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The Macroeconomics of Fiscal Austerity in Europe[3]

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1   Introduction

Sovereign debt in a number of countries has been rising since the great recession started in 2007-2008. There are many reasons for the rise of sovereign debt and the causes of debt crises are diverse. From 2007 to 2009 the US administration has put forward banking bailout and fiscal stimulus packages. Similar policies were implemented world-wide, particularly in many EU countries. But public deficit and sovereign debt also rose due to the recessionary effect, falling output, income and tax revenues.

The European countries were exposed to other causes of the rise of debt. Some countries had traditionally high sovereign debt, and in some other countries the bail-out of private, real estate and banking debt, led to the public debt increase.[1] Additionally in some European Union countries, the acceleration of sovereign risk created high premia on sovereign bonds, triggering high cost of borrowing and further rise of debt which finally generated debt crises, for example in Greece, Ireland, Italy, Portugal, and Spain. Those crises revealed the vulnerable interconnection between sovereign debt, financial market stress and recessions. Because of those vulnerabilities and an imminent threat to the existence of the EU-zone, the sustainability of sovereign debt is increasingly being perceived as an important issue in the EU.

The concern over the sustainability of sovereign debt is not entirely new in the Euro-area, it has been the subject of many debt sustainability studies.[2] Until the years 2006/7, many studies had concluded that the debt in the EU is sustainable, see Greiner et al (2005) and Roch and Uhlig (2012). Recently, many countries, in particular EU-zone member states, have introduced − or were steered into− policies of fiscal consolidation and stabilization of sovereign debt.[3]

Yet, the outcome of the fiscal consolidation policies were not what one expected. It is by now clear that there is no simple threshold for debt, as claimed in the Reinhart and Rogoff (2009) study, where growth rates start declining when the debt to GDP ratio reaches a certain threshold, for example 90 percent as they suggested. What is also underdeveloped are studies that show how fiscal consolidation actually works in recessionary periods and in a situation of high financial stress. Since austerity and fiscal consolidation policies have extensively been pursued, it is important to evaluate them. There are now new views on this, even by the IMF, that show evidence that these type of austerity policies are not effective and lead to excessive social costs.[4]

In this paper macroeconomic and macroeconometric studies are reviewed and a dynamic model is presented to throw some light on these issues. The fiscal multiplier has become the central element in these types of studies. One view is that the fiscal multiplier, when public expenditures are reduced or taxes are raised, is too strong, or is asymmetric − being stronger in recessions than in expansions[5] − in particular in the presence of financial market stress, so that the contractionary effects can become very severe when fiscal consolidations are pursued. This, for example has been observed in some member states of the EU, where the experience has been, after fiscal consolidations, falling output and income, rising unemployment, falling tax revenues, and rising deficits and sovereign debt, triggering more financial stress and so on.

To explain this occurrence in the EU, some have modeled this as a multiple equilibria phenomenon. It is argued that some EU countries may be locked into a bad equilibrium. In this view, economists

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[1] See Stein (2011).

[2] See the many contributions by Bohn, for example, Bohn (1998), Greiner et al (2005.) and Roch and Uhlig (2012) for a literature review.

[3] See the diverse publications of the IMF, for example Blanchard et al (2013a), Baum et al (2012) and Batini et al (2012).

[4] See again the IMF studies by Blanchard et al (2013a), Baum et al (2012) and Batini et al (2012)

[5] On the asymmetric and size dependent fiscal multiplier, see Mittnik and Semmler (2012a)

work with models of expectation dynamics, where a self-fulfilling prophecy can lead to the situation that countries end up in a bad equilibrium generated through a self-enforcing mechanism. De Grauwe (2011) has shown that in the Euro-zone there is a danger of such a self-enforcing mechanism. Such a mechanism is likely to work for the EU currency union, but may work differently for stand-alone countries, for example the US, UK and Japan. In particular, for countries in a loose currency union one might observe such a mechanism (De Grauwe, 2011, 2012).

Yet, instead of referring to a self-enforcing mechanism, generated through expectation dynamics, one can also show that countries may face a vicious cycle, through financial markets, where financial stress and macroeconomic self-enforcing feedback mechanisms can eliminate the usual automatic stabilizers and create strong downward multiplier effects, partly arising from fiscal consolidation policies undertaken at a wrong time of the business cycle, for example when there are income and credit constraints of agents and financial market stress.

What will be stressed here are nonlinearities in macroeconomics. Policy effects are not only state dependent, or business cycle dependent, they are also size dependent. This view is related to business cycle studies in the tradition of Keynes, Kalecki, Kaldor, and Goodwin.[6] If policies have different effects in booms and recessions, wrong policies can create strong contractionary effects in recessions. Since the multiplier studies have become central, we are looking first at the fiscal multiplier in econometric regime change models, but then also explore fiscal and monetary policy under financial stress. We in particular explore downward pushing forces in an economy under financial stress that can prevent recoveries and debt stabilization from taking place.

Next we study sovereign debt dynamics using a dynamic macro model. In a first variant of a model we keep the interest rate on sovereign debt constant, by assuming that the central banks can sufficiently decrease interest rates and reduce financial stress. The interest rates are set by the central bank close to zero, as many recent multiplier studies assume. This can generate a tranquil period where there are large capital gains and an asset price boom, where, however, risk premia are low and net worth is rising. Yet, in this normal period overleveraging can occur. In a second version of the model we let the interest rate be endogenous, reflecting risk premia, for example on sovereign indebtedness. When there is a rise in sovereign risk, endogenous risk premia, credit spreads, and strong macroeconomic feedback loops, we can demonstrate the likelihood of higher credit spread, higher indebtedness and falling output.

