightly modified version of the ECB Working paper written jointly with Cristina Checherita-Westphal during my PhD traineeship in the DG Economics in the ECB.

ically to increases in government debt by adjusting the primary balance (reducing the deficit or increasing the surplus net of interest payments). However, as pointed out in Ghosh et al. (2013), this condition can be thought of as a **weak sustainability criterion** that does not, for example, rule out a permanently increasing debt-to-GDP ratio. In this way, the criterion does not take into account the initial debt level (which may be regarded by markets as dangerously high) or the likely bounds to primary surpluses that a country may sustain due to (uncontrolled) institutional or political factors. Nor does it say much on the forward-looking policy that governments may implement to address (or not) sustainability concerns[1]. However, it remains informative on the type of fiscal policy reaction governments did have in the past, and is helpful in providing signals for potential problems linked to future policies.[2] Generally, studies employing large panels of advanced economies find evidence that governments tend, on average, to meet (such weak) fiscal sustainability constraints.

This chapter seeks to estimate a fiscal reaction function for the euro area countries and to derive a simple measure of fiscal fatigue. Our dataset is an (unbalanced) panel of 18 euro area countries over the period 1970–2013, but we also conduct various robustness checks for country and time period sub-samples. Fiscal balance data is adjusted for government support to the financial sector (a specific type of 'one-off items'), which allows us to avoid peaks in primary deficits that would unduly reflect fiscal loosening and induce high data volatility. In this way, we enhance the robustness of our results by addressing the issue of extreme outliers that emerged in recent years. A simple FRF is estimated in the first stage to assess whether fiscal policy in the Euro area behaved in an overall (weakly) sustainable way. Using various dynamic panel techniques, we find evidence that euro area sovereigns abide, on average, by such sustainability constraints. We show that the FRF estimates are rather robust across various specifications, time periods and the exclusion of individual countries.

In the second stage, we importantly propose a novel approach to investigate fiscal fatigue for the euro area sovereigns, which gauges a country's capacity to maintain primary surpluses based on its past efforts and the estimated fiscal reaction function. The FRF empirical framework allows the quantification of the strength of the feedback from debt to primary balance. The resulting coefficient can in turn

[1] For a comprehensive debt sustainability analysis framework for the euro area (EA, henceforth) sovereigns, see Bouabdallah et al. (2017).

[2] This reaction can not only be tested with respect to the sustainability objective (the relation between primary balance and debt), but also to the stabilisation function of fiscal policies (for example the relation between primary balance and output gap).

be used to benchmark the realism of primary balance projections, which represent key inputs to debt sustainability analysis (DSA, henceforth). Finally, the chapter also investigates the risk of fiscal fatigue in the Euro area resulting from **non-linear** FRF estimation in the spirit proposed by Ghosh et al. (2013).

The chapter is structured as follows. Section 2 reviews the literature and methodology. Section 3 presents the data and model. Section 4 discusses the results of the fiscal reaction function, including extensive robustness checks. Section 5 outlines our novel measure to investigate the fiscal fatigue hypothesis, and section 6 concludes. The Appendix includes a comparative summary of literature, a description of data sources and further robustness checks.

2.2 Review of literature and methodology

Complementing the theoretical approach of Blanchard et al. (1990) and other more complex sustainability frameworks, Bohn (1998) proposes a simple empirical test of sustainable fiscal policy (model-based sustainability, see D'Erasmo et al., 2015). This relates the primary balance to the level of debt, with or without conditioning on further controls (such as business cycle). It can be written as follows:

$$pb_t = \kappa \cdot d_t + \xi_t, \tag{2.1}$$

where pb_t is the primary balance in terms of GDP, d_t is the government debt-to-GDP ratio, κ is the responsiveness of the primary balance to the debt ratio and ξ_t contains effects of various other determinants of primary balance (such as economic, institutional, etc.) and the error term.

Bohn (2008) shows formally that for an economy to satisfy its intertemporal budget constraint and the so-called no-Ponzi condition, the coefficient $\kappa > 0$ is sufficient, provided that the present value of GDP is finite, and $\xi_t < \infty$ is a fraction of GDP as well. However, as shown in some studies (see, *inter alia*, Ghosh et al., 2013 or Daniel and Shiamptanis, 2012), a positive coefficient κ cannot be viewed as sufficient to achieve fiscal sustainability if there is a limit for positive values of primary balances. Instances of such limits can occur at very high debt levels[3] or if the reaction of financial markets is explicitly considered (for example the increase

[3] An upper limit on the amount of debt that can be repaid creates additional restriction for government policy. An extension of Bohn's approach for a country restricted by fiscal limits using a non-linear fiscal rule is in Shiamptanis (2015). Ghosh et al. (2013) and Fourier and Fall (2015) consider the reaction of financial markets in conjunction with fiscal limits.

in the primary balance is not large enough to account for the exploding interest rate-growth differential). In this respect, Ghosh et al. (2013) call Bohn's condition a 'weak sustainability condition'.

Further issues have been raised in the literature regarding country-specific and cross-country estimation, mainly in panel data studies, that is, time and country stability of estimated coefficients. Some more recent empirical studies have employed both approaches subject to data availability (see EC, 2016). In general, most **panel** FRF studies tend to find evidence of fiscal sustainability for advanced economies ($\widehat{\kappa} > 0$). The intensity of the reaction (that is, the size of $\widehat{\kappa}$) varies between 0.01 and 0.10 (country, time, method and estimator-dependent). See table A.1 in the Appendix for a literature review summary (primarily covering European/OECD countries).

Analyses of **individual countries** find more mixed results, though evidence of 'weak' sustainability condition tend to be more prevalent. See, for instance, results for the US in Bohn's studies, for four EA countries in Legrenzi and Milas (2013), or for the majority (9 out of 17) OECD countries in Wyplosz (2015). Lukkezen and Rojas-Romagoza (2012) find sustainability concerns for three out of a sample of seven OECD countries using a combination of FRF estimation on very long time series and stochastic debt simulations. When relaxing the assumption of time-invariance on debt-related responses, Cuerpo (2014) find evidence of sustainability for Spain, though with regime variation during the period of investigation (1986–2012). On the other hand, Galí and Perotti (2003) find a positive and statistically significant coefficient on lagged debt in only five out of eleven EA countries, in a model that uses cyclically adjusted primary balance (CAPB, henceforth) as a way to model the discretionary reaction of fiscal policy.[4] In our study for 18 EA countries, we do find that fiscal responses are compatible with weak sustainability constraints, with moderate cross-country variation for our time sample (when excluding one country at a time).

Few studies have explored effects related to the European integration process, such as the Maastricht Treaty, for example Weichenrieder and Zimmer (2014), or first effects of the European Sovereign Debt Crisis such as Baldi and Staehr

[4] FRF models using CAPB instead of the primary balance generally find similar evidence of sustainability. For instance, Golinelli and Momigliano (2006) estimate FRF in a panel of 19 OECD countries based on ex-post and real-time data on CAPB for 1988–2005(2006). Their results confirm sustainability (in addition to stabilization behaviour) of fiscal policy and a positive effect of fiscal rules. Similarly, Ayuso-i-Casals et al. (2007) use CAPB (and primary expenditures) in a panel of 25 EU countries over the period 1990–2005. They find evidence for fiscal sustainability and stabilisation function (in addition to the main finding that the design and coverage of fiscal rules matter).

(2016) for quarterly fiscal series. In this regard, we find an increased debt response coefficient for both the post-Maastricht period (including the Euro period) across specifications, and for effects associated with the ESDC, which could only be partially and indirectly explored because of our time sample.

The FRF literature has more recently focused on the investigation of non-linear fiscal behaviour conditional on the level of debt. Specifically, the hypothesis of fiscal fatigue has been tested[5] by including polynomial (quadratic or cubic) functional forms in the reaction of the primary balance to the debt ratio. In this respect, some studies point to the possibility of fiscal fatigue, meaning that, at very high debt ratios, the fiscal effort must be so large that it becomes untenable. For instance, Ghosh et al. (2013) report evidence of fiscal fatigue starting at $90-100\%$ of GDP for a group of 23 advanced (but rather heterogeneous) economies over the period 1970–2007 as a whole. That is, although the primary balance response to debt levels remains positive, it starts declining when the debt ratio reaches around $90-100\%$ of GDP. At even higher debt levels (around 150% of GDP); the reaction of primary balance turns negative (as the coefficient of the cubic debt term indicates). Yet, a shorter time period (1985–2007) leads to a significant loss of significance for the coefficient on lagged debt. Similar results are reported by Medeiros (2012) for a panel of EU countries with debt thresholds in the range of $80-90\%$ of GDP. However, these results seem to depend on the sample composition (inclusion of one or few high-debt countries) and estimation approach (Fourier and Fall, 2015). This latter study also finds evidence of fiscal fatigue on a sample of OECD countries (1985–2013) using a threshold model, starting around a debt ratio of 120% of GDP with a twist around 170% of GDP (without Japan there is no evidence), while two thresholds (at 152% and 167% of GDP) are identified for the Euro area group (15 countries). These results seem to be driven by the inclusion of Greece. When Greece is dropped, fiscal fatigue appears at a debt ratio around 120% of GDP. Our estimates of Ghosh's specifications do not reveal any similar debt threshold, even when the crisis period is excluded.

Our findings seem to be supported by Legrenzi and Milas (2013) estimates of individual non-linear FRFs over the period 1960/70–2012, for four EA countries that have been most affected by the sovereign debt crisis (Greece, Ireland, Portugal and Spain) and do not show evidence of fiscal fatigue. The reaction of primary balance is made conditional on the size of debt, state of the economy, and a measure of financial pressure. The chapter concludes that all countries adjust fiscal imbalances only in

[5] The notion of fiscal fatigue can be stated as the existence of mean reversion properties in the primary balance, especially for high levels of public debt; see Ghosh et al. (2013).

the higher debt regime (estimated to start at thresholds of 69% of GDP for Greece, 49% for Ireland, 47% for Portugal and 43% for Spain), and that financial market pressure leads all countries to lower the thresholds. Similarly, EC (2011) tests in a panel of EU countries show the presence of non-linear debt effects (level above 60% of GDP, quadratic and cubic terms) for the behaviour of CAPB, and do not find significant supporting evidence. The paper also verifies fiscal solvency for the panel of EU countries over the period 1975/1980–2010 and confirms a positive relationship between debt and primary balance. Therefore, in this chapter we propose a linear rule that allows us to analyse fiscal fatigue for sovereigns without putting emphasis on non-linearity. Our rule combines estimated debt response coefficients (in the first part of this chapter), and information about a country's past fiscal performance that can be easily obtained from reports of national or international organisations. Our results indicate that several euro area members are potentially endangered by the fiscal fatigue (with data up to 2013), and as such, another economic recession could result in difficulties when dealing with it. By repeating the same exercise with series up to 2008, our measure indicates a high risk of fiscal fatigue in Greece, Portugal and some other countries, but does not however signal any problems for three remaining members of the GIIPS group.

2.3 Model and data

2.3.1 Panel model specification

Our empirical model is an extension of the relationship given by equation (2.1):

$$pb_{i,t} = \alpha + \varphi pb_{i,t-1} + \kappa \cdot d_{i,t-1} + \sum_{j=1}^{k} \beta_j X_{j,i,t} + \delta_i \ [+ \ \gamma_t] + \epsilon_{i,t}, \tag{2.2}$$

where $pb_{i,t}$ is the primary balance as a share of GDP and $pb_{i,t-1}$ is its one year-lagged value, $d_{i,t-1}$ is the one year-lagged debt-to-GDP ratio, $X_{j,i,t}$ is a set of j various (macro)economic, institutional and political determinants of the primary balance, δ_i are country fixed effects (complemented in some specifications by time fixed effects, γ_t); measurement errors and random shocks are captured by the error term $\epsilon_{i,t}$. The coefficient κ of interest measures the response of the primary balance to changes in the debt ratio.

The basic model is estimated for a panel of 18 euro area countries[6] over the

[6] All members of the Euro area as of 2013, that is, Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Malta, the Netherlands, Portugal, Spain, Slovakia, and Slovenia. The current 19$^{\text{th}}$ member, Lithuania, is not included because of its

period 1970–2013 (with various robustness checks for country and time period subsamples). Naturally, a FRF estimated for one country for a relatively recent period of time would provide an ideal tool for assessing country-specific responses to fiscal policy in the face of changing debt levels and economic environments. However, the number of meaningful observations for only one country (especially for the new member states) is relatively limited. Second, for the purpose of investigating fiscal policy responses, annual data capturing budgetary years are more appropriate than higher frequency data. Third, in our view, it is more meaningful for the purpose of this research to capture common policy responses for the relatively recent past, rather than country-specific ones for very long dated periods, which are characterised by very different historical conditions. In this regard, and given data availability constraints for most euro area countries, we prefer using a panel approach.

2.3.2 Choice of variables

Two main policy variables – the primary balance (PB, henceforth) or the cyclically-adjusted primary balance – have been employed in the FRF literature as the **dependent variable**. Such a choice obviously highlights the primary focus of a study: models with PB are connected with the output gap and show the total 'fiscal impulse',[7] while models with CAPB estimate the 'fiscal effort' directly.[8] Given that the primary balance is the 'observable' fiscal policy variable and is less prone to ex-post revisions (because of frequent revisions of output gap series and/or uncertainty about budgetary elasticities'), we follow the majority of studies in using the PB as our dependent variable for both the estimation of a FRF model and a FF (non-linear) model for euro area countries. The other commonly employed variable, the CAPB, is used for robustness checks.

There is a large number of possible **determinants of the fiscal position**, which can be divided into three broad groups as shown in Abiad and Baig (2005): (1) those related to a government behaving as an optimizing agent (à la Barro, 1979), which has been subject to scrutiny since Bohn (1998)'s findings of a link between debt and deficits; (2) broad economic environment such as business cycle controls or external relations; and (3) political economy considerations and broadly

later entry (in 2015).

[7] See van Riet (2010) for an exposition of the various concepts related to fiscal balance decomposition. As pointed out in Golinelli and Momigliano (2008), there is basically no difference whether one chooses the dependent variable (CAPB/PB) in first differences or in levels, only the coefficient on the lagged term is different.

[8] There are other possible choices: the total balance or the structural balance. However, they are exposed to criticisms because of a similar construction to the CAPB (the latter) and issues of actual coverage (the former), and therefore, neither is commonly utilized in the literature.

defined institutional factors that shape the use of fiscal measures and the policy environment.

Our estimated models encompass variables covering all three groups since each of them determines the willingness and ability of a government to meet sustainability constraints. The core ('Base') FRF model includes the lagged public debt-to-GDP ratio (main variable of interest), the lagged primary balance (to account for persistence in fiscal policy), output gap (a proxy for cyclical conditions), current account balance (to control for cross-country spillovers and the twin-deficit hypothesis), and a political risk variable (dummy for election year).[9] Country fixed effects are included to capture all remaining time-invariant country-specific factors that are not explicitly controlled for. Finally, a dummy variable for the effects of the Great Recession (from 2008 onwards), and a time trend to capture common cross-country factors varying over time are also added to the basic model. There are other variables that are included in the base FRF model (extended specifications), when analysing institutional or political effects. A detailed description of these variables can be found in the appendix. Similarly, variables utilized in the FF non-linear model follow the Ghosh et al. (2013) model's specification and include further determinants, such as a proxy for age dependency or oil and non-oil price indices.

The main **data source** for our analysis is the AMECO database (economic series), and specialised databases such as the IMF (2015) fiscal rules database. Our panel is unbalanced because of missing observations at the beginning of our sample and the inclusion of new EU member states, whose time series are generally shorter (usually available from the early 1990s).[10] As a robustness check, the AMECO primary balance and debt series for the old EU member states are extrapolated to the 1970s using a historical database prepared by Mauro et al. (2013), and complemented with the other data sources (for details see the Appendix).

2.3.3 Estimation techniques

Several estimators have been employed in the FRF literature. A particular choice reflects key problems one has to deal with in dynamic panel data setting, especially when a set of potentially endogenous variables has to be treated appropriately. In this chapter, our focus is to tackle estimation issues such as endogeneity and cross-

[9] Evidence of political cycles in a panel of EU countries is also shown in Golinelli and Momigliano (2006).

[10] Since many countries did not exist in the current form before 1990, we do not attempt to use any proxy or artificially constructed series.

sectional correlation.[11]

Even though our panel is dynamic and includes country fixed effects (γ_i), we start with the fixed effects estimator to allow for the presence of potentially endogenous variables (IV estimation). Being aware of criticisms of its use (the Nickell's bias), we argue that our panel is medium to large in the time dimension compared to the cross-section dimension and the potential bias should be limited ('rule of thumb' based on Bond (2002) who states that for cases when T is larger than 20, the potential bias of the FE estimator should be negligible[12]). It has been shown that GMM estimators would not alleviate the problem (see Judson and Owen, 1999).[13] Their asymptotic properties are negatively affected by the dimensions of our panel and they are left for robustness checks. The bias corrected least-square dummy variable (LSDVC) estimator (Bruno, 2005) offers some efficiency for large (time series) panels spanning over 30 years of data and, therefore, it is also used in the robustness section. Haque et al. (1999) do not recommend first-differencing in IV cases with time dimensions above 20 since it may result in less efficient estimates.

Another problem is the presence of cross-sectional or 'spatial' dependence that may severely affect estimation efficiency, and render some estimators inconsistent (standard difference and system GMM estimators for dynamic panels) unless the unobserved factors are not correlated with the explanatory variables (see Phillips and Sul, 2003). Similarly, standard errors should be treated accordingly to adjust for overoptimistic $t-$statistic and confidence intervals (see Petersen, 2008).[14]

[11] There is also a potential problem of non-stationarity of some series (primary balance and debt, both in levels and as GDP ratios). This is, however, less acute in a panel setting and can be dealt with based on theoretical grounds (see Bohn (1998, 2007); Favero and Marcellino (2015) who state that the intertemporal budget constraint is not violated provided the $x-$th differencing renders the series stationary). In addition, as Daniel and Shiamptanis (2013) point out, a scaling of both series by GDP also mitigates (or even eliminates) problems with non-stationarity. Alternatively, one may use panel unit root tests allowing for endogenously generated structural breaks, as in Im et al. (2005) and Carrion-i-Silvestre (2005). Yet, one problem is the relatively high persistence of fiscal series (as pointed out in Bohn, 1998), which make it rather difficult to arrive at an unambiguous conclusion.

[12] This condition is met for both our large sample (1970–2013) and the shortened sample (1991–2013). Nevertheless, it is conditional on the actual panel setting and therefore, various estimators are used in the robustness section to show stability and (unbiasedness) of our results.

[13] In this context, Celasun and Kang (2006) propose a simple rule based on the main interest of the study. GMM estimators are recommended for testing cyclical sensitivity of fiscal policy variables, FE estimators (LSDV) when tests of intertemporal solvency are performed.

[14] One further possibility would be an estimator with $AR(1)$ correction for serial correlation (applied for example by Ghosh et al., 2013) such as FGLS, which also allows for spatial dependence. Such an estimator works fine for small (balanced) panels. However, Beck and Katz (1995) show that standard errors computed with this method are rather small (overoptimistic estimates). Another possibility is an OLS/Prais-Winstein estimator with the panel-corrected standard errors (PCSEs); however, it assumes strictly exogenous independent variables, and for small ratios of T/N, it produces rather imprecise estimates. In the best scenario for our panel, this ratio is around 2.4, which is

Overall, in the main regressions, we prefer using an IV, FE estimator to avoid endogeneity problems and robust standard errors to deal with heteroskedasticity, serial correlation and cross-sectional dependence. In the robustness section, further estimators are included (*inter alia*, to provide results comparable with the literature). Since in the case of weak instruments the LIML (limited information maximum likelihood) estimator shows better properties in comparison with GMM estimators, it is also used alongside the differenced GMM (Arellano-Bond) estimator (without/with forward orthogonal deviations that are more suitable for unbalanced panels). In addition, more FE estimators are utilized to allow comparison with other studies (for example Ghosh et al., 2013; Plödt and Reicher, 2015): one allowing for the error term to follow an $AR(1)$ process, and the other FE estimator explicitly allowing for cross-sectional dependence in our panel (TPCSE). In addition, as an alternative to mitigate cross-sectional correlation problems,[15] the Driscoll-Kraay estimator is also used. Since our results do not differ substantially, we consider them to have passed the robustness tests (see section 2.4.2).

2.4 Empirical results

2.4.1 Baseline specification and extended models

In the first step we apply the Base specification to the whole EA-18 group and the entire time span (1970–2013), employing our original (non-extrapolated) dataset. The literature suggests several instruments to deal with the issue of several variables, primarily the output gap (both determined and affected by fiscal policy), being affected by endogeneity (and reverse causation). Some studies simply work with lagged values; others rely on additional variables or even the GMM approach.[16] Our study uses IV (and GMM estimators as a robustness check) for the output gap, lagged dependent variable (primary balance) and current account (or its alternative). Our instrument set[17] includes second and third lag of the dependent variable;

not far on the way to a large T panel to guarantee its consistency. In addition, its superiority with respect to the FGLS estimator on the basis of efficiency has been questioned mainly for the $T > N$ case; see Reed and Webb (2010). Therefore, we prefer to use an IV, FE estimator and robust standard errors.

[15] A test for the presence of cross-sectional dependence (see Hoyos and Sarafidis, 2006) confirms its presence for our specifications (longer/shorter time periods).

[16] Some country studies such as Weichenrieder and Zimmer (2014) or D'Erasmo et al. (2015) do not report the use of any adjustment, which may cast doubts on their results.

[17] Ayuso-i-Casals et al. (2007) use a proxy for international influences (export-weighted output gap of three major export markets of each country). EC (2011) works with trend output gap and adds the contemporaneous US output lag, while Plödt and Reicher (2015) use output gap instrumented with lagged output gap and potential GDP growth corrected for real GDP growth as

lagged output gap and second and third lag of a proxy for output gap ($\frac{Y_{t-1}^P}{Y_t^P} - \frac{Y_{t-1}}{Y_t}$, following Plödt and Reicher, 2015), as well as the first and second lag of the current account, unless specified differently. This Base model performs well in various robustness tests such as the Kleibergen-Paap test (a test for weak instruments[18]) or Sargan/Hansen test (overidentifying restrictions). Moreover, the explanatory power of the Base model (and of its derivations) is very good (above 0.70 as measured by adjusted R^2 within groups). In this model (see Table 2.1, first result column), the estimated FRF coefficient of interest (the response to the debt ratio) amounts to 0.034. The model Base *A* shows results for the base specification with time fixed effects, while in the model Base *B* the output gap was replaced with the real GDP growth rate (instrumented with its second and third lag following Baldi and Staehr, 2016). The FRF coefficient is slightly lower in these two specifications and remains highly statistically significant.

Turning to the other variables included in our base specification, the responses of the primary balance are overall, highly statistically significant and have the expected sign. Somewhat surprising, while the output gap coefficient is generally positive, it is not found to be statistically significant (only in robustness checks for shorter time periods). This result is similar to other recent studies, such as Berti et al. (2016). On the other hand, the real GDP growth is positive and highly statistically significant. Election years have, on average, a negative effect on fiscal positions. The positive coefficient of the current account balance underpins the twin-deficit hypothesis. Particularly high and positive values of the lagged dependent variables indicate persistence in fiscal policy. The dummy for the effects of the crisis is negative and highly statistically significant, pointing to deteriorating fiscal positions compared to earlier periods. Finally, since the estimated value of the constant term is negative and significant, the implication from these models is that the euro area debt-to-GDP ratio is going to stabilise at a positive value in the long run.[19]

instruments (trend GDP as robustness) and lagged debt. Neither combination was possible in our case since the Hansen/Sargan test and the first stage results showed violation of assumptions for these combinations of instruments. Because of problems with output gap calculations, Berti et al. (2016) use the second and third lag of primary balance and debt. Baldi and Staehr (2016) work with GDP growth rates only.

[18] Our models are also tested using Anderson-Rubin Wald test and Stock-Wright LM S statistic for weak-instrument-robust inference (not reported due to space considerations).

[19] An estimated value can be calculated based on an estimate of the real interest rate and real economic growth. In addition, since our estimate of the government response in table 2.1 is the short-run response ($\widehat{\kappa}$), the long-run value ($\widehat{\kappa}_{LR}$) can be calculated as shown in Caruso et al. (2015): $\widehat{\kappa}_{LR} = \frac{\widehat{\kappa}}{1-\widehat{\varphi}}$, where $\widehat{\varphi}$ is the estimate of the lagged dependent variable for the model Base *A*; the long-run response is equal to 0.0783.

The remaining columns of Table 2.1 present a first set of robustness checks of our base specification by adding one variable at a time, as often used in the literature. Such a variable set includes: a proxy for openness (sum of exports and imports), inflation, consumption smoothing (in the spirit of Barro, 1979), political stability and fiscal rules (additional institutional factors), and financial markets (represented by various specifications of interest payments). Columns *mf* and *mf1* show results for models with all these variables, with and without time fixed effects. Finally, we also investigate the effects on the debt response of the financial crisis (model *m7*) and of other important events over the period of monetary integration (model *m8* includes a Euro dummy, being one for all years after euro introduction in individual countries, and its interaction with debt; in a similar model, not shown in Table 2.1, the euro dummy is replaced with a dummy equalling one for the EMU period, that is, as of 1999 onwards for all countries).

In all specifications, including the full models, the lagged debt ratio remains statistically significant, with a coefficient ranging between 0.031 and 0.041 when interest payments are included. There are no substantial changes in sign or significance level for the estimated effects of the other baseline determinants either. Regarding added explanatory variables, higher interest payments – as a ratio of lagged debt, current GDP or total revenues (the first one only shown in model *m6* of Table 2.1) – seem to have a (residual) negative impact on the capacity of governments to maintain higher primary surpluses (after controlling for the debt level). This is in line with findings in Debrun and Kinda (2013) on the 'squeezing feeling' of the interest burden. Similarly, the cyclical component of government consumption, used in several FRF studies to capture stabilising effects of fiscal policy, is found to limit primary surpluses.[20] At the same time, stronger government stability[21] or the existence of a fiscal rule,[22] though leading to better fiscal positions, are not found to be significant at standard levels. In the combined models (*mf*–*mf1*), the debt response remains broadly unchanged (somewhat lower in the model without time fixed effects).

Regarding the events over the monetary union period, we find evidence for a significant, positive effect of the crisis on the response of fiscal policy to debt.

[20] See Bohn (1998) or Mendoza and Ostry (2008) for further details.

[21] We also use other variables for political factors such as total risk rating or political risk rating (from the PRSG database) and find similar conclusions.

[22] As measured by a dummy based on the IMF fiscal rule database. Results for an alternative index – the fiscal rules index (FRI) – from the European Commission (see EC, 2016a) are less robust (FRI is statistically significant only in certain models, a result that can be due to the relatively short time span of the index). In general, effects of variables capturing fiscal rules are rather mixed in the literature (subject to period and country composition, see for example Debrun et al., 2008; Escolano e al., 2012; EC, 2011).

The FRF coefficient almost doubles over the crisis (the estimated coefficient of the interaction term between the crisis dummy and the debt ratio is 0.022, while the coefficient of the debt variable, denoting how the response before the crisis, declines to 0.029). The evidence with respect to the effect of the EMU creation or the euro introduction is more mixed. While the interaction terms between the respective dummies and the debt ratio are also found to be statistically significant and have a positive sign for the whole sample, these results may mask the crisis effects. When the sample is restrained to the period before the crisis (1970–2007), the interaction terms generally lose significance.

The appendix includes a robustness check for the Base model specification (Table A.2) with respect to (*a*) the choice of the dependent variable (CAPB instead of PB) and (*b*) the length of fiscal series (based on the use of extrapolated series, especially for the 'old' member states, as opposed to original, shorter series). The response coefficient of the lagged debt is similar with that using extrapolated series (0.027 for the Base model, *am0*), while when CAPB is employed the coefficient is lower in the base model (0.006), but increases in other models (for example to 0.027 when real growth is used instead of output gap).

Table 2.1: Basic model and extended specifications, EA-18, 1970–2013

	Base	Base A	Base B	m1	m2	m3	m4	m5	m6	mf	mf1	m7	m8
Lagged primary balance	0.566***	0.716***	0.608***	0.626***	0.566***	0.502***	0.567***	0.510***	0.589***	0.521***	0.640***	0.581***	0.558***
	[0.059]	[0.046]	[0.042]	[0.057]	[0.059]	[0.068]	[0.059]	[0.064]	[0.056]	[0.074]	[0.059]	[0.056]	[0.058]
Lagged debt	0.034***	0.029***	0.030***	0.038***	0.037***	0.038***	0.031***	0.037***	0.041***	0.036***	0.029***	0.029***	0.030***
	[0.006]	[0.006]	[0.006]	[0.007]	[0.007]	[0.008]	[0.006]	[0.007]	[0.006]	[0.008]	[0.007]	[0.006]	[0.006]
Output gap	0.072	0.076		-0.072	0.072	0.138*	0.061	0.107	0.058	0.085	0.040	0.095	0.100
	[0.071]	[0.070]		[0.058]	[0.073]	[0.082]	[0.069]	[0.080]	[0.064]	[0.074]	[0.079]	[0.069]	[0.074]
Current account	0.157***	0.156***	0.101***		0.152***	0.180***	0.128**	0.166***	0.150***	0.141***	0.146***	0.173***	0.175***
	[0.054]	[0.042]	[0.036]		[0.055]	[0.056]	[0.055]	[0.058]	[0.047]	[0.052]	[0.044]	[0.056]	[0.058]
Election dummy	-0.448***	-0.546***	-0.489***	-0.447***	-0.451***	-0.398**	-0.404***	-0.437***	-0.511***	-0.406***	-0.472***	-0.445***	-0.435***
	[0.155]	[0.142]	[0.134]	[0.157]	[0.156]	[0.161]	[0.155]	[0.160]	[0.142]	[0.152]	[0.146]	[0.154]	[0.154]
Crisis dummy (2008+)	-1.884***	-1.951***	-0.368	-2.250***	-1.942***	-1.976***	-1.710***	-1.912***	-1.199***	-0.977***		-3.064***	-1.867***
	[0.364]	[0.582]	[0.420]	[0.379]	[0.364]	[0.419]	[0.349]	[0.406]	[0.286]	[0.331]		[0.570]	[0.365]
GDP growth			0.350***										
			[0.087]										
Openness				0.013**									
				[0.006]									
Lagged GDP deflator					0.035					0.025	0.025		
growth					[0.040]					[0.037]	[0.039]		
Lagged IMF fiscal rule						0.432				0.453	0.418		
						[0.445]				[0.416]	[0.433]		
Government consumption							-0.078***			-0.062**	-0.032		
expenditures							[0.027]			[0.028]	[0.026]		
Government stability								0.078		0.014	0.025		
								[0.051]		[0.051]	[0.063]		
Interest payments									-0.156***	-0.152***	-0.085***		
									[0.021]	[0.027]	[0.027]		
Crisis#debt												0.022***	
												[0.007]	
Euro dummy													-0.672
													[0.449]
Euro*debt													0.014**
													[0.006]

Continued on next page

Table 2.1 – *Continued from previous page*

	Base	Base A	Base B	m1	m2	m3	m4	m5	m6	mf	mf1	m7	m8
Year	-0.005		-0.005	-0.005	0.004	-0.005	-0.004	0.002	-0.020	-0.037		-0.012	-0.017
	[0.015]		[0.012]	[0.016]	[0.018]	[0.029]	[0.015]	[0.019]	[0.013]	[0.026]		[0.014]	[0.020]
Constant	-1.125**	-0.307	-1.939***	-2.440***	-1.605**	-1.803**	-1.027**	-2.225***	-1.042**	-0.870	-2.767***	-0.705	-0.700
	[0.490]	[0.559]	[0.470]	[0.549]	[0.786]	[0.832]	[0.478]	[0.771]	[0.453]	[0.976]	[0.989]	[0.484]	[0.548]
Observations	431	431	455	431	431	378	431	392	429	378	378	431	431
R-squared	0.720	0.807	0.758	0.711	0.722	0.727	0.731	0.722	0.766	0.774	0.820	0.731	0.726
Country FE	yes	yes	yes	yes	yes	yes	Yes	yes	yes	yes	yes	yes	yes
Time FE	no	yes	no	no	no	no	No	no	no	no	yes	no	no
Kleibergen-Paap LM stat.	35.110	36.260	24.540	30.030	33.970	28.670	34.720	31.550	38.610	32.900	28.050	36.260	36.150
Kleibergen-Paap p-val	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen test	7.264	4.353	3.184	6.430	7.437	7.940	6.621	6.484	6.565	7.026	4.045	7.841	7.881
Hansen p-val	0.123	0.360	0.364	0.169	0.115	0.094	0.157	0.166	0.161	0.135	0.400	0.098	0.096

Notes: P-value: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$: variable is statistically significant at the 1%, 5% and 10%, respectively. Country fixed effects and time fixed effects are not reported, robust standard errors. The null of Kleinbergen-Paap LM test is that instruments are weak. *Source:* own calculations.

2.4.2 Further robustness tests

Period effects

In the following series of robustness checks, we first focus on a **period effect** since the literature shows a varying impact of some variables over time. Further to the interaction models discussed in the previous section, we test for a change in fiscal policy responses by breaking the sample into several sub-periods, with and without the years of financial crisis (from 1970, 1985 or from 1991, just before the signature of the Maastricht treaty).[23] In general, the primary balance response to debt for the periods that include the crisis years is larger than for periods excluding the crisis. See Table A.3 in the Appendix. The reaction coefficient of the base model remains broadly unchanged, with an increase for the period after the Maastricht treaty (from 0.034 to 0.046). Yet, this increase seems to be mainly determined by the crisis period since the change in the FRF coefficient is much lower when the crisis is excluded (from 0.025 to 0.027). These results should be interpreted with some caution because of the shorter data timespan (also indicated by the IV tests, especially in models *m22* and *m33*). The output gap becomes (marginally) significant (and remains positive) for models without the crisis. In addition, it turns significant for the entire period in model *m2* (1985–2013).

Country effects

Next, we analyse the **country dimension** of fiscal responses for subgroups of EA18 members. In our case, three subgroups are considered: (*i*) consisting of the 12 'old' EA members (EA12) or (*ii*) when Greece (the country with the highest average debt ratio) or/and (*iii*) Luxembourg (lowest debt ratio) are excluded. In all three specifications, estimated FRF (debt) responses are only marginally smaller (around 0.03), for both the entire period (1970–2013) and for the periods without the financial crisis years. Similar results are found when the Maastricht period (1991–2013) is considered. See Table A.4 in the Appendix. Regarding other variables, the output gap turns again significant in the smaller samples. Otherwise, there are no major changes in the significance or signs of individual variables.

Subsequently, we examine the issue of panel heterogeneity and control more extensively for potential outliers by running the base specification while omitting one country at a time. Albeit there is some variability in the FRF coefficient,

[23] Because of the relatively short period since the launch of the Euro, we do not show estimates for a model covering only the post-EMU period (1999 onwards, that is, only 15 years) since results may be subject to severe bias.

the differences are rather small. The statistical significance of the debt coefficients remains unaffected by country exclusions and the size hovers between 0.03 and 0.04.[24] See Figure A.2) in the Appendix.

Further tests for country and period effects

To check the robustness of our average estimates of FRF, two further checks are carried out. They take the form of a simple decomposition based on the 'random coefficients model' over both panel dimensions (cross-section and time). For that purpose, an individual country dummy or a time dummy is interacted with the debt variable, and our model described in equation (2.2) is estimated with all these additional terms.[25] That allows us to evaluate country and time effects, while keeping both the model specification and our sample size unchanged. Nevertheless, there is one alternation; in order to gain some robustness (for the early years of our sample), the whole exercise is carried out on the extended data set.

We focus on the narrow group of 'old' EA members, with comparable series (same length for all countries, that is, the EA-12 group without Luxembourg; results for the EA-18 group can be found in appendix). Based on this exercise there seems to be some evidence for a link between average response and debt ratios (low indebted countries with low responses vs. highly indebted ones with larger responses despite not being significant for some members). With the exception of the Netherlands, the other countries show positive FRF responses. Finland, Austria, Ireland (not significant for Germany, France, Spain, and Belgium) have estimated responses below or close to the EA-11 average response, while Portugal and especially Italy and Greece show larger response coefficients compared to the EA average (see figure 2.1 below).

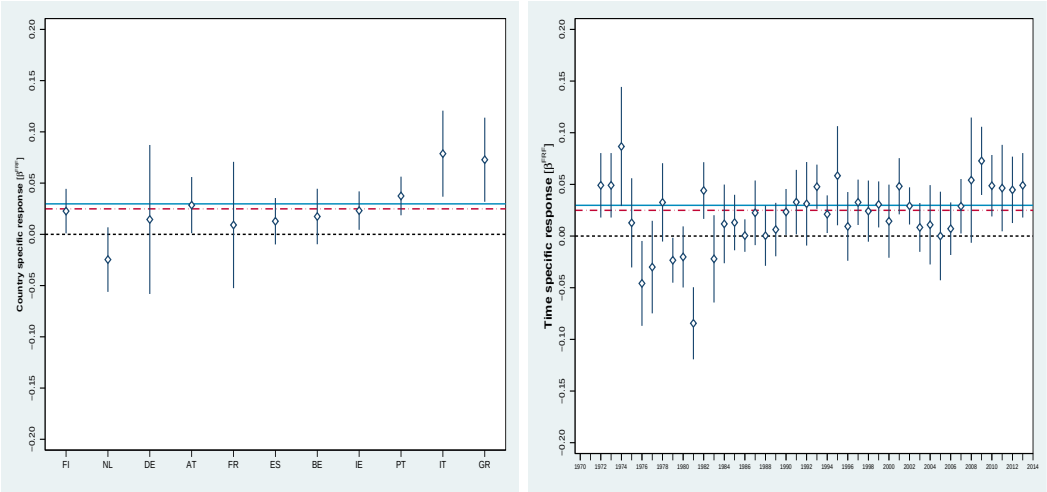
[24] We also carried out a test of homogeneity of the FRF coefficients based on a modification of the equation (2.2):

$$pb_{i,\,t} = \alpha + \varphi\ pb_{i,\,t-1} + \kappa \cdot d_{i,\,t-1} + \kappa_i \cdot d_{i,\,t-1} + controlvar_{i,\,t} + \delta_i + \vartheta_{i,\,t},$$

where κ_i is the dummy for a country i, κ and κ_i are to-be-estimated panel (EA average) and country-specific slope coefficients, the remaining variables have the same interpretation as those in the equation (2.2). After having estimated this equation by country, a test of similarity of both coefficients was carried out (the null: $(\widehat{\kappa} - \widehat{\kappa}_i) = 0$). Since there are no observations for all countries and all debt-to-GDP ratios, following Ghosh et al. (2013), we estimate this equation for the debt ratios between 30% and 100% of GDP (without Estonia, Latvia, Luxembourg, and Slovenia). The null was rejected at 5% level for three countries: France, Ireland and the Netherlands, but for none belonging to the narrower group of 'programme countries'. Detailed results available upon request.

[25] The model specified in equation (2.3) then includes a set of additional terms ('interactions') with the debt variable for all EA countries [panel a)] and/or years [panel b)] and one country/one period is selected as the reference country/year [r]: $\delta_i \cdot d_{i,\,t-1} \forall_{i,\,i \neq r}$ or $\gamma_t \cdot d_{i,\,t-1} \forall_{t,\,t \neq r}$. This model is then similar to the random coefficient model in case of the IV FE estimator, for further details see appendix A.1.

Figure 2.1: Fiscal responses by country and by year, EA-18 countries, 1970–2013



Note: country ordering based on the 2013 debt level values. Blue line stands for EA-11 average response with a linear time trend, red dashed line for average response with time fixed effects (all EA11 countries and for all years). The black dotted line indicates the null response. Whiskers around point estimates (diamonds) represent the 95% confidence intervals. *Source:* own calculation.

When considering the other dimension (time), there seems to be a great deal of variation in the 1970s and early 1980s, and then, a rather mitigated level just before the onset of the Great Recession (illustrating tensions during first years of the monetary union and problems with the original Pact). A closer inspection of the figure (and estimates) reveals some 'turning points' that indicate few changes in government responses over our sample period. However, many 'time' effects are not significant at standard levels.[26]

Overall, these country-specific results should be taken with caution, because of the medium time dimension of our panel and the caveats of the method (simple linear interactions with respect to a base country/year) in case of country-specific and time responses. Mainly for the latter, this method lacks flexibility that is associated with Bayesian style time-varying parameter estimations (full model specification), such as in Cuerpo (2014) for Spanish public finances.

[26] Some of these turning points are found significant in the non-parametric time-varying estimation, which gives us more confidence and provides a robustness check of our findings.

Choice of estimators

As already introduced in section 2.3.3, we also test the robustness of our results by employing a battery of estimators to gauge any potential biases in our estimated coefficients compared to the base estimator (FE IV). See Table A.5 in the Appendix. Regarding our variable of interest, the debt ratio remains highly statistically significant across estimators (except for the simple Arellano-Bond GMM estimator). In terms of economic significance, the FRF coefficient estimated with pooled OLS is viewed as a (quasi)-lower bound (0.010 in our case). Leaving aside the pooled OLS results, relatively low FRF coefficients are found with the corrected least-squares dummy variable estimator (LSDVC) and LIML and two-step GMM estimator with time effects (0.031 and 0.033 respectively). On the other hand, an upper bound 0.064 is given by the Arellano-Bond (difference) GMM estimator, when orthogonal deviations are used. Such an estimate seems to lie near the upper interval for EU/EA countries (see the literature survey in the Appendix or a short summary in Berti et al., 2016). The other explanatory variables largely keep their levels of significance and signs.

Other robustness checks

Two further robustness checks are carried out and shown in appendix. First, we investigate the effect of introducing a constraint on fiscal policy behaviour in the form of a fiscal rule (table A.6 in appendix). The inclusion of a proxy for fiscal institutions in a broad sense is associated with a reduced sample size since most of them are not available before 1990 (or 1985). While the impact on the FRF coefficient is rather small, the effects of the fiscal rules themselves are not found statistically significant. For example, the EC fiscal rule index (FRI, see EC, 2016a), perhaps owning to its limited availability before 1990 or its specific construction) leads only to a significant response of the output gap, while the variable itself remains insignificant. Similarly, the overall IMF fiscal rule dummy and its four subcomponents are not found to have a statistically significant effect on the primary balance. These results seem to confirm previous findings in more recent literature (see Ayuso-i-Casals et al., 2007; Cordes et al., 2015).

Second, we investigate the effects of broadly defined political institutions (such as government stability or political risk rating prepared by the Political Risk Services Group (PRSG), and alternatively from the IADB database of political institutions; see description in Table A.8 in the Appendix). These variables are not found statistically significant for our group of countries with the exceptions of the

election dummy and total risk rating variable. One reason can be due to rather highly developed political systems having differences that are hardly detectable by this type of soft-data comparable across a world sample.

Finally, a simple test for the presence of non-linear responses is conducted by using a debt dummy variable. A large number of studies report estimates of nonlinearities found around the debt-to-GDP ratio of 50 percent, such as Mendoza and Ostry (2008). Since we are agnostic about a location of such effect (perhaps in the neighbourhood of 60 percent if the Pact was binding), we estimated our base model specification with a simple dummy variable (one at a time), taking the value one for a particular debt ratio lying between 5 and 135 percent and zero otherwise. Our results show (see figure A.3 in appendix) that there are several intervals of levels of indebtedness where the coefficient on a debt dummy becomes significant, one of them around 40 percent, others for rather low levels of indebtedness (below 20 percent), and then for higher levels (around 70 percent, including the 60 percent ceiling). There are even two visible (significant) points of discontinuity (measured in term of the estimated coefficients), one around 35 percent, and the other around 56 percent. Similar but rather noisier results are obtained when our non-extended sample is utilized. These finding would point towards the need to explore possible non-linearities in debt responses. This is done in the next section.

2.5 Fiscal fatigue

In this section, we first propose a novel approach to measure fiscal fatigue (FF) building on the linear FRF. In turn, we investigate the fiscal fatigue hypothesis across euro area countries using a non-linear approach. So far, the concept of fiscal fatigue based on a FRF has been mainly investigated in the literature using a non-linear (cubic) function in line with Ghosh et al. (2013). In related fields, the empirical evidence on the capacity of sovereigns to maintain high primary surpluses is rich (see Eichengreen and Panizza, 2014, for a recent study).

2.5.1 Detecting fiscal fatigue – the linear case

In the **linear FRF literature**, a sufficient condition for sustainability is that the primary balance ratio improves when the government debt ratio increases. However, large increases in primary surpluses and, especially maintenance of such surpluses over long periods of time, are constrained by a multitude of economic, institutional and political factors denoting fiscal fatigue. The linear FRF literature provides the size of the estimated coefficient for the reaction of the primary balance to debt. This

can be used to calculate upper limits for the primary surpluses that a country can maintain, and thus provides a useful input for debt sustainability analyses (DSA).[27] For instance, a central question in DSA exercises is the size of the needed primary balance to stabilise the debt ratio or bring it below a certain threshold by the end of the simulation horizon. The resulting primary balance can be evaluated against the risk of fiscal fatigue by comparing it with the country's historical track-record. If the simulated primary surplus is above the average or, even worse, above some maximum primary balance maintained in the past (call it 'Benchmark', B), then the government may be at risk of fiscal fatigue. However, governments may have maintained a relatively low fiscal surplus in the past given a low debt level. An increase in the debt level (due, for instance, to a crisis) would improve the fiscal effort if the respective government obeys sustainability constraints. To calculate such an upper limit for the fiscal fatigue, an estimated linear FRF coefficient k can be used. For instance, taking a prudent coefficient of 0.04 based on our analysis of the euro area FRF, any 10 percentage point increase in the debt ratio (ΔD) would add 0.4 percentage point to the primary balance. The 'adjusted primary balance Benchmark' (B_{adj}) would then be derived as follows:

$$B_{adj} = B + k \times (\Delta D). \tag{2.3}$$

One could assign for instance a risk score (and a heat map) for fiscal fatigue as follows:

1. Low risk (L) if the simulated primary balance (say average over 5 or 10 years during the DSA horizon) is lower than the benchmark B of the recent past;

2. Medium risk (M) if the simulated primary balance is above the past benchmark, but below the benchmark adjusted with the FRF coefficient for the increase in the debt level (B_{adj});

3. High risk (H) if the simulated primary balance is above the debt-adjusted benchmark (B_{adj}).

An example for the application of the linear FRF-based fiscal fatigue criterion to the euro area countries (EA-18), based on the DSA data from the latest IMF documents (mostly Art. IV reports), is shown in Table 2.2 below. Column 8

[27] DSA has been gaining popularity as a tool that allows us to assess the behaviour of public finances in the short and medium-term horizon under uncertainty. A country-specific example (for Spain) can be found in Cuerpo (2014).

shows the risk of fiscal fatigue when we take the benchmark as the average fiscal performance over the monetary union period (the average primary balance net of support to the financial sector for the period 1999–2013), and employ an adjustment FRF coefficient of 0.04. According to this measure, from the perspective of their past track-record and an average fiscal reaction function, more than half of our EA-18 sample (10 countries) would be signalled in DSA simulations at high risk of fiscal fatigue. Results would remain unchanged if the FRF coefficient of our base model, 0.034 or the lower and upper bounds of its 95% confidence interval (0.022 and, respectively, 0.046) would be used instead. See columns $8.1 - 8.3$. Results would change (to lower risks) for only three countries (highlighted in column 8.4) if the upper estimator bound (0.064 with the difference AB estimator) were used.

Alternative (less stringent) applications of the fiscal fatigue criterion refer to the chosen benchmark for the primary balance track-record (see Table 2.3). If the crisis years are broadly excluded from the benchmark (that is, only the average primary balance over a 10 year-period, 1999–2008, is considered) and the FRF coefficient from model $m7$, table 2.1 (0.029) is used for the adjustment, then the upper adjusted PB benchmark increases and the risk assessment improves in several countries (7 countries, highlighted in column 8, Table 2.3). This less stringent assessment would be justified by the normalisation of the economic conditions and a low probability of a crisis revival. This setup is likely more suitable for a DSA baseline, while the one in Table 2.2 may be considered for DSA risk scenarios.

Though less accurate estimates, the use of country-specific FRF coefficients (as per Figure A.2)[28] instead of the common panel coefficient would not significantly change the risk assessment. See second panel of Table 2.3. The risk of fiscal fatigue would change for only two countries, Austria and Greece (higher for Austria and lower for Greece). For countries with large increases in the debt ratio, such as Greece, the size of the FRF coefficient plays a more sizeable role. According to this model, the upper limit of the primary balance benchmark for DSA simulations (B_{adj}) would be around 0.6% of GDP, at an average (common) FRF of 0.04. This would however increase to 3.5% of GDP if a country-specific FRF coefficient of about 0.075 were to be used.

[28] For the EA-11 countries; for the remaining EA-18 countries, the common FRF coefficient (0.04) is used instead.

Table 2.2: An application of the linear FRF-based fiscal fatigue criterion: 1999–2013 benchmark

Country	Average 1999–2013		Average 5 year DSA simulations (latest IMF DSA)		Risk of fiscal fatigue: Adjustments with FRF coefficient of 0.04				**Risks of fiscal** fatigue – alternative FRF coefficients:			
	PB (B)	Debt	PB	Debt	Change in debt	Adj. in PB	Max PB (B_{adj})	**Risk: Comparison with DSA sim**	0.034	0.022	0.046	0.064
	1	2	3	4	$(5 = 4 - 2)$	$(6 = 5 * 0.04)$	$(7 = 1 + 6)$	8 (**3 vs.** 1 **&** 7)	8.1.	8.2.	8.3.	8.4.
AT	0.82	71.4	1.40	74.5	3.1	0.12	0.94	**H**	H	H	H	H
BE	2.96	100.6	0.74	104.1	3.5	0.14	3.10	**L**	L	L	L	L
CY	-0.35	62.3	2.24	116.5	54.2	2.17	1.82	**H**	H	H	H	M
DE	0.83	67.6	1.92	66.0	-1.6	-0.06	0.77	**H**	H	H	H	H
EE	0.48	5.9	0.50	6.9	1.0	0.04	0.52	**M**	M	M	M	M
ES	-0.70	55.6	-0.32	97.5	41.9	1.68	0.98	**M**	M	M	M	M
FI	3.57	42.9	-0.90	60.9	18.0	0.72	4.29	**L**	L	L	L	L
FR	-0.95	70.6	0.16	93.0	22.4	0.90	-0.05	**H**	H	H	H	M
GR	-2.08	121.9	2.60	168.1	46.2	1.85	-0.24	**H**	H	H	H	H
IE	-0.51	54.8	2.08	103.2	48.5	1.94	1.43	**H**	H	H	H	M
IT	1.88	108.4	2.30	130.0	21.7	0.87	2.74	**M**	M	M	M	M
LU	2.12	12.0	0.00	38.5	26.5	1.06	3.18	**L**	L	L	L	L
LV	-1.54	22.4	0.10	36.4	14.0	0.56	-0.98	**H**	H	H	H	H
MT	-0.78	66.3	1.40	67.2	0.9	0.04	-0.74	**H**	H	H	H	H
NL	0.63	53.8	-0.68	68.4	14.6	0.58	1.21	**L**	L	L	L	L
PT	-2.01	77.0	1.70	123.4	46.5	1.86	-0.15	**H**	H	H	H	H
SI	-1.36	33.2	-0.34	84.3	51.1	2.04	0.68	**M**	M	M	M	M
SK	-2.86	41.5	0.64	51.8	10.3	0.41	-2.45	**H**	H	H	H	H

Notes: PB denotes primary balance (adjusted for the government support to the financial sector, GAFS); both PB and debt as % of GDP. Max PB (B_{adj}) denotes the debt-adjusted primary balance benchmark (see eq. (2.3) above). DSA simulated PB and debt are taken from IMF Article IV reports and similar materials, as available online, up to August 2015. In column 8, the FF risk categories (L, M, H – low, medium, high risks) are described in the text (see eq. (2.3) above).
Source: own calculations.

Table 2.3: Alternative applications of the linear FRF-based fiscal fatigue criterion

Country	10-year average 1999–2008		Risk of fiscal fatigue: Adjustments with FRF coefficient for period before crisis (0.029)				Risk of fiscal fatigue: Adjustments with country-specific FRF coefficient (whole period)		
	PB (B)	Debt	Change in debt	Adj. in PB	Max PB (B_{adj})	**Risks: Comparison with DSA sim**	Adj. in PB	Max PB (B_{adj})	**Risks: Comparison with DSA sim**
	$1'$	$2'$	$(5' = 4' - 2')$	$(6' = 5' * 0.029)$	$(7' = 1' + 6')$	$8'$ **(3 vs. $1'$ & $7'$)**	$(6'' = 5' * k)$	$(7'' = 1' + 6'')$	$8''$ **(3 vs. $1'$ & $7''$)**
AT	1.19	66.4	8.1	0.23	1.42	**M**	0.16	1.35	**H**
BE	4.68	99.8	4.2	0.12	4.80	**L**	0.17	4.85	**L**
CY	0.88	57.7	58.8	1.71	2.59	**M**	2.35	3.24	**M**
DE	0.78	62.5	3.5	0.10	0.88	**H**	0.04	0.81	**H**
EE	0.78	5.0	1.9	0.06	0.84	**L**	0.08	0.86	**L**
ES	2.02	47.3	50.2	1.46	3.47	**L**	0.90	2.92	**L**
FI	5.77	39.8	21.1	0.61	6.39	**L**	-0.53	5.24	**L**
FR	0.15	63.1	29.9	0.87	1.01	**M**	0.45	0.59	**M**
GR	-1.26	104.6	63.5	1.84	0.58	**H**	4.76	3.50	**M**
IE	2.12	32.4	70.9	2.05	4.18	**L**	1.77	3.89	**L**
IT	2.37	102.9	27.2	0.79	3.16	**L**	2.17	4.55	**L**
LU	2.95	8.0	30.5	0.89	3.83	**L**	1.22	4.17	**L**
LV	-1.26	12.8	23.5	0.68	-0.58	**H**	0.94	-0.32	**H**
MT	-1.19	65.3	1.9	0.06	-1.13	**H**	0.08	-1.11	**H**
NL	2.09	49.6	18.8	0.55	2.64	**L**	0.57	2.66	**L**
PT	-1.39	60.8	62.6	1.82	0.42	**H**	1.57	0.17	**H**
SI	-0.36	25.3	59.0	1.71	1.35	**M**	2.36	2.00	**M**
SK	-2.44	39.4	12.4	0.36	-2.08	**H**	0.50	-1.94	**H**

Notes: See Table 2. Columns 3 and 4 as per Table 2. Highlighted cells show differences in risk assessment compared to column 8 Table 2.2.

The debt-adjusted benchmark based on the linear FRF can be complemented with the upper sustainable limits suggested in other empirical literature strands, for instance, the primary surplus threshold of 4% of GDP in Eichengreen and Panizza (2014). Overall, the results of such analysis (here for illustrative purposes), can serve as a basis for further investigation of the fiscal fatigue hypothesis in the context of debt sustainability analyses.

2.5.2 Non-linear estimation of FRF

Turning to the **non-linear FRF**, this section aims to investigate the existence of a non-linear link between primary balance and debt ratios. First, our focus is to test the fiscal fatigue hypothesis in line with Ghosh et al. (2013), using our euro area dataset. In this case, the model to estimate extends the specification in eq. (2.2) simply by adding lagged polynomial terms of public debt. The cubic specification below is only one particular form to capture a non-linear behaviour and we also explore a modification that includes only squared lagged debt term:

$$pb_{i,t} = \varphi pb_{i,t-1} + \beta_0 d_{i,t-1} + \beta_0' d_{i,t-1}^2 + \beta_0'' d_{i,t-1}^3 + \sum_{j=1}^{k} \beta_j X_{i,j,t} + \delta_i \,[+\,\gamma_t] + \omega_{i,t}, \tag{2.4}$$

where the variable definitions are as per equation (2.3) (measurement errors and random shocks are captured by the error term $\omega_{i,t}$).

The results for the entire period 1970–2013 (using the original, not-extended dataset) are presented in Table A.7 in the appendix. These models are divided into two groups: one labelled base, which presents results for our specification and the Ghosh's base specification estimated with our data, and the other, extended, that does the same for Ghosh's extended specification. Both groups are an extension of the Base specification with non-linear debt terms (quadratic and cubic debt terms), as follows: *IV FE ff0a* includes not only both nonlinear terms but also the lagged dependent variable while *IV FE ff1* does not. Neither of Ghosh's models includes the lagged dependent variable. All models are estimated with IV estimators – FE IV as in previous text and two-stage PCSE estimator correcting for serial correlation and cross-sectional dependence with panel specific $AR(1)$ type error term.[29] Our base results do not indicate any presence of the fiscal fatigue (significance and/or signs), neither for our Base specification nor for Ghosh's models. The signs and levels of significance are very similar to previous results, in case of Ghosh's model to

[29] Results based on the FE estimator are sensitive to period of data utilized in estimation and the way endogenous variables are treated (output gap). Results for both estimators are not sensitive to alternations in oil prices and/or non-oil price indices (IMF or WB definition, see appendix).

their results. The only exception is the output gap that turns significant in models without the lagged dependent variable. The other half of table A.7 shows results for our base model with nonlinear debt terms, with the lagged dependent variable, and with output gap and current account variables not instrumented, but replaced by their first lags estimated with FE estimator. Only in one model – *FE ff3a* – all debt variables become significant and with correct signs. Output gap in these specifications remains significant with a positive sign (not for model *FE ff2a*), and the election dummy loses its significance in some models. The last two columns of the table presents results of Ghosh's extended model for our data. However, debt variables remain insignificant and with incorrect signs as in the previous case.

To check the robustness of our findings, our 'fiscal fatigue' models (*IV FE ff0a* and *IV FE ff1*) were also estimated on a sample where one country was dropped at a time. While there were no significant differences across estimated models, after dropping a county, some estimates had the correct signs but lacked significance for higher order debt terms. In addition, we also explore the effect of excluding the crisis years (after 2008 in line with our definition of the crisis period).

While in the Ghosh et al. regressions, the results remained mostly insignificant, in our specifications, mainly *FE ff3a*, we find statistically significant estimates with correct signs for the nonlinear fiscal fatigue pattern. Possible debt turning points were calculated, but were found to be very high (approaching 200% of GDP). Overall, in this type of fiscal fatigue specification, it appears that the significance of findings is lost when instrumental variables are employed and/or when the years after 2007 are included in the sample.[30] Apart from the sample composition, another explanation for the difference in results compared to Ghosh et al. (2013) can be associated with the underlying debt series: for instance, Fourier and Fall (2015) find evidence of fiscal fatigue for OECD public debt series but not for debt series calculated according to the EDP rules.

To summarize our findings, there does not seem to be clear evidence for non-linear fiscal fatigue in line with Ghosh et al. (2013), even though some (high debt) countries may have been exposed to such problems in the more recent past. This conclusion is not surprising given the relatively low number of observations with very high debt ratios in our sample. In addition, some studies have shown sensitivity of fiscal fatigue estimates on some variables, particularly interest rates

[30] Even though the onset of the Sovereign Debt Crisis can be traced back to late 2009 or 2010, samples including 2008 or 2009 show a lack of significance in debt coefficients.
Using an extended country sample (EU-28 or OECD countries) does not lead to significantly different results, but coefficients turn positive and with the correct signs in the case of OECD countries, where some of them have experienced high levels of indebtedness (Japan or as a result of a crisis such as Bulgaria in early 1990s). Results available upon request from the authors.

(see Daniel and Shiamptanis, 2015).

2.6 Conclusions

This chapter addressed two main research questions that result in two contributions of this text. First, we estimated a 'stylised' fiscal reaction function for 18 euro area countries employing longer and more recent time series. Second, we explored the issue of fiscal fatigue in greater depth.

Having used various dynamic panel techniques and a battery of robustness checks, we found evidence that euro area sovereigns abide, on average, by weak sustainability constraints. The primary balance improves by about 0.03–0.05 for every 1 percentage point increase in the debt-to-GDP ratio after controlling for other relevant factors. The positive reaction of primary surpluses to higher debt strengthened over the crisis (2008 onwards), which seemed to have acted as a disciplining device compared to the preceding period. Similar evidence with respect to the behaviour over the monetary union period (after 1999 and in individual country after the euro adoption) is less strong (the higher FRF coefficient seemingly determined by the crisis period). Overall, we find that the FRF estimates are rather robust across various specifications, time periods and exclusion of individual countries. Moreover, the fiscal reaction is not substantially different for our base model specification across EA countries. Though country-specific results should be regarded with caution, we find that the FRF coefficient deviated somewhat more substantially from the average one in a few countries, especially as a reaction to the crisis, .

Regarding other determinants of fiscal positions (higher primary surpluses), we find evidence for persistence in fiscal policy; political factors (election years only, with a negative impact), for the twin deficit hypothesis (improved external positions and more openness) and the squeezing effect of interest payments. We do not find strong evidence for a stable cyclical behaviour (stabilisation) function of fiscal policy across the euro area countries. When the whole period (crisis years included) is considered, the output gap does not seem to have a statistically significant impact in the setting of the cyclically-adjusted primary balance (a proxy for the discretionary fiscal policy) and, more surprisingly, of the primary balance. A statistically significant and positive impact, which may be taken as weak evidence of counter-cyclical effects of fiscal policy, is found only when the GDP growth rate is used, or, in the case of the output gap, only for the periods excluding the crisis years. However, neither the output gap or the real growth rate is found to have a statistically significant impact on driving the CAPB (discretionary fiscal policy). In

this sense, we do not find strong evidence for either a continuously pro-cyclical or counter-cyclical fiscal policy for the euro area countries, on average.

The second contribution of the chapter consists in proposing a novel measure of fiscal fatigue that allows us to classify countries based on their actual fiscal behaviour with few assumptions. Considering a prudent coefficient for the fiscal policy reaction function, we can measure the extent of fiscal fatigue by comparing simulated primary balance paths in the context of debt sustainability analyses with countries' track-record, adjusted for the estimated fiscal reaction coefficient. Support for the fiscal fatigue hypothesis using a non-linear FRF as proposed in Ghosh et al. (2013) is weak and not sufficiently robust in the euro area sample.

Our study is subject to caveats associated with a panel approach when investigating the fiscal fatigue hypothesis. A natural response seems to be more data-demanding country-specific models that can be estimated with a battery of econometric techniques allowing for various types of non-linearities. This would come, though, at the cost of reduced comparability and applicability to more recent economic, institutional and political conditions. Because of limited availability or comparability of time series (at the same or a higher (quarterly) frequency that is available for most EA countries as late as 2000) for our set of countries, we leave this extension for further research. As such, further investigations could focus in more detail on the fiscal fatigue hypothesis in a larger sample of countries such as EU-28 or OECD, or attempt to endogenise it to see effects of its main determinants such as economic growth or real interest rate. In a similar vein, one could try to link it with the literature on fiscal limits (see Davig et al., 2011). Another extension could relax the assumption of time-invariant responses over the sample period in an attempt to explore effects of steps in the monetary integration and/or effects related to the debt crisis. For that purpose, higher frequency series and/or Bayesian techniques for the EA as a whole or at a country level could be a starting point.

Appendix A

A.1 Fiscal responses – country and time specific effects

To evaluate country specific responses in our panel, we present one test that drops a country at a time in the main text. Since this is an indirect way of capturing possible effects on debt responses associated with one country in our group, another model is estimated. Since we are interested in country specific and/or time specific responses, we estimate a model that resembles the random coefficients model:

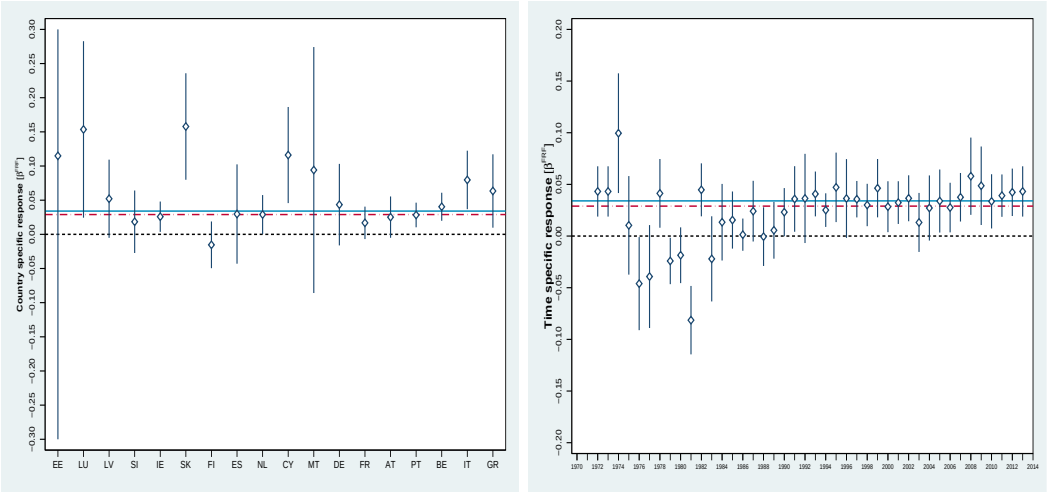
$$pb_{i,t} = \alpha + \varphi pb_{i,t-1} + \kappa \cdot d_{i,t-1} + \sum_{i,\, i \neq r} \lambda_i \cdot d_{i,t-1} + \sum_{j=1}^{k} \beta_j X_{j,i,t} + \delta_i + \upsilon_{i,t}, \tag{A.1}$$

where λ_i represents a set of $i-1$ country specific debt responses and the other items have the same interpretation as in the main text.

Coefficients shown in the main text and also in figure A.1 below, show the total response for individual countries (sum of the estimated coefficients $\kappa + \lambda_i$) with a country r chosen as the base country. Similarly, for time specific responses, when there is a sum of time specific debt responses for all years over our sample period without two (model with a constant term and a full set of country FE). When the extended dataset is utilized, all EA-12 countries have the same number of observations. However, since our panel is unbalanced, EA-18 results presented below are not directly comparable because of different coverage for new EA member states. Nevertheless, time specific responses are rather similar for both groups of countries, and similarly for country specific responses.

When looking at the panel a) of the figure A.1, one can see generally larger (positive) responses by new EA members that can be related to their sample period (and ordered by their 2013 debt levels). The relative position of old EA members is almost unaffected (two changes in positions), and response coefficients are quite

Figure A.1: Fiscal responses by country and by year, EA-18 countries, 1970–2013



Note: country ordering based on the 2013 debt level values. Blue line stands for EA-18 average response with a linear time trend, red dashed line for average response with time fixed effects (all EA18 countries and for all years). The black dotted line indicates the null response. Whiskers around point estimates (diamonds) represent the 95% confidence intervals, CIs for Estonia are [-0.587; +0.817]. *Source:* own calculation.

similar to those shown for the reduced model for EA-11 countries in the main text. Relatively stronger responses in case of new EA member states partially reflect shorter time coverage and on average more sound fiscal policy behaviour since most of their public debts were wiped out during first years of their transformation processes in the 1990s. Significance of individual response coefficients can be judged from the size of confidence intervals shown around the point estimates ('whiskers'). Our reading of these results is that they can be considered a test of fiscal fatigue *sui generis* (see further details in the main text) for this group of countries. When countries are ordered by their average debt values, there is some reshuffling of positions but there is no significantly improved picture of fiscal fatigue.[i]

When considering the other dimension, time variation, and visible patterns (panel b) of figure A.1), there seems to be a great deal of variation in the 1970s and early 1980s. The extension of the country dimension is reflected in smaller dispersions of debt responses in the 1990s (almost cyclical patterns), but mainly over the

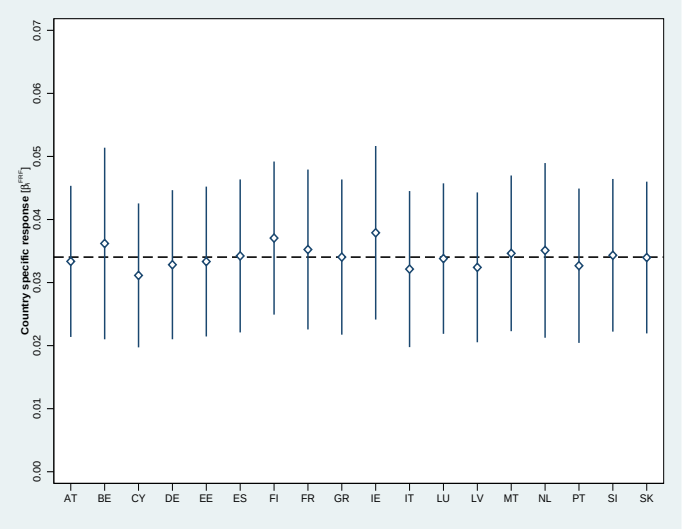
[i] The same is true even for similar exercises taking into account values before the start of the debt crisis, that is, until 2007/2008; for example for 2007 the ordering of countries is quite similar (both ends of the distribution) and the responses of countries with higher debts are close to that EA-11 average – larger responses showed only Germany, and surprisingly Portugal and Greece.

most recent period (Great Recession and Sovereign Debt Crisis). A closer inspection of the figure (and estimates) reveals few 'turning points' that indicate changes in government responses over our sample period. However, they are not significant at the 95% level.[ii] Some of them can be associated with events in the process of European integration, preparations for the monetary union or the sovereign debt crisis (the last three years). Nevertheless, these results should be taken with caution, because of different lengths of series for our set of countries (only the EA-11 group is broadly comparable), and the interaction method employed.

[ii] Some of these turning points are found significant in the non-parametric time-varying estimation, which gives us more confidence and provides a robustness check of our findings, see below.

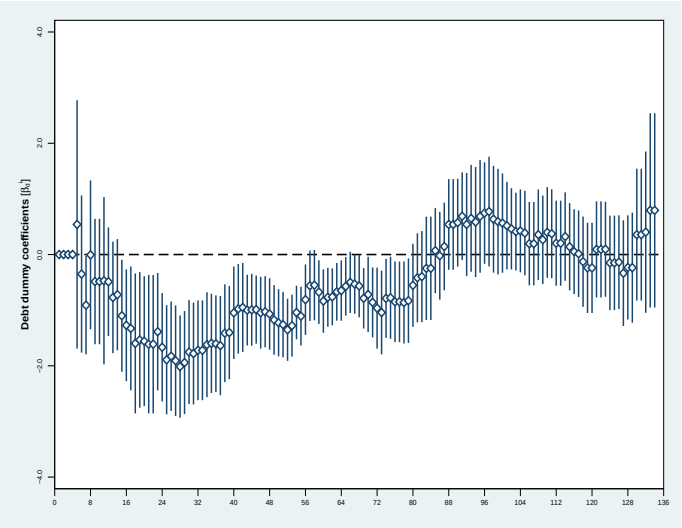
A.2 Figures and tables

Figure A.2: FRF coefficients: EA-18 panel excluding one country at a time, 1970–2013



Note: Country excluded shown on the OX-axis. Horizontal line shows the FRF coefficient for the whole panel (EA-18), base model. *Source:* own calculation.

Figure A.3: Coefficient on a debt dummy, EA-18, 1970–2013



Note: debt-to-GDP ratios are shown on the OX-axis. Horizontal line shows the coefficient on a particular debt dummy for the whole panel (EA-18), base model, and extended dataset. *Source:* own calculation.

Table A.1: Summary of FRF literature

Study	Model specification	Coefficient on lagged debt	Further notes
		Country specific estimation	
Bohn (1998)	PBAL Period: 1916–1995, US	0.054	OLS with Newey-West S.E., GVAR and YVAR fiscal variables; extensions: fiscal fatigue (second and third polynomial terms, break at 34%); various sub-samples,
Bohn (2008)	PBAL Period: 1792–2003, US	0.094–0.121	OLS with robust S.E., with time trend; extensions: debt squared, $AR(1)$ process for outlays, public debt is not lagged.
Legrenzi and Milas (2013)	PBAL Period: 1960(1970)–2012, models for GRC, IRL, PTL and ESP	0.087–0.177	OLS and 2STLS (IV) estimation; extensions: non-linear (logistic) model with state-varying thresholds, a measure of financial pressures.
Cuerpo (2014)	PBAL Period 1986q1–2012q4 (quarterly data), ESP	-0.032 – 0.018	Bayesian time-varying coefficients technique (TVC)
D'Erasmo et al. (2015)	PBAL, 1972–2014, US Eurozone, EU, OECD	0.0767–0.105	OLS with HAC S.E. and military expenditures; extensions: time trend, squared debt, asymmetrical response, with $AR(1)$ term, with/without recession
Debrun and Wyplosz (1999)	PBAL (with 1 lag) Panel: 11 European countries, some specifications with country FE, period: 1982–1997	0.01–0.03	FE OLS, GLS and 3SLS estimators, no institutional or political variables included
Galí and Perotti (2003)	CAPB and general government PBAL divided by potential output, EU-11+OECD-5 (individual, pooled estimation), period: 1980–2002	-0.06 -0.07 (only EU-11) -0.02 (only OECD5)	FE and IV FE estimator with country FE; extensions: debt as a fraction of potential GDP, expected output gap, pre- vs. post-Maastricht period; monetary policy rule; government investment, spending, and revenues to potential output;
IMF (2004)	General government CAPB (with 1 lag) Panel (unbalanced): EA-12 (without Luxembourg), period 1971–2003	0.00–0.08	2SLS IV estimator, model with monetary gaps; country specific FRF
Annett (2006)	CAPB (with 1 lag) Panel: EU-14 (without Luxembourg), period: 1980–2004	0.01–0.03 (EU-14) 0.01–0.02 (EU-11)	Pooled and 2SLS estimator with and without country FE; extensions: dummy for election year, commitment/mixed forms of fiscal governance, and delegation relative economic size in EU-15/EA-12, a 10-year real growth volatility; pre- and post-Maastricht period and pre- and post-SGP period estimation

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Table A.1 – *Continued from previous page*

Study	Model specification	Coefficient on lagged debt	Further notes
Golinelli and Momigliano (2006)	Change of CAPB, lagged PBAL included Panel: 19 OECD, 11 Euro area, three periods covering 1988–2006	0.008–0.024 (only EA countries)	Real-time data, various estimators (OLS, FE, GMM), country and fixed effects; extensions: dummy variables for stages of European monetary integration, phases of business cycle and election cycle, a Maastricht variable (number of years for elimination of excessive deficits and expected interest payments);
Ayuso-i-Casals et al. (2007)	CAPB (with 1 lag) and primary expenditures (with 1 lag) Panel: 22 EU, period: 1990–2005	0.00–0.03 -0.18– -0.02 (for primary expenditures)	testing symmetry of fiscal responses FE estimator and TSLS (IV) estimator with country FE; extensions: analysis for various types of fiscal rules and fiscal institutions, cyclical stance
Debrun et al. (2008)	General government and CAB (with 1 lag), Panel: EU-25, period: 1990–2005	0.02–0.04 0.02 (only EU-15)	OLS, LSDVC, FE and FE IV estimator with country FE; extensions: subgroups estimations, focus on fiscal rules
Golinelli and Momigliano (2008)	Change in CAPB (one 1 added) Change in CAPB (lagged PBAL) Change in PBAL (1 lag added) Panel: 11 EA, period: 1978–2006	0.008–0.080 0.009–0.011 0.009–0.014	Pooled OLS, Within group, difference and system (one-step) GMM estimators; extensions: real-time and ex post data, symmetry of responses, political and institutional variables, the Maastricht variable, real ex ante interest rate; rolling regression (15-year-long windows)
Afonso and Jalles (2011)	PBAL (with 1 lag) Panel: 18 OECD countries, period: 1970–2010	0.01–0.15 -0.05–0.17 (time series estimators)	Pooled OLS and FE IV estimators, system GMM estimator, narrow specification (debt and/or output gap only); extensions: panel time series estimation (MG, AMG, CCEMG) and Driscoll-Kraay estimator
EC (2011)	PBAL Panel: EU-27, period: 1975/1980–2010	0.027–0.031 0.033–0.038 (extensions)	FE IV estimator with country FE; ; extensions: with the FRI variable for the period 1990–2008
Eller and Urvová (2012)	General government PBAL (with 1 or 2 lags) Panel: 8 new EU member states, period: 1995–2011	0.026–0.060	Pooled OLS, FE, system GMM estimators with FE and time effects; extensions: debt spline (at 40%), output gap analysis, various election variables and price indices, fiscal institutions (FRI, WB governance)
Escolano et al. (2012)	General government and CAB (with 1 lag) Panel: EU-27, period: 1990–2008	0.0367 0.0455–0.0563 (for CAPB) 0.0415 (only EU-15)	LSDVC and FE estimator with country FE; extensions: focus on fiscal rules; subgroups
Medeiros (2012)	General government PBAL Panel: EU-27/-21, period 1976–2011	0.054–0.078	FD and FE IV estimator with country FE allowing for $AR(1)$ errors; extensions: estimation of fiscal fatigue via FD IV estimation (with output gap only)
Theofilakou and Stournaras (2012)	CAPB (with lag) Panel: 10 EA (unbalanced), time dummies for selected years,	0.0240–0.0426; 0.064	One-step BB estimator with forward orthogonal deviations; specification similar to Bohn (1998) with bond yields included; non-linear specification with quadratic term (not significant)

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Table A.1 – *Continued from previous page*

Study	Model specification	Coefficient on lagged debt	Further notes
	1988–2009	(NL model with a squared term) 0.022 (2 subgroups based on the 60% threshold)	
Betty and Shiamptanis (2013)	PBAL Panel: 11 EA, 1970–2011, pre-EMU (1970–1998) and post-EMU (1999–2011)	0.0727	Panel cointegration estimators (DOLS) allowing for heterogeneity,
Schoder (2014)	PBAL OECD 15, period: 1981–2010 (quarterly observations)	0.041 (1980–1996) 0.011 (1997–2010)	MG and PMG estimators; extensions: various sub-periods and subgroups
Weichenrieder and Zimmer (2014)	general government PBAL Panel: EA, 1970–2011	0.043–0.059	FE estimator with time and country FE; extensions: focus on changes over time – three periods (dummy shifter) and no crisis period
Baldi and Staehr (2016)	Quarterly PBAL (with $t-4$ lag) Quarterly panel, EU-27, period: 2001Q1–2008Q2 (before the crisis) (before the crisis) and 2009Q1–2014Q1 (during the crisis)	0.026 (before, EA-12) 0.087 (during, EA-12)	2SLS estimation with robust S.E., country FE and quarterly dummies with GDP growth only; variables are not seasonally adjusted; extensions: various subgroups of countries (EA12, CEE10, old and new EU countries grouped by 'seriousness' of their fiscal problems)
Developing and developed countries			
IMF (2003)	General government PBAL (with 1 lag) Panel: 54 emerging and industrial countries, period: 1990–2002;	0.039–0.047 0.057–0.060 (only for industrial economies)	GLS estimator, country FE; extensions: spline regression (threshold at 50%); subsample of 20 industrial economies and spline regression (threshold at 80%)
Abiad and Baig (2005)	PBAL Panel: 34 emerging market countries, country FE, period: 1990–2002	0.034 0.055–0.086 0.063–0.089 (with debt spline) (ext. model with debt spline) 0.048–0.072 (all variables and debt spline)	FE OLS estimator core model (macroeconomic variables only); debt spline at 50%; extensions: model with political or institutional variables; model with both variables
Abiad and Ostry (2005)	PBAL Panel: 31 emerging market countries, country FE, period: 1990–2002	0.05–0.10 0.04–0.06 (extended model)	FGLS estimator, debt spline at 50%; extensions: alternative fiscal institution measures
Celasun et al. (2006)	General government PBAL	0.030–0.046	Difference LIML, GMM estimators with country FE;

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Table A.1 – *Continued from previous page*

Study	Model specification	Coefficient on lagged debt	Further notes
	Panel: 34 emerging economies, period: 1990–2004		extensions: spline regression (threshold at 50%) and positive and negative output gap
Ghosh et al. (2011)	General government PBAL Panel: 23 developed countries, period 1970/1985–2007	-0.2080 (long) -0.0805 (short)	FE estimator with robust S.E. and with $AR(1)$ error term process; extensions: fiscal fatigue explored (coefficients of the second and third polynomial), government expenditure gap
Debrun and Kinda (2013)	PBAL Panel: advanced (28) and emerging (26) countries, period: 1980–2010	0.035–0.040 (FE) 0.032–0.037 (LSDVC)	FE and LSDVC estimator; extensions: interest payments, and interest payments thresholds (linear)
Mendoza and Ostry (2008)	PBAL Panel: 22 industrial and 34 emerging countries, period: 1980/1990–2005	0.033–0.072 0.020–0.038 (only industrial countries)	FE estimator with country FE, robust S.E. with country $AR(1)$ coefficients; extensions: subsamples (high/low debt countries); spline regression (threshold at 48%); shorter periods for most emerging countries; YVAR and GVAR government expenditure variables
Ghosh et al. (2013)	General government PBAL panel: 23 developed countries (EU-14), period 1970/1985–2007	-0.208– -0.225 (long) -0.081– -0.086 (short)	FE country-fixed effect estimator with robust S.E. and with $AR(1)$ error term process; extensions: OLS, PCSE estimators, fiscal fatigue explored (second and third polynomial terms included in both specifications); government expenditure gap; age dependency, IMF arrangement, fiscal rules, oil price, non-fuel commodity price, trade openness
Debrun and Kinda (2014)	PBAL Panel: advanced (28) and emerging (26) countries, period: 1990–2011	0.015–0.023	LSDVC estimator; extensions: exploring fiscal rules and fiscal councils;
Cevik and Teksos (2014)	CAPB Panel: 49 developed and developing countries, period: 1990–2012	-0.01–0.01 (reduced form) 0.003–0.025	GLS (reduced form only), one and two-step system GMM estimator (with/without collapse option), output gap and country FE (reduced form); extensions: macro-finance variables (real exchange rate, domestic credit, market capitalization, residential property prices, and natural resource rents), institutional and demographic variables; estimation also for standard deviation of CAPB.
Cordes et al. (2015)	PBAL (with 1 lag) Panel: 57 advanced and developing economies, period: 1985–2012	0.013	LSDVC estimator, expenditure rule index/dummy; extensions: model specified for primary expenditures
D'Erasmo et al. (2015)	PBAL Panel: 25 advanced and 33 emerging economies, period: 1951–2013	-0.001–0.692	FE with White cross-section corrected S.E. with output gap and government expenditures; extensions: government expenditure or consumption gap (HP filter), country $AR(1)$ error.

Note: PBAL – primary balance, CAPB – cyclically adjusted PBAL, CAB – cyclically adjusted balance, NL – non-linear, standard errors – S.E., FE – fixed effects.
Source: studies listed in the table.

Table A.2: Robustness checks – main specification (PBAL with extrapolated series) and CAPB (not extrapolated sample), EA-18, 1970–2013

	am0	am1	am2	am3		am0'	am1'	am2'	am3'
Lagged primary balance	0.645***	0.754***	0.642***	0.653***	Lagged CAPB	0.653***	0.690***	0.619***	0.644***
	[0.049]	[0.039]	[0.038]	[0.046]		[0.059]	[0.056]	[0.065]	[0.065]
Lagged debt	0.027***	0.024***	0.027***	0.029***	Lagged debt	0.006***	0.015***	0.029***	0.027***
	[0.005]	[0.006]	[0.005]	[0.006]		[0.002]	[0.004]	[0.006]	[0.006]
Output gap	-0.034	0.049		-0.096*	Output gap	0.001	0.080		-0.057
	[0.065]	[0.063]		[0.052]		[0.057]	[0.068]		[0.054]
GDP growth			0.325***		GDP growth			0.153	
			[0.081]					[0.100]	
Current account	0.097**	0.105***	0.079**		Current account	0.101***	0.103***	0.099***	
	[0.045]	[0.035]	[0.033]			[0.037]	[0.035]	[0.032]	
Openness				0.016**	Openness				0.008
				[0.006]					[0.006]
Election dummy	-0.516***	-0.576***	-0.499***	-0.509***	Election dummy	-0.602***	-0.569***	-0.556***	-0.539***
	[0.154]	[0.151]	[0.130]	[0.154]		[0.143]	[0.143]	[0.142]	[0.148]
Crisis dummy	-1.973***	-1.630***	-0.327	-2.245***	Crisis dummy	-0.515***	-0.536***	-0.534***	-0.501***
	[0.360]	[0.552]	[0.370]	[0.373]		[0.145]	[0.154]	[0.143]	[0.143]
Year	0.006		-0.007	-0.004	Year	-0.971***	0.188	-0.342	-1.188***
	[0.015]		[0.011]	[0.016]		[0.319]	[0.588]	[0.425]	[0.340]
Constant	-1.005***	-0.102	-1.679***	-2.146***	Constant	-0.020*		-0.020*	-0.020
	[0.313]	[0.552]	[0.366]	[0.500]		[0.012]		[0.011]	[0.014]
Observations	533	533	566	533	Observations	442	442	450	442
R-squared	0.690	0.785	0.731	0.696	R-squared	0.708	0.744	0.700	0.710
Country FE	yes	yes	yes	yes	Country FE	yes	yes	yes	yes
Time FE	no	yes	no	no	Time FE	no	yes	no	no
Kleibergen-Paap LM statistic	38.220	41.820	27.490	40.020	Kleibergen-Paap LM statistic	36.370	46.030	22.480	34.470
Kleibergen-Paap p-val	0.000	0.000	0.000	0.000	Kleibergen-Paap p-val	0.000	0.000	0.000	0.000
Hansen test	5.883	2.793	2.295	3.913	Hansen test	4.908	2.721	2.907	2.039
Hansen p-val	0.208	0.593	0.514	0.418	Hansen p-val	0.297	0.606	0.406	0.729

Note: Model *am0* is the base model. Model am1 includes country and time fixed effects (IV). Model *am2* is the base model, which uses GDP growth rates instead of output gap. Model *am3* is the base model that includes export and import instead of current account. CAPB specifications are the same as PBAL models. CAPB denotes the cyclically adjusted primary balance. Robust standard errors used in all specifications. The null of Kleinbergen-Paap LM test is that instruments are weak. x – exactly identified model. P-value: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$: variable is statistically significant at the 1%, 5% and 10%, respectively. *Source:* own calculation.

Table A.3: Main specification for various periods, EA-18

	m1	m11	m1a	m11a	m2	m22	m3	m33
	1970–2013	1970–2007	1970–2013	1970–2007	1985–2013	1985–2007	1991–2013	1991–2007
Lagged primary balance	0.566***	0.627***	0.645***	0.721***	0.492***	0.497***	0.493***	0.469***
	[0.059]	[0.064]	[0.049]	[0.046]	[0.064]	[0.086]	[0.081]	[0.137]
Lagged debt	0.034***	0.025***	0.027***	0.019***	0.040***	0.026***	0.046***	0.027**
	[0.006]	[0.005]	[0.005]	[0.005]	[0.008]	[0.007]	[0.010]	[0.011]
Output gap	0.072	0.138**	-0.034	0.025	0.159*	0.260***	0.140	0.260*
	[0.071]	[0.069]	[0.065]	[0.059]	[0.084]	[0.093]	[0.096]	[0.135]
Current account	0.157***	0.102	0.097**	0.052	0.188***	0.145*	0.182**	0.120
	[0.054]	[0.070]	[0.045]	[0.046]	[0.060]	[0.080]	[0.075]	[0.126]
Election dummy	-0.448***	-0.659***	-0.516***	-0.693***	-0.401**	-0.624***	-0.371**	-0.665***
	[0.155]	[0.171]	[0.154]	[0.172]	[0.166]	[0.196]	[0.180]	[0.234]
Crisis dummy	-1.884***		-1.973***		-2.093***		-2.523***	
	[0.364]		[0.360]		[0.409]		[0.481]	
Year	-0.005	-0.012	0.006	0.006	0.018	-0.007	0.060*	-0.023
	[0.015]	[0.013]	[0.015]	[0.014]	[0.023]	[0.018]	[0.033]	[0.034]
Constant	-1.125**	-0.591	-1.005***	-0.738**	-2.324**	-0.815	-4.128***	-0.394
	[0.490]	[0.521]	[0.313]	[0.298]	[0.911]	[0.861]	[1.194]	[1.568]
Observations	431	327	533	429	364	260	312	208
R-squared	0.720	0.733	0.690	0.712	0.729	0.721	0.731	0.720
Country FE	Yes	yes	yes	yes	yes	yes	yes	yes
Time FE	No	no	no	no	no	no	no	No
Kleibergen-Paap LM stat.	35.110	25.860	38.220	32.480	28.210	19.610	25.070	15.610
Kleibergen-Paap p-val	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.008
Hansen test	7.264	5.679	5.883	1.125	7.812	8.677	7.936	10.170
Hansen p-val	0.123	0.224	0.208	0.890	0.099	0.070	0.094	0.038

Note: models *m1a* and *m11a* are estimated on linked series for most of the euro area countries. Robust standard errors, country FE used in all specifications. The null of Kleinbergen-Paap LM test is that instruments are weak. P-value:
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$: variable is statistically significant at the 1%, 5% and 10%, respectively.
Source: own calculation.

Table A.4: Main specification by groups of countries, various periods

	1970–2013					1991–2013				
	m1	m2	m3	m4	m5	m1a	m2a	m3a	m4a	m5a
	EA18	EA12	EA11a	EA11b	EA10	EA18	EA12	EA11a	EA11b	EA10
Lagged primary balance	0.566***	0.581***	0.569***	0.587***	0.571***	0.493***	0.456***	0.407***	0.443***	0.358***
	[0.059]	[0.061]	[0.068]	[0.065]	[0.074]	[0.081]	[0.079]	[0.093]	[0.092]	[0.109]
Lagged debt	0.034***	0.029***	0.029***	0.030***	0.030***	0.046***	0.033***	0.037***	0.035***	0.040***
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.010]	[0.010]	[0.011]	[0.010]	[0.011]
Output gap	0.072	0.095	0.140	0.107	0.163	0.140	0.218*	0.352**	0.265*	0.485***
	[0.071]	[0.079]	[0.092]	[0.086]	[0.101]	[0.096]	[0.124]	[0.157]	[0.153]	[0.185]
Current account	0.157***	0.218***	0.214***	0.216***	0.213***	0.182**	0.316***	0.300***	0.325***	0.316***
	[0.054]	[0.046]	[0.055]	[0.047]	[0.058]	[0.075]	[0.060]	[0.069]	[0.063]	[0.070]
Election dummy	-0.448***	-0.424***	-0.452***	-0.411**	-0.440***	-0.371**	-0.279	-0.316*	-0.270	-0.322*
	[0.155]	[0.158]	[0.158]	[0.161]	[0.160]	[0.180]	[0.187]	[0.175]	[0.190]	[0.175]
Crisis dummy	-1.884***	-1.515***	-1.437***	-1.609***	-1.535***	-2.523***	-1.948***	-1.676***	-2.130***	-1.760***
	[0.364]	[0.439]	[0.443]	[0.452]	[0.450]	[0.481]	[0.605]	[0.635]	[0.612]	[0.601]
Year	-0.005	-0.018	-0.019	-0.017	-0.019	0.060*	0.029	0.013	0.034	0.011
	[0.015]	[0.015]	[0.015]	[0.014]	[0.015]	[0.033]	[0.038]	[0.040]	[0.040]	[0.040]
Constant	-1.125**	-0.559	-0.493	-0.588	-0.520	-4.128***	-2.449*	-2.150	-2.696**	-2.301
	[0.490]	[0.455]	[0.505]	[0.452]	[0.501]	[1.194]	[1.337]	[1.443]	[1.357]	[1.400]
Observations	431	351	332	330	311	312	232	216	212	196
R-squared	0.720	0.756	0.764	0.761	0.771	0.731	0.771	0.792	0.784	0.812
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time FE	no	no	no	no	no	no	no	no	no	no
Kleibergen-Paap LM stat.	35.110	29.280	28.370	24.970	23.980	25.070	16.950	21.600	14.170	19.000
Kleibergen-Paap p-val	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.001	0.015	0.002
Hansen test	7.264	9.079	8.895	9.514	9.285	7.936	5.604	5.346	5.093	4.640
Hansen p-val	0.123	0.059	0.064	0.050	0.054	0.094	0.231	0.254	0.278	0.326

Note: robust standard errors, country FE used in all specifications. The labels: EA12 represents a group of countries without new EU member states (i.e., AT, BE, DE, ES, FI, FR, GR, IE, IT, LU, NL, PT). EA11a and EA11b represent the EA-12 group without GR, and respectively, LU; EA-10 is EA12 without both countries GR and LU. The null of Kleinbergen-Paap LM test is that instruments are weak. P-value: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$: variable is statistically significant at the 1%, 5% and 10%, respectively. *Source:* own calculation.

Table A.5: Main specification: robustness check with various estimators, EA-18, 1970–2013

	Pooled OLS	IV FE (Base)	IV FE + TE	LIML	LSDVC	IV GMM 2S	DK	PCSE	AB GMM	ABo GMM
Lagged primary balance	0.607***	0.566***	0.716***	0.570***	0.706***	0.576***	0.498***	0.204***	0.635***	0.655***
	[0.047]	[0.059]	[0.046]	[0.064]	[0.034]	[0.059]	[0.079]	[0.077]	[0.099]	[0.067]
Lagged debt	0.010***	0.034***	0.029***	0.033***	0.031***	0.031***	0.051***	0.056***	0.049	0.064**
	[0.003]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.008]	[0.008]	[0.030]	[0.029]
Output gap	-0.101	0.072	0.076	0.056	-0.025	0.076	0.096	0.216***	0.062	0.113
	[0.067]	[0.071]	[0.070]	[0.071]	[0.047]	[0.069]	[0.095]	[0.074]	[0.104]	[0.088]
Current account	0.086***	0.157***	0.156***	0.159**	0.148***	0.158***	0.167***	0.171***	-0.091	-0.023
	[0.023]	[0.054]	[0.042]	[0.063]	[0.032]	[0.052]	[0.061]	[0.040]	[0.054]	[0.064]
Election dummy	-0.415**	-0.448***	-0.546***	-0.450***	-0.484***	-0.468***	-0.361*	-0.414***	-0.514***	-0.444***
	[0.195]	[0.155]	[0.142]	[0.116]	[0.168]	[0.154]	[0.210]	[0.153]	[0.166]	[0.131]
Crisis dummy	-1.987***	-1.884***		-1.935***	-1.591***	-1.637***	-1.506*	-1.669***		
	[0.372]	[0.364]		[0.439]	[0.297]	[0.345]	[0.756]	[0.574]		
Year	0.042***	-0.005		-0.003	-0.009	-0.009	-0.024	-0.018		
	[0.012]	[0.015]		[0.021]	[0.014]	[0.014]	[0.022]	[0.024]		
Constant	-0.909**	-1.125**	-2.257***	-1.113		-0.901*	-1.341***	-1.917**		
	[0.379]	[0.490]	[0.558]	[0.684]		[0.480]	[0.490]	[0.814]		
Observations	431	431	431	431	431	431	431	431	462	463
R-squared	0.521	0.720	0.807	0.716		0.720	0.479	0.412		
Country FE	No	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time FE	No	no	yes	no	no	no	no	no	yes	yes
Kleibergen-Paap LM statistic		35.110	36.260	12.530		35.110				
Kleibergen-Paap LM p-val		0.000	0.000	0.028		0.000				
Hansen test		7.264	4.353			7.264			19.770	20.240
Hansen p-val		0.123	0.360						0.072	0.063
AR(1) p-val					0.000				0.001	0.003
AR(2) p-val					0.188				0.502	0.484

Note: All results for the original (not-extended) sample. Robust standard errors or clustered standard errors for DK; bootstrapped S.E. for pooled OLS and LSDVC estimators (500). AB GMM (xtabond2, collapsed), ABo GMM (xtabond2, orthogonal, collapsed); DK – Driscoll-Kraay estimator assuming heteroskedasticity, cross-sectional and temporal dependence with country FE; PCSE model: with a common AR(1) error term (= 0.401). Hansen test's null hypothesis is that instruments (orthogonality conditions) are valid. The null of Kleinbergen-Paap LM test is that instruments are weak. x – exactly identified model. Specification of instruments between estimators may change. For estimators without explicit IV option, we estimated the first stage for both endogenous variables on the same set of instrument as for models with IV option, including lagged dependent variable. Fitted values for these variables were then utilized for estimation of our base model. .. – not available/not calculable. P-value: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$: variable is statistically significant at the 1%, 5% and 10%, respectively. *Source:* own calculation.

Table A.6: Robustness checks – effects of fiscal rules in detail, EA-18

	afr1	afr2	afr3	afr4	afr5	afr6	afr7	afr8
Lagged primary balance	0.473***	0.459***	0.513***	0.502***	0.516***	0.518***	0.510***	0.510***
	[0.065]	[0.066]	[0.064]	[0.068]	[0.063]	[0.062]	[0.063]	[0.063]
Lagged debt	0.045***	0.045***	0.037***	0.038***	0.038***	0.038***	0.037***	0.037***
	[0.008]	[0.008]	[0.007]	[0.008]	[0.007]	[0.007]	[0.007]	[0.007]
Output gap	0.193**	0.196**	0.121	0.138*	0.122	0.119	0.118	0.116
	[0.081]	[0.080]	[0.079]	[0.082]	[0.080]	[0.079]	[0.080]	[0.081]
Current account	0.205***	0.207***	0.176***	0.180***	0.181***	0.177***	0.174***	0.174***
	[0.060]	[0.061]	[0.058]	[0.056]	[0.059]	[0.059]	[0.059]	[0.060]
Election dummy	-0.367**	-0.353**	-0.417***	-0.398**	-0.421***	-0.417***	-0.422***	-0.418***
	[0.165]	[0.165]	[0.159]	[0.161]	[0.159]	[0.159]	[0.159]	[0.158]
Crisis dummy	-2.275***	-2.289***	-2.015***	-1.976***	-2.091***	-2.064***	-1.998***	-2.007***
	[0.410]	[0.429]	[0.415]	[0.419]	[0.403]	[0.400]	[0.424]	[0.418]
FRI fiscal rule	-0.093							
	[0.132]							
Lagged FRI fiscal rule		0.149						
		[0.167]						
IMF fiscal rule			0.170					
			[0.506]					
Lagged IMF fiscal rule				0.432				
				[0.445]				
Expenditure rule					-0.393			
					[0.296]			
Revenue rule						-0.250		
						[0.291]		
Balanced budget rule							0.257	
							[0.440]	
Debt rule								0.255
								[0.447]
Year	0.045*	0.033	0.004	-0.005	0.018	0.013	-0.001	-0.001
	[0.025]	[0.027]	[0.028]	[0.029]	[0.021]	[0.021]	[0.028]	[0.028]
Constant	-3.510***	-3.085***	-1.801**	-1.803**	-2.166***	-1.986**	-1.688**	-1.692**
	[0.932]	[0.963]	[0.776]	[0.832]	[0.784]	[0.817]	[0.815]	[0.811]
Observations	348	340	385	378	385	385	385	385
R-squared	0.737	0.735	0.724	0.727	0.724	0.724	0.724	0.723
Country FE	yes	yes	yes	yes	yes	yes	yes	yes
Time FE	no	no	no	no	no	no	no	no
Kleibergen-Paap LM stat.	27.800	28.100	30.620	28.670	31.440	31.170	30.870	31.330
Kleibergen-Paap p-val	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen test	8.717	8.490	6.964	7.940	6.897	6.803	6.947	6.878
Hansen p-val	0.069	0.075	0.138	0.094	0.141	0.147	0.139	0.142

Note: EC FRI – period: 1990–2013, IMF fiscal rule and sub-rules – period: 1985–2013. Robust standard errors, country FE used in all specifications. Hansen test's null hypothesis is that instruments (orthogonality conditions) are valid. The null of Kleinbergen-Paap LM test is that instruments are weak. P-value: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$: variable is statistically significant at the 1%, 5% and 10%, respectively. *Source:* own calculation.

Table A.7: Extended benchmark model and fiscal fatigue, EA-18, 1970–2013

		base				extended						
	IV FE ff0	IV FE ff0a	IV FE ff1	Ghosh – IV FE	Ghosh – IV PCSE	IV FE ff2	FE ff2a	FE ff3	FE ff3a	FE ff4a	Ghosh – ext. FE	Ghosh – ext. PCSE
Lagged primary balance	0.566***	0.516***				0.594***	0.717***					
	[0.059]	[0.064]				[0.066]	[0.040]					
Lagged debt	0.034***	-0.030	-0.134*	0.001	0.016	-0.009	-0.016	-0.097	-0.140**	-0.107*	0.005	0.020
	[0.006]	[0.043]	[0.078]	[0.101]	[0.098]	[0.035]	[0.026]	[0.063]	[0.057]	[0.059]	[0.078]	[0.053]
Lagged debt2		0.001	0.002	0.000	0.000	0.000	0.001*	0.001*	0.002***	0.001	0.000	0.000
		[0.001]	[0.001]	[0.001]	[0.001]	[0.000]	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Lagged debt3		0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.000**	0.000	0.000	0.000
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Output gap (y/n IV)	0.072	0.109	0.484***	0.368***	0.345***	0.139*		0.528***		0.457***	0.420***	0.381***
	[0.071]	[0.076]	[0.087]	[0.114]	[0.083]	[0.073]		[0.062]		[0.081]	[0.074]	[0.035]
Lagged output gap							-0.027		0.330***			
							[0.034]		[0.063]			
Current account (y/n IV)	0.157***	0.187***	0.323***			0.188***		0.206***		0.352***		
	[0.054]	[0.063]	[0.084]			[0.056]		[0.060]		[0.078]		
Current account							0.106***		0.260***			
							[0.035]		[0.069]			
Election dummy	-0.448***	-0.424***	-0.286*	-0.232	-0.300	-0.450***	-0.471***	-0.311*	-0.285	-0.392**		
	[0.155]	[0.155]	[0.168]	[0.176]	[0.213]	[0.158]	[0.153]	[0.161]	[0.179]	[0.181]		
Dummy crisis (2008+)	-1.884***	-1.930***	-2.089***							-1.658***		
	[0.364]	[0.363]	[0.501]							[0.451]		
Lagged growth of GDP				0.134**	0.088						0.158***	0.128***
deflator				[0.068]	[0.071]						[0.056]	[0.040]
IMF fiscal rule				1.401***	-0.089						1.381***	0.794**
				[0.473]	[0.511]						[0.481]	[0.318]
Cyclical component of				-0.141***	-0.183***						-0.148***	-0.179***
government consumption				[0.038]	[0.040]						[0.032]	[0.023]
Government stability				0.165**	0.160**						0.099	0.058
				[0.083]	[0.081]						[0.074]	[0.046]

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Table A.7 – *Continued from previous page*

		base				extended						
	IV FE ff0	IV FE ff0a	IV FE ff1	Ghosh – IV FE	Ghosh – IV PCSE	IV FE ff2	FE ff2a	FE ff3	FE ff3a	FE ff4a	Ghosh – ext. FE	Ghosh – ext. PCSE
Oil prices / non-oil				-0.030***	-0.014						-0.026***	-0.007
commodity price index				[0.007]	[0.009]						[0.009]	[0.006]
Dependency ratio				0.134*	-0.086							
				[0.081]	[0.138]							
Openness				0.014*	0.043***						0.015*	0.022***
				[0.008]	[0.016]						[0.008]	[0.008]
Age dependency											0.046	-0.054
											[0.070]	[0.072]
Future age dependency											0.001	-0.084**
											[0.061]	[0.042]
IMF arrangement											-1.249	-0.033
											[0.870]	[0.502]
Year	-0.005	0.001	0.007			-0.059***	-0.044***	-0.051**	-0.057**	-0.012		
	[0.015]	[0.014]	[0.021]			[0.012]	[0.011]	[0.021]	[0.022]	[0.020]		
Constant	-1.125**	0.650	3.491*	-7.614*	-0.219	1.227	0.884	3.118**	4.166***	3.448**	-4.398	3.323
	[0.490]	[1.180]	[1.824]	[4.380]	[6.364]	[0.941]	[0.698]	[1.519]	[1.380]	[1.430]	[3.985]	[3.450]
Observations	431	431	461	381	366	431	477	493	487	431	422	422
R-squared	0.720	0.724	0.578	0.637	0.448	0.700	0.704	0.543	0.450	0.563	0.627	0.480
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time FE	no	no	no	no	no	no	no	no	no	no	no	no
ILS (+ corrected S.E.)	yes	yes	yes	yes	yes	no	no	yes	no	yes	no	no
Kleibergen-Paap LM statistic	35.110	39.210	37.760	..	..	38.410	..	..	..	..	..	..
Kleibergen-Paap LM p-val	0.000	0.000	0.000	..	..	0.000	..	..	..	..	..	..
Hansen test	7.264	7.812	6.957	..	..	8.261	..	..	..	..	..	..
Hansen p-val	0.123	0.099	0.073	..	..	0.083	..	..	..	..	..	..

Note: robust standard errors. Output_gap and current account are instrumented if 'IV' shown. Oil prices/non-oil commodity price index – average oil price for oil exporters, non-oil commodity price index for all other countries (in our case); for definition see appendix. Dependency ratio is defined as non-active population over active population (15–64 years old). Lagged debt2 (lagged debt3) represent the quadratic and cubic term of public debt variable. ILS – indirect (two stage) IV estimation. PCSE model (col. 6 and 13) assumes panel-specific disturbances to be heteroskedastic and contemporaneously correlated (an AR(1) error structure; estimated average value: 0.416 for IV PCSE model; 0.485 for extended PCSE model). Hansen test's null hypothesis is that instruments (orthogonality conditions) are valid. The null of Kleinbergen-Paap LM test is that instruments are weak – only for *IV FE ff0* model: 24.51 and p-val = 0.000. x – exactly identified model. P-value: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$: variable is statistically significant at the 1%, 5% and 10%, respectively. *Source:* own calculation.

Table A.8: Description of main variables and their sources

Variable	Definition	Period	Transformation(s)	Main source
Primary balance	General government primary balance (ESA 2010, EDP);	1970–2013	Series extended using series of previous methodological concepts – growth rates from OECD database, complemented with EC Statistical Annexes [FR, GR, IE, LU, and PT]. Values after 2007 adjusted for GAFS in percent of nominal GDP.	AMECO, ECB, OECD
Debt ratio	General government debt (EDP, ESA 2010);	1970–2013	Series extended using growth rates of non-EDP series ESA79 or ESA2010 (IMF WEO, OECD) or Mauro et al. (2013) [DE, FR, NL, PT]; in percent of nominal GDP.	AMECO
Price index	GDP deflator (ESA 2010); HICP;	1970–2013	–	AMECO, ECB [HICP]
Output gap	GDP minus potential GDP over potential GDP	1970–2013	AMECO definition	AMECO
			HP filtered GDP series ($\lambda = 6.25$), CF filtered GDP series.	Own calculations based on AMECO series
Current account balance	Current account balance in % of GDP	1970–2013	–	AMECO
Current account	Approximated current account balance in % of GDP	1970–2013	Export minus import of goods and services, in % of nominal GDP (in current prices, national accounts definition) or current account balance in percent of GDP.	AMECO
Election dummy	Binary variable (1 = election);	1970–2013	Own corrections of mistake for new Euro area member states.	Electionresources.org
FRI	Fiscal rules index (de jure definition, five sub-indices, random weights)	1990–2013	–	EC (FRI database)
IMF fiscal rules index	Binary variable (1 = any fiscal rule is applicable);	1985–2013	Own calculation from IMF database – if any fiscal rule is applied then dummy variable is equal to = 1.	IMF's Fiscal Rules database
Government stability	A measure of both of the government's ability to carry out its declared program(s), and its ability to stay in office. The risk rating assigned is the sum of three subcomponents: Government Unity, Legislative Strength, and Popular Support;	1984–2013	–	PRSG
Total risk rating score	Composite Political, Financial, Economic Risk Rating for a country (CPFER) = 0.5 (Political Risk + Financial Risk + Economic Risk) Ranging from Very High Risk ($00.0 - 49.5$) to Very Low Risk ($80.0 - 100$). The higher the points, the lower the risk	1984–2013	–	PRSG
Political risk rating score	A means of assessing the political stability of a country on a comparable basis with other countries by assessing risk points for each of the component factors of government stability, socio-economic conditions, investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions, democratic accountability, and bureaucracy quality. Risk ratings range from a high of 100 (least risk) to a low of 0 (highest risk), though lowest de	1984–2013	–	PRSG

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Table A.8 – *Continued from previous page*

Variable	Definition	Period	Transformation(s)	Main source
	facto ratings generally range in the 30's and 40's.			
Bureaucratic quality	Institutional strength and quality of the bureaucracy is a shock absorber that tends to minimize revisions of policy when governments change. In low-risk countries, the bureaucracy is somewhat autonomous from political pressure. (Refer to ICRG Methodology for maximum points for this variable, as well as for related formulas for calculating risk.)	1984–2013	–	PRSG
System of checks	Checks – countries where legislatures are not competitively elected are considered countries where only the executive yields a check.	1984–2013	–	PRSG
Government system	Parliamentary (2), Assembly-elected President (1), Presidential (0);	1975–2013	Only non-missing observations.	IADB DPI2015
Rule of majority	This is the fraction of seats held by the government. It is calculated by dividing the number of government seats by total (government + opposition + non-aligned) seats.	1975–2013	Only non-missing observations.	IADB DPI2015
Index of fractionalization	The probability that two deputies picked at random from among the government parties will be of different parties. Equals NA if there is no parliament. If there are any government parties where seats are unknown (cell is blank), GOVFRAC is also blank. No parties in the legislature results in NA.	1975–2012	Only non-missing observations.	IADB DPI2015
Index of polarization	Maximum polarization between the executive party and the four principle parties of the legislature	1975–2013	Only non-missing observations.	IADB DPI2015
Economic policy	Party orientation with respect to economic policy, coded based on the description of the party in the sources, using the following criteria: Right (1); Left (3); Center (2); No information (0); No executive (NA)	1975–2012	Only non-missing observations.	IADB DPI2015
Interest payments	Absolute volume of interest payments (ESA 2010);	1970–2013	Relative (as % of GDP, lagged debt or total revenues)	AMECO database
Cyclical component of government final consumption expend.	Final government consumption expenditures, ESA 2010;	1970–2013	HP filtered cyclical component ($\lambda = 100$)	AMECO database
Trade openness	Ratio of exports and imports to nominal GDP	1970–2013	Own calculation	AMECO database
Age dependency	Ratio of population < 15 and > 64 to population between $15 - 64$	1970–2013	Own calculation	PF WG EC
Future age dep.	The same definition, but projection for 20 year ahead (medium variant)	1970–2013	Own calculation	PF WG EC
Oil-price	Simple average of three spot prices (Dated Brent, Texas Intermediate and the Dubai Fateh)	1970–2013	Own calculation	IMF commodity price database, WB commodities database
Non-oil price	Non-fuel price index, 2005 = 100 (Food and Beverages and Industrial Inputs Price Indices)	1992–2013	–	IMF commodity price database
	Non-energy Commodities, 2010=100 (including Food and Beverages, Agricultural and Other Raw materials, Metals and Minerals and Fertilizers), annual prices, nominal USD	1970–2013	–	WB commodities database

Note: AMECO – Macroeconomic Database (EC, 2016); IADB DPI2015 (Cruz et al., 2016) – The Database of Political Institutions 2015; FRI – EU fiscal rule index (FRI, EC, 2016a); *PRSG* – Political Risk Services Group (PRSG, 2015); GAFS – Government Assistance to Financial Institutions (see ECB, 2016). World Bank Commodities Price Data (The Pink Sheet) – WB (2015), IMF Primary Commodity Prices – IMF (2015a). Period indicate the earliest year of data available in our sample. *Source:* own calculation.

Table A.9: Summary statistics

	Debt (% of GDP)				Primary balance (% of GDP)			
	min	mean	max	st. dev.	min	mean	max	st. dev.
AT	16.7	52.9	82.4	20.0	-2.4	0.5	3.2	1.4
BE	54.4	98.5	134.4	25.4	-7.7	1.3	6.7	3.5
CY	45.1	60.0	102.5	12.8	-3.7	-0.4	6.0	2.5
DE	16.2	46.1	81.0	19.6	-6.0	0.7	9.0	3.2
EE	3.7	6.2	9.9	1.7	-2.9	1.2	9.5	2.6
ES	11.5	40.6	93.7	21.1	-9.3	-0.8	3.8	2.9
FI	6.3	29.0	56.2	17.8	-3.8	3.3	9.6	3.4
FR	20.1	45.9	92.3	21.9	-4.8	-0.2	4.2	1.8
GR	15.4	73.4	177.7	45.5	-5.8	-1.1	2.8	1.9
IE	23.6	67.7	120.1	28.3	-9.6	-0.1	6.8	4.1
IT	35.8	87.0	129.0	26.8	-7.0	-0.4	6.2	3.3
LU	4.2	10.9	23.3	5.2	-1.1	2.4	6.3	2.1
LV	8.4	19.7	47.5	13.2	-6.6	-0.2	6.9	2.8
MT	22.4	54.4	72.0	16.9	-6.4	-1.6	1.2	2.4
NL	38.0	56.4	75.5	12.6	-3.4	1.1	5.2	2.0
PT	13.2	53.0	129.0	26.4	-7.0	-1.4	2.2	2.2
SI	18.3	29.7	71.0	12.9	-6.1	-1.4	1.2	2.0
SK	21.7	37.5	55.0	9.7	-8.0	-3.0	-0.2	2.4

Note: extended series (according to the ESA2010 methodology extended using Mauro et al., 2013). St. dev. – standard deviation.
Source: own calculations.

Chapter 3

Do Institutional Changes Affect Fiscal Policy Behaviour? Time-Varying Evidence from Europe

3.1 Introduction

> A policy reaction function is likely to be a fragile creature. Over time, ... the importance attached to conflicting objectives [of the policy] may change, [policy makers'] views on the structure of the economy may change.
>
> [McNees, 1986, p. 7]

The conduct of national fiscal policy is crucial for the existence of a single monetary policy and a single currency for all members in a monetary union. While monetary policy helps to deal with common symmetric shocks such as currency fluctuations or changes in consumers' preferences abroad, fiscal policy plays a vital role in responding to country-specific shocks coming from differences in business cycles across member countries (asymmetric shocks). Accordingly, a sound (sustainable) fiscal policy that is able to account for public debt level and its long-run sustainability, enables the single monetary policy to focus on its objectives of low and stable inflation (see Fatás and Mihov, 2010). Therefore, coordination (integration) among national fiscal policies would provide assistance when national resources were not enough to deal with national cyclical fluctuations.[1]

[1] Such coordination can take the form of: (*i*) increased coordination among member states

Fiscal sustainability is important for monetary unions because of two primary reasons:[2] firstly, in the already described macroeconomic sense of being able to cope with asymmetric shocks and enable a smooth coordination with monetary policy. Secondly, in the finance-fiscal sense, where sustainable (sound) fiscal policy is a key condition for stabilising financial institutions (see Bénassy-Quéré, 2016). In this financial-fiscal sense, fiscal sustainability provides an important loop between the sovereign, and those financial institutions that hold its domestic financial instruments on their balance sheets. Therefore, a deterioration of fiscal policy towards unsustainable levels is often reflected in the prices of sovereigns' debt instruments, and has negative effects on financial institutions' balance sheets, profitability, and potential need to provide state guarantees. This in turn puts additional pressure on already distressed public finances (so-called 'Diabolic loop', see Acharya et al., 2014; Brunnermeier et al., 2016). This feedback effect is crucial for addressing the (increasingly) high home bias[3] of domestic financial institutions that is visible in many EU or euro area (EA, henceforth) countries today.[4] Unsustainable (debt) fiscal policy not only puts pressure on the government, but also on the common currency, and could result in an exit from or even in a break-up of the currency union. Such fears have frequently emerged in some EA members since the onset of the Global Recession, and particularly during the Euro area Sovereign Debt Crisis (ESDC, henceforth).

In this chapter I aim to shed some light on the effects of institutional changes on fiscal policy in Europe, focusing on the twelve 'old' members of the Euro area (EA-12)[5], and three stand-alone EU countries (EU-3)[6]. The first research question is

without creating explicit 'federal' institutions or (*ii*) an additional level of governance (supranational institutions) equivalent to the level that European institutions enjoy.

[2] The notion of fiscal (debt) sustainability was coined in a seminal paper by Blanchard et al. (1990), and has been discussed by many authors over time.

[3] Home bias represents a situation when financial institutions prefer purchasing and holding domestically issued debt instruments.

[4] Early evidence for selected EA countries is provided in Merler and Pisani-Ferry (2012); more recent evidence for so-called GIIPS countries (Greece, Ireland, Italy, Portugal and Spain) is provided in Ongena et al. (2016) and references therein.

[5] This group of countries includes: Austria, Belgium, Finland, France, Germany, Greece, Luxembourg, Ireland, Italy, the Netherlands, Portugal, and Spain. Greece became an EU member in 1981, Spain and Portugal in 1986, Austria and Finland in 1995.
None of the 'new EU' member states that have since joined the Euro area is considered in this study, because of different starting conditions (public debt were mostly erased by high inflation rates in the first years of the transformation processes in the early 1990s), structural characteristics, and a general scarcity of data before the 1990(95).

[6] This group of countries consists of: Denmark, Sweden and the United Kingdom. Denmark joined the European Communities (EC, henceforth) in 1973 with an opt-out clause, but has tight monetary policy linkages; Sweden joined the EU in the 1995 enlargement, rejected participation in the European monetary union (EMU) in September 2003, and have since followed a quasi-independent monetary policy, and the United Kingdom, which joined the EC in 1973, is the other

therefore concerned with whether changes in the EU-wide institutional environment have affected fiscal behaviour during the decades long European integration process. The final version of the EC/EU treaties that shaped the third state of the European monetary integration process (the establishment of the Euro area) only focused on coordination, and did not attend to fiscal matters in in great detail. It is therefore not surprising that an early 1990's pre-EA report (EC, 1990) put a great deal of emphasis on guaranteeing fiscal (debt) sustainability, and resulted in a series of fiscal rules. While EA members can face even (pecuniary) sanctions if they do not comply with various forms of regulation of fiscal matters, non-EA members subject to the same regulation may face 'only' (non-binding) recommendations without de facto sanctions. This may of course affect the effort that individual countries devote to meeting such a regulatory framework.

The fact that sovereigns are subject to fixed rules in a common environment, opens up a Pandora box: in the case of EA countries, those with weaker institutions have tried to free-ride, while those firmly sticking to the rule(s) have not been able to prevent such behaviour.[7] Despite awareness of such problems, and the fact that fiscal policy has been subject to increased scrutiny since the first stage of the integration process in the early 1990s,[8] problems first emerged in the early years of the Euro area – not only high and sustained indebtedness, but also repeated violations of yearly budgetary limits by many member states. The 'natural' response at that time was: a modification of fixed fiscal rules, but these rules did not help to remove the fundamental tension. The subsequent revelation of even deeper problems (including improper statistical evidence in fiscal accounts, see Irwin, 2015) in several states led to the emergence of the ESDC in the very first decade of the Euro. I accordingly analyse the institutional changes that had an impact on fiscal policy from the very beginning of the EC/EU integration process, in order to assess their effect on country-specific fiscal behaviour across the EU: both for EA members and selected stand-alone EU countries. I particularly focus on effects of crisis-related

opt-out country, and is potentially a soon-to-be non-EU country. The UK is usually analysed outside of the EMU but has applied a number of monetary strategies that could potentially affect its fiscal policy decisions.
I do not include Norway (with a rather specific fiscal policy), Switzerland or other small members of the European Free Trade Association (European Economic Area, EEA) since their fiscal policy was not explicitly subject to regulation/supervision by EU institutions.

[7] The implementation of any fixed (numerical) rules is faced with credibility problems, and attempts to avoid them altogether (moral hazard), see for example studies by Buti et al. (2006) and Irwin (2015), and references therein.

[8] For a brief overview see EC (2013); EC (2015) or more recently Masten and Gnip (2016).
There is also a non-negligible aspect associated with strong and weak institutions across EU/EA countries, for example in case of compliance with rules; for discussion and references see for example De Grauwe (2016).

changes in institutions (post-2010 such as the Fiscal Treaty) that have so far not been empirically assessed.

The second question will explore the accompanying effects of institutional changes in the EC and later on in the EU, and will specifically investigate how these changes have shaped the harmonization (increased similarity) of national policy-making and fiscal policy behaviour. For instance, the last series of institutional changes, and mainly the so-called Fiscal compact (see below) could most likely cause national fiscal policies to behave in a similar way (in line with arguments of Holland and Portes, 2012).

In order to answer both research questions, I create a novel quarterly fiscal dataset comprising fiscal variables for twelve 'old' EA members and three stand-alone EU countries, for the period 1980q1–2015q4.[9] I use a recent approach based on Bayesian methods (see Bańbura et al., 2015 or Giannone et al., 2015) to calculate variables for this dataset. The dataset covers all the main stages in the integration process, starting with those in the late 1980s up until the most recent changes in the wake of the ESDC.[10] This dataset is my first contribution to the literature since there are only a few EU countries with quarterly series available before 1999, such as those reconstructed for Spain or the Euro area as a whole (see De Castro et al., 2014 and Paredes et al., 2014 respectively).[11]

Budgetary balance is a key variable for policy-makers since fiscal institutions may apply new or change current fiscal measures, and in turn affect budgetary outcomes. This balance does not only depend on past active or passive government's behaviour, as reflected in public debt, but it also depends on economic conditions (business cycles), trade flows and various other determinants. As a proxy for fiscal policy behaviour, I draw upon a modelling strategy that is similar to that used for monetary policy – fiscal behaviour is approximated with a fiscal rule, providing a link between the key fiscal variable (primary balance) and a set of fiscal policy determinants.[12] Here, I consider two fiscal rules, since there is no single universal concept: one in line with Leeper (1991) and Bohn (1998)'s strand of literature

[9] It complements available quarterly fiscal series from Eurostat that for most EU countries, start either in 1999q1 or 2002q1 for flow variables (balances), or in 2000q1 for stock variables (debt).

[10] Mainly the Delorse Report, the pre-EMU period (Maastricht period), the creation of the Stability and Growth Pact (1996), the Euro launch (1999), fiscal sustainability problems of EMU countries and a modification of fiscal rules (2005), and the Sovereign Debt Crisis and institutional responses (2011–2012), such as the Fiscal Treaty.

[11] I do not consider 'simple' mechanical decompositions of yearly series that is considered by Schoder (2014). However, the national statistical offices of some countries like France and the UK do provide official series.

[12] Primary balance is viewed as a tool that encompasses all governmental actions that affect both revenues and expenditures less interest payments over a period of time (usually one year).

(model based sustainability, 'macro-fiscal rule'), and the other resembling 'optimal monetary rules' à la a Taylor rule in line with the model by Kirsanova et al. (2005) ('micro-based rule').

Governments can often unexpectedly modify their behaviour in response to internal and external incentives and/or shocks. Such modifications are often accompanied by changes to policy variables.[13] This makes it particularly challenging to devise a modelling strategy that captures their behaviour, using a standard econometric toolkit. Accordingly, in the empirical part of this chapter, I estimate both fiscal rules using the time-varying parameter (TVP) model combined with Bayesian techniques. This estimation approach is my other contribution to the literature. An overwhelming majority of studies (for EU countries) has utilized time-invariant estimation in panel models (such as Baldi and Staehr, 2016 and Weichenrieder and Zimmer, 2014) or country-specific models (such as Berti et al., 2016). Compared to those, my approach views observed values of primary balance as a result of 'behavioural changes', in estimated coefficients of its key determinants such as government debt and business cycle, without explicitly specifying an impact period, while also minimizing some other problematic aspects related to the standard estimation of fiscal rules (such as structural breaks).

To preview, my results addressing the first question on the effects of institutional changes show that national fiscal policies behaved rather heterogeneously over the entire sample period. This suggests that one of the key determinants of fiscal behaviour is related to differences in debt levels across EA countries. Specifically, different pre-existing needs existed when adjusting policies according to the new set of rules (constraints). Despite delays and variation in the exact implementation of the required institutional changes, I only find weak effects related to the Maastricht Treaty. Only one low debt country (debt below 50% of GDP), and one in a group of high debt countries (above 80% of GDP) modified their fiscal policy, so that a change in their fiscal responses – coefficients on the lagged public debt variable – could be identified. In contrast to the recent literature emphasising the effect of Maastricht rules, my findings provide only limited support to the usual explanation.[14] However, the Pact and the race to adopt the single currency amongst the frontrunners corresponded with a high share of countries responding to the Pact's limits (nine

[13] Conversely, the behaviour of a monetary policy authority should be as predictable as possible to create a stable environment.

[14] Traditionally, a dummy variable or a dummy interaction term is included in the regression or a model is estimated for the entire sample period and for a Maastricht sub-sample; for an recent application using a panel of EA countries see Weichenrieder and Zimmer (2014). Results of these estimations can suffer from a low number of observations in the latter case, or an assumption of a linear effect on the coefficient of interest in the former case.

out of twelve). Similar to the literature, I do also find some support for Pact's modification in 2005 (six out of twelve). My exploration of these changes reveal that less than half of the countries responded to the most recent changes (mainly some of the medium and high debt countries), particularly since the dataset covers the outset of the ESDC and a series of more recent reforms (the Fiscal Treaty in particular). For a comparison, in the 'control' group of three stand-alone EU countries, some responded to the Maastricht Treaty, while in the case of the most recent changes, their responses were ambiguous.[15]

My last contribution is associated with the harmonization of national fiscal policies. Surprisingly, there is only some anecdotal (see van Rompuy et al., 2012), indirect evidence on the process of harmonization of fiscal policies such as results of simulations in stylised models (see Holland and Portes, 2012), or some simple statistics (see Fatás and Mihov, 2010). My results offer the first empirical evidence on this process with important implications for the on-going discussion of fiscal federalization (see Evers, 2015) and risk sharing issues (see Verstegen and Meijdam, 2016) in the EU/EA. Turning to the results, I find reduced dispersion for EA-12, approximated with the standard deviation of coefficients on the lagged public debt variable (fiscal responses) for both models of fiscal rules over the sample period. However, this conclusion hides a rather heterogeneous transition since the 1980s. The EA dispersion became increasingly larger before the Maastricht period, and was followed by a decline, and another increase during the early years of the Euro area (a sort of 'Olympic effect'). Subsequently, around the onset of the ESDC, there was an increase in the harmonization of fiscal policies, represented by a decline in dispersion that continued almost until the end of the sample period. The dispersion in the case of the stand-alone EU countries was much lower in absolute terms, compared with EA-12, but comparable with that of EA-10.

Given the existence of rather harmonized fiscal responses, there is a strong need for further changes in intra-EA fiscal policy arrangements, in order to alleviate pressures on members facing idiosyncratic shocks, and on the single monetary authority. Increased harmonization, and the resulting possibility of more aligned co-movements in sovereign debt instruments can also create a challenge in terms of the finance-fiscal link, the 'Diabolic loop'. Some suggested solutions will only work under the assumption of not-perfectly correlated fiscal policies.

The remainder of the chapter is structured as follows. Section 2 reviews the main theoretical concepts used, and provides links to relevant literature. Section 3

[15] As expected since they have not signed some or all (the UK) of the newly introduced institutional amendments.

presents the time varying parameter model (Bayesian TVP model) and illustrates the main parts of the estimation methodology for fiscal rules that is used in the chapter. Section 4 describes the dataset and reviews all steps necessary for the (re)construction of variables. Section 5 presents results for EA countries and stand-alone EU countries, and the Euro area as a whole, and discusses the implications of these findings. Finally, section 6 concludes and offers some suggestions for further research.

3.2 Review of literature and methodology

3.2.1 A theoretical review: fiscal rules, fiscal regimes and interactions with monetary policy

Knowledge of fiscal policy measures, their effects and related implications have improved substantially over recent years. However, there are still wide gaps and a general lack of 'rigorous' understanding of many aspects, in comparison to its more well-studied monetary policy counterpart (as a consequence of the Great Moderation), as outlined in Alessina and Givazzi (2013).[16] Those 'problematic' areas include: (1) effects of policy interventions (multiplication effects), (2) long-term implications of fiscal policy measures (such as long-term trends bringing about changes in the workforce), (3) ways of tackling (high levels of) indebtedness and (4) the links between fiscal policy and political processes (institutions), particularly links around finding efficient (robust) ways of putting constraints on fiscal policy. This chapter aims to provide some further evidence within area (4), which is predominantly concerned with fiscal rules and fiscal institutions.

In a similar vein, contrary to monetary policy's already well-established and relatively simple policy rules (mainly those of the Taylor's and/or McCallum's type), and its recent theoretical and empirical scrutiny, fiscal policy importantly lacks clearly formulated rule(s) that would be applicable in analyses of fiscal behaviour.[17] Such rules would enable us to structure a way of thinking about key variables and main relationships, and differentiate between various types of policies (mainly discretionary *vs.* rule based ones), with ample implications for practical policy-making.[18]

[16] A strong incentive was the Great Recession and/or the ESDC that have led to the use of unconventional monetary policy instruments alongside or as a substitute for a lack of fiscal measures.

[17] Apart from those rules suggested by Taylor (2000) that are similar to a Taylor rule, and/or rules suggested by Bohn (1998) that focus primarily on providing a testable sustainability condition. In addition, Yoshino et al. (2015) derive a more comprehensive fiscal rule, modifying the Bohn's rule by including both public debt, its change, and a measure of output gap as a combination of optimal spending and taxation rule. Its use enables both fiscal sustainability and economic growth.

[18] There are also some potential pitfalls that are related to simplifications of reality so that it

Reasons for this substantial gap in fiscal policy are manifold, but mostly revolve around the differences between the conduct of monetary and fiscal policy *inter alia*: ways of setting (selecting) and possible choices of pursued targets, independence of considerations and/or political influences alongside well-known problems such as lack of (higher frequency) fiscal series, identification and explanatory problems (fiscal policy heterogeneity, see Claeys, 2008; Leeper, 2010).

Nevertheless, in the last 30 years there have been many simpler rules (at least those systematically documented) attached to particular types of fiscal policy behaviour ('problematic aspect'). Some limitations put on fiscal policy behaviour are much older in origin.[19] More recently in response Global recession rooted fiscal problems, a larger number of national (independent) fiscal institutes have been established alongside the existing ones (that can be traced back to as early as the mid-1940s, such as the Dutch 'watchdog' Central Planbureau, CPB) to strengthen public scrutiny (mitigate 'fiscal bias').[20] The existence and importance of some sort of rules of conduct for fiscal policy is thus not a completely recent phenomenon compared to monetary policy.[21]

As briefly outlined above, another important layer for countries in a monetary union is related to the classification of fiscal authorities behaviour according to the so-called Fiscal theory of the Price level (FTPL, henceforth). FTPL originates from the seminal work of Sims (1994) and that of Leeper (1991), even though Buiter (2002) mentions even earlier contributions.[22] In the FTPL, both both fiscal and monetary policy are considered perfect substitutes for price level determination and government debt stabilization, with the former conventionally belonging to monetary policy and the latter to fiscal policy. Fiscal policy behaviour can be classified as *active* or *passive* (alternatively Ricardian or non-Ricardian) with respect to its link between public debt and prices/output.[23] Only the latter is, however, com-

can be approximated via a rule, which may turn unfavourable during large business cycles or in the case of shocks.

[19] A document that lists all rules for countries around the world is the IMF's Fiscal rules database (see IMF, 2015). There has been similar activity by the EU Commission (numerical rules only and for its members, see EC, 2016a). Going to ancient times, one could find some institutions even in Ancient Rome or Greece.

[20] In the case of EU-28, there were as many as 47 independent fiscal and other institutions in 2014 (see EC, 2014). A formal test of the effects of fiscal institutions is presented in Beetsma and Debrun (2016).

[21] An example of a monetary rule *sui generis* is the so-called $k-$percent rule suggested by Milton Friedman in the early 1960s. Simple monetary rules were also applied during the so-called Gold standard in late 19^{th} century or even before.

[22] Woodford (1995, 1996) shows that price setting does lead to important differences in this concept.

[23] 'Passive fiscal policy' (regime) means that it does respond to debt, and the intertemporal budget constraint (IBC) is satisfied for all price paths (Ricardian policy). Conversely, 'active fiscal

patible with sustainability since outstanding liabilities are expected to be balanced by future revenues. In this way fiscal solvency is guaranteed as budget (primary) balance responds accordingly to debt development.[24] In this framework, as pointed out by Creel and Le Bihan (2006), the existence of a passive fiscal policy (a Ricardian) regime across EA countries is essential to the European Central Bank's (ECB, henceforth) activities to control inflation so that price stability (according to their definition) can be achieved. The existence of a fiscal rule (Pact) itself, however, is not a unique way of guaranteeing the passive regime (see *ibid.*).

The (fiscal) Maastricht criteria and/or the Pact are commonplace examples when analysing fiscal rules in a monetary union. But why has been so much emphasis on fiscal policy? While the seminal papers of Mundell (1961) and Mundell (1973) considered 'fiscal policy' (predominantly 'transfers') to be a rather extraordinary tool, it has been criticised in the case of non-existing market forces, for not being able to cope with asymmetric shocks (slightly changed views in later contributions) in a single monetary authority environment. Authors later treated transfers as an important part of any monetary union, see for example Kenen (1969).[25] Early arguments assumed that independent and flexible national fiscal policy could deal with any shock(s) on its own and therefore, there was no need to propose any common framework for national (decentralised) fiscal policies. However, this argument rests upon two important implications: (*a*) fiscal policy remains sustainable (increased indebtedness after a negative shock is reduced in 'good times', see below) and/or (*b*)

policy' (regime) implies smaller than necessary responses to debt (in fact, it can follow any process even in contrast with the notion of sustainability). Fiscal policy eventually has the upper hand over monetary policy for the determination of prices (monetary authority can only deal with the consequences, i.e. inflation). In terms of the model (3.4) or (3.4) below, $\alpha > 0$ can be interpreted as a Ricardian policy, that is, the latter case. The notion of active/passive can reflect changes in taxation as well. For example, a policy can be passive when taxation responses to debt are large enough to the real interest rate payments (see Davig and Leeper, 2007). An implication of the active fiscal regime can be a lower response coefficient in an estimate of a Taylor rule (the so-called Taylor principle would not be satisfied). The labelling of these policies as 'Ricardian' and 'non-Ricardian' stems from the work of Aiyagari and Gertler (1985).
However, the results of empirical testing have been rather ambiguous because of the observational equivalence (for examples see Afonso et al., 2011).

[24] However, an instability region is occurs when both fiscal and monetary policy are 'active', and prices would still be affected by fiscal policy measures, for discussion see Creel and Le Bihan (2006).

[25] In his view, a system of fiscal transfers was necessary to mitigate effects of adverse shocks in parts of the monetary union, funded by resources coming from taxation. A recent report prepared by four top officials in the Euro area (see van Rompuy et al., 2012) has highlighted the need for an integrated budgetary framework comprising of the issuance of common debt instruments, and shock-absorbing mechanism (system of transfer payments) for strengthening of EA fiscal capacity. However, a very similar argument was already made in pre-EMU reports – the MacDougall Report (see EC, 1977,a) or the Delorse Report (see Delors, 1989).
Interestingly, a recent publication – Deutsche Bundesbank (2015) – considering future paths in European fiscal policy, operates with country-specific responses to asymmetric shocks.

the overwhelming majority of shocks occur because of exogenous factors (affecting more or less all members in a symmetrical manner).[26] However, neither implication is true for euro area countries, since most of the shocks affecting euro area countries have had their roots in their economies (asymmetrical business cycles, degrees of openness).[27]

Beetsma and Giuliodori (2010) or Badinger (2009) outline the need for some fiscal rules in such an environment: ($a1$) guaranteeing fiscal sustainability, and ($a2$) coordination and harmonization (limiting the size of deficits and potentially unsound fiscal policies), (b) helping to achieve economic stability (setting limits to discretionary policies). More recently, even more emphasis has been put on fiscal sustainability since it is viewed in terms of (see Bénassy-Quéré, 2016): (1) macroeconomic stability (achieving stable economic environment by promoting sound economic growth) and (2) finance-fiscal stability (emphasising fiscal (debt) sustainability as a key condition of the financial sector stability, that is, the fiscal-banking nexus, see Brunnermeier et al., 2016). Such rule(s) when implemented, complement the fiscal policy role as outlined in many classical. For instance Mundell (1961, 1973) highlight the need for fiscal transfers in the case of market rigidities and/or limited mobility of factors, and work by Kenen (1969) highlight the need of some form of a fiscal union.[28]

A brief review of links to the literature

Many studies have estimated some type of a fiscal rule ('fiscal response (function)'), whose specification has varied with the main interest of the study (usually a panel with yearly fiscal series). Without a great deal of simplification, these can be classified as belonging to one of three substantially heterogeneous strands in the fiscal policy rules literature (irrespective of a country's involvement in a monetary union):[29]

[26] This has been challenged by several authors, for example Ferrero (2009) shows in a simplified two-country model that the role of fiscal authorities is essential, even without proper coordination of the two governments.

[27] The most recent evidence for euro area countries (since 1995 with effects of the Global Recession) can be found in De Grauwe and Ji (2016). For a longer time span (from 1980) see for example Allard et al. (2013).

[28] While the '$1{:}n$' case in a monetary union is tacitly ignored in early literature, more recent contributions concerned with discretionary fiscal policy include: 'unpleasant' volatility of output and/or inflation (Sargent and Wallace (1981); Badinger (2009), unsustainable fiscal path (Sargent, 2012), negative spillovers (Beetsma and Giuliodori, 2010).

[29] An overview of earlier literature and questions addressed can be found in Bayar and Smeets (2009).

1. simple fiscal rules (and their outcomes) resembling monetary Taylor type rules are analysed for individual countries or regional integration groups such as Taylor (2000) for the US economy or Galí and Perotti (2003) for EU countries;

2. fiscal rules in the spirit of Bohn (1998, 2008)'s seminal work – fiscal response function (FRF, henceforth) – , whose estimates provide an empirical test of fiscal policy sustainability ('model based sustainability', MBS); these estimates are utilized *inter alia* in debt sustainability analysis (DSA) since they lie at the heart of its model-based debt simulation exercise (for example Burger et al., 2011 or Berti et al., 2016).[30, 31]
   More recent contributions emphasize sustainability and other characteristics (such as economic recovery, see Yoshino et al., 2015), reflecting the growing importance of sustainability in the wake of periods of depressed/slowly-growing economies, for example in Japan.

3. fiscal rules related to the aforementioned work on the FTPL, employing techniques to capture fiscal policy changes with two broad sub-strands: one for fiscal policy rule estimations based on primary balances, the other for fiscal rules using revenues or expenditures, while allowing for mutual interactions (see Afonso et al., 2011 for references; a recent survey of the FTPL literature and main strands is provided by Bajo-Rubio et al., 2009, complementing an early review by Buiter, 2002).[32]

Although many studies adhere to the previously characterised three groups, no studies have explicitly tried to systematically capture changes in institutions

[30] Burger et al. (2011) was also one of the first studies to use directly non-linear estimation techniques. They utilize yearly data (both cash (GFS) and accrual (SNA) definition) for South Africa over the period 1946/1974–2008, and find strong(er) positive responses to indebtedness in the late 1970s and the 1980s, and after 1998 in particular. Their estimation allowing for non-linear effect is, however, simply based on the use of the Kalman filter.

[31] Focusing on the second group of studies, empirical analyses of fiscal rules and their effects have also followed a few alternative routes: either country-specific estimations or panel analyses. Importantly, employed specifications considered both public debt and output gap, and/or further variables shaping fiscal policy (and institutions). However, there has not been an attempt to consider a larger group of countries and analyse their behaviour, both as a group and individually.

[32] The FTPL literature estimates fiscal policy behaviour and its changes using (Bayesian) Markov-switching techniques (MSM, henceforth) or more recently, (Bayesian) time-varying parameters estimators that allow the identification of up to n individual regimes (usually only two for the dichotomy) and associated turning points. Modelling regime changes or time-varying responses pose a challenge for estimation due to the length of available time series and the high sensitivity of MSM techniques to the analysed data.
A complication of testing the FTPL is linked to the fact that the intertemporal budget constraint is understood as an equilibrium condition in both concepts (active/passive), and not as a constraint *per se*. However, it is possible to differentiate between these concepts (endogenous/exogenous) by focusing on achieving solvency. For a discussion see Creel and Le Bihan (2006).

and fiscal outcomes and/or harmonization as a result of the integration process in Europe. An overwhelming majority of studies focused on a selection of events such as the Pact or the Euro adoption. Few studies have employed higher than yearly frequency of fiscal series (either mechanically reconstructed or on cash basis) and/or attempted to find reasons for changes (switches) in fiscal behaviour, either conditional on external events or as a result of a policy-makers game. This is in stark contrast with the monetary policy literature that has addressed both the effects of institutional changes on transmission mechanisms, and the conduct of monetary policy and/or their effects on economic indicators such as output gaps. Similarly in case of harmonization, few papers have presented statistical evidence on (cyclically-adjusted) primary balances or the exogenous components of fiscal policy (error terms from a simple fiscal rule resembling my FR I rule), such as Fatás and Mihov (2010). This study contributes to the literature by explicit estimates of the achieved level of harmonization of national fiscal policies.

This chapter thus provides another contribution to the literature by combining the estimation of two types of rules (both a macro-fiscal and an optimal) with the Bayesian TVP technique. This allows the smooth identification of changes in fiscal regimes, when analysing institutional effects across EA countries, and making comparisons with those observed in the group of stand-alone EU members. To the best of my knowledge, only one study by Canova et al. (2012) is to this chapter's analysis of the effects of three institutional changes in the case of a synthetic measure of business cycles: the Maastricht Treaty, the creation of the ECB and the Euro changeover. The TVP VAR results for a group of seven EA and three EU stand-alone countries reveal some support for effects related to the European convergence process rather than to institutional changes.

In the case of quarterly fiscal time series, empirical studies have recovered fiscal series by primarily employing a mechanical decomposition of yearly series or a combination of sources of different quality/methodology (cash). The major EU/EA members, and also countries with a 'history' of fiscal issues like Greece, Italy, Portugal and Spain, have been analysed more often. For example Thams (2007) applies Bayesian Markov-switching techniques to a quarterly series for Germany and Spain, to identify fiscal policy regime changes in both countries around the launch of the Euro in 1999 (more sustainable). There was also less stable behaviour in the case of Germany and stronger responses resembling non-Ricardian policy in Spain. Schoder (2014) finds that the Pact supports the restoration/preservation of fiscal policy sustainability in countries with high responses, but does not provide much support in other countries (Greece, Portugal and France). In contrast with

my models, the last study utilizes a model without covariates, but simply derives from a stochastic optimization problem in line with (Bohn, 1998, 2007)'s models. In addition, the dataset contains 'mechanically' reconstructed quarterly fiscal series (Chow and Lin approach for primary balances and net debt) from the 1980s to 2010 for 15 OECD countries (including non-European member states). In contrast to that approach, I employ a recent approach based on Bayesian methods (see Bańbura et al., 2015 or Giannone et al., 2015) to create a novel database of accrual fiscal series for EA-12 and EU-3 countries. I prefer gross debt series because of uncertainty about the valuation of governmental assets. This provides quantitatively and qualitatively different types of information on fiscal behaviour compared with cash series or a mechanical decomposition (see Irwin, 2015). In addition, my country-specific series are comparable with an alternative method that combines individual series from national accounts with statistical and econometric techniques in several steps; for further details see De Castro et al. (2014).

Regarding the modelling technique, Cuerpo (2014) applies a quasi-Bayesian TVP technique (proposed by Ciapanna and Taboga, 2011), similar to my approach. He uses Spanish quarterly fiscal series (1986q1–2012q4) provided by De Castro et al. (2014) to estimate a simple fiscal (debt) rule without any controls. He finds that fiscal policy behaved in a sustainable manner during the 1996–2008 period. However, this period was characterized by the zeal of meeting convergence criteria in order to join the first wave of Euro countries, and years of robust conjuncture in the Spanish economy. While these findings resonate with the conclusions of De Castro et al. (2014), Ricci-Risquete et al. (2016) analyse a longer sample of the same data with a MSM VAR technique and only find one change in Spain's fiscal policy regime (in late 1992). This indicates possible bias in previous studies using samples prior to the ESDC. Afonso et al. (2011) also use MSM techniques to analyse fiscal behaviour in Portugal between the late 1970s and 2008, and find a change in fiscal regimes in 1988 (two subtypes of a non-Ricardian regime). They also find mixed evidence of more restrictive (that is sustainable) fiscal policy prior to the launch of the Euro, and around 2002 when Portugal was the first EA country facing sanctions in the EDP process as a result of violating the Pact. Lastly, Afonso and Toffano (2013) estimate optimal fiscal reaction functions on quarterly data (from 1970s/1980s to late 2000s) coupled with monetary reaction functions for three EU economies (EA countries: Germany, Italy, and one non-EA country: the UK). Allowing for regime-switching in parameters (MSM technique with two regimes), they find fiscal policy in Germany to be rather passive (sustainable). Compared to these studies, my estimation is not limited by a potentially strict assumption about the number of

regimes in which fiscal policy can operate. I overcome this limitation by performing TVP estimation of both a simple and a more complex fiscal rule. This approach allows me to make comparisons, both with the other studies listed, and between the results of the different estimations. Moreover, I explicitly control for institutional effects through my estimation approach, while also mitigating problems arising from additional variables, and a choice of relevant periods. Compared to previous, the incorporation of a lagged dependent variable also allows me to distinguish between short-run and long-run behaviour. My results also take into account changes in the aftermath of the Great Recession and the ESDC, which are not covered in most of the previous studies that also use data ending during the high-growth period of the 2000s.

Fiscal policy rules

A fiscal rule or a fiscal reaction function closely resembles monetary policy rules, or so-called Taylor rules (for a direct comparison see Taylor, 2000) because of the use of: (*i*) output gap (growth rates of potential or real GDP) as a proxy for cyclical behaviour and (*ii*) a 'policy variable' such as the structural component of a budget deficit. A standard (functional) form usually uses models proposed by Leeper (1991) or Bohn (1998). This standard represents a model specification that allows for the estimation of fiscal responses and testing of so-called (macro) model based fiscal sustainability (MBS). In a more general way, a fiscal policy rule (governmental primary balance response to lagged public debt ratio) can take the following form (see Bohn, 2008; D'Erasmo et al., 2015 or Ghosh et al., 2013):[33]

$$bs_t = \alpha d_{t-1} + \psi. \tag{3.1}$$

The reduced-form fiscal rule (3.1) links the primary balance (bs_t),[34] the lagged outstanding public debt (d_{t-1}), both variables expressed as a fraction of GDP, and 'other' determinants (ψ) that include a constant and the one-period lagged primary balance. The other determinants enable to systematically control for economic, financial, and institutional conditions such as output gap, external

[33] Arguments for the inclusion of debt level in fiscal rules can be found for example in Favero and Giavazzi (2007). In addition, Fatás and Mihov (2010) find evidence for cyclically-adjusted primary balance and growth rates, but find no significant evidence for output gaps in case of EU countries (dataset only included early years of the Euro area). Since output gaps are commonly utilized and they are in line both with Taylor rules and an optimal behaviour in micro-based types of models, my preference is to follow this approach.

[34] Primary balance is defined as a difference between total government revenues and expenditures without interest payments.

deficit or components of government expenditures for some country or group of countries i, and a time period t (for example as a forward-looking role for $k < \infty$ period, $\langle t, t+k \rangle$). Possible further determinants may matter but are not directly incorporated in the model and cannot be explicitly evaluated with respect to their impact on fiscal behaviour, but only through their effect on already employed determinants. An estimated coefficient on public (government) debt characterises the response of primary balance to public debt. In the Bohn (1998)'s inspired strand of the literature, the coefficient on debt ($\widehat{\alpha} > 0$) is interpreted as a (weak) test of public debt sustainability, in the case when the intergovernmental budget constraint (IBC) and no-Ponzi Game condition are satisfied (i.e. explosive behaviour is eliminated). However, the steady state level of public debt and its behaviour depends on the difference between the estimated response coefficient and growth adjusted interest rate, assuming a standard debt accumulation equation (for details see for example D'Erasmo et al., 2015).[35] One of the shortcomings of this specification lies in the fact that the debt response coefficient – α – is typically treated as time invariant, which has been addressed in different ways in the literature (time, debt or a particular determinant dependent fiscal rules); for these extensions see below.[36]

Recent studies on FRF have emphasised two further important links between fiscal responses and a broadly defined environment: (a) optimising behaviour of fiscal agents, (b) the importance of a connection between fiscal policy behaviour and monetary policy actions. Therefore, I consider another type of rule that extends/reformulates the simple model (3.1), that is, a model explicitly allowing for both factors: optimising behaviour and presence of inflation spillovers (Kirsanova

[35] Some authors claim that the failure to control for the role of financial markets is the primary cause of fiscal policy response estimates that are too low. Therefore, a reformulation of the rule (3.1) can be viewed as a sufficient sustainability condition, only if the value of ($\widehat{\alpha} \gg 0$) is large enough. This is however, possibly conditioned on further determinants including interest payments on the current stock of debt, and if there is no upper limit on positive values of primary surpluses, for example as shown in Daniel and Shiamptanis (2013).
Either in the simple or in the more complex approach, empirical estimations of such a rule are so-called MBS tests (see D'Erasmo et al., 2015).

[36] The validity of this point, however, relies on the actual specification (country/time dimension). For further discussion see for example Berti et al. (2016).

et al., 2005). The 'static' form of such a rule then reads:[37]

$$bs_t = \alpha d_{t-1} + \beta ogap_{t-1} + \gamma \pi_{t-1}, \tag{3.2}$$

where π_{t-1} is the one period lagged rate of inflation (in percent), $ogap_{t-1}$ is the lagged output gap (in terms of the natural output), and the other variables have the same interpretation as above. In contrast to monetary policy rules, fiscal rules usually do not include expectation terms for output gap and/or inflation, and only occasionally can be estimated on real time series because of their limited availability.

Further modifications and extensions of fiscal rules

As already indicated above, fiscal rules are usually specified as time-invariant, which is not necessarily a good approximation of policy-makers behaviour. As a result, there have been several extensions of the FRF concept including: (1) debt-level specific responses, (2) interest rate dependent responses, (3) threshold effects or (4) time-varying responses.

Firstly, a linear rule is only an imperfect proxy of real fiscal policy reactions since plots showing (primary) fiscal balance and debt can even reveal a non-linear relationship. There have been several attempts to account for this possibility. One approach, already tested in Bohn (1998)'s paper, rests upon adding higher-degree order terms of a debt polynomial, either in the form of a difference with respect to a country's average value (capturing deviations from a country-specific 'steady state') or as additional polynomial terms. Usually, the second and third polynomial terms are used to estimate changing responsiveness (increasing and decreasing) as indebtedness increases. A theoretical justification for this non-linear model is linked to the so-called fiscal fatigue hypothesis (ff hypothesis, henceforth) that was proposed and empirically examined for a sample of developed countries in Ghosh et al. (2013). The ff hypothesis assumes different behaviour of fiscal authorities depending on the actual debt level, which can give rise to larger or smaller responses of fiscal balance.[38] Similarly, the second case considers fiscal responses conditioned on levels

[37] This study develops a three/five equation model with a goods market (dynamic IS curve), an expectation augmented version of the Phillips curve (PC), a Taylor type monetary rule (output and inflation, MP), a debt accumulation equation, and a rule for fiscal authorities (output and debt). In that model, fiscal authorities respond not only to debt, but also to inflation and output. As a result, the specification of the fiscal rule takes the form presented in (3.2). Assuming monetary policy is capable of stabilising the economy, then small responses to debt and only negligible responses to output and/or inflation, should be found in the case of fiscal authorities (*ibid.*).

[38] For example for very high debt levels, a fiscal authority can respond with a stabilization policy to reduce deficits (and consequently stabilization/decrease of indebtedness), or the current debt level can be so high that the fiscal authority will not adjust its policy or even make it loose (that

of growth adjusted interest rates. Daniel and Shiamptanis (2015) show that for a group of developed countries, estimates provide similar (or even better information) compared to the model of ff hypothesis. Other approaches such as threshold models, attempting to capture varying responsiveness to changing indebtedness (resembling the previous concept of fiscal fatigue) can result in fiscal responses that are discontinuous at one or several debt levels. Lastly, there have been few studies recently that estimated a FRF with a time varying response coefficient α_t, similar to these utilized in this chapter, that are discussed in a grater detail below.

3.2.2 How much do institutions matter for fiscal policy?

Previous sections briefly described country-specific estimates of time-varying fiscal responses. Below I try to find some evidence of whether few major changes of European institutions can be identified as triggers of different fiscal behaviour (responses). In particular, my interest lies in providing some evidence on the most recent set of institutional changes (crisis-related), and countries that have been exposed to severe (financial market) pressures. Accordingly, I also explore the other aspect of the research question, regarding the outcomes of institutional changes around the harmonization of EA fiscal policies.

There is hardly any robust (indisputable) test for verifying effects of institutions and subsequently harmonization of fiscal policies. A set of figures is included in the empirical section of this text to check whether there has been any effect coming from changes in the EA institutional environment for national fiscal policies. These figures are split into two groups: countries with some fiscal problems (GIIPS), and all the remaining EA members. My results are compared with a (imperfect) control group that is made up of three stand-alone EU countries. To make the comparison more adequate, countries are divided into three groups by using a debt criterion, while keeping the stand-alone countries together. Presenting all members of a group in one figure provides a more 'realistic' view of individual responses and their changes over time, compared with separate discussions of the results. Accordingly, I provide both a visual presentation of harmonization via simple statistics (standard deviations) for my measure of fiscal behaviour.[39]

is, a fall in responsiveness, which gives the name to the hypothesis), and a sovereign default will follow. However, there is no guarantee that fiscal behaviour will follow such a non-linear pattern since this approach is more mechanical than related to so-called fiscal capacity, fiscal space of a country, or past behaviour of policy-makers (for details see *ibid.*).

[39] Since there is no clear suggestion regarding a measure of harmonization, in the case of country-specific estimates (time series models), one could also follow Arouri et al. (2013) utilizing the Geweke (1982)'s test for measuring monetary policy harmonization of three main central banks (short-term interest rates).

In my point of view, there have been three important sets of events since the late 1980s that can be associated with major institutional changes. These are as follows:[40]

(a) the Maastricht Treaty (1991–1993) at the inception of preparations for the Euro adoption, including a set of the well-known Maastricht convergence criteria (despite being more concerned with high debt levels than with budget deficits in the case of fiscal criteria);

(b) the launch of the Euro (1999), which initiated the need to comply with the first version of the Stability and Growth Pact (established in 1996, but only fully at work from 1999 onwards, including the excessive deficit procedure (EDP, henceforth) and its sanction clauses for EA members), and

(c) the full unwinding of the Great Recession in the Euro area (late 2009) leading to the European sovereign debt crisis and a particularly long list of changes to the fiscal policy framework that was approved and implemented over the period of 2011–2013.[41]

Since there is a significant amount of uncertainty regarding the timing for the set of institutional changes – items ad a) through ad c) above –, I follow Canova et al. (2012)'s approach for setting a particular cut-off time for individual events. Therefore, I leave aside for this moment possible lags in observable effects (which can be checked as a robustness exercise). The key dates are set as follows: in the case of the Maastricht treaty, the decisive quarter is set to the first quarter of 1993. The effects associated with the Pact can be set to the third quarter of 1998, when final decisions were made (on the single monetary policy and the common currency), and it was finally clear who would be subject to its rule and sanction principles. Linking to that event, I also add the first major amendment to the Pact that was endorsed

[40] For an early overview of important dates in the European integration process see for example Rogers (2007).

[41] These changes included, both further minor modifications of the Pact, the second major change since 1996 that was mainly implemented to enhance compliance with its principles, and additional changes of the institutional framework, comprising: (i) the so-called 'Six pack' (October 2011), focused on improving compliance with the Pact, introducing an early warning system, and a correction mechanism in case of excessive macroeconomic imbalances; (ii) the so-called 'Two pack' (May 2013) that complemented the six pack by adding further layers for coordination and surveillance of EA countries; and (iii) the Fiscal Compact (the third title of the Fiscal Treaty, October 2012) that modified and extended the Pact by introducing balanced budget rule and debt brake rules (if debt is above 60% of GDP), and precipitated the establishment of independent national fiscal councils alongside the existing set of fiscal rules. The Fiscal Treaty is expected to modify fiscal policy behaviour as shown for example in Baldwin and Giavazzi (2016); for an overview of all changes see EC (2013); EC (2015); EC (2016c) or Masten and Gnip (2016).

in late March 2005. I set the cut-off to 2005q1 since the complexity and uncertainty around the final version of the rule's text resulted in a great deal of effort to fix issues such as, ameliorating problems with non-compliance. While the first wave of effects stemming from the Global Recession (via trade links) arrived around the third quarter of 2008 (with the exception of Ireland and the UK facing problems of financial institutions already in 2007q3), the outbreak of the debt crisis (ESDC) is associated with events in late 2009 and particularly in early 2010 (see Bruegel, 2015). I set the date to the fourth quarter of 2011 since these events triggered later changes in the institutional framework – the so-called Six-pack became effective as late as December 2011 (aimed to strengthen fiscal surveillance and introduce the Macroeconomic Imbalances Procedure, MIP). The last sequence of this series of institutional 'corrections', the Fiscal Treaty, was ratified by a twelfth EU member in late December 2012, and entered into force from January 2013. Signatories to this Fiscal Treaty were additionally granted a period of one year to carry out necessary amendments at the national level. As a result, it became binding for the first time for EA participating countries from January 2014. Given the conceptually different nature of the last change, it is rather difficult to assess how much this Treaty actually influenced the behaviour of signing countries. Nevertheless, its cut-off is provisionally set to 2012q4. Since this study analyses institutions, it does not consider, for example, the case of coordinated short-run demand management (2009) aimed to propel aggregate demand and growth into positive territory.

The aforementioned dates can be subject to changes (shifts) as already indicated. For example in the case of the Maastricht treaty, one could think of bringing that cut-off date back to 1992q1. Since the time-varying methodology allows to estimate a model specification in any period within the sample period, the previously mentioned cut-off dates only provide the most likely data points for changes that are highlighted in individual figures. The final verdict will be passed by plotting a trace of calculated coefficients. Nevertheless, one can think of factors leading to differentiation: some of the dates have already been investigated in the literature and included in models in a form of a dummy (mainly around the Euro introduction), while others are not. Results illustrate individual changes in a smoother way and there is also a possibility of simple mutual comparisons. Since the sample period includes even more recent periods it reveals whether there was any change associated with the ESDC and the series of measures implemented thereafter. My expectation is that there should be a differentiated impact of institutional changes, particularly, there should be stronger responses in more indebted countries and those seriously hit in the course of recent events. An overwhelming majority of institutional changes

has aimed to modify fiscal behaviour towards a more unified framework, so another dimension to be analysed is their impact on dispersion of individual country-specific responses by means of standard deviation.

3.3 Time-varying parameter fiscal functions

As outlined in previous sections of this chapter, fiscal responses functions or fiscal rules are usually estimated as time invariant for a country or group of countries. Commonly used specifications draw on Bohn (1998)'s model, similar to the model (3.1) above. A 'flexibility' is added to the estimation with the help of time or state-dependent interactions (see above). Flexibility is by representing the former by time or event-related dummy variables, and the latter by a Markov-switching model, where two or more types of responses are assumed.[42] Since my aim is to capture the changing nature of fiscal policy over time given both endogenous and exogenous changes in economic, financial, institutional and other types of environment, several techniques could be applied to empirically investigate their effects (see below). A particular choice of technique can also be driven by the availability of fiscal data that still varies substantially, even for many European countries (for a recent summary of data coverage by methodology see Irwin, 2015).

3.3.1 Model specification

In this chapter, a modification of the simple fiscal rule presented as the model (3.1) above is considered. Firstly, my model will capture time-varying fiscal responses by relaxing the restriction (time invariability) put on the estimated debt response parameters, and allowing a fiscal rule to change over time. Secondly, the traditional approach based on a linear response rule in the spirit of (Bohn, 1998, 2008) allowing for persistence of fiscal measures, is complemented with an explicit set of controls:

$$bs_t = c_t + \varrho_t bs_{t-1} + \alpha_t d_{t-1} + \boldsymbol{\Gamma_t \Theta}_{(.)} + \xi_t, \tag{3.3}$$

where bs_t, bs_{t-1} represent the current and lagged primary balance respectively, d_{t-1} is the one period lagged debt (all variables in percent of GDP),[43] $\boldsymbol{\Theta}_{(.)}$ stands for a set of determinants (economic, financial, ...) of fiscal policy exactly specified below

[42] Regimes are usually found to be rather persistent with low switching probabilities, which may or may not be a good description of fiscal policy. In the case of imperfect information, changes of regimes may remain unidentified. Similarly, the existence of temporary sub-regimes may not be allowed for.

[43] I employ a model with the one period lagged debt variable following Greiner et al. (2007) and similarly in case of the output gap series so that there is not problem with simultaneity bias.

and random shocks (ξ_t), and c_t is the constant term. ϱ_t, α_t, and $\mathbf{\Gamma_t}$ represent a set of time-varying coefficient to be estimated.[44] Regarding the determinants, the literature has yet to reach a consensus as to which are the most important (apart from the debt variable and a proxy for economic conditions). As a result, I consider two versions of the fiscal rule:

(i) **Fiscal Rule I** (FR I, henceforth) – a model that resembles a Leeper (1991)'s fiscal rule, combining the very simple idea of fiscal policy responding to debt, while controlling for business cycle related fluctuations. This rule is close to the (macro) sustainability strand of the literature,

(ii) **Fiscal Rule II** (FR II, henceforth) – a specification in accordance with the model outlined in Kirsanova et al. (2005) and briefly outlined above ('optimal fiscal policy'), with an inflation rate and a proxy for taxation motives in line with the original Barro (1979)'s argument (and thus more in the vein of the FTPL literature).

Models such as the reduced-form fiscal rule (3.1) are meant to capture short-run fiscal policy behaviour at a yearly frequency, not explicitly considering lags related to policy-makers actions. Since policy-making reality is different, one can specify a fiscal rule that explicitly accounts for these lags. This can also be viewed as an example of the differences between fiscal and monetary policy, as reflected in their policy rules. In addition, since my model will be estimated at a quarterly frequency, a simple transposition of a yearly-based model to the quarterly environment may not be intuitive. Given the typical set-up of fiscal policy, fiscal responses could possibly be more aligned in a four-quarter-change period (that is one year), than those from quarter to quarter, as is commonly done in the literature by bringing a Bohn's yearly model to quarterly data.[45] However, unexpected events requiring immediate fiscal intervention (such as catastrophes) often result in ad hoc quarter-to-quarter changes $[{}^{(q+1)}/_{(q)}]$ of government expenditures (structural measures). These are rather limited in terms of their size during a fiscal year. Similarly, while (big) changes in taxation are only very rarely carried out on a quarterly basis because of their implications for the behaviour of economic subjects, tax rates do experience changes during a year. In addition, government's plans for a fiscal year reflect not only quarterly, but also monthly variation, based on the matching of revenue and

[44] Based on estimated values, long-run (steady state) levels of debt for the analysed country can be calculated. If $\widehat{c}_t < 0$, then debt in such an economy will level out to a positive long-run level of debt ratio.

[45] Only few studies have considered such differences so far, for example Burger and Marinkov (2012).

expenditure streams. Given the system of checks on budgetary development by the European Commission, governments that clearly deviate from planned (agreed) paths are expected to correct them without delay.[46] Therefore, the assumption of fiscal policy acting on a quarterly frequency seems plausible. Moreover, one additional exception can be the case of crisis management to stabilise fiscal accounts (public finances) in fiscally distressed countries, for example the measures recently adopted in GIIPS countries such as Greece and Ireland. Most of the fluctuation can be thus attributed to the role of automatic fiscal stabilisers and planned discretionary measures (such as investments).

In this chapter I begin with a model including only one lag for the sake of comparability with the literature. Further alternatives such as time-invariant estimates or a possible four-lag specification consistent with yearly frequency, are left as a robustness exercise. Therefore, the FR I specification for quarterly series based on the macro-fiscal rule (3.3) resembling Leeper, 1991's model (see above) includes only a control for business cycles and takes the form:

$$bs_t = c_t + \varrho_t bs_{t-1} + \alpha_t d_{t-1} + \boldsymbol{\Gamma_t \Theta'_{(.)}} + \xi_t, \tag{3.4}$$

where $\boldsymbol{\Theta'_{(.)}} \in \{ogap_{t-1}\}$, where the output gap series ($ogap$) is estimated using the Baxter-King band-pass filter (or for robustness check using the HP filter, see data section or data appendix for details) expressed in relative terms and ξ_t is the error term. Interpretation of remaining variables is the same as above.

The alternative specification (resembling 'optimal fiscal rules', see above) with inflation rate and expenditure/tax smoothing variables (FR II) takes the form:

$$bs_t = c_t + \varrho'_t bs_{t-1} + \alpha'_t d_{t-1} + \boldsymbol{\Gamma'_t \Theta''_{(.)}} + \xi'_t, \tag{3.5}$$

where $\boldsymbol{\Theta''_{(.)}} \in \{ogap_{t-1}, \pi_{t-1}, gcout_{t-1}\}$, with π_{t-1} is the rate of inflation (CPI, in percent) and $gcout_{t-1}$ represents the trend deviations of total current expenditures (estimated using the Baxter-King band-pass filter or for robustness check using the HP filter, see appendix for details), and ξ'_t stands for the error term. Interpretation of remaining variables is the same as above. Based on theoretical considerations and the work of (Bohn, 1998, 2008), the coefficient ϱ_t on lagged primary balance is expected to be positive (persistence of fiscal measures). The coefficient for the

[46] This has become even more important since 2011 when the new procedure for correcting imbalances (MIP) came into force, complementing the already existing 'European Semester' (since 2010), see for example Bénassy-Quéré (2016).

variable of main interest, the lagged debt ratio, α_t would be positive as long as the government responds with a reduction of primary balance deficit (that is, an increase of primary surplus) for rising debt and *vice versa*.

Debt response coefficients estimated in both models (3.4) or (3.5) represent short-run fiscal responses ($\widehat{\alpha}_t^{SR} \equiv \widehat{\alpha}_t$), which can be viewed only as partial information. Therefore, estimates of long-run fiscal responses ($\widehat{\alpha}_t^{LR}$) can be added, and calculated for a particular time period t, following the logic for ARDL models outlined in Chudík et al. (2015) as:

$$\widehat{\alpha}_t^{LR} = \frac{\widehat{\alpha}_t}{1 - \widehat{\varrho}_t} \tag{3.6}$$

where $\widehat{\varrho}_t$ is the estimated coefficient on the lagged primary balance variable from the model (3.3) for period t.

Some studies have flagged/raised the issue of estimating fiscal responses with the lagged dependent variable – the models (3.4) or (3.5) – because of the effects of automatic stabilisers for fiscal responses.[47] Even though this particular problem seems to be relevant for reduced versions of fiscal rules, not explicitly controlling for other determinants but output gap (and for cyclically adjusted primary balance as the dependent variable), which is not the case here. Since such a model is (dynamically) misspecified, an appropriate estimation technique is necessary, see for example Davidson and MacKinnon (2004).[48] In addition, such a specification (3.7) does not allow to distinguish the time frame of the response as with the case of a model with the lagged dependent variable:

$$\begin{aligned} bs_t &= c_t + \alpha_t' d_{t-1} + \boldsymbol{\Gamma_t \Theta'}_{(.)} + \varkappa_t, \quad \text{(in case of the FR I)} \\ bs_t &= c_t + \alpha_t' d_{t-1} + \boldsymbol{\Gamma_t' \Theta''}_{(.)} + \varkappa_t, \quad \text{(in case of the FR II)} \\ \varkappa_t &= \beth \varkappa_{t-1} + \xi_t, \end{aligned} \tag{3.7}$$

where $\boldsymbol{\Gamma_t \Theta''}_{(.)}$ or $\boldsymbol{\Gamma_t' \Theta''}_{(.)}$ includes the same variables as in (3.4) or (3.5) respectively, $\varkappa_t$ is the $AR(1)$ error term, $\beth$ is the estimate of the autoregressive coefficient for the $AR(1)$ process and ξ_t is assumed to be an *iid* error term.

[47] For example see Golinelli and Momigliano (2009); Fourier and Fall (2015) or Plödt and Reicher (2015).

[48] An estimation of the FR I and/or the FR II without the lagged term with an $AR(1)$ error term can thus be carried out as a robustness check.

3.3.2 Estimation technique

Few techniques are applied in the literature when estimating the effects of determinants on fiscal policy variables: (*i*) VAR technique and a number of its modifications, however, VAR estimates are subject to various critiques (see Afonso, 2005) because of their reliance on causality or the effect of variables' ordering. (*ii*) Panel techniques can help address some further empirical challenges (short fiscal series, quarterly in particular), even though the implicit assumption of one regime across the panel may be too strict. (*iii*) Markov-switching models allow for several states of the dependent variable, however, they are subject to issues both with the choice of the number of states (usually two or three) and their rather data-demanding (sensitive) features. (*iv*) A rolling regression and/or the Kalman filter is employed to estimate similar models since they allow for the time-variation of parameters. However, both the former and the latter method works with 'fiscal flexibility' in a particular manner, in comparison to more flexible TVP models.[49] (*v*) Quasi-Bayesian methods in the form of a 'classical' maximum likelihood estimation (MLE), combined with the Kalman filter represent a more recent approach.[50]

In this chapter, I utilize a state-space representation of two models of fiscal rules (FR I and FR II), and their parameters are estimated using TVP model estimation combined with Bayesian methods. Bayesian methods consider all parameters to be random variables, and all to-be-estimated parameters are treated as those stemming from jointly distributed random variables. Their estimation takes into account the uncertainty associated with all the others (see Kim and Nelson, 1999) and as a result, it enables the computation of the so-called credible intervals using the posterior distribution (for details see for example Koop et al., 2007). Although it is not the only possibility that is available in this case, it ensures that the estimation proceeds in a way that helps to eliminate issues associated with applications of MLE in combination with the Kalman filter (see footnote 50).

Since the choice (specification) of priors, that is the formulation of beliefs on prior distributions, is of key importance, I follow recommendations in Primiceri (2005) or Blake and Mumtaz (2012) and use the beginning of my sample to gener-

[49] Some authors raise the issue of rolling window regression estimates' sensitivity to outliers, in small samples in particular, see Zivot and Wang (2006) or the specification of a window utilized.

[50] There are two potential problem of this combination (for details see Kim and Nelson, 1999): 1) there is a risk of accumulation of estimation errors since there can be numerous likelihood functions, especially in large models where one state variable estimation is carried out with conditioning upon the MLE estimates of the remaining parameters in the system, and 2) the initialization of the Kalman filter requires specifying correct (objective) priors. While the latter can be solved easily (for example using a training sample), (the former) obtaining efficient estimates of parameters is non-trivial.

ate the necessary information for country-specific models (parameters and variance), each of the same length for all countries. This choice means that country-specific characteristics are taken into account at the start of the estimation procedure and thus, they are aimed at alleviating problems with a fixed choice of some arbitrary values. This approach is also assumed to lead to more accurate time-varying estimates (reduced variance) because of the natural shrinkage contained in the likelihood (Byrne et al., 2016).

My novel quarterly dataset allows to carry out simultaneously country-specific estimations and capture time variation, owing to the use of Bayesian methods for time-varying parameter estimation in the state-space model framework. Following Blake and Mumtaz (2012), for the simulation of draws from the parameters' posterior distribution, the Gibbs sampler is employed (belonging to Markov Chain Monte Carlo (MCMC) methods), complemented with the Carter and Kohn (1994) algorithm. In order to do that, one has to specify (see Byrne et al., 2016): (a) the unknown parameters of the model to be estimated and (b) their posterior conditional distributions, subsequently allowing (c) the algorithm to draw samples from them.

The TVP regression model allowing for specified time-variation of coefficients with the measurement (also called observation) equation being the (3.8a), and the transition equation being the (3.8b) below) takes the following form:

$$y_t = \aleph b_0 + \boldsymbol{\beta_t} \boldsymbol{X_t} + \epsilon_t, \tag{3.8a}$$

$$\boldsymbol{\beta_t} = \omega + \boldsymbol{\Lambda} \boldsymbol{\beta_{t-1}} + \varepsilon_t, \tag{3.8b}$$

where the error terms take the form

$$\epsilon_t \sim N[0, \Xi] \ (iid), \tag{3.8c}$$

$$\varepsilon_t \sim N[0, \Theta] \ (iid). \tag{3.8d}$$

y_t is univariate $(T \times 1)$, $\boldsymbol{X_t}$ consists of $p > 2$ fiscal rule determinants (including the first lag of dependent variable), $\boldsymbol{\beta_t}$ is a $p \times 1$ matrix of coefficients, $\boldsymbol{\Lambda}$ is the $p \times p$ matrix ($\sim I_k$ identity matrix), and $E[\epsilon_t, \varepsilon_t] = 0$ (independence). When setting $\Xi = I_k$ and parameter $\omega_\epsilon = 0$), the regression coefficients evolve according to a random walk with innovations ε_t. $\aleph b_0$ represents any time invariant variables – none in my case – and the coefficient (matrix $(k \times k)$ of their coefficients) included in the model specification. In this case it is set to zero.

As Kim and Nelson (1999) or Blake and Mumtaz (2012) explain, initial

values for time-varying parameters $\boldsymbol{\beta_t}$ (observable state variables), $\boldsymbol{\beta_{(0|0)}}$, and their variances ($\boldsymbol{V_{(0|0)}}$) need to be specified before the Kalman filter can be initialized. This is done alongside selecting initial values for the variance of the measurement (observation) equation – $\boldsymbol{\Xi}$ – and the variance-covariance matrix of the transition equation – $\boldsymbol{\Theta}$. A full derivation of the Kalman filter can be found for example in Frühwirth-Schnatter (2006, Ch. 13) or in Blake and Mumtaz (2012, Ch. 3).

Following Primiceri (2005) to find the initial values ($\beta_{(0|0)}$, $V_{(0|0)}$) for the TVP model, a simple time-invariant OLS regression is run over a training period (TP) of five years at the beginning of the sample; because of one-quarter lag the actual period is: T_{TP} = 1980q2–1984q4. Even though the length of this training sample period is rather short, it should provide some information for the estimation. The potentially limited information content is reflected in the value of the scaling parameter ν (see below), which accords with Byrne et al. (2016) suggestion for country-specific estimations. As a result, the starting values for the Kalman filter are (the initial state and the initial variance): $\beta_{(0|0)} \equiv \beta_{OLS}$ and $V_{(0|0)} \equiv V_{OLS}$. This, however, reduces the sample period for estimation of fiscal responses to 1985q1–2015q4 (i.e. 124 quarters).

$$\beta_{OLS} = (\mathcal{B}'_{TP,t} \cdot \mathcal{B}_{TP,t})^{-1}(\mathcal{B}'_{TP,t} \cdot y_{TP,t}), \tag{3.9a}$$

$$V_{OLS} = \Omega_{TP} \otimes (\mathcal{B}'_{TP,t} \cdot \mathcal{B}_{TP,t})^{-1}, \tag{3.9b}$$

where β_{OLS} is the vector of OLS coefficients and V_{OLS} is the OLS covariance matrix with

$$\Omega_{TP} = (y_{TP,t} - \mathcal{B}_{TP,t} \cdot \beta_{OLS})'(y_{TP,t} - \mathcal{B}_{TP,t} \cdot \beta_{OLS}) \cdot (T_{TP} - r)^{-1}, \tag{3.9c}$$

where r is the number of parameters to be estimated and $\beta_{(.)}$ and $V_{(.)}$ are priors to be calculated.

The priors for the measurement (observation) and transition equation are respectively represented by the inverse Gamma distribution and inverse Wishart distribution, for a country-specific estimation. Firstly, inverse Gamma (IGa^{-1}) for the measurement equation, $P(\Xi) \sim IGa^{-1}\left[\Xi_{TP}, (T_{TP} - r)\right]$ with the degree of freedom from the training sample $(T_{TP} - r)$ and the scale parameter $\Xi_{TP} = \Omega_{TP}$. The prior for the transition (updating) equation is the inverse Wishart distribution: $P(\Theta) \sim IW\left[\Theta_{TP}, T_{TP}\right]$ with the training sample variance $V_{TP} = \Theta_{TP}$ (with a scaling factor, see below) and degrees of freedom of the training sample T_{TP}. Following the recommendations of Blake and Mumtaz (2012), I restrict the con-

tents of the matrix Θ_{TP} since it affects the variation of coefficients in my model (larger values lead to large dispersion), and the starting period provides limited information on individual variables. Therefore, the calculated variance is re-scaled via: $\Theta_{TP} = V_{OLS} \times T_{TP} \times \nu$, where ν is the factor of proportionality. I set it to a relatively small number $\nu = 3.510 \cdot 10^{-5}$ for the base model – FR I – following Blake and Mumtaz (2012); a similar treatment of variance for a single equation model is justified in Byrne et al. (2016). That choice also affects the speed of adjustment for parameters of my model.[51] Parameters (β's) are drawn from multivariate normal distribution, in accordance with the recommendation in the Bayesian literature (see Kim and Nelson, 1999). Since my both models include the lagged dependent variable, I restrict the generated set of random draws of coefficients for that variable to those that lie only between zero and one in absolute value, that is, for $\Psi = \{\widehat{\varrho}_t, \widehat{\varrho}'_t\}$ in models (3.4) or (3.5) above so that $\Psi \in (-1; +1)$ holds.[52]

Also for the initialization of the Gibbs sampler some initial values are required – Ξ and Θ. These are set similarly to the previous case: $\Xi_0 = V_{TP}$ and $\Theta_0 = V_{TP} \times T_0 \times \nu$. In this model I do not consider the possibility of allowing for changing volatility over time (stochastic variability, see for example Blake and Mumtaz, 2012) that can be added, when estimating policy rules. This decision is primarily driven by the length of available time series, which limits the amount of information that can be obtained for the identification of individual parameters.

Two statistics were calculated to verify that the algorithm meets the necessary conditions for convergence. Firstly, a statistic that contains information about the necessary number of draws to achieve a given level of numerical accuracy for a particular simulation (for details see Geweke, 1992). It is the relative numerical efficiency (RNE) of the Gibbs sampler. The other (*ibid.*), is a statistic (convergence diagnostic, CD) that aims to capture the behaviour of the generated sample by comparing its two sub-samples, usually at 10% and 50% of the retained Gibbs draws. I reduced the lower threshold to 20%, which is similar to its application in Byrne et al. (2016); for details see Blake and Mumtaz (2012). Using the calculation suggested by Raftery and Lewis (1992), I arrive at the minimum number of draws (~ 4000) for both models, but I utilize 30000 draws and 10000 draws are stored and used for further inference. Blake and Mumtaz (2012) recommend analysing autocorrelation

[51] On the one hand, one could argue that fiscal measures and changes in fiscal policy are not very frequently adopted because of institutional dynamics. On the other hand, there have been periods of time, when fiscal policy have responded rather quickly. Therefore, alternative values of the scaling factor ν were tried, see the robustness section below.

[52] This step eliminates non-stationary processes. For some countries this condition is met without difficulties, while for others a larger number of draws is needed to generate the stored sample (for example, the Netherlands or Denmark).

functions and recursive means of the retained draws from the Gibbs sampler, to detect any irregularities in the simulation exercise.[53] Therefore, I conduct a recommended visual inspection of the simulated series and for all models autocorrelation and values of the CD statistic are calculated.[54]

3.4 Data and their treatment

My quarterly dataset covers the period between 1980q1 and 2015q4, meaning that all the major steps in the European integration process in the 1990s and 2000s are included. This dataset consists of twelve old EU countries (including two members that entered in the 1980s and three members in mid 1990s, see footnote 5) forming a monetary union and three stand-alone old EU member states – Denmark, Sweden and the United Kingdom. This composition of EU countries will enable analysis of the effects and reactions of fiscal policies across different types (utilizations) of fiscal policy, and as a result, levels of indebtedness.

For the estimation of country-specific fiscal rules over time, both fiscal time series, and other macro-economic variables are needed. This study utilizes several sources of macroeconomic series (see below and in details in appendix). Despite the fact that quarterly fiscal time series have been published by Eurostat for EU countries for some time, their length and coverage vary substantially across countries.[55] For the purpose of this study, it was necessary to reconstruct quarterly fiscal series. My approach to reconstruction (Kalman filter based) is briefly described below, and in greater detail in appendix. Few alternative attempts have been made to reconstruct quarterly fiscal series from individual revenue and expenditure items. These attempts used macroeconomic aggregates based on the System of National Accounts (SNA) or its European version (European System of National Accounts, ESA), such as Paredes et al. (2014) for the Euro area (currently, EA-15 covering the period 1980q1–2013q4), and a similar methodology as in the case of Spain (recently

[53] Baumeister and Benati (2013) propose as an alternative, so-called inefficiency factors (IF) that are calculated as the inverse of relative numerical efficiency. Series of IF should be below twenty to indicate convergence.

[54] There was a 'light' problem with autocorrelation for some countries (slightly above the 95% confidence intervals), however, coefficients returned fast to confidence intervals. All countries passed the CD test ($|CD| < 2$) as commonly required, even though, I had to increase the burn-in number of draws (to 50000 or 100000 draws for countries like Germany, Sweden or the UK), while keeping the stored sample size unchanged at 10000 draws. Values of the RNE varied across countries across specifications.

[55] Otherwise, one would have to start as late as around the first quarter of 2002 for most EA countries with few exceptions such as France or Finland. The case of stand-alone countries presents a somewhat better situation. This is because of the 'obligatory' beginning of publishing fiscal quarterly series that goes back to the first quarter of 1999.

updated to 1970q1–2015q4), see De Castro et al. (2014). Even that reconstruction is not without problems because of several changes in methodological concepts (ESA 1979, ESA 1995 and ESA 2010) over last decades. As illustrated for Spain in appendix, my generated fiscal series (primary balance) matches the SNA-reconstructed series very closely, providing a visual check of the method (robustness) and supporting the Bayesian approach. The same does hold for reconstructed public debt series that is not shown because of space considerations.[56]

3.4.1 Reconstruction of quarterly series

This section summarises the main steps used to reconstruct quarterly fiscal and economic time series (for more details on data treatments see the data section in the appendix). The main source of quarterly series for my dataset is Eurostat for fiscal time series (Government finance statistics, ESA2010 and Quarterly national accounts, ESA2010) and OECD (Quarterly National Accounts). Yearly fiscal policy variables are primarily taken from the database of the European Commission (Annual macro-economic database, AMECO) that is compatible with Eurostat, OECD (Economic Outlook database) and from a historical dataset of fiscal variables prepared by the IMF (Public Finances in Modern History Database, see Mauro et al., 2013). In order to have comparable series, the same database is used for country/year observations, that is debt and primary balance, in line with suggestions in Berti et al. (2016). Furthermore, to eliminate 'spurious' responses coming from during the Sovereign Debt Crisis conducted (one-off) interventions into financial institutions' balance sheets in a few EA countries (so-called government support to financial institutions – GAFS, for further details see the data subsection in appendix), these transfers are excluded from primary balance series. Since these measures did not directly affected public debt series (but changed so-called contingent liabilities), no adjustment of public debt series was carried out. Moreover, there were various one-off operations realised in the past (before 2007). However, there is no consistent and systematic evidence of these items, even for EA countries. Some authors have tried to adjust series for these effects; one approach uses differences in dynamics of net capital transfers see Joumard et al. (2008). However, I decided not to distort the dynamics of the fiscal series with imprecise corrections since their implications

[56] I thank Javier Pérez (Banco de España) for providing me with the latest version of their fiscal dataset accompanying De Castro et al. (2014).
Furthermore, an empirical illustration for GIIPS countries and the Netherlands (with and without GAFS series) is shown in the panels of figures (B.1) in the appendix. Details on one-off items and their treatment can be found in EC (2015), and a brief summary for GAFS series is presented in van Riet (2010).

were also related to countries' debt series.

Since quarterly fiscal time series are rather short or missing for primary balance and debt, and the output gap (see below),[57] for a majority of EU countries are available from 1999q1 onwards at best, they are extended for the whole sample period, with quarterly series created with help of the Kalman filter technique and a Bayesian approach for decomposition of low frequency series.[58] One of the biggest advantages of this approach compared to commonly used mechanical techniques for temporal disaggregation[59] is that quarterly series are constructed with the help of the information provided by using other (macro) quarterly series that are highly correlated with to-be-reconstructed fiscal series (primary balance and debt). The set of variables employed for the reconstruction consists of the following series: unemployment rate, CPI index, short-term and long-term interest rate, real GDP and government consumption.[60] A similar procedure was employed when reconstructing other quarterly series (government current expenditures). Further details are provided in the data section in the appendix.

Output gap and the cyclical component of total current expenditures for individual quarters are calculated with the help of the Baxter and King (Band-pass) filter. The calculation uses commonly used parameters ($BK_{12}(6, 32)$ covering main business cycle frequencies in the range $1^1/_2 - 8$ years) that provides better estimates, as compared to the Hodrick-Prescott filter (with $\lambda = 1600$) on quarterly frequency (HP filtered series are utilized in robustness section).[61] Since both filters have been shown to have problems in the beginning and end of a time series ('end-points'), and a few initial period are lost in the BK filter because of the filter construction),

[57] For example even the most recent OECD publication on output gaps for individual OECD countries is for yearly frequency only, see Turner et al. (2016); the same holds true for the ECB; however, Jarocinski and Lenza (2016) discuss methods of estimating output gap at quarterly frequency for the Euro area as a whole.

[58] This way of reconstructing quarterly series draws upon the contributions of Giannone et al. (2015) and Bańbura et al. (2015). I thank Giovanni Ricco for sharing an earlier version of their Matlab code used in Caruso et al. (2015).

[59] The most commonly used are Chow-Lin, Fernandez or Litterman; for overview and details on available methods with references see for example Quilis (2004).

[60] I also tried to recalculate quarterly series utilizing both techniques, and the results were broadly similar in terms of trends and turning points.

[61] Other high values of smoothing parameters for the HP filter were utilized, such as those recommended by Perron and Wada (2009) or Market and Ravn (2007) for GDP. However, their gains compared to the standard HP filter were given by the length of available time series. Market and Ravn (2007) argue that setting the BK filter equal to $BK_{12}(6, 32)$ works well for quarterly series; the closest counterpart of the HP filter for quarterly data would be $BK_{12}(2, 32)$ according to Baxter and King (1999).
I will treat the HP filtered series as a robustness check following a recent paper – Hamilton (2016) – arguing that one should use different filtering techniques other than the HP filter in empirical applications.

series are extended with three or four years (12 or 16 quarters of observations) using forecasting and backcasting in a bivariate $VAR(p)$ model.[62] For these extended series, both filtering techniques were applied, fitted values were stored, and the extensions of series were dropped. All series were seasonally adjusted (either directly when accessed in particular databases or before any calculations using the ARIMA X-13 method).[63]

Owing to data revisions, several studies have shown the importance of data vintages' effects on fiscal series (such as Golinelli and Momigliano, 2009), mainly government balances (in particular on cyclically adjusted fiscal series). Unfortunately, real-time analysis cannot be carried out in the case of quarterly time series that are published by Eurostat. Even in the case of yearly series, the AMECO database that has been running since 2002, comparable series available since 2008, and the OECD Economic Outlook database, also provides yearly series.

3.5 First results

This section consists of several subsections that follow the logic of my work. Firstly, country-specific fiscal responses' estimates are presented (median time-varying coefficients on the lagged debt variable, that is, $\widehat{\alpha}_t$), so that effects of individual institutional changes can be assessed. Subsequently, some preliminary evidence on common behaviours of countries is provided (median responses) for the EA-12 countries and stand-alone EU-3 countries. Thirdly, because institutional limits place restrictions on the conduct of fiscal policy, simple standard deviations of country-specific responses are presented to see effects of institutional changes on harmonization of national fiscal policies represented by fiscal responses. All these results are presented for the 'macro' rule #1 (FR I). In the sensitivity section further below, results for a set of robustness checks are shown that include exclusion of several countries, changes in specification of Bayesian estimation and also some evidence for the other 'optimal' rule, FR II. Since results are broadly comparable, only the base specification for the FR I rule are presented. In the following figures, the plotted responses for the lagged debt variable for a country or a group (i) represent the long-run responses ($\widehat{\alpha}_{i,t}^{LR}$) using the transformation shown in equation (3.6), unless specified

[62] I follow Watson (2007) for GDP series, where the $VAR(p)$ is with GDP and prices (Okun/Phillips relationships). In the case of expenditures, I use a model with GDP (Wagner's law). Alternatively, $AR(p)$ models are utilized; for details see appendix.

[63] Some authors also employ a much simpler approach in the context of exchange rates models, rolling the mean over four quarters as suggested in Engel et al. (2015). However, I prefer the more standard method for comparability of seasonally adjusted series (commonly applying the same method) in my dataset, as it comes directly from statistical offices.

differently.[64]

3.5.1 Baseline model – has there been any institutional effect?

In this section, I explicitly analyse the effects of all five institutional changes outlined in the previous text. Any evaluation of those effects can naturally differ because of a choice of one of my two fiscal rules. Country-specific responses to modifications in the institutional environment were mainly determined by a country's (non-)compliance with debt requirements. Accordingly, the group of EA countries is divided into three sub-groups (low, medium and high debt level) for the detailed investigation of institutional changes. With some degree of arbitrariness regarding a choice of thresholds, the debt intervals for the EA group are the following: 50%, 80% and above 80% of GDP. Alternatively, it would be possible to group countries based on their performance during the ESDC, such as those with softer 'fiscal constraints' (GIIPS countries) than others. However, this classification would mix countries with different adjustment needs over the sample period. Individual time-varying coefficients on the lagged debt for FR I are shown, calculated as a median value of all stored responses for a particular quarter and country, repeated over the entire sample period.

Individual panels in figures 3.1 and 3.2 only provide a general illustration, since, for the sake of readability, individual so-called credible intervals (the High Posterior Density Interval, HPDI) are not shown. However, they can be found in a particular country-specific panel in figure B.2 in the appendix. In these figures, countries that were subject to international supporting schemes are labelled as programme countries, and those with 'softer' budgetary constraints already challenged by financial markets during the ESDC are labelled as weaker countries. In all those country-specific figures, median values of time-varying debt responses are accompanied by the 10^{th} and 90^{th} percentiles of the posterior distribution.

Starting with the Maastricht Treaty institutional change, its cut-off period is set to 1993q1 (indicated by a vertical line in the first row of the figure 3.1). An analysis of countries' behaviour over three panels of each row in the figure highlights (only significant changes are considered, and the number of the panel from the row is bracketed after the last name in the group): France in the low debt group (#1), no significant response in the medium debt group of countries, and only Greece from the high debt group (#3). For some countries a change of their behaviour may have occurred even before, possibly coinciding with the Treaty ratification process, such

[64] All results were generated using Matlab. My code draws mainly upon Blake and Mumtaz (2012) for the Kalman filter and the Carter and Kohn algorithm.

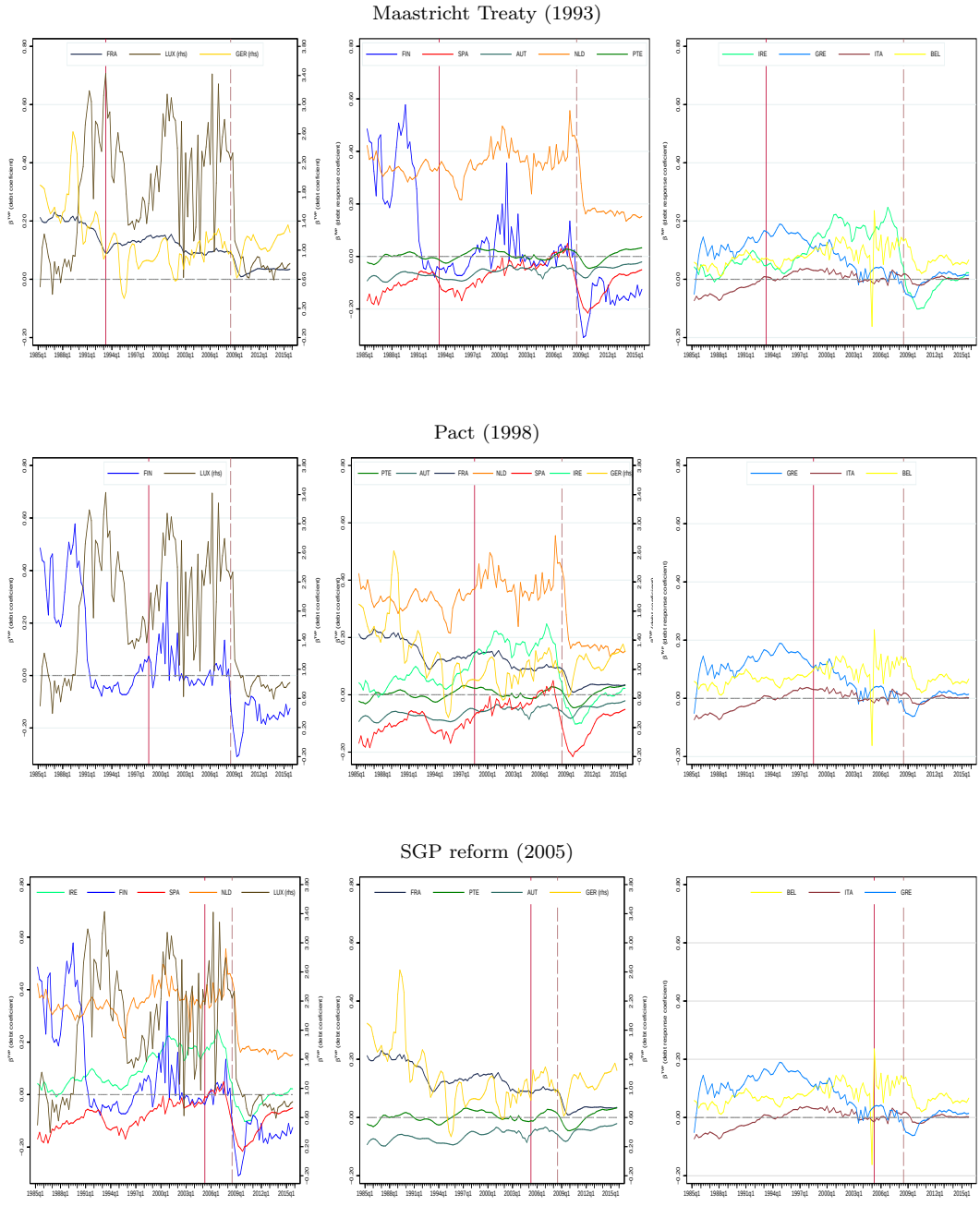
as Spain, the Netherlands or Luxembourg (improving their public finances in early 1990s).[65] In the case of the Stability and Growth Pact, whose enforcement rules became binding for EA countries in 1998q3 (second row in the figure), there is a change of behaviour in the low debt group – Luxembourg and earlier on in Finland (#1), in the middle group – almost all countries change behaviour (Austria, France, Ireland, the Netherlands and Spain (#2)), and finally in the high debt group – Belgium and Greece change behaviour (#3).

The last row in the figure is related to a major reform of the Pact that was finally approved in early 2005 (2005q1) in an attempt to strengthen fiscal discipline and restore vanishing credibility of the rule: in the low debt group responses are changed for Luxembourg and Ireland (#1), in the medium debt group responses change in for Austria and Germany (#2) and finally, for the high debt countries Belgium and Greece show different behaviour (#3). In the case of several countries, estimated responses are significant but did not change much or remained at the previous level, as in France or the Netherlands. Somewhat surprisingly, there were no significant responses in the cases of Italy or Portugal, despite relatively high debt levels in both countries during that period(s).

For the purpose of comparison, responses for the stand-alone EU-3 countries are shown in figure 3.3 further below indicating all changes. A brief inspection reveals that debt responses for Denmark (belonging to the medium debt group), and the United Kingdom (belonging to the low debt group) are significantly different around the period of the Pact. Responses were also significantly different for low debt countries around the period of the change of the Pact. Responses for Sweden are not significant for any of these three institutional changes.

[65] Results for Austria and Finland (and Sweden) can be affected by the fact that they formally became EU members in 1995. However, their preparation for Euro adoption was subject to the Maastricht convergence criteria including two measures for public finances (deficit and debt).

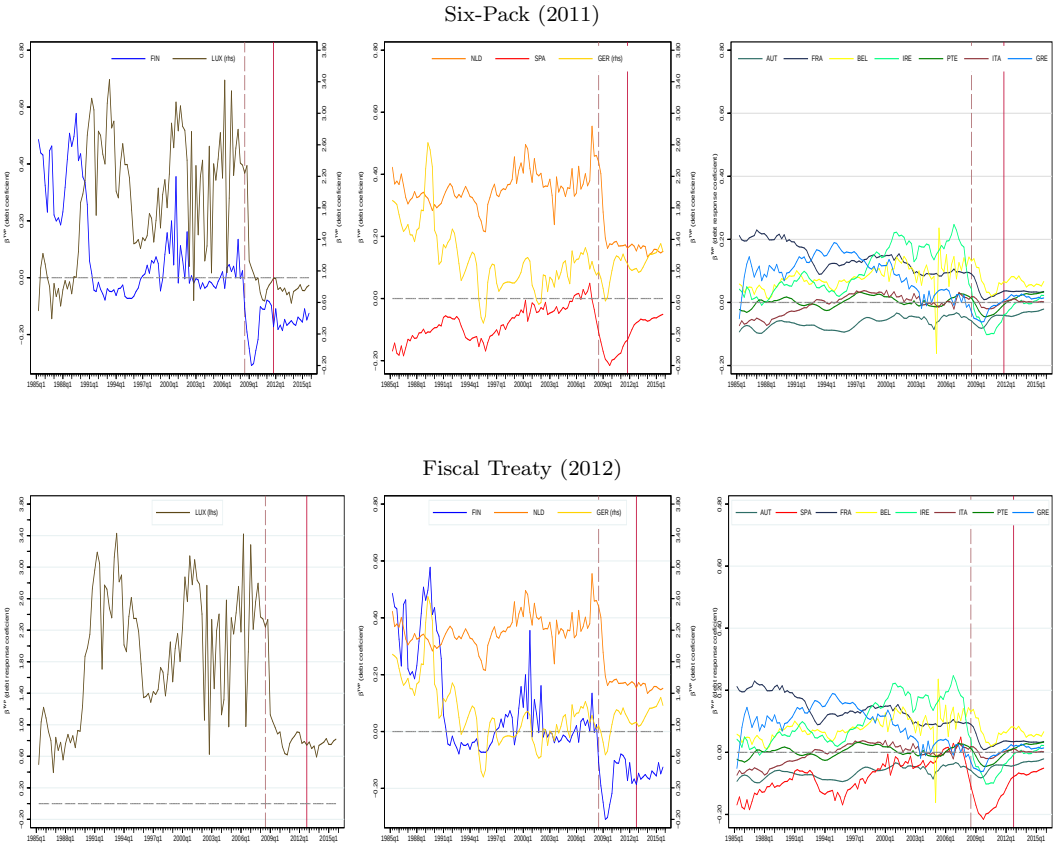
Figure 3.1: Fiscal behaviour – in the pre-sovereign debt crisis period (–2009)



(1) **low indebtedness** (2) **medium indebtedness** (3) **high indebtedness**

Note: country-specific responses for FR I (median). A vertical red line represents a particular institutional change, and the dashed line is the Great Recession (2008q3). Colours for individual countries do not vary across time periods for the sake of comparison. Country debt limits for the year of a change (fixed across time): (1) low indebtedness: $d_t < 50\%$, (2) medium indebtedness: $50\% \leq d_t < 80\%$, (3) high indebtedness: $d_t \geq 80\%$. The grey horizontal line is set at zero level (left axes) and it can be different from the second (right) 'y' axis. *Source:* own calculations.

Figure 3.2: Fiscal behaviour – in the sovereign debt crisis period (2009–)



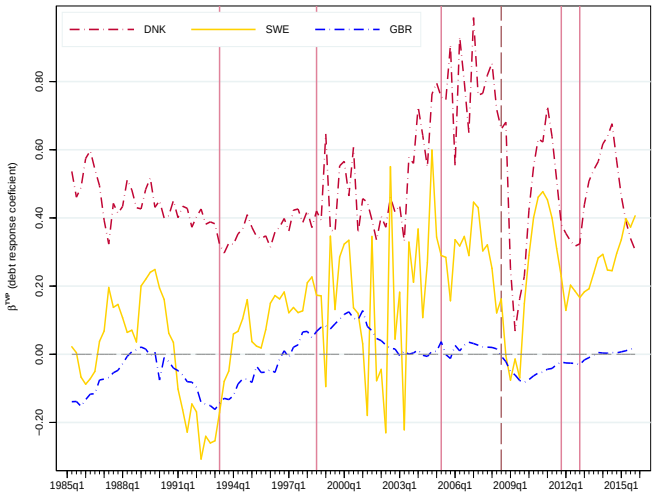
(1) **low indebtedness** (2) **medium indebtedness** (3) **high indebtedness**

Note: country-specific responses for FR I (median). A vertical red line represents a particular institutional change, dashed line is the Great Recession (2008q3). Colours for individual countries do not vary across time periods for the sake of comparison. Country debt limits for year of a change (fixed across time): (1) low indebtedness: $d_t < 50\%$, (2) medium indebtedness: $50\% \leq d_t < 80\%$, (3) high indebtedness: $d_t \geq 80\%$. The grey horizontal line is set at zero level (left axes) and it can be different from the second (right) 'y' axis. *Source:* own calculations.

Two further sets of results (see panels in figure 3.2 above) are related to changes in the wake of the ESDC. Even though the remaining sample period before its end is rather short, some consequences of these changes are already visible, at least in the case of countries trying to restore soundness of their public finances. This can be interpreted as a first evaluation of those reform steps in the macro-fiscal rules (governance principles).

Firstly, I investigate the so-called Six Pack in its final version approved in 2011q4 since it seems to have triggered different responses. Using the same definition of debt groups, the responses were statistically significant, but were not large in terms of their size. In the case of Luxembourg (#1), a change is visible somewhat

Figure 3.3: Fiscal behaviour – stand-alone EU countries



Note: country-specific responses for FR I (median). A vertical red line represents a particular institutional change, dashed line is the Great Recession (2008q3). Colours for individual countries do not vary across time period for the sake of comparison. The grey horizontal line is set at zero level (left axes) and it can be different from the second (right) 'y' axis. *Source:* own calculations.

earlier. For medium debt countries, only Spanish responses look affected (#2), and also Austrian, French, and not surprisingly Greek responses (#3). Secondly, in the case of the Fiscal Treaty (2012q4), results are de facto unchanged, compared with the first change where only the composition of groups is affected (Finland and Spain moved to the next, higher, debt groups): no change in case of Luxembourg, however, a positive response for Finland and Germany (#2) and Spain and Portugal (#3).[66]

Comparing the evolution of responses for the stand-alone EU countries, Denmark and Sweden (low debt group) show positive responses around the second change (2012q4), while British responses remain insignificant (with their debt ratio belonging to the high debt group in this period).[67]

To summarise results of this exercise so far, I find effects related to the Maastricht Treaty only for few countries (only two of twelve). I do however identify effects for many countries in the case of the Pact (nine out of twelve), and for the modification of the Pact (five out of twelve). The most recent institutional changes do not seem to have had a successful impact on fiscal responses (until the

[66] Given the fact that EA participating member states were granted a period of one year to carry out necessary changes, a change in behaviour should be seen from 2013 onwards, when accounting for the existence of various lags from 2014 onwards.

[67] This result for the EU-3 can be expected since they have not signed most or all (the UK) of the newly introduced institutional amendments.

sample period), with only five and four countries respectively, and there are no visible significant changes for most of the group of high debt countries. A partial explanation can be associated with estimates of fiscal responses being weak and insignificant in many countries. It is also possible that in the case of several EA members, changes in the more general integration process or external constraints played a more important part than institutional changes. This pattern deserves further investigation than is possible within the scope of this chapter. Nevertheless, it could explain why I do not find any effect on fiscal behaviour for countries like Italy, in the set of 'major' events.

Country-specific behaviour – further comments

As already mentioned, the results for Italy are especially surprising since their public debt was increasing throughout the sample period. However, a detailed investigation of Italian country-specific responses in the appendix reveals that they were hovering around zero most of the time and were not significant. Conversely, Afonso and Toffano (2013) identify several fiscal regimes in a MSM model using a sample period up to 2010.

A very similar pattern can be seen in the case of another country facing a substantial debt burden, Portugal. Time-varying responses reveal a significant worsening of the fiscal situation during the ESDC, which may have been reversed at the end of the sample period (insignificant).[68] However, there is a difference in fiscal behaviour of both countries that reflects the preferences of both policy-makers and voters.[69]

Regarding results for Spanish, one can see a spike after 1993 with an upward trend that continued until 2007 (not significant since the launch of Euro), followed by crisis-triggered negative responses that subsequently reduced around 2012. My findings for this fiscal rule (FR I) partially resonate with the quasi-Bayesian TVP estimates presented in Cuerpo (2014).[70] The two remaining countries in the group show different trajectories: Irish responses had been increasing since the mid 1990s (levelling out around 2000), with an increase just after 2007 followed by a steep decline, and a reversal (post-2012 results are not significant). Greece was losing

[68] These findings resonate with Afonso et al. (2011), who also find just negligible effects of the Maastricht, and the EDP. My results show more clearly the inefficiency and short-livedness of fiscal measures in Portugal.

[69] While Italy tends to report a primary surplus since 1990s, without a significant impact on high public debt accumulated throughout the 1970s and 1980s (a reduction towards the 60% limit), Portugal has kept running primary deficits since the late 1990s following a period of primary surpluses in the 1980s, which has taken its toll on their indebtedness (the third highest in the Euro area in 2015) and resulted in a prolonged recession during the ESDC (2011–2013).

[70] It also supplements the finding on fiscal regimes in Ricci-Risquete et al. (2016).

fiscal ground even in the Maastricht period, with a short spell of stabilisation around 1999. The post-2000 period is a combination of declining responses interrupted with temporary stabilisations, as well as strong negative responses during the ESDC, and a slow reversal in light of international fiscal supervision and the heavy debt burden.

Turning now to the remaining EA countries, three sub-groups can be identified: (*i*) Luxembourg and the Netherlands, whose fiscal responses remained positive and mostly (Luxembourg) significant throughout the period (with a drop after 2007); (*ii*) France with positive responses following a declining trend in several stages throughout the period, (*iii*) Austria with significant but negative responses, and Finland with rather volatile responses (strong positive responses followed by a drop amidst the turbulent early 1990s, with a change in fiscal behaviour around 1995 reaching a peak around 2000, followed by negative responses over the ESDC period),[71] and finally (*iv*) Belgium and Germany, with positive but mostly insignificant responses for Belgium. My results for Germany are somewhat surprising, but they do correspond with those in Thams (2007) – they are insignificant in the early 1990s during the reunification of Germany (and before). However, in line with the findings of Afonso and Toffano (2013), improved fiscal performance is reflected in positive, rather strong numerical terms, and significant responses after 2004.

What about countries outside the Euro area with more or less independently set monetary policies, who are not restricted by any common enforceable fiscal rules but their own? The figure 3.3 above offers an illustration. In the case of the standalone EU-3 countries, fiscal patterns seem to have been driven by factors other than the need to comply with the EU institutional framework.[72] It is therefore not surprising that the national fiscal policies of this group of countries do not show many similarities with some of those discussed for previous groups, apart from the UK: Denmark shows positive and significant responses only affected by the ESDC, Sweden shows highly volatile and mostly insignificant responses, and the UK shows rather 'cyclical' but mostly insignificant patterns.

[71] This specific behaviour of Finnish fiscal policy is usually explained with large stocks of assets, that is, the net position is positive (a net *creditor*). A similar explanation holds for Luxembourg, where improved fiscal performance allowed it to achieve very low levels of public debts.

[72] In particular, both Sweden and the UK have had national fiscal rules working to largely determine fiscal outcomes, at least for some years over the sample period such as the fiscal Golden Rule and the so-called Sustainable investment rule in the UK between 1998–2008, later replaced with the so-called temporary operating rule based on CAPB balance and a net debt rule. Swedish fiscal rules that have been modified several times since the late 1990s, see Claeys, 2008; EC, 2016a).

Group exercise – pooled fiscal behaviour

The country-specific evidence presented above was based on the inspection of trends across groups of countries. It is also possible to construct EA-wide aggregates utilising stored results from the simulation exercise (draws from posterior distributions). Figure B.3 in the appendix presents the median of time-varying fiscal responses, that is, long-run values of debt response coefficients, across all EA-12 countries for the FR I ('macro rule') over individual quarters of the sample period. No weights are applied in this transformation, so each of the EA-12 countries contributed with its 1/12 share to the common pool. In addition, commonly used percentiles (the 16^{th} and 84^{th}, and the 10^{th} and 90^{th}) illustrate the pooled distribution of fiscal responses for individual periods.[73] Their asymmetry reveals cross-country differences in behaviour across several periods during the sample period, for example around end of 2008. A very similar picture is presented in the case of the EA-10 countries (see panel b) in figure B.3 in the appendix). For the sake of comparison, median responses are also calculated for the group of stand-alone EU-3 countries (see figure B.5 in the appendix). Similar to the previous two figures, results are not significant for shown quantiles, apart from a short spell between 2002 and 2005 and marginally around 2010.

3.5.2 Has there been any institution-driven harmonization of fiscal policies?

While the previous sections analysed consequences of individual institutional changes aimed at restricting fiscal policy behaviour in case on of two criteria is not met, this subsection attempts to answer the second question of whether the previously mentioned institutional changes also had an effect on the harmonization of fiscal policies across euro area countries. As a preliminary test, standard deviations of individual fiscal responses are calculated both for EA-12 and EU-3 countries. For that purpose I utilize the same 'pool' of time varying fiscal responses that were instrumental for calculating median responses in the previous section.

Figure 3.4 below plots cross-sectional standard deviations of country-specific fiscal responses to illustrate dispersion within the EA-12 group of countries over the sample period. While the calculated dispersion hovers around 0.15 before the Maastricht Treaty, there is an upward trend from the early 1990s that continues until 1996 (reaching 0.30). There is a visible effect around the time of the Maastricht

[73] Under normality, the 16^{th} and 84^{th} percentiles represent one standard deviation bounds, equal to 68 per cent of the object's distribution.

Treaty – a temporary stabilisation followed by an increase, so the dispersion of fiscal responses looks like an inverted hump shape in late 1980s and early 1990s. The Pact seems to result in a decline to pre-Maastricht values that are followed by an increase, which is interrupted around the time of its first change. That does not seem to help stabilise fiscal behaviour since the standard deviation remains highly volatile and slowly increasing in quarters following the modification. A change in trend comes around the first set of changes in 2011. Afterwards, a declining trend persists until the end of the sample period. As a result, dispersion drops below levels observed in the late 1980s or 1990s (below 0.10).

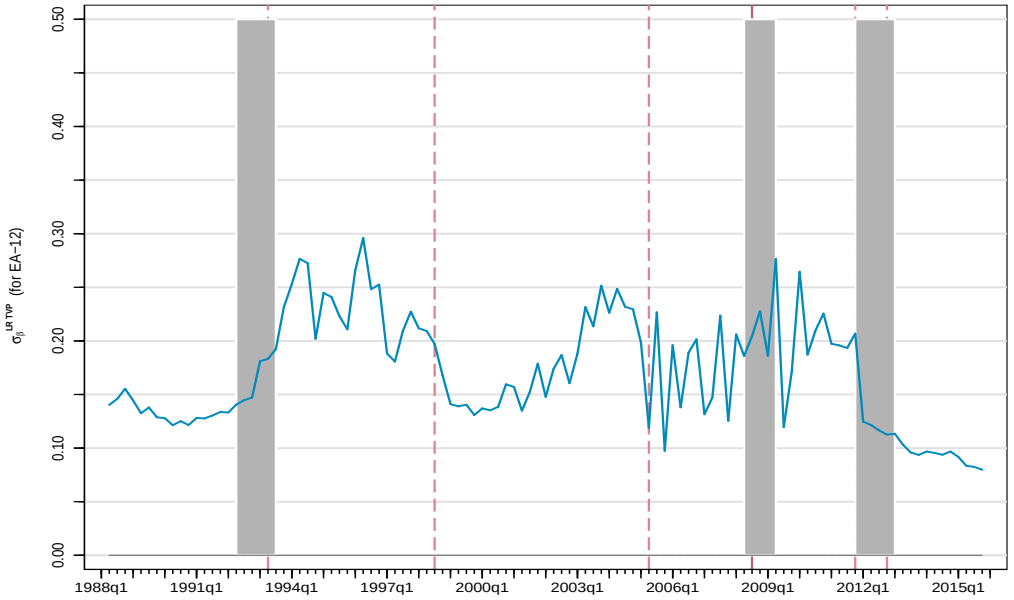
In the case of the EU-3 group, calculated dispersion is lower in absolute terms, see figure B.5 in appendix. Otherwise, it follows a similar path with a more gradual increase in the post-2000 period that last until the end of 2014, when a decline is observed. These results can be compared with some early statistical evidence for the EA-12 and a larger group of non-euro countries presented in Fatás and Mihov (2010). In their case, dispersion is calculated using a series of yearly residuals from a fiscal rule similar to the FR I, based on an exogenous discretionary fiscal policy, that is, one that is induced primarily by non-economic factors such as political determinants or by the Pact. Both analyses capture increases in the post-Maastricht and post-2000 period that are more persistent in the case of my measure of dispersion. A direct comparison is not possible for their other group that consists of many non-European OECD countries.

The issue of harmonization and business cycles

Even though I explicitly control for business cycle, questions remain as to how much of the observed (shown) harmonization is because of output gap synchronization across EA countries, and how much can be attributed to the 'real' efforts of policy-makers. There are many ways of capturing the effects of harmonization (synchronization) of business cycles. For the sake of comparability, I simply calculate harmonization (synchronization) of business cycles across EA countries as standard deviation, since both fiscal rules include quarterly series of output gaps.

Figure B.4 in the appendix provides an illustration of calculated standard deviation of output gaps across twelve EA members, and their trend defined as a centered moving average – a $MA-13$ process – following the suggestion of Gayer (2007). This illustration reveals an increasing trend in dispersion until 1992 (from values around 1.00 to 1.30) with a more or less gradual decline in dispersion of output gaps over the Maastricht period. This decline reached a trough around the launch of the Euro, reaching and hovering around a value of 0.70 until mid 2000.

Figure 3.4: Dispersion of TVP fiscal responses for EA12 countries, 1985q1–2015q4



Note: unweighted cross-sectional standard deviation of EA-12 TVP responses (based on FR I). Dark areas are CEPR based recession periods for the Euro area. The red dashed lines represent the Maastricht Treaty (1993), the Pact became binding (1998), a modification of the Pact (2005), and the Six-Pack and Fiscal compact (2012 and 2013). Source: own calculation.

Since then, there was a steep increase reaching a peak in 2010 (around 1.50, the highest value over the sample period), followed by a slow decline that ends in 2014 because of the variable construction. Comparing these trends with those for fiscal responses discussed above, shows that there is no particularly frequent and direct influence coming from dispersion of output gaps in the case of dispersion of fiscal responses for the EA-12 group of countries.[74]

3.5.3 Sensitivity section

In this section I present and briefly comment on various robustness checks that are carried out: (*a*) those that are related to the estimation of country-specific fiscal rules and (*b*) those for groups of countries. In case of ad (*a*), firstly, a set of robustness checks aims to check the effects of a longer training period: (1) a training period is extended to 32 quarters (8 years) for the sake of comparability with the FR II's estimation, (2) since my dataset consists of reconstructed fiscal series, it is

[74] Since results for HP filtered series are similar – changes are somewhat more pronounced because of the more 'ragged' HP filtered series – they are not reported in the robustness section below, but are available upon request from the author.

shortened, so that it covers only the period of officially published series by Eurostat, that is, 2000q1–2015q4 with the length of 64 quarters.[75] The remaining quarters are used for the training sample. Secondly, I explore the effect of changing the factor of proportionality ν to ν^{alt_i} for the training sample variance adjustment in the base model (FR I). Thirdly, I investigate whether results of the base fiscal rule model, FR I, change for an alternative method of calculating output gaps, the commonly used Hodrick-Prescott filter since it provides slightly different results compared with the Baxter-King band pass filter.[76] Fourthly, results for the alternative ('optimal') fiscal rule, FR II, are added. All these robustness checks are shown for one country (Spain), see panels in figure B.6 in the appendix. These results can be compared with the base model results in panel i) of figure B.2 in the appendix.

In the case of robustness checks ad (b), I investigate the effect of excluding 'outliers', such as a country with very sound, and a country with very 'troublesome' fiscal policy in the EA-12 sample (Luxembourg and Greece). Results for these two countries are presented and discussed in the main text. In addition, countries that joined the EU in 1995 are excluded (EU-8, that is, EU-10 without Austria and Finland). And lastly, I present some evidence on harmonization using the FR II.

Country-specific responses

A first set of robustness checks aim to check the effects of: (1) extending the training sample period from 5 to 8 years, that is, 32 quarters (also for comparability with results for the FR II below). As shown in panel a) of figure B.6 in the appendix, the picture is almost unchanged with only some quarters becoming (in)significant. A similar picture is presented in the case of, (2) using a pre-2000 sample (the previous period, that is 1980q1–1999q4, was treated as a training sample without any further changes) to expand the training period to 80 quarters in panel b) of the same figure; while the general tendencies are preserved, responses are stronger in absolute value and more volatile, with some over the period before the ESDC and mainly the after 2010 turn insignificant.[77] However, these last two checks come at an additional cost, particularly in the latter case, since the sample period does not include the pre-Maastricht and pre-EMU periods that offer some interesting information and implications for the EMU period. In addition, given the length of the training

[75] That corresponds with the period of data availability for an overwhelming majority of EU countries in this sample.

[76] Sometimes a modification of the HP filter is used, which is the HP band pass filter where the time series is adjusted twice to filter out both short and long frequencies, see Gayer (2007). I do not utilize this double filtering approach.

[77] An alternative check of my results would be to use the official fiscal series for EA countries when they are available.

sample in the latter case (20 years), the of factor of proportionality can be also adjusted; that is done in the next check below. Results for median responses and its standard deviation are very similar to results for the full sample shown in the text above.

Another series of robustness checks are carried out to investigate the effects of alternating a very important parameter in the Bayesian TVP estimation (the scaling factor ν). Firstly, I allowed for a lower (higher) amount of information to be passed through from the training period, and also allowed for faster changes of parameters represented by the parameters ν. The base value ($\nu = 3.510 \cdot 10^{-5}$) is reduced ($\nu^{alt_1} = 3.510 \cdot 10^{-6}$) and then increased to ($\nu^{alt_2} = 3.510 \cdot 10^{-3}$), other things being equal to the base model. Results shown in panels c) and d) of the figure B.6 in the appendix reveal only some minor changes to the base results.

Using the Hodrick-Prescott filter (with all other parameters unchanged) with the standard choice of smoothing parameter for quarterly series ($\lambda = 1600$), there is only a negligible impact on the median of Spanish fiscal responses, and the credible intervals (see panel f) of the figure B.6 in appendix). An alternative for this check would be to use GDP growth rates instead of the estimates output gap. However, I leave this option as an extension of this work since this approximation of cyclical position is not commonly used in the literature. Similarly, I do not present a check that uses industrial production series because of the poor coverage of GDP behaviour in European countries.

In addition, a modification of the base rule specification is employed, the optimal fiscal rule (FR II) (see equation (3.5) above), which takes into account potential effects of inflation and tax smoothing. The result for Spain of this micro-founded fiscal rule differ somewhat as can be see in panel f) of figure B.6 in the appendix. While main patterns are preserved, the entire series of median responses is 'lifted up', thus leading to different conclusions in terms of significance (only the change of the Pact and its modification). Further implications such as effects on dispersion are discussed below.

Harmonization

The country-specific responses described in previous sections showed heterogeneity, so it is important to explore the effect of excluding some countries that may be driving the aggregated (pooled) results presented above.[78] As a result, the EA-12

[78] Another possibility is to calculate variation coefficients, provided the relative dispersion (standard deviation) for the period; it is defined as $\zeta = \frac{\sigma_{(.)}}{\overline{x}_{(.)}}$, where $\sigma_{(.)}$ is the cross-sectional standard deviation for a group of EA countries (EA-12 or EA-10) and $\overline{x}_{(.)}$ is the mean for the same definition of the group. Values of variation coefficient seem more or less close to the changes in dispersion

group is modified by excluding one so-called programme country facing the most serious restrictions on its fiscal policy behaviour (Greece), and another country with very sound fiscal policy and specific structural characteristics (Luxembourg). Figure B.3 in the appendix shows the dispersion of responses calculated for this EA-10 group (without Greece and Luxembourg). I repeat exercises from the last section on this sample of countries (calculation of dispersion of responses and also output gaps).

The measure of harmonization (standard deviation) for the EA-10 group provides somewhat different picture compared with the EA-12 figure. This difference arises from the EA-12 excluding Greece, whose responses have been determined by supervisory bodies, and Luxembourg with rather specific fiscal policy behaviour. It shows a decline and an increase in dispersion just before the Maastricht Treaty period, followed by a reduction in the mid-1990s (below 0.10), see figure B.3 in the appendix. Afterwards, dispersion hovered around that level until the Great Recession, when another decrease followed during the second recession period in the aftermath of the ESDC. From 2013 onwards, dispersion has been basically flat around 0.05. This picture does not reveal any major change in dispersion as a result of institutional changes, apart from the Maastricht Treaty and a stabilisation effect seen after the last change at the end of 2012.[79]

Repeating the same exercise for the optimal rule (FR II) generated fiscal responses, with only small differences; see panels in figure B.7 in the appendix. In the case of EA-12 countries, there is an increase in the late 1980s, followed by a reduction of dispersion around the Maastricht Treaty (from 0.16 to 0.09). An increase of dispersion in the first quarters of the EMU is mitigated (to about 0.12), and the same holds true for volatility pattern before the ESDC. There is also a decline of dispersion visible after 2010 (to about 0.05) that is partially reversed in the last quarters of the sample period. For the EA-10 group (see lower panel of the same figure), plotted dispersion is again very similar. Apart from a small level effect (lower dispersion), there is a visible effect of the Maastricht Treaty in this specification, which is then partially offset in the EMU period. Similar to the recently described dispersion of EA-12 countries, there is a decline and a sluggish increase at the end of the sample period with much more reduced volatility during

measured by standard deviation over the sample period. However, this characteristic is problematic because of the unboundedness revealed during the financial crisis period. Specifically, ζ is a very large number since the calculation of the mean is affected by extreme values. I therefore do not report these values.

[79] A very similar picture is also obtained for EA-12 without Luxembourg (EA-11) or for an even smaller group – EA-8, that is EA-12 without Austria, Finland, Greece, and Luxembourg (EA-8). Both sets of results are available from the author upon request.

the first decade of the Euro.[80]

Turning to the output gap series, I check robustness by calculating the dispersion of EA-10 countries' output gaps. This check reveals that the distinction between both series is more similar than in the case of fiscal responses. While the dispersion of fiscal responses was only declining or stable (see description above), the dispersion of output gaps resembled the recently described case of EA-12 countries in figure B.4 in the appendix): a decline and an increase before the Maastricht Treaty (from 0.75 to above 1.25), a reduction before the launch of the Euro (at levels around 0.50), more or less stable dispersion until 2005, followed by an increase that peaked in 2010 (single peak), and a gradual decline.

3.5.4 Is a high degree of harmonization necessarily a bad thing?

A higher degree of harmonization of fiscal policy in a monetary union can be viewed as a potential problem since individual member states would behave as one, that is, as a (large) closed economy. One particular reason for concern that has been discussed at great lengths in the literature, is the risk associated with negative fiscal spillover effects during periods of economic difficulties. In a series of papers in and around 2012 some authors (for example see Bagaria et al., 2012; Holland and Portes, 2012 or DeLong and Summers, 2012) tried to make a theoretical point by analysing the risk of fiscal tightening leading to self-defeating recessions, especially when fiscal measures are applied in countries forming a monetary union.

Particular attention was paid to the combination of the existence of a zero-lower bound on nominal interest rates (ZLB, henceforth) when the interest rate channel of monetary policy does not work, and/or liquidity constraints in the case of EA (or EU) countries. This on-going debate since 2009, see the 'introductory' paper by Barell et al. (2009), has highlighted several key aspects, such as (see Holland and Portes, 2012): the multiplication effects of fiscal measures not only depend on a (1) country and time, including cyclical position and broadly defined institutions such as financial institutions, but also on (2) the type of 'instrument' utilized (revenue or expenditure side), (3) on the composition of economic agents in the economy, that is, (non-)Ricardian behaviour, and (4) the links provided by the movements of financial capital and flows of goods and services.

If one finds a scenario of sequential or simultaneous fiscal tightening plausible, what would be the possible alternative that could prevent that from occurring? To

[80] The dispersion for stand-alone EU-3 countries is also rather similar. There is a level effect – dispersion is larger in absolute terms –, increases from 1997 to 2003, and declines during the Great Recession period, and is followed by an increase in the last quarters of 2014 and 2015, see figure B.8 in the appendix.

begin with, one mechanism is linked to the OCA theory, which highlights that this type of risk would be mitigated or even eliminated in the case of a large and effective system of transfers within a monetary union ('risk sharing'). However, van Rompuy et al. (2012) report in late 2012 points out that this 'risk sharing' condition does not seem to be the case in the Euro Area (or the EU) at the moment. This report simply echoes conclusions already made in EC (1977); EC (1977a) and in Delors (1989). Moreover, a recent comparison of the US economy and their fiscal federalism, to that in the EU (see D'Apice, 2015) reveals that on average, estimated transfers only amounted to 1/4 of a percent of GDP of the EU, and were almost equal to zero for the Euro Area. Conversely, the US reached 1 1/2 percent of GDP (over the period 1980–2005) and increased to about 9% of GDP during the Great Recession. The achieved level of harmonization could thus pose a threat for economic growth given the very low level of 'federal budget' flows in the EU/EA (currently represented by flows from and to the European budget). This is another problem related to the increased harmonization of national fiscal policies, especially in the zero-lower-bound environment that is echoed in Portes and Wren-Lewis (2015).[81]

It seems that the current EU budgetary system would have to be reformed in order to represent an efficient tool in policy-makers' toolkit.[82] There is also a system of payments related to the Structural funds, whose purpose is very different, and whose re-allocation would represent a challenge. While countries in trouble would be forced to request help from the ESM fund, this fund is basically restricted to provide support in crisis situations.

Other possibilities discussed in the literature are related to degrees of fiscal centralisation in a monetary union, and mainly draw on literature concerned with the effects of fiscal federalisms (dating back to the late 1950s or early 1970s, see a summary in Evers, 2015). These discussions cover a wide range of alternatives, spanning various levels of revenue sharing ('equalization') up to a full fiscal union, that is, the existence of a supranational fiscal institution. A few recent studies have even attempted to investigate the effects of such fiscal arrangements in relation to

[81] This recent study recommends larger interconnectedness of rules of the Pact with aggregate demand (member states' cyclical situation). Moreover, when the probability of reaching the ZLB is larger than 50% (forecasted by a central bank), the rules would be temporarily disabled. However, such a change of the 'rules of the game' would call for another mechanism that clearly sets up ways of dealing with the consequences of the freeze, and supposedly large increase in public indebtedness that would follow.

[82] Estimates of the importance of fiscal transfers have been declining since the pioneering studies of Sala-i-Martin and Sachs (1992), which suggest that up to 40% should be compensated by transfers. More conservative estimates of around 10% are later suggested by Asdrubali et al. (1996). Estimates for the Euro Area have been much lower and indicate lower efficiency, see Sørensen and Yosha (1998).

the current state of affairs in the Euro Area. Simulations in a stylised two-country DSGE model (see Evers, 2015) reveal that simple tax revenue sharing would not be particularly helpful if an asymmetric shock occurred. On the contrary, it would bring about a large volatility in macroeconomic indicators (consumption and production). However, a fiscal union (a common fiscal authority) would meet expectations in terms of smoothing and regional income insurance (about 30% of regional income).

Another aspect of my analysis relates to the fact that fiscal rules cannot be viewed as a *panacea*. Studies as early as the work of Kydland and Prescott (1977) shows that they can sometimes be suboptimal. Although they can help countries carry out sustainable fiscal policy while preserving macroeconomic stability, as with any simple rule, they are subject to 'specification' and enforcement issues.[83]

The European fiscal policy framework currently faces several parallel challenges, leaving aside the problems associated with inadequate transparency or the challenge of enforcing rules that are watered down and made inefficient by exceptions and 'balancing' actions of the Commission. The increased harmonization of national fiscal policies has raised the question of how to address crises without making economic problems worse. One way of making the current, rather complex system more transparent would be by removing the long list of exceptions and special circumstances that are *a ball and chain* for the modified Pact. Although they were adopted with good intentions to make the clear and simple fiscal rules (Pact) more flexible, they come at the cost of increased complexity and reduced enforceability.[84] A more promising approach is a combination of a simple fiscal rules with an independent fiscal institution (see Fatás and Mihov, 2010 for references). Such an approach is especially helpful in cases when a strict requirement of meeting the rule's conditions may be suboptimal for the short-term or medium-term, consequently creating a long-term issue. An alternative would be the introduction of some sort of a Golden rule and a simple debt ceiling with or without automatic restriction on spending when that limit is reached, if for example, combined with an independent fiscal authority. The latter has already been implemented in many countries in the EU/EA. If the debt level was low enough, it could also help deal with idiosyncratic shocks without the necessity to introduce further fiscal mechanisms at the supranational level. However, that is not observed across EU/EA countries in the post-ESDC period. Since that alternative does not seem to be plausible in the near future, one

[83] For example, Fatás and Mihov (2010) highlight that natural diversity of national government opinions and vested interests towards fiscal priorities can create tensions among stabilisation policies inside a monetary union.

[84] Similar remarks on possible fiscal policy arrangements (the need for simplification, open access to information, etc.) have been made, for example in Deutsche Bundesbank (2015).

has to think of using existing institutions such as the ESM to accumulate resources ('rainy days' fund) to be used in countries affected by idiosyncratic (asymmetric) shocks. The necessary resources could be raised by negligibly increasing the current system of mainly output based (GNI) contributions, than by completely changing the current system. Such simple solutions may have a chance of being implemented rather quickly since policy-makers are very aware of the problem, and realise that a change would help them deal with future crises at lower costs, thus, increasing their chance of remaining in the office.

3.6 Conclusions

The primary importance of sound (sustainable) fiscal policy in a monetary union has been repeatedly highlighted, both in the theoretical literature, and policy-makers' documents for individual members and other participating countries. Therefore, this chapter aimed to shed some light on the effects of a few essential institutional changes that directly influence national fiscal policies in the Euro Area. Even before the Great Recession, various measures were already implemented in the form of institutional constraints placing limits on the behaviour of fiscal policy variables (deficit, and government debt). Nevertheless, a series of recent events that have shaken up several Euro Area members has revealed the simple truth – despite having spent a significant amount of time and effort in repeated attempts to boost the fiscal resilience of the monetary union towards endogenously generated shocks by setting anew, the rules of the 'fiscal game', fiscal policy has remained an Achilles heel of the European integration project.

For my empirical analysis, I utilized a simple tool for modelling fiscal policy behaviour suggested in the literature. A country-specific fiscal behaviour was approximated by two types of fiscal rules. One that followed macro-fiscal response literature (in line with the Leeper (1991) or Bohn (1998) type of literature), the other resembling a Taylor rule, that is, a micro-based, optimal fiscal rule (in line with a model by Kirsanova et al., 2005). These rules were estimated using a combination of time-varying parameter techniques and Bayesian methods to produce a path of estimated coefficients. These estimates explicitly showed any changes in fiscal behaviour as a result of institutional changes controlling for relevant determinants. In order to do that, I created a novel quarterly dataset of fiscal and economic determinants covering twelve EA members and three stand-alone EU countries, covering the period 1980q1–2015q4. Since fiscal variables were not readily available at quarterly frequency for all EA/EU countries and the sample period, they were recon-

structed using a Bayesian decomposition method, following Giannone et al. (2015) and Bańbura et al. (2015).

To summarize the findings, my results showed that the process of institutionalization of fiscal policy for EA countries was grouped by their debt levels. In only a few countries, the Maastricht Treaty resulted in differentiated fiscal behaviour over the pre-Euro period. Conversely, the Pact and its modification had some more broad impact on national policies. The last set of results are related to changes and attempts to address the causes of a worsening of fiscal indicators during the Sovereign Debt crisis. Though these changes seem to have triggered responses, they were also not explicitly associated with high debt countries. There were no significant behaviour changes in the case of the three stand-alone EU countries chosen as a control group.

As a part of the analysis, I also addressed another question related to the effects of changing institutions on the harmonization of fiscal behaviour across EA members. Some evidence was presented that fiscal responses (estimated coefficients on debt variable in fiscal rules) were already harmonized, measured by their standard deviation, even before the Maastricht period that led to a small decrease in dispersion in the EA-12. However, that trend started to change before the launch of the Euro. Changes during the first years of the monetary union had almost no impact until the outset of the European sovereign debt crisis. That major disruption of economic activity resulted in a new phase in EU-wide macro-fiscal regulation, eventually ushering in a decline of dispersion of fiscal responses to levels comparable or even below those from the 1980s. My results are robust both to the specification of Bayesian estimation and the choice of a fiscal rule, and to the method used for output gap calculation. Since the calculated quarterly output gap series show somewhat different behaviour over the sample period, they cannot be viewed as the only (main) driver of fiscal harmonization. This finding is of essential importance for the single monetary policy and its conduct. Nevertheless, a harmonization of fiscal responses does not imply anything about the actual shape of fiscal policy. Mainly, when the commonly utilized concept of Bohn (1998)'s sustainability is applied, the median response for EA countries is positive but rather low. That seems to indicate that despite the extra fiscal space provided by interest rates being unprecedentedly low, in some countries even negative, the sustainability of fiscal policy may be easily endangered by another unexpected shock, and lead to an economic downturn with the need to actively use fiscal measures.

Naturally, there are many avenues for extension of my work. One or both fiscal rules can be estimated either with four lags (or up to four lags) or with

compatible growth rates of individual variables to compare my results with those under the assumption of a traditional fiscal behaviour (yearly planning horizon). It would be possible to re-estimate fiscal rules on aggregated series for the Euro area and compare its behaviour with the pooled method utilized in the chapter. An extension of my approach could include not only fiscal rules but also their monetary counterpart (a stylised ECB response function), to see their changes and possible interactions over years of monetary integration, and mainly over the Euro period. A multilateral measure of harmonization could provide a clearer picture regarding this issue. Since the choice and specification of priors is of key importance for Bayesian techniques, it would be possible to extend this chapter by using a so-called hyperprior, that is a prior distribution on a hyperparameter (see Amir-Ahmadi et al., 2016). That modification would also allow to carry out sensitivity exercises (evaluate uncertainty regarding a prior) by considering variations in the hyperparameter of a prior. Another extension can be aimed to capture the effects coming from policy changes, that is, to model variations in policy-makers' fiscal responses completely, following a similar exercise done for monetary policy rules (Primiceri, 2005). This would be possible by employing a Bayesian TVP estimation allowing for changes in volatility over time (fiscal regimes with more or less discretionary measures), and would require a much longer time series than was available in this study.

Appendix B

B.1 Data treatment

The main steps and data sources for creating the quarterly database of fiscal and other control variables employed in this chapter are summarized in this section. Following recent studies – Mauro et al. (2013) and Berti et al. (2016) –, Emphasis was put on ensuring that the reconstructed time series was consistent over the utilized sample period. In general, the main steps applied in the case of fiscal and other variables were the following:

- Eurostat databases are the primary source of fiscal quarterly series (total deficit, gross debt, interest payments, and non-interest expenditures, in ESA2010 standard often available only from the mid-1990s to 2015); see Eurostat, 2016; Eurostat (2016a,b).

- In case that series was not available, yearly series were taken from a database published by the European Commission (Annual macro-economic database, AMECO henceforth, see EC, 2016b). If they were available only partially (usually public debt series but not primary balance series), the Historical Public Finance Database (HPFD, henceforth, see Mauro et al., 2013) providing both series was preferred as the main source for both primary balances and public debt series.
  The HPFD series were linked to AMECO series by utilizing growth rates of HPFD series to the first data point (observation) available in the AMECO database if necessary.
  GAFS series (government support to financial institutions) came from a Eurostat database on the excessive deficit procedure (EDP) notifications provided by individual member states (see Eurostat, 2016a). GAFS are values that represent budgetary impact of government actions to support financial institutions and/or financial markets over years of the Great Recession and/or the

European sovereign debt crisis. They are available from 2007. As of the end of 2015, only three EA countries have not reported any GAFS values (Estonia, Malta and Slovakia, as of the end of 2016). GAFS series are then related to auxiliary fiscal measures (one of the so-called one-off items) not stemming from the outstanding value of government debt, budgetary situation or a situation in financial markets as a result of one or both of them. GAFS are also excluded when assessing programme countries by international organisations such as the IMF; for further details see van Riet (2010).

- Once yearly series for the time period were completed (1980–2015), they were imputed into a mixed frequency database (quarterly series alongside yearly ones) to check consistency of yearly and quarterly country-period observations. There were only minimal differences between the yearly values provided by the AMECO database and sums of reconstructed series (since quarterly series reflect seasonal adjustment, minor differences ($< 0.5\%$) are to be expected because of rounding, etc.).

- Missing observations for fiscal variables were reconstructed using country-specific information contained in series (unemployment, CPI index, government short-term [3M or its proxy] and long-term interest rates [10Y or its proxy], GDP and Government consumption)[i] by employing the Kalman filter and Bayesian approach, as described in (Giannone et al., 2015 and Bańbura et al., 2015); for further details on individual series see text below.

- Since series of quarterly output gaps were not readily available (only yearly series), they had to be calculated using the Baxter-King (BK) band-pass filter and the Hodrick-Prescott filter (HP filter).[ii] The utilized dataset contains quarterly GDP observations (prior to 1980q1 from the same OECD Quarterly National Accounts database, QNA henceforth, see OECD, 2016a) that can be used to extend the sample period. Moreover, the OECD Economic outlook (EO No. 99 from June 2016, see OECD, 2016) contains forecasted quarterly GDP. Both are used to evaluate this exercise.

  To mitigate the issue with the beginning and end of quarterly GDP series

[i] Extending this set of variables to a larger one by adding: consumption, investment and current account balance, led to similar values of reconstructed fiscal series.

[ii] The BK filter ($BK_{12}(6, 32)$) was used as a benchmark in line with Market and Ravn (2007). Even though this study also derives a formula for optimal HP filter, my interest is not in finding an optimal business cycle for the group of countries. Thus, for the sake of comparability, it is left as another robustness check for further research. The closest approximation to the widely used HP filter is $BK_{12}(2, 32)$ according to Baxter and King (1999). However, the HP filtered series were only used for robustness checks in this paper because of the objectives explained in Hamilton (2016).

(as a robustness check year-on-year growth rates in a particular quarter were utilized), the main steps were the following:
firstly, I forecasted and backcasted up to four years (16 quarters) of GDP using an unconditional bivariate $VAR(p)$ model for log differences of GDP and differences of inflation. The lag length p was selected via the Akaike information criterion (AIC henceforth), following the recommendation of Watson (2007).[iii] Since the original Watson (2007)'s approach works with time series, including house permits that were not available for this sample (all countries and years), quarterly series of industrial production and inflation (and interest rates spreads) were used instead as a robustness check for output gaps generated using quarterly GDP and inflation (and interest rates).[iv] OECD series of industrial production were already seasonally adjusted.
Both filtering techniques were applied on the extended GDP series, carefully selecting the specification of the BK filter, and the HP filter as a robustness check with a standard choice for quarterly series: $\lambda = 1600$ (see below).[v] Next, all observations outside the sample period were excluded from further estimation. Similar results were obtained when backcasted observations were replaced with actual GDP observations. I therefore decided to use them instead.

Alternatively, I repeated all previous steps using an alternative approach suggested in Watson (2007) for reconstructing output gap series – an $AR(p)$ model for GDP without any covariates. I also followed another approach proposed by Marcellino and Musso (2010) that uses GDP growth rates in an $AR(4)$ model, and also with country-specific $AR(p)$ models to allow for differences across countries in the sample (some catching-up, other developed countries). An evaluation of forecasted/backcasted observations was carried out by comparing all results against the OECD forecast and OECD QNA database. All methods performed well in terms of relative errors of predictions for the period 2016q1–2017q4. As a consequence, I decided to use the $VAR(p)$ predictions and keep the other version for robustness.[vi]

[iii] The optimal lag selection starts with the 'rule-of-thumb' recommendation for the maximum number of lags as suggested by Schwert (1989) and commonly applied for lag selections.

[iv] OECD database contains quarterly and monthly series of permits issued for dwellings. For this sample they were available since 1980q1 only for six (four EA) countries, and were not available at all for some countries.

[v] Since the optimal lag length of the BK filter was larger than 12 for several countries, 16 quarters of GDP were forecasted and backcasted, and not just 12 (three years) as recommends by Watson (2007). That allowed to keep the sample period at the same length for all EA and stand-alone countries.

[vi] Since the variables (GDP and CPI) are non-stationary, the transformations mentioned in the

Secondly, output trends were calculated using the Baxter-King band pass filter that was applied to individual GDP series in order to find the best fit; the standard specifications for most of the EA/EU countries (MA component with 12 lags and the length of cycles between 6 and 32 months) were able to provide smooth series (checked by periodogram). The optimal number was higher in only a few countries (16 lags: Greece, Ireland and Sweden). In order not to lose observations from the sample (which is usually a reason for using the HP filter), four years of actual (backcasted) data were used with this filter. The differences between both specifications of output gaps were negligible.
Thirdly, as a robustness check, I applied the HP filter with the standard smoothing coefficient value λ recommended in the literature (equal to 1600, for example see Ravn and Uhlig, 2002). In addition, following Perron and Wada (2009)'s suggestion, an alternative corrected HP filter was considered with the smoothing parameter equal to $8 \cdot 10^5$ (500 times the standard value) to capture changes in the slope of the trend, and thus eliminate bias coming from attributing too little variation to the cyclical component in comparison with the trend component. However, I did not use this HP filter since it did not effectively fit the given sample length. Lastly, I used the Christiano and Fitzgerald filter with the cycles between 6 (min) and 32 (max) quarters, assuming that GDP follows Random walk with drift (process assumed for the underlying data generating process). The main result was that the commonly utilized HP filter could not be viewed as optimal since it did not filter out cyclical frequencies of quarterly series, while the BK filter performed quite satisfactorily.

In particular, for the reconstruction of quarterly time series of primary balances and public debt, the following steps have been done:

a) Fiscal variables – both debt and primary balances (net lending/net borrowing series, B.9, with interests payable), all series were in levels in the ESA 2010 methodology – millions of units of national currency, not seasonally adjusted – provided by Eurostat and DG ECFIN (AMECO database). Because of a lack of quarterly observations before 1995 (public debt) and 1999 (primary balance) for most of the Euro area/EU countries (except for Belgium, France and Spain) and the United Kingdom, both series were reconstructed using the

text were applied to both series. I also experimented with a larger bivariate *VAR* (with differences of unemployment rate and interest rate spread, as suggested by Watson (2007). However, results were similar in terms of prediction errors, to the simpler model that was then kept (transformations reduced correlations among variables).

Historical Public Finance Database (HPFD), by applying growth rates calculated from level series;
The main challenge was the recalculation of the primary balance series for Luxembourg due to missing observations at the end of the 1980s (1988 and 1989). I collected information on central budget from OECD Economic Survey of Luxembourg (OECD, 1986, 1988, 1989, 1990, 1992, 1994) and calculated growth rates for budgetary out-turn and preliminary values for 1989 (no other values are available even after consultations with staff working with fiscal data in the Banque de Luxembourg) of net lending/net borrowing items. These rates were applied to the AMECO database's ESA 1995 series available for other years in this period. Since estimates of interest payments are unavailable as well, payments in both years were approximated with values representing linearly decaying payments between the observed endpoints (1987 and 1990). This approximation is mostly likely overestimating the actual interest payments due to the reduction of debt ratio, and fall in interest rates following the high-interest rate period of the early 1980s (see OECD, 1990).
As a robustness check, (1) I kept primary balance unchanged or replaced missing years with linearly approximated values (between endpoints), with negligible impact on the level of primary balance and recalculated series respectively and (2) I used a trend of interest payments for central and general governments provided by the IMF GFS (Government Finance Statistics, cash data, see IMF, 2014) with basically unchanged results.
Germany was treated as West Germany before 1990 and growth rates applied to the first observation for the re-united country in 1991 using the HPFD database (separate calculations for West Germany up to 1991 and for Germany 1990–2015 in comparison with the previous approach, had only negligible effect on the output gap estimate, so the previous method was preferred).

b) Total current expenditures without interest payments were calculated from underlying series of this National account aggregate using series from Eurostat database (quarterly, mil. of national currency, not seasonally adjusted), using the exact definition provided in the methodological notes to the AMECO database, and then complementing these with AMECO database and/or the HPFD database (yearly series, for most of the EA countries before 1999). Since they were at yearly frequency, quarters were created using the same decomposition method as fiscal series. Consequently, three years (twelve quarters) of observations were backcasted/forecasted via $VAR(p)$ model, where its lag length p was chosen optimally for each country in the sample (the AIC cri-

terion). Subsequently, the BK and HP filter were applied to calculate trend deviations of current expenditures, without intercept ($cgout_t$) that is used in the fiscal rule.

c) GDP and its components (General government final consumption expenditures, Private final consumption expenditures and Investments – Gross Fixed Capital Formation) – real (2010 constant prices), nominal, both series seasonally adjusted, came from OECD QNA Database and OECD EO No. 99 Database. No further adjustments were necessary;

d) Price index series (consumer prices, seasonally adjusted, national definition) were obtained from the OECD EO No. 99 database;

e) Interest rates, both short term (3M interbank rates) and long term (10Y bonds), were primarily obtained from Eurostat databases (Eurostat, 2016b) and complemented with OECD EO No. 99, OECD Main Economic Indicators database (MEI henceforth, see OECD, 2016b) and with IMF IFS database (IMF, 2016) and AMECO database.
Missing observations of long-run interest rates for Greece (between 1989 and 1991) were approximated using growth rates from short-term interest rates (both series are highly correlated over this period). As a robustness check, I use information on average lending rates from the WDI database of the World Bank (see WB, 2016) for Portugal, that faced double digit interest rates at that period (as the only member of the EC) there is only negligible impact on recalculated series or fiscal series. 3M series for Portugal obtained from OECD database (1980q1–1985q4) are estimates, therefore, to keep the same approach to series in the database, they were replaced using yearly observations and correlations with other series in line with the reconstruction of fiscal series.
As a robustness check, missing observations for early 1980s in the case of Ireland were reconstructed with the help of growth rates based on short-term exchequer's bills provided by the Irish statistical office (CSO, see CSO, 2016), with negligible impact on the series itself and fiscal variables;

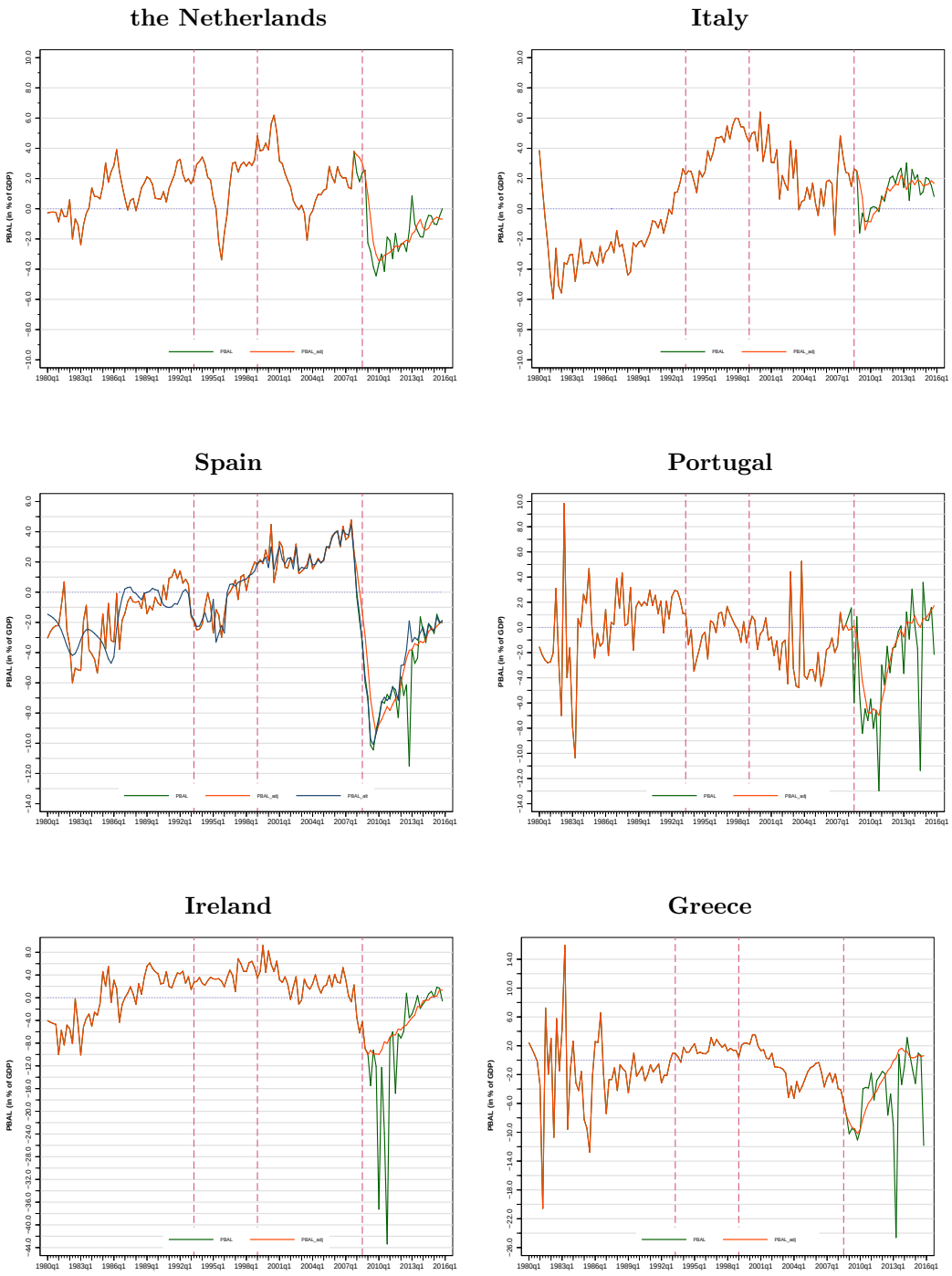
f) Unemployment rates (Labour force survey, harmonized series – ILO definition, seasonally adjusted) were taken from OECD MEI database and from IMF IFS database;

g) Current account balances (according to the IMF's 6th Balance of Payments manual – IMF BMP6) were taken from OECD EO No. 99, seasonally ad-

justed (ARIMA X-13) or calculated as a proxy, utilizing series of exports and imports of goods and services (national account definition, annual levels, national currency, seasonally adjusted) from OECD EO No. 99 and OECD QNA database.

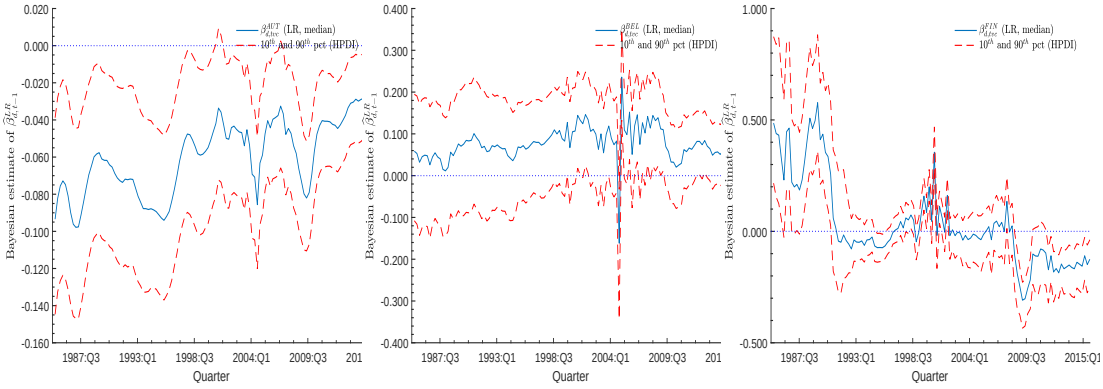
B.2 Figures and tables

Figure B.1: Examples of primary balances – original and adjusted, 1980q1–2015q4

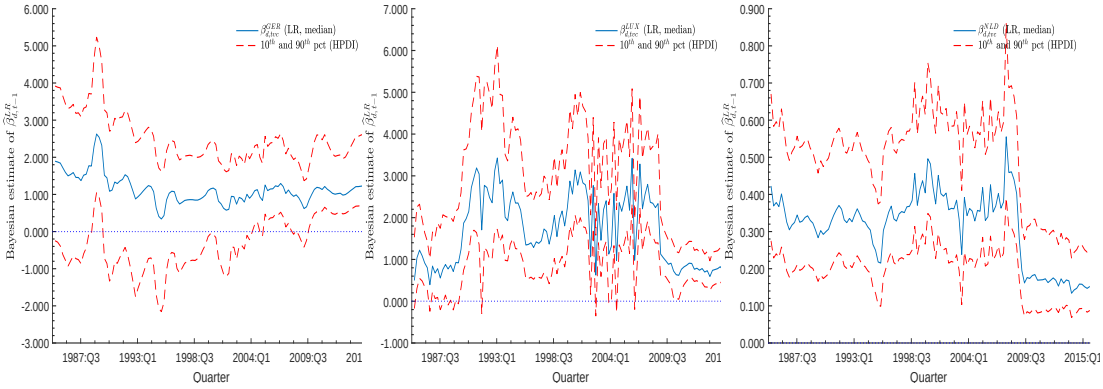


Note: GAFS series are non-zero for the Netherlands, Portugal and Spain since 2008, for Greece, Ireland and Italy since 2009. *PBAL* – officially published series, *PBAL_adj* – officially published series with adjustments for GAFS. *PBAL_alt* series in case of Spain is without GAFS items only between 2011 and 2015, and thus not fully comparable since Eurostat provides non-zero GAFS observations from 2008; the plotted series is based on a 2016 update of the dataset accompanying De Castro et al. (2014). Vertical axes are different for some countries. Source: own calculation and Eurostat (2016); Eurostat (2016a).

Figure B.2: Long run country-specific fiscal responses

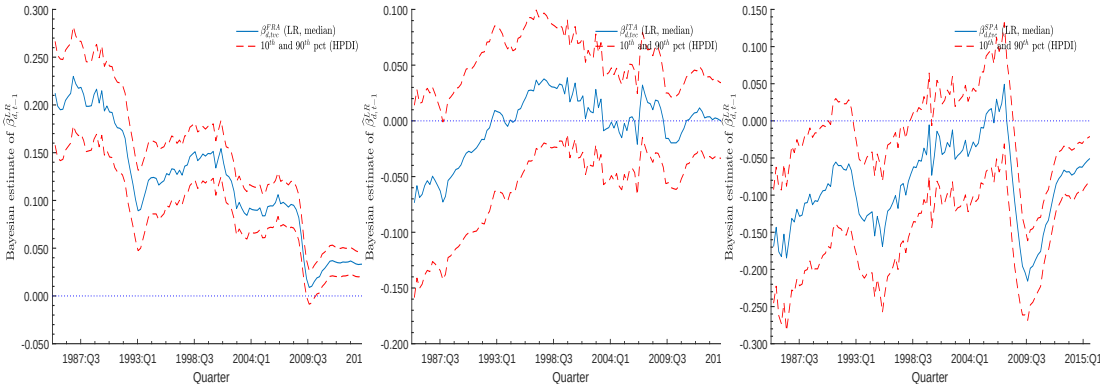


(*a*) **Austria** (*b*) **Belgium** (*c*) **Finland**



(*d*) **Germany** (*e*) **Luxembourg** (*f*) **the Netherlands**

Weaker countries

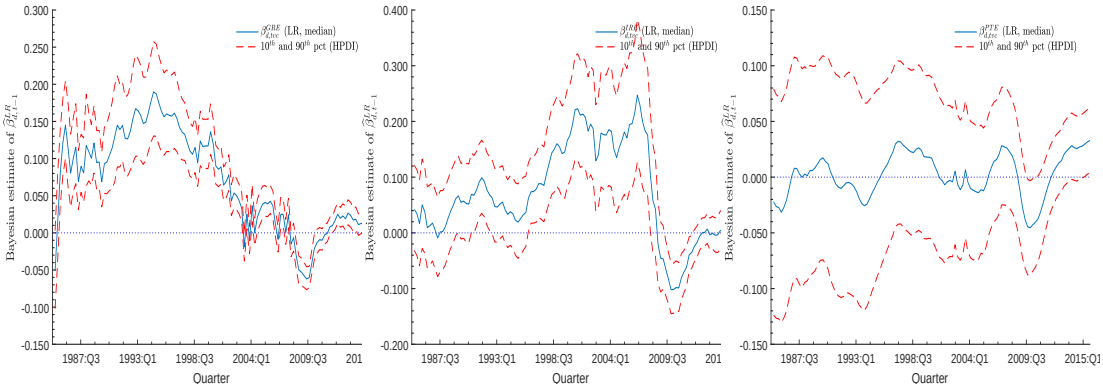


(*g*) **France** (*h*) **Italy** (*i*) **Spain**

Note: country-specific debt responses for FR I (median). Red dashed lines represent the credible intervals: the 10^{th} and 90^{th} percentiles of the posterior distribution. *Source:* own calculations.

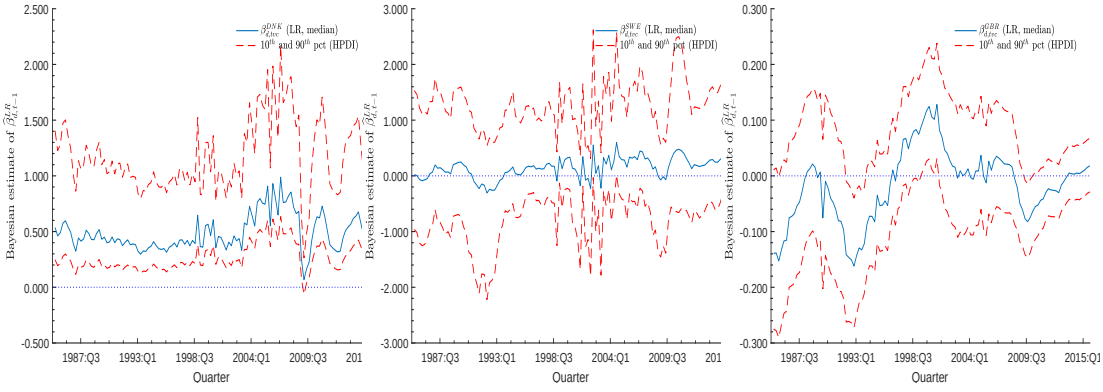
Country-specific fiscal responses *(cont.)*

Programme countries



(*j*) **Greece** (*k*) **Ireland** (*l*) **Portugal**

Stand-alone countries

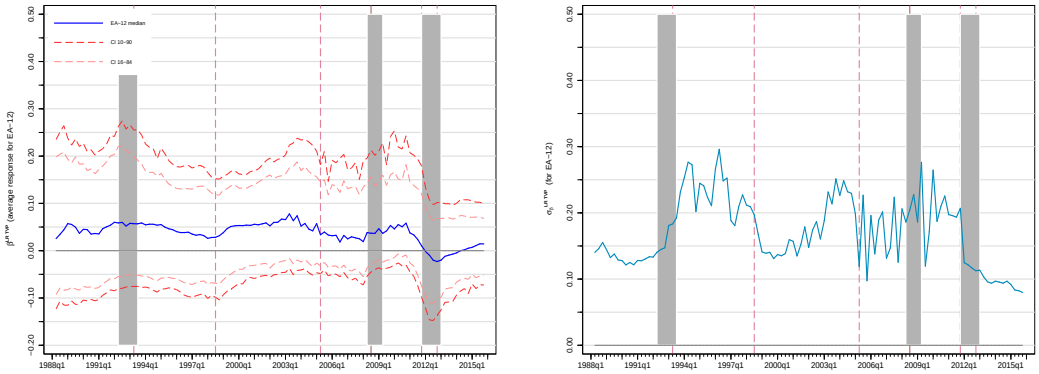


(*m*) **Denmark** (*n*) **Sweden** (*o*) **the United Kingdom**

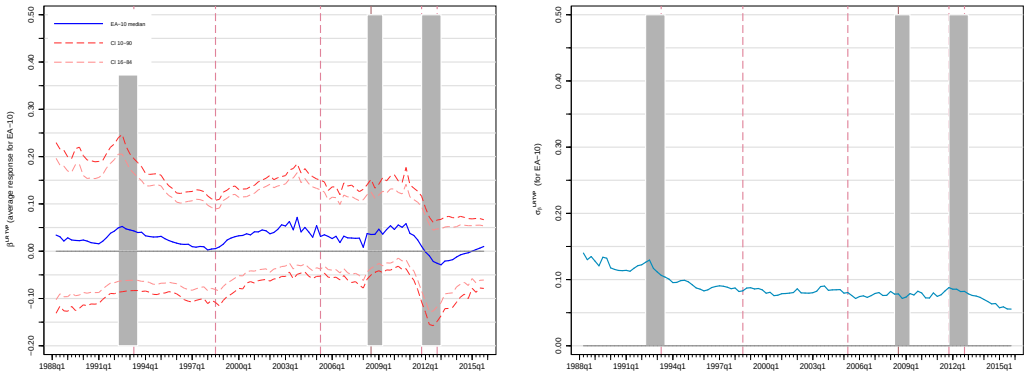
Note: country-specific debt responses for FR I (median). Red dashed lines represent the credible intervals: the 10^{th} and 90^{th} percentiles of the posterior distribution. *Source:* own calculations.

Figure B.3: TVP fiscal responses for Euro area countries, 1985q1–2015q4

median (EA-12) **standard deviation (EA-12)**



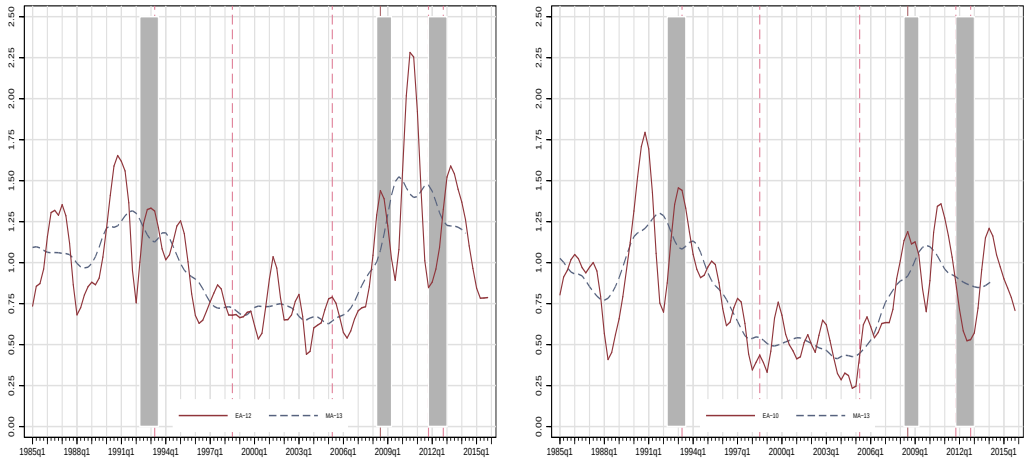
median (EA-10) **standard deviation (EA-10)**



Note: median debt response for EA-12, and EA-10 countries (EA-10 = EA-12 without Greece and Luxembourg, based on FR I). Unweighted cross-sectional standard deviation of EA-12, and EA-10 TVP responses (without Greece and Luxembourg, based on FR I). Dark areas are CEPR based recession periods for the Euro Area. Red dashed lines ($CI\ XX$) represent the 16^{th} and 84^{th}, and the 10^{th} and 90^{th} percentiles of the posterior distribution of TVP EA-12, and EA-10 responses. The red vertical dashed lines represent quarters relevant for institutional changes (for details see the main text). Source: own calculation.

Figure B.4: Dispersion of output gaps, 1985q1–2015q4

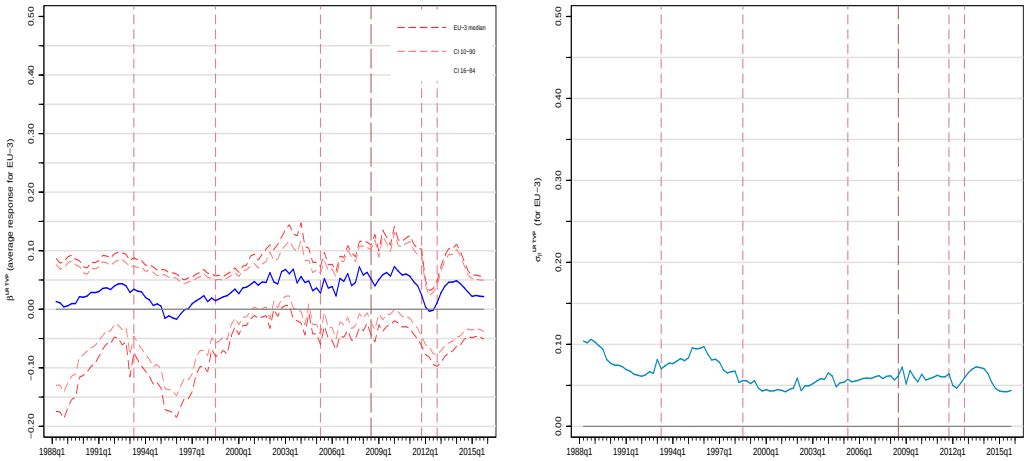
EA-12 **EA-10**



Note: unweighted cross-sectional standard deviation of output gaps calculated with the BK filter for EA-12 and EA-10 countries (EA-12 without Greece and Luxembourg). *MA*−13 stands for the centered moving average of length 13 quarters (symmetric filter). Dark areas are CEPR based recession periods for the Euro Area. The red dashed line represents the launch of Euro in January 1999. Output gaps and their dispersion is available since 1980q1. Source: own calculation.

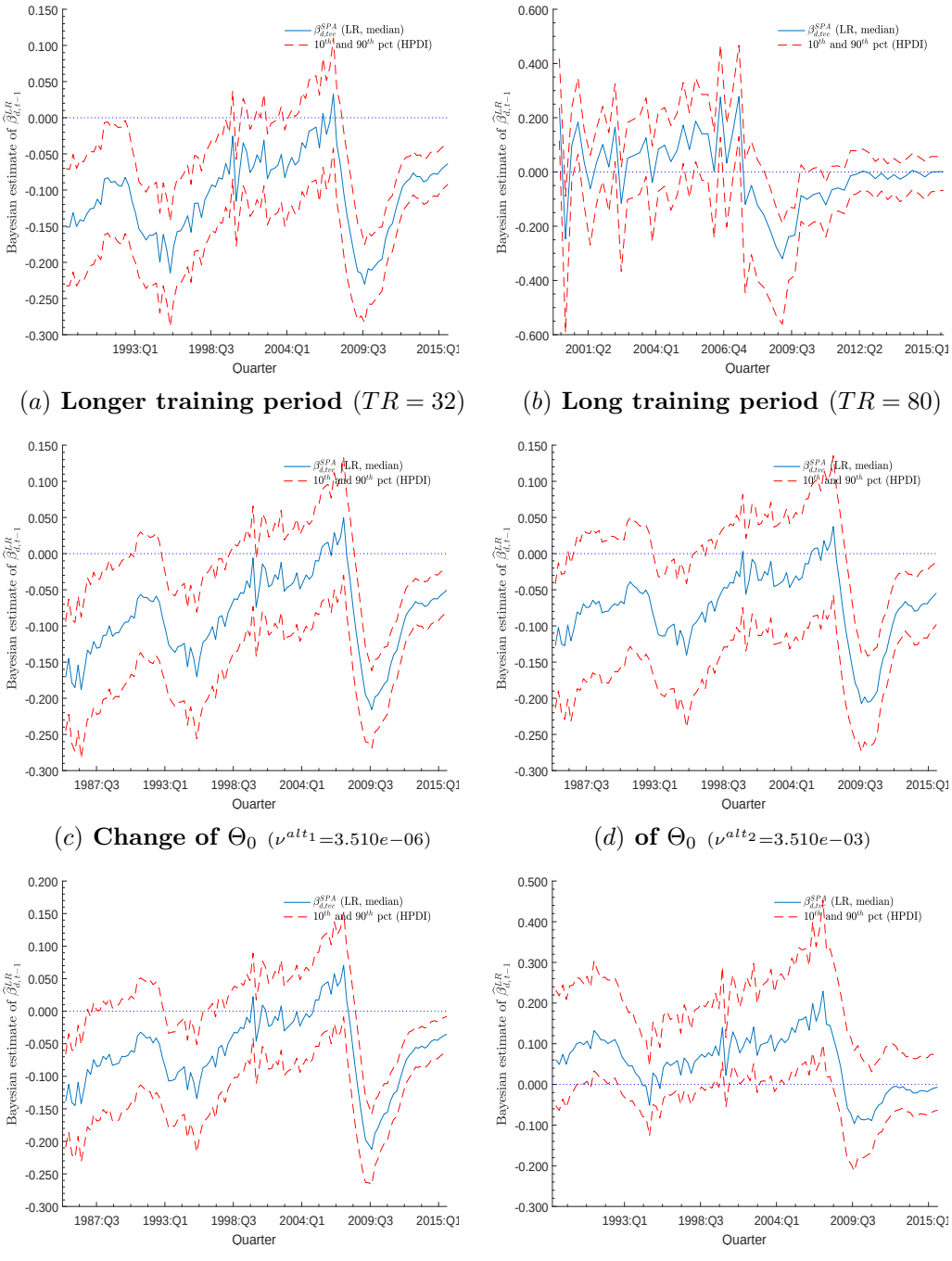
Figure B.5: TVP fiscal responses for stand-alone EU countries, 1985q1–2015q4

median **standard deviation**



Note: median debt response for EU-3 (based on FR I). Unweighted cross-sectional standard deviation of EU-3 TVP responses (based on FR I). Output gap estimated with the BP filter. Red dashed lines (*CI XX*) represent the 16^{th} and 84^{th}, and the 10^{th} and 90^{th} percentiles of posterior distribution of TVP EU-3 responses. The red vertical dashed lines represent quarters relevant for institutional changes (for details see the main text). Source: own calculation.

Figure B.6: Robustness checks – country-specific fiscal responses for Spain



(*a*) **Longer training period** ($TR = 32$)

(*b*) **Long training period** ($TR = 80$)

(*c*) **Change of** Θ_0 (ν^{alt_1}=3.510e−06)

(*d*) **of** Θ_0 (ν^{alt_2}=3.510e−03)

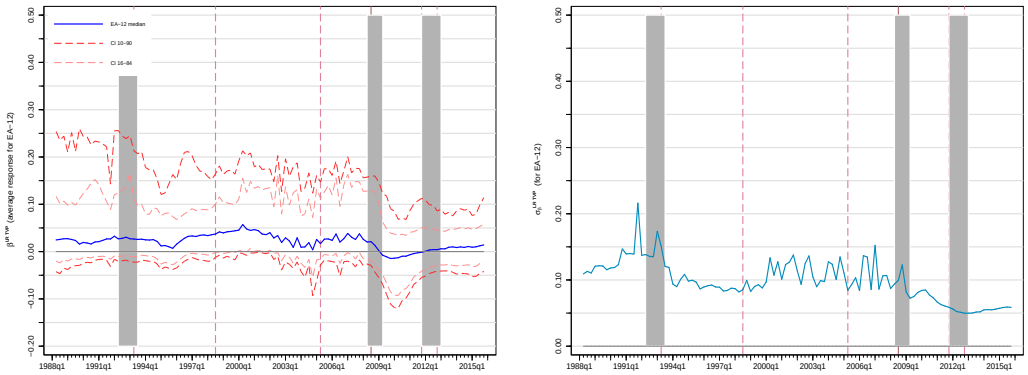
(*e*) **HP filtered output gap**

(*f*) **Alternative fiscal rule (FR II)**

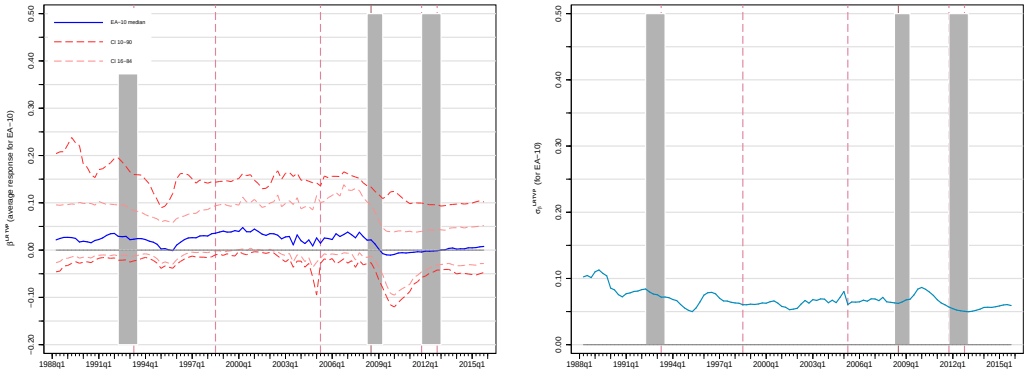
Note: country-specific debt responses for FR I and FR II (median). Red dashed lines represent the credible intervals: the 10^{th} and 90^{th} percentiles of the posterior distribution. *Source:* own calculations.

Figure B.7: Robustness – TVP fiscal responses for Euro area groups, 1988q1–2015q4

median (EA-12) **standard deviation (EA-12)**



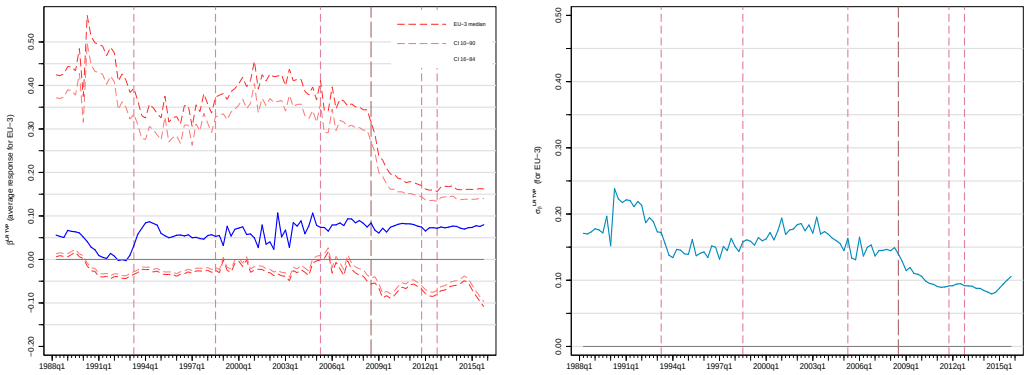
median (EA-10) **standard deviation (EA-10)**



Note: median debt response for EA-12, and EA-10 (EA-10 = EA-12 without Greece and Luxembourg, based on FR II). Unweighted cross-sectional standard deviation of EA-12, and EA-10 TVP responses (based on FR II). Output gap estimated with the BP filter. Red dashed lines ($CI\ XX$) represent the 16^{th} and 84^{th}, the 10^{th} and 90^{th}, and the 5^{th} and 95^{th} percentiles of posterior distribution of TVP EA-12, and EA-10 responses. Dark areas are CEPR based recession periods for the Euro Area. The red vertical dashed lines represent quarters relevant for institutional changes (for details see the main text). Source: own calculation.

Figure B.8: Robustness – TVP fiscal responses for stand-alone EU countries, 1988q1–2015q4

median **standard deviation**



Note: median EU-3 debt response (based on FR II). Unweighted cross-sectional standard deviation of EU-3 TVP responses (based on FR II). Output gap estimated with the BP filter. Red dashed lines ($CI\ XX$) represent the 16^{th} and 84^{th}, the 10^{th} and 90^{th}, and the 5^{th} and 95^{th} quantiles of posterior distribution of TVP EU-3 responses. The red vertical dashed lines represent quarters relevant for institutional changes (for details see the main text). Source: own calculation.

Chapter 4

Consumption Responses to an Unexpectedly Large Shock in Public Salaries – Evidence From a Government Intervention in Hungary

4.1 Introduction

> It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong.
>
> [Richard P. Feynman (1918–1988)]

True natural experiments in social sciences are rather rare events, particularly because it is difficult to trace exogenous and unanticipated shocks, such as unexpected changes in income or wealth and their effects on consumption, savings and other variables. In most cases, one has to rely on data from controlled experiments in 'artificially created environments', such as laboratory or field experiments. In the case of macroeconomic issues however, such experiments are unlikely for a number of reasons (see Fuchs-Schündeln and Schündeln, 2015).

Since 2000 and mainly in the post-2007 period, governments in developing countries have instituted many interventions in attempts to stimulate consumption and consequently, economic growth, after unexpected shocks. As a consequence of such government interventions, a number of empirical studies have explored how

these interventions lead to changes in income, and corresponding effects on consumption or wealth. Most interventions have been randomized but pre-announced, that is, expected, such as tax cuts and rebates in the US economy in response to two crisis events: (*a*) in 2001: Johnson et al. (2006); Agarwal et al. (2007) and (*b*) in 2008: Parker et al. (2013).[1] These studies provide evidence, either on the basis of consumption expenditure surveys such as the US CEX (see Johnson et al., 2006 or Parker et al., 2013), or on monthly credit card spending and debt series (see Agarwal et al., 2007), that households responded in a, sometimes even more than, modest way to these random but expected income shocks.[2] Related estimates of the marginal propensity to consume (MPC, henceforth) vary substantially, lying between 0.3 and 0.9. These findings disprove the implications of the permanent income hypothesis (PIH, henceforth), the Life-Cycle model (LCY, henceforth) or Ricardian equivalence and give further credit to the liquidity-constraint-hypothesis explanation (see Carol, 2001).[3] However, only a few interventions have been 'truly' unexpected, such as Agarwal and Qian (2014) examining a 'cash' experiment in Singapore, Jappelli and Padula (2014) exploring a change in the pension system in Italy. My study belongs to this group and utilizes the same intervention as Telegdy (2017), to study the effects of a change of public wages in Hungary. Nevertheless, both types of studies are of key importance to policy-makers deciding upon changes in direct or indirect taxation or pension and social system reforms (see Jappelli and Pistaferri, 2010 or Fuchs-Schündeln and Schündeln, 2015).

In this chapter I identify a time period when there was an exogenous shock to households lifetime resources as a result of an unexpected increase in the permanent component of total (disposable) income. I study the reaction of consumption expenditures to this shock in a quasi-natural experiment setting (in terms of Fuchs-Schündeln and Schündeln, 2015's terminology). The shock, a result of a government intervention, is an unanticipated and unexpectedly large increase in the basic salary (50%) of employees in the Hungarian public sector in 2002. This intervention represented a large share of total public employment since it affected 90 percent of

[1] The 'September 11' event and a sluggish recovery thereafter, and the US sub-prime mortgage crisis turning into the Great Recession.

[2] Jappelli and Pistaferri (2010) point out that many studies on tax rebates, including those from Regan's tax changes or Bush's temporary tax reduction, work with surveys on households' expectations about their consumption plans or with questionnaires trying to discover households' behaviour in such situations. As a result, they are both subject to limitations and mismeasurement.

[3] A particular wealth situation can also affect consumers' response to income shocks, assuming that responses are driven by shocks affecting consumers' employers. For example, Baker (2017) found that consumption responses are stronger with increasing indebtedness, using a dataset of individual income, consumption and wealth for the period around the Great Recession (2008–2012) when shocks were rather frequent. However, these findings only complement previous findings for wealthier parts of the US population because of the characteristics of the dataset.

workers in the public sector.[4]

Given the characteristics of the intervention, I use a similar approach to Jappelli and Padula (2014) in order to study effects at the household level, instead of analysing individuals and their incomes. This allows me to compare household heads that are directly exposed to the government intervention, with those that are not, assuming that a variation in consumption responses is driven by a realization of the income shock.[5] I will consider households of public employees as the treated group since this government intervention only targeted public employees, and I contrast this group with a control group of households of private employees and other types of public workers. Because of limitations regarding consistent information on the source of household incomes, I use a novel approach to select those that were affected within a group of households. I calculate probabilities of working for the public sector over an exhaustive set of occupational categories, using a novel individual dataset based on the cross-sectional Hungarian household budget survey (HHBS, henceforth). This allows me to use a regression framework to identify the consumption responses of households in response to the exogenous change in their income, when controlling for relevant economic and socio-demographic characteristics.

A few studies have used a similar approach to analyse the effects of unexpected shocks to individual (household)'s income (wealth), in a quasi-experimental setting, with perfect knowledge of individuals' (households) types. For example, Jappelli and Padula (2014) used this approach to explore a change in the pension system of public employees in a cross-sectional dataset of Italian households. Their difference-in-difference estimation revealed large increases in the income-wealth ratio and a small reduction of the consumption-income ratio. Larger responses are found for younger households and for households where more than one member works in public sector. Several studies already in the early 2000s, such as Browning and Crossley (2001), also explored the effects of exogenous changes in health conditions or labour market situations, and their implications for consumption. Recently Agarwal and Qian (2014) examine a Singaporean government cash-bonus intervention in 2011 that only applied to citizens. They use credit/debt cards and bank checking accounts to analyse the time-dimension-effect for consumption (announcement and disbursement effect). Their difference-in-difference estimation reveals effects on

[4] Those public sector employees who worked for publicly owned firms such as the national railway company, MÁV, or the Hungary Post, Magyar Posta (separate employment contracts similar to private sector firms), and workers in the judiciary system, were not affected by this intervention; for details see below.

[5] Although a 'natural' choice would seem to be the individual level, I chose this modelling approach because controls for some household characteristics are only observed at the household level in budget surveys.

small durable goods and discretionary items, with stronger responses for liquidity constrained individuals. Nevertheless, there are not many empirical studies that document large permanent income shocks. In addition, this study represents one of the first analyses of a shock – in a transition country –, that affected almost all public sector employees, in a quasi-experimental setting. It also complements the only other study (Telegdy, 2017) that uses the same salary intervention to study public-private sector salary spillovers. He finds spillover effects in the case of male, younger and highly educated current workers, while there are less effects for newly hired workers whose bonuses are raised more than regular salaries.

The recipient side of government intervention is represented by households surveyed in the repeated cross-section survey (HHBS) between 2000 and 2005, inclusive of the two years prior and two years after the intervention. The HHBS is a representative survey of Hungarian households that is carried out regularly by the Hungarian central statistical office (HCSO, henceforth), with quite a long history compared to similar surveys in other European countries.[6]

The HHBS has very detailed information on household consumption, and a rich set of socio-demographic household members' characteristics. Since there is no consistent (explicit) information on households members' source of primary labour income over the sample period, I propose the following identification strategy. Firstly, I establish a link between the occupational categories of public and private workers, and establish their primary labour income. Probabilities of working in public sector occupations that were directly affected by the salary change are calculated (only a subset of all public sector workers, since for example, the judiciary system was excluded from the salary increase). Employment data is sourced from surveys by Hungarian firms and public sector workers, which were used in Earle et al. (2012) or more recently in Telegdy (2017). This survey data covered around three-fifth of the public sector and around seven percent of private sector workers (of firms with five and more employees). Secondly, I use this (probabilistic) information to select those among households that were likely or very likely to be exposed to the unexpected increase in permanent income. Thirdly, after establishing the occupational-sector-probability-income link, I proceed with analysing households' consumption behaviour. Consumption behaviour is approximated with changes of expenditures on a consumption basket or its individual components, employing two standard measures: the level of consumption and average propensity to consume

[6] This survey has been used for a number of mostly *ad hoc* research projects, and *inter alia* for the calculation of inflation rates in the economy. Recent studies used HHBS data for a decomposition of inflation rates in order to analyse household specific inflation (see MNB, 2015), and income and consumption behaviour before the Great Recession (see Hosszú, 2011).

(*APC*, henceforth).

Given the structure of public sector employees remuneration, a change in their base salary can be viewed as a change in the permanent component of their total disposable income. Standard consumption theory postulates that the effects of such an unexpected increase in income are associated with changes in consumption expenditures at the household level. However, my findings are somewhat surprising: there are significant responses for subcomponents of total consumption expenditures (durable and non-durable), but no significant changes in total consumption. I therefore propose an alternative explanation: In the early 2000's, a change in the system of subsidies on housing loans triggered a consumption boom[7] that left many households with higher actual levels of consumption expenditures compared with their disposable incomes.

The salary increase thus led to a consolidation of 'weak' balance sheets in households living above their means.[8] This seems to be supported by some evidence showing an increase in consumption (catching up effect) over the period 2004–2005. Moreover, I argue that this unexpected income change may have unintentionally prevented (together with regulatory restrictions on housing loans) a burst in loan-driven-consumption *bonanza*, which occurred a few years later on the eve of the Global Recession, in a more severe fashion.

The main drawbacks of this approach are related to the indirect identification strategy, and the implicit assumption that there is no self-selection into public jobs that would bias my results.[9] To address these concerns I first show that, the results remain robust when compared to alternative probability specifications of working in the public sector (restricted to between 60% and 90%). I also show that there is no significantly different path of income growth for other types of public sector workers (public servants), and/or particularly significant difference in the salary trends of private sector workers.

[7] That strongly resembles Mian and Sufi (2015) illustration of the mid 2000s US credit crunch (mortgage-bubble) unfolding into the most severe economic crisis since the Great Depression, or Kumhof et al. (2015) alternative illustration that places more emphasis on income inequality and indebtedness.

[8] Since Hungary shares borders with Austria and there have been many links between both countries (going back in time to pre-1989 period), it is not surprising that Austrian and Hungarian consumption patterns are relatively similar despite a world of difference between the average income in both countries.

[9] Some advantages of public sector workers (for details see below) are more than compensated by the larger number of benefits available to private sector workers, and the fact that public opinions on jobs were not in favour of just one type of job sector. Moreover, public workers were exposed to the same labour market laws as private workers (no indefinite employment guarantee), and many professions had the alternative to set up private businesses (particularly within the health and education sectors).

The remainder of the text is organised as follows: chapter 2 briefly reviews consumption theory, and provides a description of government interventions, and their economic and institutional background. Section 3 summarizes the identification strategy and describes the data sources and their adjustments. Section 4 presents the main results and robustness checks, and discusses them in the context of other studies. Section 5 concludes and offers some suggestions for further research.

4.2 Consumption and income link – what do theoretical concepts suggest

4.2.1 A brief review of consumption theories

An individual (household, agent) maximizes the expected utility of a stream of consumption over a (finite) period of time ($t = 1, \ldots, T$), subject to commonly defined intertemporal budget constraints (IBC) and a wealth condition so that the possibility of a Ponzi scheme is eliminated. If there is no restriction on an agent's access to credit markets, no difference between the subjective and objective interest rates, and their utility function is assumed to be time and state separable, then the (consumption) Euler equation for the agent can be expressed as follows:

$$\frac{U'(C_t)}{\beta(1+r_{t+1})} = \mathbb{E}_{t+1}\left[U'(C_{t+1})\right], \tag{4.1}$$

where β is the subjective discount factor (being the inverse of the subjective rate of preferences, ρ) equal to $(\frac{1}{1+\rho})$, r_{t+1} is the real (market) interest rate (objective discount factor) and $\mathbb{E}_{t+1}[.]$ denotes the expectation operator.

The equation (4.1) states that the agent cannot increase their expected utility from consumption by shifting available resources between any two periods (for example t and $t+1$). Already Hall (1978) shows that the condition (4.1) can be transformed into the expression (4.2), where the expectation of the $t+1$ period consumption in the period t ($\mathbb{E}_t[C_{t+1}]$) is the current value of consumption (directly substituted in below); similarly for the general case – marginal utility of consumption is a martingale – without assuming certainty equivalence, that is, quadratic utility function, see Deaton (1992), in cases where the subjective and objective interest rates are equal:

$$C_{t+1} = C_t + \xi_{t+1}, \tag{4.2}$$

where ξ_{t+1} is the random innovation (martingale difference, $\mathbb{E}_t[\xi_{t+1}] = 0$) that contains any information about innovations in any of consumption determinants.

However, there can be a change in (marginal utility of or) consumption when expectations are not realised, that is, when evaluated *ex post* as shown by Jappelli and Pistaferri (2010). The implication of this assumption (consumption follows a Random walk) is twofold:[10]

- unexpected changes of income will affect (marginal utility of) consumption;
- expected (anticipated) changes of income will only have an effect on consumption when new information about income becomes available (and will bring about changes in the previously optimal consumption plan).

The magnitude of a consumption change will depend on other determinants of the consumption profile, such as the type of income shock (size, length, etc.) and the way in which an agent's economic environment affects how they adjust their consumption path. Jappelli and Pistaferri (2010) show that the implications of the equation (4.2) can be verified via the orthogonality condition test (a weak test for known values of determinants). When there is uncertainty around the values for determinants, such as with work-related income, the equation (4.2) can be rewritten to explicitly express the main consumption determinants, and their effects on the optimal consumption plan (see *ibid.* for an example of only labour income as a source of shocks).

Subsequent empirical tests have shown (see for example Friedman, 1957; Deaton, 1992) that consumption responds differently when compared to the assumptions of the standard (neoclassical) model outlined above. These tests not only consider the type of income shocks, that is, the agent's perception about their nature, but also the time horizon, life expectations of agents, or utility function and its exact specification.

To begin with, some realised income shocks are viewed as temporary (transient in their nature), such as winning a lottery, receiving dividend payments or extra work related emoluments such as money-like vouchers or bonuses. Other income shocks are considered more permanent in their nature and associated with expected

[10] As Deaton (1992) points out, the equation (4.2) – in consumption levels compared to its 'marginal utility of consumption' version – is not *sensu strictu* a random walk because of the seldom occurrence of heavy tails (large outliers).

changes, for example with professional career progress, ageing or major health problems such as serious illness or disability. That has resulted in a reformulation of the stream of income (Y_t^D) into an income process, consisting of two components (in the case of income or capital taxation a stream of disposable income):

$$Y_t^D = Y_t^P + Y_t^T, \tag{4.3}$$

where Y_t^P is the permanent income characterised as a random walk: $Y_t^P = Y_{t-1}^P + \theta_t$, with the innovation θ_t, and Y_t^T is the transition income that follows an *iid* process.

Depending on the specification of a structural model for consumption (finite or infinite time horizon), changes in disposable income result in changes of the optimal consumption path. If a shock arrives and consumption does not respond (unexpected shocks), the difference is automatically saved; for some examples of unexpected temporary income shocks, see Fuchs-Schündeln and Schündeln (2015).

Secondly, there are alternative explanations for different types of behaviour of consumption and income that is captured by the workhorse LCY model, which are not necessarily at odds with the assumption of rational consumers. One explanation is offered by precautionary savings models. This class of models changes the assumption of the functional form of the utility function (to isoelastic), resulting in a savings behaviour driven by changes in uncertainty of income processes. In spite of this change, the main conclusions of the quadratic utility model explained above remain unchanged – consumption responds to unanticipated changes only. The consequences of income shocks cannot be easily established and studied in this particular class of models. However, consumption responses can be worked out with the help of various approximations. For example, Blundell et al. (2008) point out whether there is a dependence on the size, length of a shock but also on individual's and broader economic environment pertaining characteristics such as a type of welfare or pension systems. The other class of consumption models are so-called buffer stock models (see for example Carol, 2009). Perhaps closer to observed reality, these models assume that consumption responses are additionally affected by the discount rate. In this environment, there is a reduction in effects as a result of permanent income changes.

Another unobservable factor that usually modifies responses is: the free availability of access to formal (external) financial and insurance markets that is assumed in the standard model above or the necessity to use informal or self-insurance possibilities. In these cases, the effects of income shocks will be modified since liquidity constraints tend to prevent the agent from responding in the expected manner, even

in the case of unexpected permanent shocks (asymmetrical responses). The reason for this behaviour being the unavailability of tools for the required adjustments in or towards the optimal consumption path.[11] Empirical studies do find larger responses of households that are subject to liquidity constraints. However, a recent study by Kaplan et al. (2014) relativises them by emphasising the effects coming from hand-to-mouth consumers, who keep a large proportion of their wealth in illiquid types of assets. For further explanation of the deviations from the standard LCY model of consumption behaviour such as ageing and other demographics related factors, see the early survey in Attanasio (1999).

More recent literature places more emphasis on the rational inattention explanation (existence of inertia) or near-rationality of consumers. These based on ideas in Reis (2006) help to explain differences in consumers' responses such as so-called excess sensitivity when pre-announced income shocks are of different magnitudes. From this perspective, only those shocks that are large enough for an 'irrational' agent result in a new optimal savings plan. Others shocks can be simply reflected in swings of actual consumption regardless of their sub-optimality. This approach helps bridge differences in the literature related to excessive sensitivity.[12]

To summarise, in the aftermath of an income shock, the consumption of an agent is expected to respond for unexpected income changes only under the strict assumptions of PIH or LCY. Their response will depend on: (*i*) the agent's characteristics and preferences, (*ii*) structure of their economic and financial environment (presence of any distortions in credit and insurance markets), and (*iii*) the type of shock itself. Therefore, there is likely to be a lower consumer response in the case of Hungary than otherwise, since it is a medium-level income (catching-up) country, that does not necessarily meet some of the standard assumptions, such as a full access to credit markets (see below).

4.2.2 Some stylised facts on Hungarian economy

Real economy and financial markets

Based on GNI per capita in USD in 1990 (World bank Atlas method), Hungary was ranked as an upper-middle income country in terms of the World Bank classification (see WB, 2017). Compared to other countries in the Central and Eastern Europe

[11] While there is no observed consumption smoothing for negative shocks, there is still saving in the case of unexpected (transient) positive shocks.

[12] Previously, only small and regular payments, and not large payments, had been found liable to this phenomenon, see for example an investigation of regular oil-related dividends in Hsieh (2003). However, a more recent empirical evaluation of the same dataset by Kueng (2015) provides evidence of near-rationality instead.

(CEE, henceforth) region, Hungary was one of the most developed countries that had been partially opened to foreign investors from Western countries, had a two-tier banking system[13], and had been represented in international organisations such as the IMF (since 1982) even before the fall of the Iron Curtain (1989–1990). Similar to other CEE countries, the governments' ultimate goal was to fully integrate with other European countries by joining the EU. The main barriers to this goal were: a relative poor economic performance compared to other CEE countries in early 1990 complemented with a relatively high level of foreign currency denominated debts, 'soft' budget constraints represented by providing support to state firms, and relatively high dependence on imports, which increased when many foreign investors opened production facilities across the country; for further details see Bokros and Dethier (1998).

Having failed to restore internal and external balance, a 'forced' reform was carried out in early 1995 under a newly appointed finance minister Lajos A. Bokros (therefore so-called 'Bokros package'). This reform included a new policy regarding privatization of state-owned firms, a banking reform, and a redefinition of revenues and expenditures of the government budget, mainly focusing on rather generous welfare and pension systems (see Bokros and Dethier, 1998). Contrary to most countries in the region, the Hungarian economy was not affected by the turbulence of the Russian debt crisis (1998–1999), or by the 'September 11' event. GDP growth remained stable throughout the sample period. However, rates of inflation were somewhat higher compared with the other V-4 countries,[14] and were mostly driven by a stark nominal wage growth, accompanied by regular changes of central parity in a crawling peg exchange rate arrangement.[15] Throughout the period, inflation rates were slowly reduced from double to single-digit values, resulting both from an anti-inflation programme introduced by the ruling government in 2000, and the introduction of inflation targeting in June 2001, with the first target was set at $4.5\% \pm 1\%$ for December 2002.

Private sector salaries grew at a relatively stable rate between 2000–2005

[13] There was a very similar one tier banking system across other CEE countries, that is, commercial banks were simply branches of the state central bank that were allowed to collect deposits and grant loans.

[14] The Visegrád group of countries (V-4) represents a particular subgroup of the CEE (neighbouring countries, originally at a higher stage of economic development compared to countries in the CEE region) that played an important role in the process of regional integration before all its members joined the EU.
The V-4 includes: the Czech Republic, Hungary, Poland and the Slovak Republic, with Slovenia also sometimes taking part in joint initiatives.

[15] With narrow bands ($\pm 2.25\%$) towards few currencies reflecting post 1995 trade patterns (predominantly to the ECU), after the financial mini-crisis with regular adjustments. Patterns later widened to $\pm 15\%$ in 2001 and were completely abandoned in 2008 (see MNB, 2001b, 2008).

(annually slightly above 5¼% in real terms), while public sector salaries were subject to large fluctuations, with annual averages of more than 8.5%.[16] These factors, along with the anticipated EU accession, led to a speculative attack on the currency (on revaluation of the central parity) with a peak around mid-January 2003. In response, the central bank had to intervene in financial markets to substantially reduce interest rates (by 100 base points, see MNB, 2003). The effect on interest rates (both deposit and lending) was visible as they reached new lows in 2003, and may have boosted what was already a strong demand for loans (mostly mortgages) since the spring of 2002 (see below).

Remuneration system

Generally, public sector employees are subject to different remuneration schemes as compared with employees in the private sector. As a result, public sector salaries tend to be lower on average, compared to private sector salaries (negative premium). The situation is worse for public sector employees in transition or emerging countries (including CEE countries), as compared to developed countries. This negative premium is larger, and is supported by statistical evidence (see Adamchik and Bedi, 2000 for Poland or ECFIN, 2014 for new EU member states).

There are a multitude of possible explanations for these stylised facts (see Adamchik and Bedi, 2000 or ECFIN, 2014): (*a*) specific market position of governments in the provision of public goods and services, (*b*) different (alternative) objectives and incentives, and public sector constraints (usually non-profit) allow for the production of mixed or public goods with positive externalities/spillover effects, (*c*) unionisation of the labour force tends to be higher in the public sector, (*d*) differences in productivity that reflect qualitatively different characteristics for employees in both sectors, (*e*) job security, working hours, competitive pressures, etc. (see also De Paola et al., 2014) and (*f*) other job-related characteristics that are hardly directly observable in most cases, seem to play an important role in the public sector (see also Borjas, 2003).[17]

The base salary of public sector employees tends to be based on a 'salary-experience' grid, where 'experience' is simply represented by the seniority principle.[18] The base salary is then adjusted by applying coefficients that reflect a par-

[16] Weighted averages for both sectors, with weights based on total employment in individual NACE categories. Own calculation based on WIIW statistical database for the main categories of the NACE employment classification (see WIIW, 2015).

[17] Naturally, this may lead to a self-selection of candidates for public sector jobs or conversely for private sector jobs.

[18] The grid system accords with the highest level of education attained by the employee.

ticular type of organisation within the public sector (central institutions vs. local administrative vs. publicly-owned firms). Moreover, there are usually (up to two) extra salaries in a year that are not commonly linked to the performance of the institution, and a range of supplements based on an employee's profile that allow for greater differentiation within public institutions. Therefore, any salary increase can come from two sources, a change of the base salary (either automatic or discrete), or when any of the other remaining components is amended.

The salary system in Hungary at that time followed these general rules that were embedded in the public sector remuneration system (for further details see Telegdy, 2017 or ECFIN, 2014): a salary grid for public workers with coefficients allowing for experience/education differentiation, various allowances, a thirteenth salary and *ad hoc* supplements. Before the unexpected income change, the government was increasingly pressured to change public sector salaries, since they were kept broadly unchanged as compared to those in the private sector. As a result, there was a negative public income gap in 2002 before the government intervention, and public sector salaries were on average more than 15 percentage points (pp) lower. In addition, the Hungarian public sector was prevailingly subject to factors such as a higher share of women and/or employees with higher levels of education. In particular, regular adjustments of the minimum wage in the period 2000–2002 resulted in many public workers' salaries falling below new thresholds.[19]

Another factor warranting serious consideration is the existence of larger shares of grey sector activities in some private sector occupations (compared to public sector). This grey sector source of income is not often captured in surveys (wage/salary/income under-reporting). For example, artificially low incomes can be supplemented with side cash payments in some services, while expenditures could be recorded 'correctly' at household level if there was no artificial hiding of any illegal sources of income.[20] This option does not seem to be very likely since large discrepancies could attract the attention of authorities. While this should be of less concern for public sector employee income, they are still subject to other extra sources of income from, for example, bribes (see Gorodnichenko and Sabirianova, 2007).[21] Since the economy was growing at a fast pace during the sample period,

[19] Minimum wage increases in 2001 and 2002 were rather important since they raised the minimum salary in real terms; other changes throughout the period (2004 onwards) only compensated for inflation; the minimum salary/average salary ratio followed this pattern between 2000 and 2005 (in %): 29 – 39 – 41 – 36 – 36 – 36; own calculation based on HCSO data.

[20] Blades and Roberts (2002) has already questioned estimates based on a macro model that edged up to as high as 25% for Hungary towards the end of the millennia, see Schneider and Enste (2000), or an updated version in Schneider and Klinglmair (2004).

[21] From time to time, workers in some occupations would receive 'in kind' items or cash for

this unofficial part of the total income could have also increased enough to have significant implications on consumption expenditures. Given the potentially exposed occupational groups and the estimated size of these effects, these dynamics could affect both durable and (some) non-durable consumption expenditures.[22] In addition, estimates of 'omitted' activities, shown in Blades and Roberts (2002), may not necessarily only be linked to the non-observed economy (grey and black), but may also reflect structural changes and standard problems that statistical offices have to deal with in emerging economies (mismeasurement, hiding of consumption expenditures or 'forgetfulness' in the case of some expenditure items). Therefore, it can be rather challenging to perform an accurate comparison of income to consumption in both sectors.

Government intervention – (post-)election 'surprises' and welfare system changes

There were several salary changes in Hungary in 2001 and 2002 (see OECD, 2004) that may have been motivated by the early 2002 elections. The reach of these changes was however, rather limited. The first change in July 2001 was aimed at civil servants and public order officers, and the other from January 2002 was targeted to different public sector employees, such as public order officers and army officers.[23] However, the autumn 2002 increase had far reaching effects because of its impact on a significantly larger number of public employees (few hundreds of thousands vs. units of thousands). This second 2002 salary increase came in the wake of a newly established government promising, and (somewhat surprisingly) almost completely delivering changes in the welfare system following their pre-election promises.

Although an April 2002 general election (two-rounds on 7th and 21st of April) saw the opposition (MSZP, Hungarian Socialist Party) winning the popular vote (by about 1 pp in percentage), they still had fewer seats than the ruling party (FIDESZ, Hungarian Civic Party). Thanks to a coalition with a liberal party (SZDSZ, Alliance of Free Democrats), the MSZP formed a coalition government with a narrow majority in Parliament, ousting the incumbent prime minister (Vik-

services provided or for getting preference for treatment, as 'presents' and not necessarily as extra payments.

[22] In order to analyse this effect, one would need more detailed information about the income structure of households going beyond what is currently available in the HHBS. Such information would help to identify members who work for the public and/or private sector with high probabilities of being exposed to such types of side payments coming from 'customers'.

[23] Although public servants' salary adjustment in 2001 primarily affected coefficients applied to the base salary (15%, see Telegdy, 2017), the 'real' effect in terms of salaries was larger. OECD (2004) states that the size hovered between 35% and 55% for both groups. The early 2002 increase was differentiated: public order officers (15%) and army officers (55%), see *ibid.*

tor Orbán and his three-party right-wing coalition) from the position. While the results of the first round of voting were somewhat surprising, the second round of voting only confirmed the previous election results. The responses of financial markets can provide some guidance on the extent to which a particular result was unexpected (an election result, an announcement, a decision). In case of the official announcement of Hungary's 2002 elections (first round), the markets responded in a number of ways.[24]

The soon-to-be prime minister (Péter Medgyessy) publicly pledged to increase the salaries of public employees (in a meeting on May 24), just a few days after he took office in mid-May, and even before the coalition agreement was signed (May 26) and he and his government were officially approved by the Parliament (May 27).[25] Soon after (May 31), during the first press conference of the newly formed government, a series of to-be-realised measures were officially announced (action programme), inclusive of measures to improve the welfare system and meet most of their pre-election promises.[26] Among those who benefited from the new programme were: students and pensioners with low incomes, and public employees.[27] This set of measures was later on dubbed as a '100-day action programme', and was followed by another '100-day programme' later in the summer of that year (targeting underdeveloped regions and support for families, see ORIGO, 2017).[28]

[24] Daily yields on government bonds moved between 1.3% and 0.8% across maturities ($3-15$ years). The HUF/euro exchange rate depreciated by about 0.1% after the announcement; own calculation from OFX, 2017, also visible in official daily announced exchange rates by the MNB (see MNB, 2017). This was partially reversed after the release of second round results, as both the coalition's entry into office and their parliamentary approval brought about a mild depreciation and increase of bond yields. However, the markets' reactions to the results could have been affected by the fact that the first trading day after the announcement was the next Monday, that is, after two days of no trading and the accumulation of pertinent election-related news.

[25] The source of the exact timing of all individual events is a series of newspaper articles – various European newspapers between May 15 and July 15 – accessed via Europresse (2017).

[26] Even though the Socialist party won the election with a program of changes and improvements to the welfare system, the action programme can be viewed as a departure from previous election norms where announced promises were simply abandoned in the post election period.

[27] The first action programme from early June included one-off lump-sum allowances to people receiving low pensions, increased support for academics (salary increases for scholarships and pensions that were below the minimum wage were realised as early as July), and the unexpected 50 per cent increase in public employees' base salary from September, that would be seen in pay pockets for the first time in October of that year. This increase was particularly important and significant since base salary was around 85% of the total remuneration, see Telegdy (2017).

[28] In the case of the first note about the programme, financial markets responded sharply – daily bond yields jumped up by a few percentage points (day-to-day change across maturities of $3-15$ years) and kept increasing almost until the end of the next week. However, on the day of its official announcement (press conference on Friday), and also a day before a correction occurred, the exchange rate responded with a small depreciation on the day of the government's approval ($\sim 0.2\%$ day-on-day change of the last value of HUF/euro, also visible in the official daily announced exchange rates by the MNB); the same data source as in the footnote 24 above. Even

Despite the limited applicability of the salary increase that was applied to the base salaries only, without effect on other public servants or employees in public companies, this measure is called 'a-50-percent increase' (see Telegdy, 2017). However, this radical salary adjustment brought about severe fiscal imbalances, as a budget deficit approaching 10% of GDP – only roughly estimated costs of these two 100-day-action programs could add as much as 4 percent of GDP in additional spending – sparked 'criticisms' from international organisations (EU, OECD), and subsequently led to a (forced) fiscal stabilisation program; for further details see OECD (2005); OECD (2007). This perhaps caused any further changes in the salary system to be postponed to later years (2005 and 2006).

Moreover, soon after the approval of the new coalition government, there were a series of political clashes between the new and old government, including accusations of public finances mismanagement (in early June) against the former right-wing prime minister and his government. Further political turmoil erupted after a news leak revealed the new prime minister as a former spy.[29] This resulted in a new wave of accusations from both sides of the political scene and eventually forced several politicians to step down, even from opposite (right) political parties. Supporters of the previous right-wing government also organised protest marches (mainly) in Budapest to demand the prime minister's retreat, and later, in first days of July, even demanding at least a re-count of election votes. However, the situation slowly stabilised from the second half of July, as individual measures of the 100-day programme started to work, and the government's approval rates began to rise.

Lending boom

The salary change described above was not the only measure that was likely to affect household incomes and their resulting consumption. Some funds obtained during the housing loan (mortgage) boom (see below) were often used for different purposes than they were originally intended. On the verge of the credit boom in 2000, Hungarian loan ratios (debt to income, assets) were at very low, single-digit levels, compared to the double-digit levels seen in other Western European countries at the time.[30] That situation was not atypical in Hungary, but it was more or less

larger fluctuations occurred later on because of further events in the early days of July, see below.

[29] A June 17th article in the conservative opposition-aligned newspaper *Magyar Nemzet* ('Hungarian nation') accused the prime minister of working for the Hungarian counter-espionage service under the former communist regime. He acknowledged that fact on June 19th; see Boyes (2002).

[30] The share of mortgages (as percent of GDP) was a mere 2.2% in 2001 but increased to 9.5% in 2004, while the share of household loans jumped from 7.5% to almost 20% over the same period according to Palacin and Shelburne (2005).

a common feature in almost all V-4 or more broadly in CEE countries, reflecting underdeveloped financial systems (historical heritage), and regional behavioural differences such as, preference of a saving concept over loan-based purchases of durable goods. However, individual (private) ownerships of homes and flats ($\sim 9/10$ of households) was much more prevalent in Hungary, compared with rather high communal or collective ownerships in other EU transition countries of the region (or the V-4); for a comparison of CEE housing markets see for example Palacin and Shelburne (2005) and references therein. Also, while housing prices development in Hungary had been growing at a very slow pace, without showing signs of a large price bubble even during the run-up period to the Great Recession, the opposite occurred in for example, the Baltic States, see Hildebrandt et al. (2012).[31]

The fast growth of loans was mainly linked to a government supporting scheme (re-)introduced in the winter of 2000 (original conditions were eased already in summer 2000) as part of the so-called *Széchenyi Plan*. After its final endorsement in January 2001, it enabled even low and lower income households to access loans.[32] This scheme involved interest rate subsidies (for further details see Kiss, 2002; Szalay and Tóth, 2003): (1) for issuers of mortgage securities (housing loans backed by issuing mortgage bonds) and (2) for private borrowers (up to 60% of the collateral value, local currency-denominated only) meeting rather strict but gradually relaxed criteria. Although these subsidies were originally only for new homes, they were later extended to existing homes in March 2002. As a results of this change, housing loans were subject to a steep increase in quantity, and accordingly became relatively cheap in comparison to standard consumer and other types of non-commercial loans.[33] This buoyant trend in the early 2000s was also supported by: (a) the limited use of credit cards since an overwhelming majority of issued cards belonged to the debit cards category, and (b) high interest rate charges for consumer and other credits,

[31] Nevertheless, there were periods of temporary fast price growth (during the credit boom described below), particularly in the (greater) Budapest region in the new millennium before EU entry, and a few traditional recreational regions.

[32] A system of housing loan subsidies was introduced in the early 1990s (declining size over its lifetime), and loans with an amortisation subsidy were aimed at stimulating the renovation, repairs or refurbishment of older buildings and new developments, for details see Hegedüs and Várhegyi (2000).

[33] This change also led to a significant reduction of interest rates for non-subsidized housing loans: by 5 pp when the average percentage rates of charge (APRC) was around 22% in 2000 for new housing loans, but only around 14% in 2002. Similarly, rates for consumer and other types of loans such as car loans were also influenced, see MNB (2001). For illustration, mortgage loans' share of total lending increased from around 33% to almost 50% in late 2002, with a real growth rate of 64%, and 34% for other types of loans (year-on-year for 2001), see MNB (2002). The majority of lending was carried out in local currency and was realised as long-term loans; only about 10% of loans in 2004 were in a foreign currency denomination (see Palacin and Shelburne, 2005). As a result, households net savings position turned into a balanced one.

only sluggishly reduced by means of financial institutions' competition, going hand-in-hand with previously high (double digit) rates of inflation, and a lack of necessary institutional measures.[34]

This situation was not only affected by rapid loan growth, but also by the modification of the loan subsidies scheme. In early 2004 a survey-based estimate cited by MNB (see MNB, 2004) stated that between 15% and 30% of the loans for existing homes were actually used for consumption purposes, because of widespread home ownership, and credit constraints that lead to low amounts of other financial assets. This increased further when strong growth in household consumption expenditures surpassed that of their real incomes. In comparison to some western countries, loan-to-market-value ratios were rather low, and only exceptionally exceeded 60% in mid-2002 (according to MNB, 2002), with the statutory limit being equivalent to 80% to 90% (see MNB, 2003).[35] In response to signs of instability and further systemic issues, particularly, rapidly increasing state budget costs, the loan subsidies scheme was modified in June and again in December 2003 in an effort to: (1) curb the demand of households for them and (2) change the 1 : 3 ratio (new vs. existing homes) to approximately 1 : 2 (see MNB, 2004). Anticipation of these changes drove up consumers' demand for these types of loans further, and their share jumped by 20 pp within a year (from 55% to 75%, see MNB, 2004a). Already in 2003 a GfK survey mentioned in *ibid.* revealed that three fifth of households did not have any financial savings, and half of them belonged to low income deciles. While there was an expected slow down after further regulatory changes,[36] another problem gradually emerged as demand was redirected towards foreign-currency denominated loans (which led to the financial crisis in 2007).

[34] One of the reasons for not using chip-equipped (credit) cards was to eliminate the possibility of large frauds, such as those that took place in the early 1990s because of low credit card security standards, for details see MNB (2002).

[35] Even that value could have been too high, given particular characteristics of the Hungarian housing market, such as high ownership ratio and the limited resellability of many properties.
In short, similar to other countries in the V-4 group, structural adjustment (reform) programmes carried out in the early 1990s and high rates of inflation changed valuations of individual assets. However, as the situation improved, the process of selling publicly owned houses and flats (from 1992 in Hungary) increased supply compared to demand. A description of the Hungarian housing market's early development can be found in Valkovszky (2000).
These dynamics started to reverse around the beginning of the new millennium, mainly driven by a rapid increase in prices in (greater) Budapest, and speculation on price increases in the wake of the EU accession that peaked in 2003, see Vadas (2007). Importantly, MNB (2003) provides a piece of information on real residential property prices; they were 75% higher in 2001 compared to 1997 (and in 2002 and later because of construction activity).

[36] Nevertheless, a further restriction of conditions took effect in 2005 (only new homes, younger generation, value of property for loans, etc.), see MNB (2004b).

4.2.3 Identification strategy

In this section I present the main steps of my identification strategy. As already mentioned, I link employment and budget data to analyse the effects of the salary change on consumption. Households are represented by household heads that are identified using a standard approach, that is, as adult members of households with the highest total (gross) income.[37] The definition of a household, as being equivalent to a consumption unit, enables to analyse consumption behaviour around the salary change for a larger number of different types of expenditures, since it dampens the problem of missing observations (expenditures of a particular type). Moreover, it seems to be rather innocuous to assume that household consumption profiles are primarily driven by their heads (families) controlling for main household characteristics, particularly in case of durable consumption items.[38]

The identification of income shock effects is rather challenging since the household budget survey (HHBS) does not contain any precise information about the type of employment (sector) for any adult member of a household over all years of interest. The HHBS offers an indirect way of selecting 'treated' households from the others since there is a 4-digit standard classification of occupations' code (FEOR-93, that is, the Hungarian version of international occupation classification, ISCO-88) among a list of various characteristics of an adult.[39] The same classification codes are available both in the employment-income survey and in the HHBS, and the employment survey covers both private and public workers. It is thus possible to use the code classifications to calculate a measure of public coverage of individual occupations ('jobs') in the economy.

In my analysis I use a measure that represents age-gender-occupation specific probabilities (occupational probabilities) that represents the probability that a

[37] Alternatively, one could define household heads using other criteria such as age, gender, which are also commonly utilized in empirical studies.
I also define a new classification using the original datasets to match the number of households as follows (for a similar treatment of household heads, see for example Gorodnichenko et al., 2009): the person with the highest primary labour income; in the case of younger/older households without any labour income: male or the oldest person in the household. The original dataset used the highest earning person in the household; alternatively a male or the oldest person. The correlation of both definitions of household heads was larger than 0.85 across the sample period (16^+ sample). Moreover, there were less households with missing primary labour income in my definition of household heads.

[38] This is similar to Baker (2017) and his links across financial datasets and consumption/population surveys. Alternatively, one can analyse the consumption behaviour of adult members of a household such as unmarried couples or single persons sharing one household, which is less common in Hungary than in more developed countries, in the case of unexpected income shocks.

[39] For example the code 2431 represents *Primary school teacher* who belongs to the group 243, *Kindergartens and primary educational institutions teachers, trainers and educators* are within the subcomponent 24, *Educators and teachers* are a part of the group 2 *Professional Occupations*.

member of a household (household head) of a certain age (between 18 and 60 years or less) and gender works in the particular occupation j in the public sector. These probabilities can be calculated using the following formula (4.4):

$$Pr^{occ_j}_{h,i,a,t} = \frac{N^{occ_j}_{h,i,a,t}}{N^{\sum(.)(j)}_{h,i,a,t}}, \tag{4.4}$$

where $N^{occ_j}_{(.)}$ is employment in occupation j in the public sector, $N^{\sum(.)j}_{(.)}$ is the total employment in the same occupation j across sectors (that is, private and public), and the subscript indices of the $Pr^{(.)}_{h,i,a,t}$ represent: a probability for a particular individual (household member h), a gender (i), an age group (a), and a year (t) respectively.

Since many household heads working in the public sector do not have their main occupation according to the 4-digit classification, probabilities are calculated for the 3-digit classification (as a robustness for the 2-digit classifications). Since not all public workers were exposed to the unexpected increase, workers in the judiciary system and public servants are not included in the public employees group as already explained above. Additionally, employees in public enterprises were also not included since their contracts are similar to private ones.

Calculated probabilities are then utilized to identify those household heads (as likely or very likely) that work in particular occupations in the public sector. Since the matching is 'probabilistic', a range of occupational probabilities between 60% and 90% (adjustable by using an interval of five percentage points) was used to create the treated (affected) group of households, a likely-to-be-treated group of household (with probabilities above 50% up to previous threshold), a likely-to-be-control group of households (with probabilities below 50% and above the complement of 10% to 40%), and the control group consisting of households with (10% to 40% probabilities of working in the public sector). This is illustrated below in table 4.1. The robustness of these results is checked by moving between the lower and upper bound for the control group, and changing the probability of working in public sector by five percentage points. This check produces very similar results results. Therefore, I set the benchmark results at a 70% probability of working in public sector.[40]

[40] Because the retirement age was lower at that time (mainly female workers), and to avoid any retirement age related issues, probabilities were also calculated for the sample of workers between 20 and 56, or alternatively between 25 and 56 years (the narrowest definition of household heads).

Table 4.1: Examples of groups of probabilities utilized for treated and control group

	Treated	Likely treated	Likely control	Control
I.	$Pr_t^j \geq 0.60$	$0.60 > Pr_t^j \geq 0.50$	$0.50 > Pr_t^j \geq 0.40$	$Pr_t^j \leq 0.40$
...			...	
VII.	$Pr_t^j \geq 0.90$	$0.90 > Pr_t^j \geq 0.50$	$0.50 > Pr_t^j \geq 0.10$	$Pr_t^j \leq 0.10$

4.3 Data and preliminary empirical evidence

4.3.1 Income and consumption dataset

Data come from various sources since there is no unique survey providing detailed information on both characteristics in the desired structure. The employment (income) component makes use of a database complied by Telegdy (2017), while the consumption component comes from yearly published Household Budget Surveys by the Hungarian central statistical office (HCSO). These sources are supplemented with data from a cleaned and harmonized dataset provided by a research unit of the Hungarian Academy of Science.[41]

The income-employment dataset makes use of the Hungarian Wage Survey Data conducted by the National Employment Office every year in May. Beside the information on a type of employment contract (private or a type of public), few further socio-demographics and economic characteristics are collected (gender, age, occupation, structure of earnings, working conditions, region and a dummy variable for new workers).

Employment data are collected differently depending on the type of sector. Workers in the public sector (public employees and public servants) working for organisations run by central and/or local public authorities are sampled exhaustively for most organizations.[42] For those that do not have a centralised accounting system, the same rules apply as for the private sector.

Data on private sector employment are collected by the size of firms: there

[41] Mainly to check and harmonize series of expenditure items that changed definitions and labels (codes) over the sample period.

[42] Public sector employees account for about 85% of the sample since they represent most of workers across public healthcare, education or administration. Employees in the judiciary system are excluded since they are subject to different types of contracts (no unexpected increase in salaries). Similarly, employees in publicly owned firms are subject to labour laws, and are therefore merged with those operating under private system contracts. Moreover, the sample excludes (affected) employees in some specialised professions (employees protecting lives and wealth), however, consumption data are available for all types of workers and have to be adjusted accordingly.

is a random sample of small firms (up to five employees) that are required to report information on all their employees. The same full reporting system is used for all firms with less than 50 employees since 2002. In the case of larger firms (originally with employment above 20, from 2002 above 50 employees), only information on selected workers born at particular days in a month is collected.

Because the differences between both sub-samples of the survey are important to its representativeness on the national level, private firm series were adjusted with the help of the National Tax Authority (providing information about all double-entry book firms, for details see Earle et al., 2012). Similarly, data on public units were adjusted with the help of records on employment in education, health care, administration and the other public sector activities. The final dataset contains full time employees only (18 through 60 years) with personalised weights allowing consistent aggregation across occupations and sectors. However they do not have their own ID and can be followed over time only using their characteristics. The random sample coverage of both sectors is approximately two-third and seven percent (public and private sector respectively), see Telegdy (2017) for details on the data construction.

A brief inspection of table C.11 (and also table C.12 in the appendix) reveals that the structure of public workers is different in some aspects compared to that of private sector workers. There are many more workers in manual professions, including technicians or specialists. Public employees are also older in terms of average age and more represented by females. Also, their experience structure (not shown) is shifted towards higher values, that is, they tend to stay longer in the sector, and the share of newly hired workers is somewhat lower compared to the private sector.

The second source of data in the dataset is the Hungarian household budget survey. It is one of the longest-running in Europe and also in the world, dating as early as 1949.[43] However, owing to institutional changes, there are natural differences in the survey's coverage or its structure over the period. The current structure has been used since 1993 (with some changes in 2002 and 2005, see below), with surveys conducted every year. Because of interest in the unexpected change of salaries, my sample is restricted to the period 2000 through 2005. Compared with other budget surveys, quarterly series for Hungarian households are not available (because of the survey structure).

Households for the HHBS are selected utilizing a stratified random sampling method (two stages), and the survey covers a total of around 9000 households in a

[43] Probably the oldest is a Swedish survey, whose beginning can be traced back to 1907.

year. For the analysis, sample sizes vary between 4500 and 6500 households with active household heads between 18 and 60 years (as a result of relatively low labour participation rates – around 62%, and a rather fast ageing population; some statistics are in table C.13 in the appendix). In the first years of the HHBS, households were followed over a few years and medium-run characteristics could be constructed (three-year rotating panels, between 1993 and 2001), see Kapitány and Molnár (2002). That type of survey was subsequently replaced with a rotating panel of households similar to the US CEX survey (only cross-section information is available or cohort (average) characteristics). Moreover, between 2004 and 2005, the survey was partially remodelled (income information and more detailed COICOP structure up to 4th level) to be consistent with the labour force survey (LFS) that was harmonized across EU countries.[44]

For the dataset, the same caveats hold as with its well-known western counterparts, particularly, regarding the coverage of very low and very high income households, and misreporting issues (for details see Eurostat, 2003 or Eurostat, 2008).[45] Income and expenditure data are obtained from both one-month-kept income and expenditure diaries. Information about irregular expenditures (for example on housing) and annual income are collected in follow-up interviews. Field workers conduct two personal interviews at the beginning of the survey (basic information on households, in spring), and at the end of a year, in order to collect further information (see above) on the household and their members. The interviews provided a comprehensive source of information since they capture many household characteristics (demographic, professional, individual), as well as information about household's dwelling (type, location, appliances), wealth or borrowing-related characteristics (some characteristics vary over time, such as questions related to daily commuting, or those releated to income/economic situation expectations).

For this study, all income and expenditure series were converted to real Forints (HUF) with the base year = 2005. For the analysis only households with positive amounts of expenditures or income are considered.[46] As a robustness check,

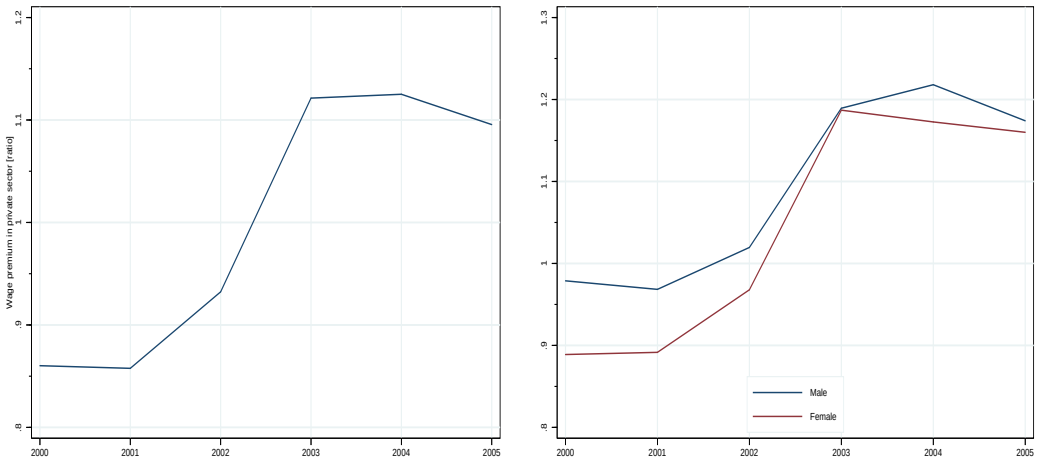
[44] The quality of data from HHBS meets standard quality requirements for budget surveys. However, the survey is not represented in a few dimensions (see Eurostat, 2003; Eurostat, 2008 or Hosszú, 2011), such as coverage of very poor or very rich people because of high rejection rates. A small bias is introduced since the aggregation of individual expenditures in the HHBS represent approximately 85% of the national account aggregate across the sample period. As a robustness check, one could also rescale all individual expenditures and re-estimate the model specification.

[45] Misreporting may stem from attempts to hide some expenditures (called 'guilty pleasure' items) such as, alcohol and cigarettes belonging to the category 'conspicuous consumption', which could arouse suspicion from authorities, or simply 'forgetfulness', typing errors, etc.

[46] The exclusion of the bottom and top 1% households – for income or expenditures – does not affect results significantly.

Figure 4.1: Income ratios in private vs. public sector, 2000–2005

(a) full sample (b) full sample by gender



Note: differences in earnings of public and private sector employees, full sample for both surveys (18–60 years), weighted data for the population (see main text). Source: own calculation.

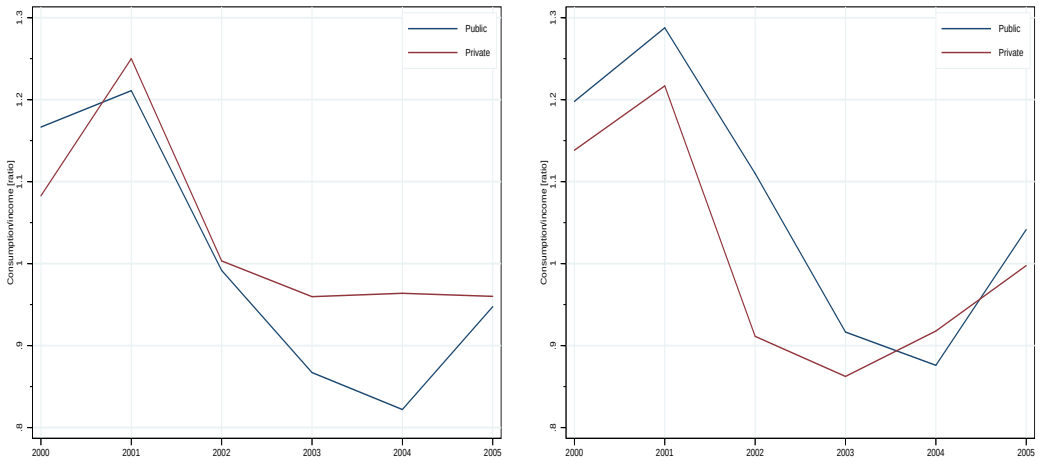
new household heads were calculated to represent the highest earning person in the family. Comparisons to the official (HCSO) definition of households show that between 85% and 90% of heads remained the same in the 16^{+} sample, or between 75% and 79% in the most restricted sample (25–56 years old heads). However, this modification resulted in a higher number of observations (households) with non-missing or non-zero primary labour income. These results are summarised in the appendix.

The panels in figure 4.1 compare the income premiums for private sector employees with those of public sector employees. The dynamics reveal a reduction of the public income gap (from about 10 pp in 2001), and its reversal into a surplus of approximately 12 pp in 2003 and 2004 going down to 9 pp in 2005. Panel b) of the same figure plots premiums by gender and reveals the well-known fact that female's remuneration is on average lower than that of men: while differences for male public employees was negligible in the years before and after the change when they turned into a positive gap of about +20 pp, the negative gap for females (around -11 pp) was reversed and stood at about +15 pp in 2005; for more evidence on different trends for selected experience or gender or occupational groups around the year of change see Telegdy (2017).[47]

Figure 4.2 provides evidence of a ratio of two medians for both real consumption expenditures ($\tilde{x}_{0.5}$) and real primary labour income, in both sectors. The

[47] As shown in table C.11 in the appendix, around $^{3}/_{4}$ of public sector employees are female.

Figure 4.2: Consumption/income ratio for private and public sector, 2000–2005



Note: probability of very likely working for public sector ($\Pi_{j,\,t} > 0.70$) (left) and probability of likely working for public sector ($0.50 > \Pi_{j,\,t} \leq 0.70$) (right), full sample (18–60 years, right). Household heads with entrepreneur type of income (fully/partially self-employed) are not included in the figure. Source: own calculation.

large ratio of median consumption and income in the early 2000s points towards insufficient resources based on primary income only.[48] For comparison, Jappelli and Padula (2014) show consumption/income median shares for Italian households (also defined for private and public sector) that partially overlap with the sample period. For these households the shares oscillated between $0.7 - 0.8$, and values above 0.9 were observed towards the end of 2000 for the private sector only.

[48] There are two possible explanations: firstly, the figures show primary gross labour income as being the only source of income, without any tax and obligatory social security payments being subtracted/added. The figures do not reflect any secondary or other sources of incomes and/or social allowances; similarly in case of grey economy's side payments or artificial under-reporting of household incomes from both sides of income distribution. Calculations based on HHBS data show that all the aforementioned 'extras' amount to around 55% (on average) of gross labour income, with various aid, allowances and benefits and obligatory tax + insurance payments largely netting out themselves across deciles of households (see also Hosszú, 2011). Therefore, it seems to be rather a crude measure of 'available' income for households. Nevertheless, as it stands, on average, it would not cover all expenditures in a year, and had to be complemented with the use of savings and/or other types of income(s) ($\sim$ 1/4 on average). Moreover, there is some evidence on 'net' *APC* of households by deciles available: up to the 3$^{\text{rd}}$ decile was above 1.0 before 2004, while the average for all deciles hovered around 90% (similar to national accounts averages) in the same period; for details see *ibid.* This resonates with some early evidence showing average *APC* above 85% for all households in the late 1990s, see MNB (2000). Secondly, it could point to a problem of the consumption dataset, that is, lower quality income data in the survey (because of misreporting, typos, etc.). This is a well-known problem of household surveys in many countries including the UK or the US, see for example, discussions in Baker (2017).

4.3.2 Estimation strategy

Prima facie evidence shown in the panels of figure 4.3 (or in C.1 – C.4 in the appendix) reveals some consumption related effects of the (un)expected salary change. However, it cannot be viewed as fully satisfactory and therefore, the next step is a regression analysis. This analysis helps to reveal the effects of the salary change (exogenously generated variation in income because of the government intervention) on households' consumption, while controlling for the socio-economic and demographic characteristics of households. For that purpose the following model is estimated:

(4.5)
$$\ln(consumption_{i,t}) = \alpha + \beta_{PE} \cdot PE_i + \beta_D \times D^{POST} + \beta_{TE} \cdot PE_i \times D^{POST} + \mathbf{\Gamma} x_{i,t} + \epsilon_{i,t}$$

where $\ln(consumption_{i,t})$ is the natural logarithm of total consumption expenditure in year t of a household i, D^{POST} is a dummy for the post-increase period (2003–2005), $x_{i,t}$ represents a vector of household specific and environment-related covariates (the highest attained level of education, age and gender of the household head, family size and region), and $\epsilon_{i,t}$ is an error term. Alternatively, the left hand variable is replaced with the $\ln(consumption/income)_{i,t}$ variable, that is, with the ratio of the natural logarithm of total consumption expenditure over primary labour income in a year t for a household i, with the remainder of the model being the same as model (4.5).

There are a few concerns about the validity of my results, related to the assumptions for estimation. Firstly, whether the change of salaries is exogenous with respect to consumption decisions of the household. Given the fact that the change of public employees' salaries in 2002 was unexpected (at least the actual magnitude as I argued in previous sections), there is no endogeneity concern. The reform was primarily aimed at improving the remuneration of public employees compared to their private sector peers. Secondly, a more difficult assumption is that the salary change should be exogenous regarding the sample composition. There is only limited evidence of employment switches since the employment-income survey only contains information about newly-hired workers, but no information about their previous job.[49] Telegdy (2017) provides some evidence on employment in the private and public sector up to 2006 (unfortunately for all public sector workers only) that reveals (compared to base level in 1998) a reduction in employment up to 2001, an increase between 2002 and 2003, and a decline until the end of the sample period. In contrast, there is slowly increasing employment in the private sector

[49] While that information could be obtained from an institutional database of all workers, I could not gain access to that source and it is thus left as a future extension of this study.

throughout the period. Therefore, I also compute a share of newly hired workers in both samples to obtain some indirect evidence of workers' turnover in both sectors. While in the public sector it was oscillating around 7% up to 2002 and around 5.5% afterwards (and a declining trend), the private sector had a positive non-zero trend throughout the period, reflecting an increase from about 9% to almost 11% at its end. Accordingly, I cannot test this hypothesis explicitly with available datasets since this evidence is rather indirect. Nevertheless, it seems that job market patterns did not change (substantially) in the wake of the change of public workers' salaries.

Since the probabilistic measure can vary from year to year, results are shown for three specifications: with no restrictions on probabilities and with fixed distributions of probabilities before the unanticipated change (for 2000 and 2002 since 2001 is similar to 2000). Firstly, results for both specifications without covariates are summarised in table 4.2. In columns two and three, there are models with occupational fixed effects without time effects (TE), and with a restricted set of TE, respectively (a linear time trend approximated by the variable *year*, column 3), and finally in the next column (4), with both types of fixed effects. The last two columns repeat the full two fixed effect specifications. The coefficient on the probability of working in the public sector (Π_j) times the post-treatment dummy (D^{POST}) is highly significant, and has the expected sign across specifications. Its estimated size is around 0.1 (for models including any type of time effects). Results of the F-test are also reported and confirm the significance of my specification. However, their values still indicate rather weaker (imperfect) identification since they are close but somewhat lower than 10 ($\sim$ 9.3 for time varying probabilities in column 4). Nevertheless, I proceed with the estimation and show results for the second stage.

The reduction of the sample for household heads between 25–56 years old (not reported), and between 20 and 56 years does not change results substantially (see C.1 in the appendix). The estimated effect of the post-treatment dummy and the probability of working in public sector is slightly higher for time varying probabilities (around $\sim$ 0.13), effects for fixed time probabilities is almost unchanged (around 0.09).

4.4 Empirical results

4.4.1 Baseline results

In the next step (second stage), development of primary labour income is linked to the development of consumption (total expenditures on goods and services) and their share on labour income (average propensity to consume). Subsequently I will explore

Table 4.2: First stage results

	time varying probabilities			fixed probabilities (= 2000)	fixed probabilities (= 2002)
Probability (Π_j)	-0.180***	-0.036	-0.043	0.013	-0.083**
	0.036	0.032	0.031	0.027	0.033
$\Pi_j \cdot D^{POST}$	0.397***	0.117***	0.117***	0.095**	0.095**
	0.003	0.033	0.003	0.038	0.038
year		0.066***			
		0.005			
Constant	7.216***	-124.261***	7.051***	7.226***	7.693***
	0.036	10.189	0.0150	0.020	0.028
Observations	19357	19357	19357	21515	21515
R-squared	0.347	0.579	0.367	0.350	0.349
Occupation FE	yes	yes	yes	yes	yes
Time FE	no	no	yes	yes	yes
Lin. time trend	no	yes	no	no	no
F-test	170.17	12.38	9.27	6.08	6.21
P-val	0.002	0.000	0.003	0.015	0.014

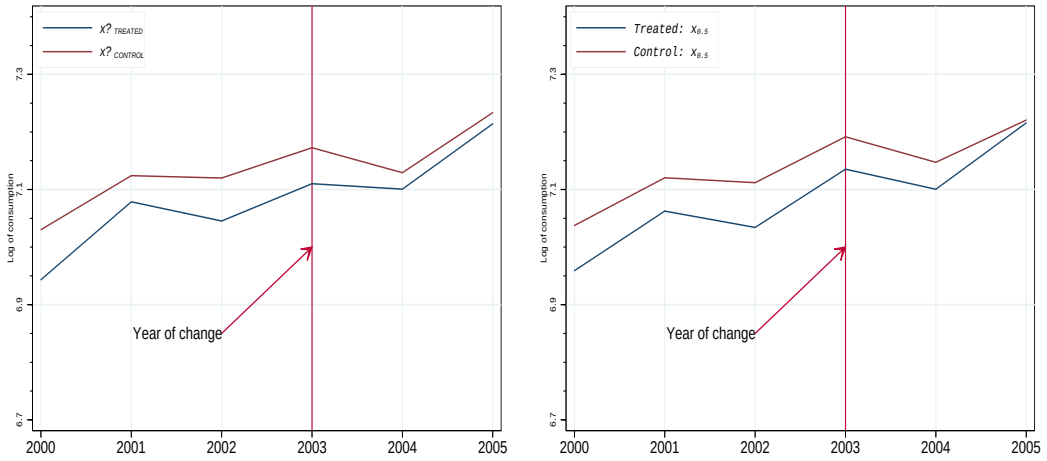
Note: Π_j is the probability of working in the public sector. Calculation is based only on positive labour incomes; for details see main text. Occupation FE and year FE not reported. Clustered S.E. at the occupational level. Households heads between 18 and 60 years *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level. *Source*: own calculation.

effects for selected subcategories of consumption such as total expenditures, without strong life-cycle hypothesis (LCY) related expenditures on health and education (category commonly used in PIH-LCY literature), or durables and non-durables.[50]

To begin with, averages of total household expenditures are shown in figure 4.3 (for probabilities of working in public sector equal or higher than 70%). Since only yearly series are available, the first observation capturing the effects of the intervention is in 2003, marked with red line in panels of the figure. Pre-change trends (2000–2002) are relatively similar for the treated and control group of households. Effects of the unexpected increase are less visible in the case of median total expenditures, which is presented in panel b) of the same figure. If total expenditures less health and education related expenditures are plotted, patterns are slightly different and these changes of expenditure are more visible. For example, figures C.1 – C.4 in the appendix show the mean and median of total consumption for subgroups of households, that is, household heads between 20–56 years, and for total consump-

[50] The number of possible consumption aggregates to be utilized for comparison is limited because the time series spans years from the early 2000s, where few changes in the HHBS methodology occurred.

Figure 4.3: Total expenditures – mean (left) and median (right), 2000–2005



Note: all expenditures for household heads between 18–60 years, probability of working for public sector ($\Pi_{j,\,t} > 0.70$), trimmed data (positive value only) to eliminate outliers defined as those observations/years below the 1^{st} and above the 99^{th} quantile. Source: own calculation.

tion expenditures less expenditures on health and education, that is, without the two types mostly related to the LCY behaviour).

In the second step, I pool individual years of HHBS to create a pseudo panel (consumption dataset) of Hungarian households organised by household heads (defined on the basis of the main breadwinner in a family), as it is commonly done in the consumption literature (following suggestions by Deaton, 1985 or Heckman and Robb, 1985). Apart from running a simple specification of the model (4.5) for the dependent variable, an extended model is added to include a set of explanatory variables (controls): age, gender and the highest attained education of the household head,[51] a measure of household size, and a regional dummy.[52] This model specification should not change the main conclusions since individual variables should affect the strength of the change in income (reduced it). In case of a regional variation, I use a regional dummy because the sample size for individual regions takes only the value = 1 if a household lives in Budapest or the Pest region (mostly suburbs of the

[51] The educational levels were defined as up to full primary education, secondary education (finished with a GSCE type leave certificate or international baccalaureate including vocational training), lower tertiary (up to bachelor's degrees, special post-secondary education of a more professional type, and upper tertiary for masters and higher degrees (PhDs).

[52] The household size is restricted to eight, so that households with more than eight members takes the same value; there are only a few observations of that particular size in the sample. I also experimented with different consumption units as a proxy for the size of household, using so-called OECD measures. Since there are negligible differences, the simple specification is preferred and utilized across models.

greater Budapest region, comprising around 20% of the yearly sample), and 0 for any other region in Hungary.[53] For the robustness section, I include seven NUTS II regions based on that Eurostat classification of EU regions.[54]

Table 4.3 summarizes the results of the intervention in terms of the baseline specification (for consumption columns 2 and 3, and for consumption/income ratio in columns 4 and 5). In the second column, the simple specification reveals that the consumption of public workers is lower (but not significantly) when compared to private workers, by 0.02 (in log terms). The post dummy is positive and statistically significant, which means a common trend of consumption expenditures for both groups of workers. The interaction of post-increase dummy and dummy for public workers is positive (increased consumption by 0.01 in log terms) but insignificant. The next column of the table comprises household variables, controlling for differences in consumption across households coming from similar age, gender, household size, attained education, or region where they live (greater Budapest or elsewhere). All of them have the expected signs and are statistically significant, and the three main dummy variables associated with the effects of the salary increase do not change sign or significance.[55]

The second to last and the last columns show results for average propensity to consume (APC): Firstly, for the set of change-related dummy variables, and subsequently for specifications with the same set of controls as in column 3. The simple specification reveals negative and statistically significant differences in APC between public and private households (-0.017). This was expected based on evidence shown in figures above. Although it also indicates a negative trend in APC shares in the post-change period, the effect on public workers (negative) is insignificant. The same set of controls utilized in the first part of the table reveal a negligible but somewhat smaller APC for older household heads, heads with higher education levels, and household heads living in the greater Budapest region. Conversely, as expected from the theory, MPC of males and larger families is higher.

[53] There are originally 20 regions in Hungary in the dataset available. Some observations are rather small, amounting only to few per cent of the total sample, and therefore not meeting the criteria of being an NUTS II level region specified by Eurostat, see Eurostat (2016).

[54] These NUTS II regions include: central and northern Hungary, Transdanubia (3 sub-regions), and Great Plain (2 sub-regions).

[55] The additional controls are in line with expectations since consumption increases with age, household size and attained education level. It also shows that living in the greater Budapest region has a small but significant impact on the level of consumption. Moreover, consumption from males is larger than their female counterpart.

Table 4.3: Baseline specification

	Consumption (log level)		Consumption/income	
DGOV	-0.022	-0.023	-0.017***	-0.009**
	[0.023]	[0.020]	[0.005]	[0.005]
POST	0.118***	0.102**	-0.043***	-0.005
	[0.045]	[0.040]	[0.009]	[0.009]
G_POST	0.005	0.030	-0.002	-0.008
	[0.033]	[0.029]	[0.007]	[0.006]
age		0.004***		-0.000**
		[0.001]		[0.000]
male		0.338***		0.036***
		[0.013]		[0.003]
fam. size		0.062***		0.015***
		[0.007]		[0.001]
secondary		0.241***		-0.037***
		[0.018]		[0.004]
lower tertiary		0.474***		-0.081***
		[0.021]		[0.005]
upper tertiary		0.640***		-0.091***
		[0.025]		[0.006]
Budapest		0.049***		-0.026***
		[0.016]		[0.004]
Constant	7.060***	6.263***	1.049***	1.053***
	[0.020]	[0.046]	[0.004]	[0.010]
Observations	5,225	5,225	5,225	5,225
R-squared	0.014	0.260	0.044	0.182
F-test	24.45	183.6	80.01	115.7

Note: sample of households (20–56 years), with primary education. Standard errors are reported in brackets. *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level. *Source*: own calculation.

4.4.2 Age and consumption aggregate specific estimates

When the same specification is executed for a larger sample of households (18–60 years) or conversely for a smaller sample of households (25–56 years), results do not change significantly. Alternative specification were estimated using a simple split-up of the full sample to see how results vary across subgroups of households (public vs. private employees/households). Three roughly equal groups were created: a group of younger, medium and older age household heads, each representing approximately ⅓ of the sample: 20–35 years old, 36–45 years old and 46–56 years old. Results for this estimation are shown in appendix tables nos. C.2 – C.4. While there is no significant difference for the youngest group, in the case of the medium age

group, there is significant effect in the extended specification for APC, where the dummy for public worker times the dummy for post-change period is negative and significant (higher income reducing APC). One can expect that these workers are from occupations with higher salaries (upper levels in the public salary-experience grid), where a change of the base salary results in larger increases in disposable income, while controls preserve their signs and significance. However, the expected positive impact on income with seniority is not confirmed in the last estimation for older households, where only the specification for APC without any controls has statistically significant variables of primary interest (public worker and the post-change dummy).

So far my specifications included only the total consumption expenditures aggregate. Since the aggregation procedure can hide some trends otherwise observable, I carry out an analysis across consumption aggregates. Tables C.5 – C.8 in the appendix present results for the base sample with and without controlling for the same set of household determinants for selected sub-aggregates: (1) total consumption aggregate excluding health and education related expenditures, (2) durable consumption, (3) services and (4) food consumption.

While there are only minor differences for expenditures without health and education, estimates for durable goods consumption show different patterns; in levels where the post-change trend turns insignificant and the dummy for public sector households becomes weakly significant (at 10% level). There are more changes in the case of the APC model (both dummy for public sector households and its interaction with post-change trend turn positive and are significant), while the post-change trend still has a negative sign but turns insignificant. Also some of the controls for the extended specification are insignificant (age, size or some educational categories).[56]

In the case of the consumption of services, the level of consumption is similar to the base estimation results. However, the APC specifications show that households of public workers consumed more services (coefficient 0.02), and there was an additional statistically significant increase after the salary change (0.05). These results are confirmed in the extended specification, where both the dummy for public workers (0.03), post-trend (0.03) and their interaction (0.04) are statistically significant with positive signs. In the case of controls, there were positive coefficients on age (was near zero in the base specification), and on household heads who attained the secondary level of education. However, there is no difference in consumption for

[56] There are only negligible differences in the case of estimates for non-durable consumption. Owing to space considerations, these are available upon request from the author.

male and female headed households.

In the case of food consumption (food, beverages including tobacco and alcohol), differences in consumption levels turn significant (still with negative signs), both without and with the inclusion of other determinants keeping their levels of significance and signs. When looking at the *APC* specification, the post-trend dummy is significant in both estimated models, the public sector dummy and its interaction with post-trend dummy change signs (higher level of consumption in public sector households) but only the interacted (G_POST) dummy in the model without covariates remains significant (the oppose it true in the case of the dummy for public workers).

4.4.3 Robustness of base results

In this section I aim to address the main concerns of the estimation procedure, and accordingly show that my results are not driven by violation of assumptions for difference-in-difference techniques. One of the most important concerns is the existence of the same or very similar trends in consumption behaviour in both sectors. The figures above showing the development of consumption already address this issue. Nevertheless, Bell et al. (1999) suggest two estimation procedures to identify any potential violation of this crucial assumption: (1) a placebo dummy in a reduced sample, when the post-change dummy is shifted to a time before the actual change happened (because of the sample structure, I moved it to 2001 and set it equal to 1),[57] (2) the placebo dummy is interacted with the dummy for public sector workers in the full sample (2000–2005).

I employ the model set-up shown in equation (4.5), but focus on the coefficient of the placebo dummy, whose significance would mean not passing the test for the difference-in-difference estimator (the main identification challenge). In the case of ad (1), the coefficient on the interacted dummy is not significant, which supports the same trend hypothesis assumption (not shown). The same is true when the other specification is estimated. I also follow Jappelli and Padula (2014) and include the correctly generated post-change dummy (D_POSTT) and its interaction with the public worker dummy. In terms of signs and size, their estimates are comparable to the base estimates. This can be seen as another sign of robustness of my findings (see table C.9 in the appendix).

The baseline specification and further (robustness) estimations control for both the household specific environment and partially for the general (macroeco-

[57] The use of this approach is rather limited since it means that there is only one year before this change and one year after it – years after 2002 are dropped.

nomic) environment, and thus increase the validity of the presented estimates. Further robustness tests can be carried out to check for particular deviations from the standard set of controls. For example, the set of household (family) controls could be expanded to allow for different types of economies of scale within the family (e.g. so-called OECD consumption units),[58] the number and structure of non-active members of a household (children in particular), finer education or age groups, or localization determinants. In the case of geographical location, only the simple dummy for the greater Budapest region versus the remaining regions is utilized. Therefore, I conduct a robustness check using a set of seven dummies representing the seven NUTS II regions in Hungary (see the footnote 54 above), with results presented in table C.10. Although these dummies are not reported, the results are quite similar to the baseline specification (A lower level of disaggregation such as a national definition of regions or NUTS III regions, cannot be utilized due to a limited number of observations for individual levels or a lack of detailed regional information.)

Furthermore, robustness checks were also carried out after a decomposition of total consumption into a few main aggregates and household head age groups. I do not report these results since they were similar to those already presented. Another set of robustness checks investigates sensitivity of my results with respect to trimming the distribution of dependent variables, when smaller and larger amounts of expenditures were eliminated (only zero observations or those below the 5% and above 95% quantiles). These checks do not lead to significantly different results compared to results presented in the paper.

4.5 Conclusion

Although a number of studies have explored the changes of income and their effects on individuals' consumption behaviour, most of them have focused on events that can only hardly be characterised as (truly) unexpected. This paper utilized a quasi-natural experiment (government intervention) related to an unexpectedly large increase of public sector employee in Hungary. This particular set-up allows to estimate the effects of this shock on consumption behaviour of public employees, which can be compared to that of private employees.

Because of data limitations, I construct age-gender-year-occupation specific

[58] As already mentioned above, I try two alternative OECD consumption units except for the simple size proxy utilized throughout the paper, and the results are comparable. Therefore, I prefer the simple size variable since it is the most restrictive specification in terms of economies of scale within a household.

probabilities for the purpose of identification of employees subject to the government intervention. These computed probabilities allowed me to link the information from employment–income labour surveys with consumption expenditures and household characteristics coming from the cross-sectional household budget surveys. While the effect on employees' labour earnings is identified and robust to alternative specifications, consumption responses (behaviour) did not show the large variation that is expected in the case of standard LCY and/or PIH type of models and their predictions. Only some subcomponents of the total consumption expenditures (such as services or durable consumption) show variation as a result of the unanticipated change. However, when consumption expenditures are related to income (average propensity to consume), my results show significant changes of these ratios. In addition, estimates for households grouped by household heads' age show differentiated responses for younger and older households.

How can these results be reconciled? One can think of the following two possibilities. Firstly, the documented talks about the rather low pay of public employees, and salary increases in some sub-groups, may have resulted in some sort of expectations of a change for the others (possibly related to the election campaign of the main rival parties in 2002). In this case, the only question may have been 'when' and 'by how much' given the situation of public employees at that time. Therefore some subsequent gradual adjustment of households' consumption profiles could have taken place. However, the change was much too large (even compared to previous rather moderate changes) to be fully compatible with this explanation.

Secondly, given the description of the Hungarian economy and financial markets, particularly the dynamics around subsidized housing loans, there is some evidence that loans were used for other purposes not directly related to purchases or renovations of houses or flats. This redirection of funds would change both the total expenditures and some of their specific subcomponents such as consumption of (non-)durable goods. Although this 'generous' loan scheme was in use since end of 2000, the main increase in the number of provided credits occurred in 2001 and partially in early 2002, just before the salary change took place. In late 2002 and early 2003 some households' budgets were already constrained by loan repayments and other outgoings. Therefore, it can be argued that the salary increase was not reflected in already inflated levels of expenditures, but instead had the unintentional effect of working as a safety net for constrained households facing serious financial (repayment) difficulties in late 2003 and later. This explanation is further supported by the observation that the group of treated households' consumption expenditures gradually caught up with those of the control group of households in 2004.

There is still a great deal of room left for further research. Since households are identified by household heads, it would be possible to analyse the impact on households with more than one public sector employee and thus investigate differences in behaviour within public sector households. The combined dataset utilized here only has a small sample of private companies, so one could utilize administrative data to obtain the same information as in the case of public employees (and further complement the information on public sector). As a result, the probabilistic part of my exercise could be improved, to allow for a more detailed identification, and perhaps 'matching' of public sector and private sector workers with the household consumption dataset. Such data enhancements on the income side would help identify those household heads in the consumption survey that are now lost due to missing observations. Future research could also aim to explain workers' behaviour (selected groups of workers), for example, their motivation to change their jobs (mobility across occupations), and the qualitative characteristics of public sector workers after such a large income shock.

Appendix C

C.1 Figures and tables

Table C.1: First stage results (20–56 years)

	time varying probabilities			fixed probabilities (= 2000)	fixed probabilities (= 2002)
Probability (Π_j)	-0.161***	-0.016	-0.023	-1.435***	0.112***
	0.036	0.032	0.031	0.025	0.028
$\Pi_j \cdot D^{POST}$	0.406***	0.128***	0.126***	0.093**	0.087**
	0.034	0.035	0.040	0.040	0.040
year		0.065***			
		0.005			
Constant	7.197***	-122.013***	7.033***	7.886***	7.228***
	0.036	9.890	0.0150	0.032	0.021
Observations	18229	18229	18229	20090	20090
R-squared	0.345	0.576	0.361	0.349	0.344
Occupation FE	yes	yes	yes	yes	yes
Time FE	no	no	yes	yes	yes
F-test	145.66	13.13	9.72	5.35	4.77
P-val	0.000	0.000	0.002	0.022	0.031

Note: for labour incomes larger than 0. Occupation FE and year FE not reported. Clustered S.E. at the occupational level. Households heads between 18 and 60 years.
Source: own calculation.

Table C.2: Baseline specification – younger households

	Consumption (log level)		Consumption/income	
DGOV	0.040	-0.002	-0.039***	-0.027**
	[0.052]	[0.047]	[0.012]	[0.011]
POST	-0.055	0.035	-0.039*	-0.009
	[0.096]	[0.088]	[0.022]	[0.021]
G_POST	0.100	0.025	-0.023	-0.017
	[0.073]	[0.065]	[0.016]	[0.015]
age		0.020***		-0.001
		[0.004]		[0.001]
male		0.367***		0.027***
		[0.030]		[0.007]
fam. size		0.049***		0.017***
		[0.014]		[0.003]
secondary		0.276***		-0.036***
		[0.047]		[0.011]
lower tertiary		0.445***		-0.063***
		[0.052]		[0.012]
upper tertiary		0.521***		-0.081***
		[0.056]		[0.013]
Budapest		0.020		-0.036***
		[0.033]		[0.008]
Constant	7.009***	5.774***	1.076***	1.072***
	[0.045]	[0.147]	[0.010]	[0.035]
Observations	1,071	1,071	1,071	1,071
R-squared	0.006	0.214	0.090	0.207
F-test	2.284	28.88	35.14	27.72

Note: sample of households (20–56 years), with primary education. Standard errors are reported in brackets. *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level.
Source: own calculation.

Table C.3: Baseline specification – middle age households

	Consumption (log level)		Consumption/income	
DGOV	-0.012	-0.011	-0.034***	-0.021**
	[0.039]	[0.035]	[0.009]	[0.008]
POST	0.159**	0.083	-0.024	0.014
	[0.078]	[0.069]	[0.018]	[0.017]
G_POST	0.001	0.048	-0.018	-0.025**
	[0.058]	[0.050]	[0.013]	[0.012]
age		0.003		-0.000
		[0.004]		[0.001]
male		0.327***		0.031***
		[0.023]		[0.006]
fam. size		0.036***		0.010***
		[0.010]		[0.002]
secondary		0.232***		-0.059***
		[0.033]		[0.008]
lower tertiary		0.490***		-0.102***
		[0.038]		[0.009]
upper tertiary		0.638***		-0.112***
		[0.045]		[0.011]
Budapest		0.080***		-0.023***
		[0.029]		[0.007]
Constant	7.080***	6.398***	1.069***	1.082***
	[0.033]	[0.165]	[0.007]	[0.040]
Observations	1,627	1,627	1,627	1,627
R-squared	0.024	0.273	0.052	0.175
F-test	13.11	60.64	29.97	34.31

Note: sample of households (20–56 years), with primary education. Standard errors are reported in brackets. *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level.
Source: own calculation.

Table C.4: Baseline specification – older households

	Consumption (log level)		Consumption/income	
DGOV	-0.053	-0.036	0.002	0.007
	[0.035]	[0.030]	[0.007]	[0.006]
POST	0.156**	0.126**	-0.056***	-0.016
	[0.067]	[0.058]	[0.013]	[0.012]
G_POST	-0.023	0.029	0.017*	0.007
	[0.049]	[0.041]	[0.009]	[0.009]
age		-0.008***		-0.001
		[0.003]		[0.001]
male		0.330***		0.042***
		[0.019]		[0.004]
fam. size		0.083***		0.018***
		[0.011]		[0.002]
secondary		0.220***		-0.027***
		[0.025]		[0.005]
lower tertiary		0.464***		-0.077***
		[0.030]		[0.006]
upper tertiary		0.720***		-0.083***
		[0.035]		[0.007]
Budapest		0.057**		-0.022***
		[0.024]		[0.005]
Constant	7.064***	6.825***	1.025***	1.043***
	[0.030]	[0.155]	[0.006]	[0.032]
Observations	2,527	2,527	2,527	2,527
R-squared	0.014	0.296	0.027	0.189
F-test	11.88	105.90	23.03	58.76

Note: sample of households (20–56 years), with primary education. Standard errors are reported in brackets. *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level.
Source: own calculation.

Table C.5: Robustness I – total consumption less spending on health and education

	Consumption (log level)		Consumption/income	
DGOV	-0.022	-0.021	-0.017***	-0.009*
	[0.023]	[0.020]	[0.005]	[0.005]
POST	0.240***	0.194***	-0.046***	-0.002
	[0.047]	[0.042]	[0.010]	[0.010]
G_POST	-0.019	0.013	-0.000	-0.009
	[0.035]	[0.030]	[0.008]	[0.007]
age		0.004***		-0.000**
		[0.001]		[0.000]
male		0.341***		0.036***
		[0.014]		[0.003]
fam. size		0.060***		0.016***
		[0.006]		[0.001]
secondary		0.242***		-0.037***
		[0.019]		[0.004]
lower tertiary		0.454***		-0.082***
		[0.022]		[0.005]
upper tertiary		0.631***		-0.092***
		[0.026]		[0.006]
Budapest		0.045***		-0.026***
		[0.017]		[0.004]
Constant	7.060***	6.269***	1.046***	1.050***
	[0.019]	[0.047]	[0.004]	[0.011]
Observations	4,601	4,601	4,601	4,601
R-squared	0.041	0.286	0.046	0.191
F-test	64.88	184.00	73.86	108.10

Note: sample of households (20–56 years), with primary education. Standard errors are reported in brackets. *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level.
Source: own calculation.

Table C.6: Robustness I – consumption of durables

	Consumption (log level)		Consumption/income	
DGOV	-0.035	-0.042*	0.006**	0.007**
	[0.029]	[0.025]	[0.003]	[0.003]
POST	0.061	0.064	-0.008	-0.006
	[0.051]	[0.045]	[0.005]	[0.005]
G_POST	-0.007	0.011	0.008**	0.007*
	[0.038]	[0.033]	[0.004]	[0.004]
age		0.007***		-0.000
		[0.001]		[0.000]
male		0.353***		0.010***
		[0.015]		[0.002]
fam. size		0.063***		0.000
		[0.008]		[0.001]
secondary		0.222***		0.001
		[0.023]		[0.003]
lower tertiary		0.428***		-0.002
		[0.025]		[0.003]
upper tertiary		0.593***		-0.002
		[0.028]		[0.003]
Budapest		0.059***		-0.010***
		[0.018]		[0.002]
Constant	7.229***	6.279***	0.192***	0.192***
	[0.024]	[0.052]	[0.003]	[0.006]
Observations	3,800	3,800	3,800	3,800
R-squared	0.003	0.264	0.002	0.018
F-test	3.99	135.60	2.17	7.11

Note: sample of households (20–56 years), with primary education. Standard errors are reported in brackets. *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level.
Source: own calculation.

Table C.7: Robustness I – consumption of food

	Consumption (log level)		Consumption/income	
DGOV	-0.046*	-0.057**	0.004	0.018***
	[0.027]	[0.023]	[0.006]	[0.005]
POST	0.142***	0.139***	-0.097***	-0.044***
	[0.050]	[0.044]	[0.011]	[0.010]
G_POST	-0.027	-0.008	0.027***	0.010
	[0.037]	[0.032]	[0.008]	[0.007]
age		0.004***		0.000
		[0.001]		[0.000]
male		0.368***		0.011***
		[0.014]		[0.003]
fam. size		0.066***		0.012***
		[0.008]		[0.002]
secondary		0.257***		-0.052***
		[0.023]		[0.005]
lower tertiary		0.493***		-0.151***
		[0.025]		[0.006]
upper tertiary		0.651***		-0.193***
		[0.028]		[0.006]
Budapest		0.045***		-0.036***
		[0.017]		[0.004]
Constant	7.105***	6.259***	1.800***	1.836***
	[0.023]	[0.052]	[0.005]	[0.012]
Observations	4,397	4,397	4,397	4,397
R-squared	0.011	0.280	0.063	0.348
F-test	15.66	170.30	99.27	234.6

Note: sample of households (20–56 years), with primary education. Standard errors are reported in brackets. *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level.
Source: own calculation.

Table C.8: Robustness I – consumption of services

	Consumption (log level)		Consumption/income	
DGOV	-0.023	-0.026	0.025**	0.037***
	[0.024]	[0.021]	[0.011]	[0.011]
POST	0.124***	0.105**	0.025	0.066***
	[0.046]	[0.041]	[0.022]	[0.022]
G_POST	0.003	0.028	0.046***	0.036**
	[0.034]	[0.030]	[0.016]	[0.016]
age		0.004***		0.001**
		[0.001]		[0.000]
male		0.342***		0.000
		[0.014]		[0.007]
fam. size		0.061***		0.019***
		[0.007]		[0.004]
secondary		0.246***		0.066***
		[0.019]		[0.010]
lower tertiary		0.480***		-0.000
		[0.022]		[0.012]
upper tertiary		0.644***		-0.036***
		[0.025]		[0.014]
Budapest		0.047***		-0.003
		[0.016]		[0.009]
Constant	7.062***	6.249***	1.560***	1.432***
	[0.021]	[0.047]	[0.010]	[0.025]
Observations	5,002	5,002	5,002	5,002
R-squared	0.015	0.264	0.028	0.058
F-test	24.67	179.50	48.14	30.71

Note: sample of households (20–56 years), with primary education. Standard errors are reported in brackets. *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level.
Source: own calculation.

Table C.9: Robustness I – pre-trend test

	Consumption (log level)			Consumption/income		
DGOV	-0.038	-0.022	-0.022	-0.013**	-0.006	-0.005
	[0.028]	[0.024]	[0.024]	[0.006]	[0.006]	[0.006]
POST_2001	0.223***	0.293***	0.227***	-0.062***	-0.011	-0.017
	[0.049]	[0.044]	[0.058]	[0.010]	[0.010]	[0.013]
G_POST_2001	-0.047	0.003	-0.010	0.008	-0.000	0.010
	[0.036]	[0.031]	[0.041]	[0.008]	[0.007]	[0.010]
age		0.005***	0.004***		-0.000**	-0.000**
		[0.001]	[0.001]		[0.000]	[0.000]
male		0.329***	0.327***		0.036***	0.036***
		[0.014]	[0.014]		[0.003]	[0.003]
fam. size		0.103***	0.104***		0.015***	0.015***
		[0.008]	[0.008]		[0.002]	[0.002]
secondary		0.258***	0.247***		-0.039***	-0.037***
		[0.019]	[0.019]		[0.004]	[0.004]
lower tertiary		0.474***	0.459***		-0.083***	-0.082***
		[0.022]	[0.022]		[0.005]	[0.005]
upper tertiary		0.655***	0.633***		-0.094***	-0.092***
		[0.025]	[0.026]		[0.006]	[0.006]
Budapest		0.048***	0.047***		-0.026***	-0.026***
		[0.017]	[0.016]		[0.004]	[0.004]
POSTT (2003)			0.092*			0.009
			[0.055]			[0.013]
G_POSTT (2003)			0.024			-0.016*
			[0.041]			[0.009]
Constant	7.064***	6.066***	6.084***	1.055***	1.053***	1.051***
	[0.024]	[0.053]	[0.053]	[0.005]	[0.012]	[0.012]
Observations	4,601	4,601	4,601	4,601	4,601	4,601
R-squared	0.022	0.292	0.299	0.052	0.189	0.191
F-test	35.05	189.3	163.00	84.31	107.1	90.22

Note: sample of households (20–56 years), with primary education. Standard errors are reported in brackets. *POSTT* is the post-change trend (2003–). *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level. *Source:* own calculation.

Table C.10: Robustness II – total consumption and regional trends

	Consumption (log level)		Consumption/income	
DGOV	-0.022	-0.016	-0.017***	-0.010**
	[0.023]	[0.020]	[0.005]	[0.005]
POST	0.240***	0.195***	-0.046***	-0.000
	[0.047]	[0.041]	[0.010]	[0.009]
G_POST	-0.019	0.015	-0.000	-0.010
	[0.035]	[0.030]	[0.008]	[0.007]
age		0.004***		-0.000**
		[0.001]		[0.000]
male		0.339***		0.036***
		[0.014]		[0.003]
fam. size		0.061***		0.016***
		[0.006]		[0.001]
secondary		0.242***		-0.038***
		[0.019]		[0.004]
lower tertiary		0.452***		-0.082***
		[0.022]		[0.005]
upper tertiary		0.626***		-0.093***
		[0.025]		[0.006]
Constant	7.060***	6.337***	1.046***	1.027***
	[0.019]	[0.048]	[0.004]	[0.011]
Observations	4,601	4,601	4,601	4,601
R-squared	0.041	0.292	0.046	0.196
F-test	64.88	126.00	73.86	74.64

Note: sample of households (20–56 years), with primary education. Standard errors are reported in brackets. NUTS II regional dummy variables not reported. *** represents statistical significance at the 1% level, ** at the 5% level and * at the 10% level. *Source:* own calculation.

Table C.11: Characteristics of employment samples

	Public						Private					
	2000	2001	2002	2003	2004	2005	2000	2001	2002	2003	2004	2005
Gender (share of female)	0.73	0.741	0.732	0.738	0.741	0.744	0.396	0.396	0.395	0.409	0.412	0.399
Age (years)	41.9	42.3	42.7	42.8	43.1	43.4	39.2	39.4	39.4	39.9	39.8	39.6
Occupation												
Managers	0.084	0.084	0.081	0.082	0.085	0.085	0.114	0.111	0.110	0.105	0.104	0.104
Specialists	0.338	0.345	0.341	0.337	0.349	0.355	0.049	0.051	0.054	0.067	0.070	0.060
Technician, associate profession	0.263	0.266	0.272	0.280	0.280	0.278	0.166	0.167	0.170	0.174	0.177	0.178
Clerks	0.049	0.048	0.054	0.056	0.055	0.055	0.080	0.080	0.073	0.073	0.073	0.072
Sales and servicemen	0.071	0.070	0.066	0.061	0.059	0.057	0.089	0.092	0.100	0.103	0.108	0.112
Agriculture	0.003	0.003	0.003	0.001	0.001	0.001	0.020	0.020	0.021	0.020	0.019	0.017
Hand workers	0.026	0.025	0.026	0.025	0.023	0.023	0.265	0.270	0.253	0.239	0.225	0.228
Operators	0.018	0.017	0.017	0.017	0.016	0.016	0.143	0.141	0.141	0.137	0.140	0.147
Manual workers	0.148	0.143	0.140	0.141	0.132	0.130	0.072	0.069	0.077	0.081	0.085	0.082
Sample (ths. persons)	413.6	408.6	439.4	506.2	514.5	508.9	125.7	123.6	133.8	135.1	149.1	153.3

Note: full employment samples (18–60 years), weighted data for the population. *Source:* own calculation.

Table C.12: Employment sample structure

	Public		Private	
	Sample	Population	Sample	Population
2000	413.6	671.0	125.7	1948.3
2001	408.6	669.8	123.6	1952.7
2002	439.4	678.9	133.8	1858.0
2003	506.2	689.8	135.1	1859.5
2004	514.5	686.7	149.1	1923.2
2005	508.9	679.2	153.3	1888.0

Note: in ths. persons. The private sector values represent those of double entry booking firms (with more than 5 workers). The public sector values are for all public sector workers (civil servants and public employees without workers in the judiciary system, and special (security) forces – members of military forces, fire-fighters, the police and border guards). *Source:* HCSO (2015), own calculation.

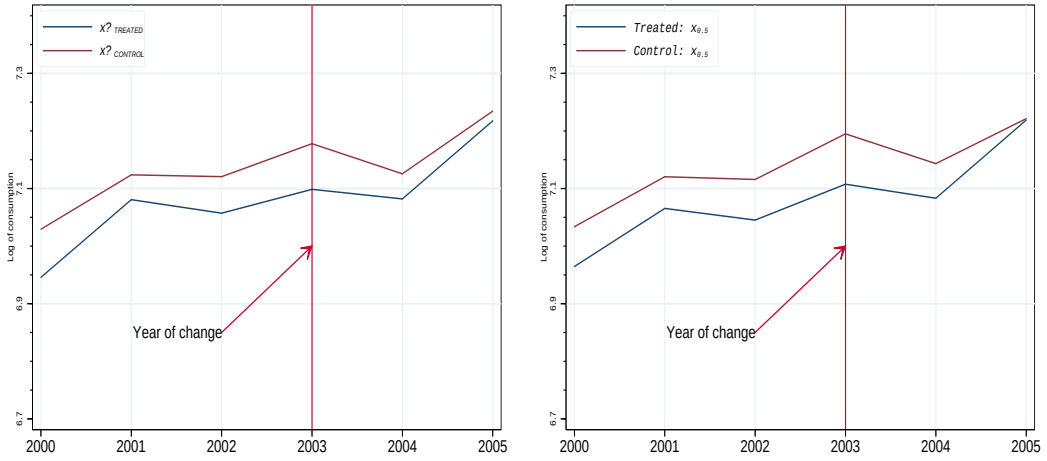
Table C.13: Budget survey sample structure

	Household heads (18–60 years)	Household heads (20–56 years)
2000	Age = 44.1 N = 6266	Age = 42.4 N = 5356
2001	Age = 43.7 N = 6186	Age = 42.3 N = 5312
2002	Age = 44.1 N = 5956	Age = 42.6 N = 5080
2003	Age = 44.5 N = 4388	Age = 42.8 N = 3770
2004	Age = 45.1 N = 6730	Age = 43.3 N = 5789
2005	Age = 39.7 N = 7133	Age = 39.0 N = 6232

Note: sample for household heads between 20–56 years reflects lower retirement age in Hungary in early 2000s. Few household/year observations were dropped due to typos, for example when the highest labour income was found in case of children. *Source:* own calculation.

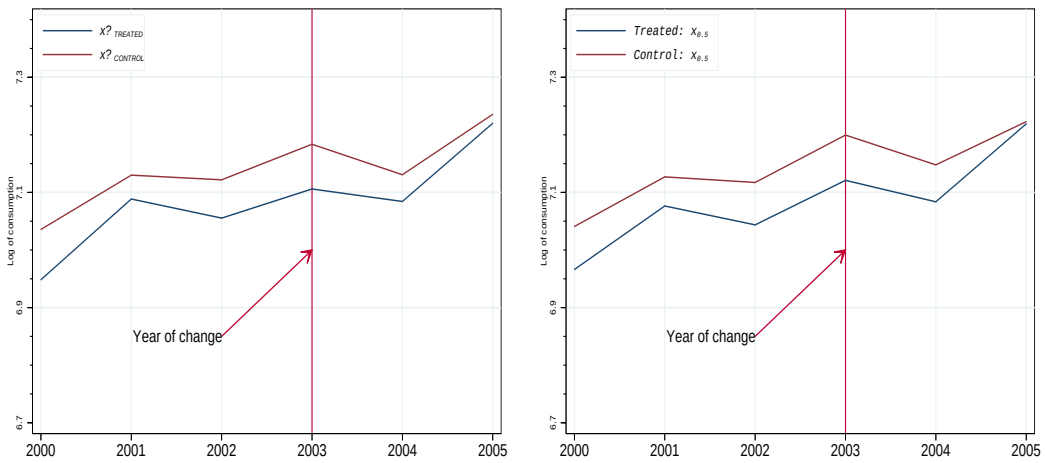
Figures

Figure C.1: Robustness I: total expenditures – mean (left) and median (right), 2000–2005



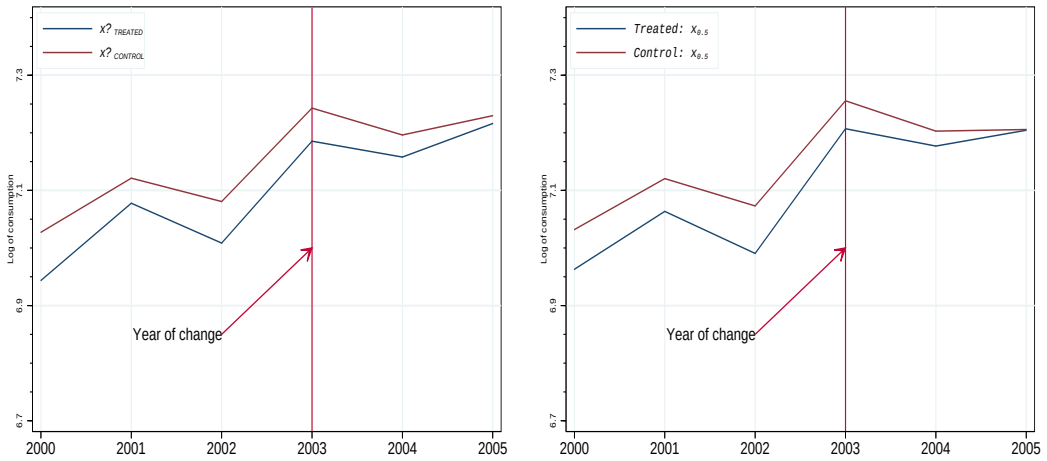
Note: all expenditures for household heads between 20–56 years, probability of working for public sector ($\Pi_{j,\,t} > 0.70$), trimmed data (positive value only) to eliminate outliers defined as those observation/year below the 1^{st} and above 99^{th} quantile. *Source:* own calculation.

Figure C.2: Robustness II: total expenditures – mean (left) and median (right), 2000–2005



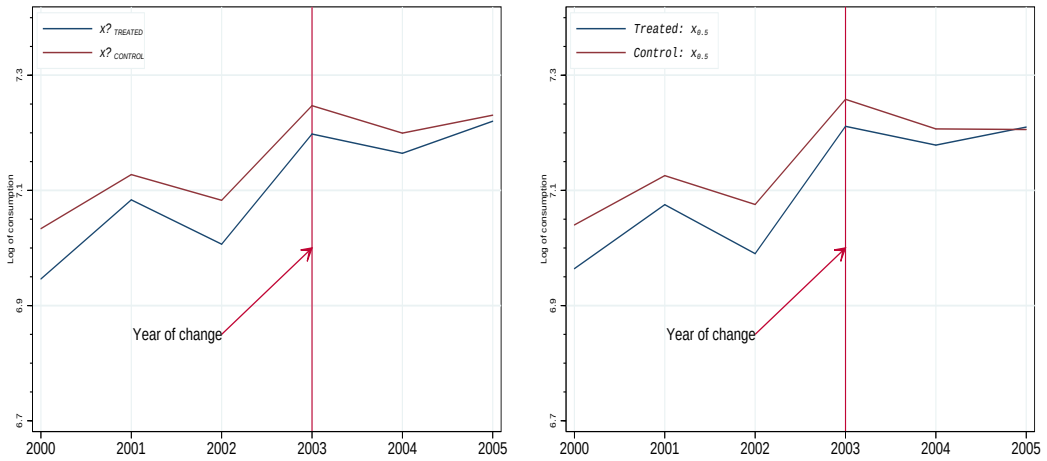
Note: all expenditures for household heads between 25–56 years, probability of working for public sector ($\Pi_{j,\,t} > 0.70$), trimmed data (positive value only) to eliminate outliers defined as those observation/year below the 1^{st} and above 99^{th} quantile. *Source:* own calculation.

Figure C.3: Robustness I: total expenditures excl. health and education – mean (left) and median (right), 2000–2005



Note: all expenditures for household heads between 20–56 years without health and education related expenditures, probability of working for public sector ($\Pi_{j,\,t} > 0.70$), trimmed data (positive value only) to eliminate outliers defined as those observation/year below the 1^{st} and above 99^{th} quantile. *Source:* own calculation.

Figure C.4: Robustness II: total expenditures excl. health and education – mean (left) and median (right), 2000–2005



Note: all expenditures for household heads between 25–56 years without health and education related expenditures, probability of working for public sector ($\Pi_{j,\,t} > 0.70$), trimmed data (positive value only) to eliminate outliers defined as those observation/year below the 1^{st} and above 99^{th} quantile. *Source:* own calculation.

Chapter 5

Conclusions and Suggestions for Future Research

There has been revived interest in fiscal policy topics following the worst economic and financial crisis since the Great Depression in the 1930s, the Great Recession, and the following sovereign debt crisis in Euro area countries. Despite continuing growth in theoretical and empirical work in this area, there are still many important questions that have not been explored (see for example Alessina and Givazzi, 2013 for a list). In particular, given that the recent years of economic and financial turmoil have had some effects on the coordination of policy-makers' behaviour and their tools. This thesis aims to fill some of the existing gaps.

Chapter 1's focus was on debt sustainability of countries in the Euro area. Our results show that the monetary union as a whole passed the macro-based sustainability test, that is, there was no indication of substantial problems in the group of countries. Yet, in spite of a battery of checks carried out showing robustness of our results, the problem can be in the detail, not explicitly captured or even concealed in a panel estimation. For example in the context of EA countries, some of them dealing with debt legacies and facing country-specific fiscal challenges. This was the impetus for my exploration of individual Euro area countries' fiscal responses in Chapter 2, firstly, looking at fiscal behaviour at a country-specific level, and subsequently, at the issue of harmonization of national fiscal policies.

My exploration of debt burden and its repercussions (fiscal fatigue or debt legacy) in Chapter 1 also lead to an important proposal. My co-author and I suggested a simple rule for assessing the risk of fiscal fatigue by quickly investigating the debt legacy in a country without running complicated (micro-based) country-specific models. This rule offers a tool that can be used for assessing potential macro-fiscal

vulnerabilities in the context of fiscal risk analysis or debt sustainability analysis (DSA). DSA has recently become an integral part of the country assessments carried out by international organisations. In this context, one possible extension of the work could be to assess the robustness of the approach, not only across different EA/EU countries, but also across various blocks of countries. Since results of our rule seem to be rather 'slowly moving animals', one could also try to improve its prediction power in order to make it an early warning-indicator. There is also scope for further exploration of debt legacy, by its endogenization or by adding explicit links to the literature on fiscal limits (see Davig et al., 2011).

My analysis of fiscal behaviour in Chapter 2 revealed that institutions can sometimes place binding (efficient) limits on fiscal policy, particularly when the value at stake is rather high. Moreover, I analysed the process of harmonization of fiscal behaviour as a direct consequence of institutional changes. While extant evidence regarding this process has only been anecdotal to date, my results present new empirical evidence. An extension could further explore the harmonization process by using alternative approaches to enhance the robustness of my findings. In addition, this chapter looked mostly at the issue of fiscal policy and did not explore macroeconomic fundamentals. Accordingly, one natural extension that I will seek in the future, is to assess the contribution of key determinants of fiscal responses. In addition, country-specific rules do not allow for various channels of spillover effects from other. Although it would require a different methodology, another extension can look into this particular aspect of fiscal behaviour in a monetary union.

Moreover, there is still much to be said about the theoretical and policy-making implications of my findings. It is also a well-documented fact (at least theoretically) that fiscal rules cannot be viewed as the *panacea* since they can sometimes be suboptimal, as alluded to in Kydland and Prescott (1977). Rules are aimed to help countries carry out sustainable fiscal policy while preserving macroeconomic stability.[1] However, any process of harmonization can also pose a more or less well-hidden threat in itself. In the case of fiscal harmonization in the Euro area, symmetrical 'fiscal tightening' as a result of spillover effects and no 'buffer zones' (strong and unshakeable economies), may present a risk to economic growth.[2] In particular, this risk can easily materialize given the very low level of 'federal budget' flows in the EU (flows from and to the European budget), as compared to the

[1] For instance, Fatás and Mihov (2010) highlight that the reason can be national governments natural diversity of opinions and fiscal priorities, which can create tensions among stabilisation policies inside a monetary union.

[2] Holland and Portes (2012) provide some evidence from a simulation in a stylised model for the UK and US economy.

US economy.[3] Despite its potential importance, this fact has not been adequately explored, especially in the zero-lower-bound environment that is echoed in Portes and Wren-Lewis (2015).[4]

Further extensions of my work, could be in the way fiscal rules interact with their monetary counterpart (an ECB's response function), to explore their changes and possible interactions over years of monetary integration and mainly over the Euro period. In a similar vein to an exercise done for monetary policy rules, another extension could capture any effects coming from the volatility of policy-makers' fiscal responses. Regarding estimation techniques, it could be possible to use Bayesian TVP estimation to allow for changes in volatility over time. Provided the sample period is extended, one could explore fiscal regimes with more or less discretionary measures. It would also be possible to employ the Bayesian TVP VAR technique to provide another robustness check to my country-specific estimation, and/or to address some further issues associated with the harmonization of such spillover effects across EA states, as already outlined above. Lastly, a Factor Augmented VAR Bayesian estimation could be done to shed some light on the selection of the main variables driving fiscal policy outcomes.

Regarding the last chapter, I partially explored the effects of a quasi-natural experiment. I proposed one possible explanation for the 'non-arrival' of results after such a massive change in individual incomes (their permanent part). As a further test of robustness of my results, it could be possible to use administrative data to expand the small sample of private companies in my dataset. That would mean obtaining more or less the same information about private workers, as was collected for public employees (and of course, further complementing the public sector information). As a result, the probabilistic part of my exercise could be substantially improved to allow for a more detailed 'matching' of public sector and private sector workers with the household consumption dataset. Such an improved piece of information on the income side would help identify household heads in the consumption survey that are now lost because of missing observations.

The share of public workers in the economy is substantial, but workers that did not directly benefit from the unanticipated change of wages were, naturally, not included in the treated group. My estimation is done for individual households whose

[3] For a very recent estimate and comparison with the US federal budget see D'Apice (2015).

[4] This recent study recommends larger interconnectedness of the Pact's rules with aggregate demand (members' cyclical situation). In addition, for cases when the probability of the ZLB is larger than 50% (forecasted by the central bank), they propose the fiscal rules to be temporarily disabled. However, such a change of the 'rules of the game' would necessitate another mechanism that would clearly set up ways of dealing with the consequences of the freeze and supposedly large increase in public indebtedness.

heads are identified as working/not working for the public sector. Since the HHBS contains information on all household members, effects across types of households can be investigated (none, one or more adults working for the public sector in a household). The estimated model can also be extended to explicitly control for the presence of the housing loan bubble (there is some information in the HHBS available since 2002). Nevertheless, the identification of the treated and control households is potentially the Achilles heel of this exercise. Given the intervention, it allows me to compare household heads that are directly exposed to the government intervention, with those that are not, using a probabilistic approach and assuming that a variation in consumption responses is driven by a realization of the income shock. However, the validity of my results could be strengthened if there was a piece of information that, would allow for the direct identification of public/private sources of the labour income for individuals or at least households, or in a perfect case, would facilitate the integration of both the employment surveys with the HHBS.

Another avenue for future study is the exploration of further effects (and medium-run/long-run consequences) of the unanticipated change in public sector salaries. I am currently exploring qualitative aspects of this change on for public sector workers and/or on selected groups of workers, looking specifically at their motivation to change occupations as a result of the income shock.

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