Those stronger macroeconomic feedback loops are basically working through the financial market and aggregate demand: Rising financial stress, rising borrowing cost from capital markets and credit spreads cause aggregate demand to fall. When aggregate demand falls utilization of capacity falls — and the lower income generates lower surplus to pay off future liabilities, which in turn create greater credit spreads, lower aggregate demand and so on.[7] In this case, mostly real forces are working, which accelerate downturns possibly creating lock-ins into a bad equilibrium. This in short might be interpreted as a positive feedback mechanism between credit spread and capital utilization[8] which may, however, let the debt stabilization effort fail.

Though our model has some similarities to Hall (2011), Gilchrist and Zabrajsek (2011), and Woodford (2011), it allows, as in Ernst and Semmler (2012), to study the credit-macro feedback mechanisms in an multi-period model. It also admits to explore the contractionary effects of private deleveraging and, in the case of public debt, the effects of fiscal consolidation strategies, as for example, discussed

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[6]See Bernard et al. (2012).

[7]On this mechanisms, see also Blanchard et al. (2013)

[8]Many recent DSGE models work with endogenous capital utilization and financial market, for example cost of capital when issuing bonds; A relationship between capital utilization and the "user cost of capital" can also be found in Keynes.

in Eggertson and Krugman (2011) and many recent IMF studies, as for example in Blanchard et al. (2013a).

As to the solution method, our model will not be solved locally through local linearization about the steady state, as used in DYNARE, but by NMPC, which has recently been developed by Gruene and Pannek (2011) and applied to economic problems in Gruene et al (2013). This global numerical method allows to approximate the accurate dynamic model by an N-period receding horizon model which will provide us with an approximate solution for the decision and state variables as well as for the value function.

The remainder of the paper is organized as follows. In sect. 2 we review some facts on the EU sovereign debt crisis and fiscal consolidation policies. In sect. 3, we discuss the empirical methodology and results of econometric multi-regime models. Sect. 4 reviews other empirical studies of similar type. Sect. 4 explores some implications of the empirical studies in the context of model variants of debt sustainability for regimes of low and high financial stress. Sect. 5 concludes the paper. The algorithm to solve the different model variants is presented and discussed in Gruene et al (2013).

2 A First Look at the Empirics

Let us take a first glance at the empirics of the EU debt crises and the attempts to consolidate the sovereign debt with policies.

2.1 The Empirics of Debt Crises

- As to sovereign debt data for EU countries we might make some preliminary remarks. Compared to the US, where the debt crisis started in the real estate sector, in the EU the causes of the debt crises are diverse, see Stein (2011). In Spain and Ireland the sovereign debt crisis has its origin essentially in the private sector, more precisely in the real estate sector, and was passed on to the public sector through bank bail outs. Portugal and Greece (and Italy) are other cases, in those countries the sovereign debt was high to begin with, and rose after the great recession. Here then the debt crises originated in the public sector but ended up being concentrated in the banking sector.

- Originally, the sovereign debt, as compared to the US, UK, and Japan, in many EU countries (also in Spain) was lower than outside the EU, but, in some periphery EU countries, the sovereign debt jumped up, see the figures presented in De Grauwe (2011). Why did such a rapid deterioration and contagion in the EU occur? Was the insurance mechanisms in the EU for sovereign debt not working?

- What happened is still not fully understood. In spite of an insufficient understanding of the actual diversity of the causes of debt, and its sudden jump in some countries, an austerity policy was rapidly enacted and imposed on EU periphery countries. A specific list of austerity measures is given below.[9]

- What was expected? One thought was that austerity reduces, through confidence building, interest rates and credit cost for sovereign debt. Though in earlier times countries, for example Ireland in the 1990s, had other instruments, such as a depreciation of currency, this was not

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[9]See also IMF Fiscal Monitor (2012), ECLM, IMK, OFCE (2012), and Busch et al. (2012)

possible in the EU context as Boyer (2012) rightly states. Apparently, the EU fiscal consolidation policies did not result in much success.

- Failure 1: As the above citations – and the data in table 1– indicate, fiscal consolidation did not seem to be very effective, debt stabilization failed, and it became evident that the success is state dependent. One evidence of the failure was that CDS's were continuously rising.[10]

- Failure 2: Austerity measures were not socially balanced, because asymmetric welfare losses and extreme downward real wage adjustments: In Greece, real wages fell by more than 30% since 2009, with damages to social cohesion and the EU social model. Given the social cost of austerity support for the default option became wide-spread[11]

- The IMF had first predicted a success of the fiscal consolidation, but if one compares the predictions with the outcome, one can observe that the negative impact of austerity was underestimated. Estimated negative multipliers from the consolidation were too small. The question arose: Were all the painful austerity efforts undertaken because of a "computational error"? Some recent publications seem to suggest this, see sect. 4 below.

2.2 Evidence on Diverse Debt Crises

In the table 1 some trends, based on Stein (2011),[12] are summarized.

One can observe a diversity of debt crisis in Europe.

- In some countries, there was first a rise in real estate debt, then after the real estate crisis the debt was then passed on to the public and it emerged a sovereign debt crisis. This happened, for example in Spain and Ireland, where the private sector debt was passed on to the public sector through banking bail-outs.

- Portugal and Greece (and Italy) are different cases, in these countries the sovereign debt was high in earlier times, partly already since the 1980s.

The countries with real estate debt were Spain and Ireland and with sovereign debt were Portugal and Greece. The latter two had on average an annual structural imbalance about roughly -4.5 percent of GDP, but Spain and Ireland less than half of this. On the other hand, for Spain and Ireland interest payments were low, from 1998 to 2007; 0.53 and 0.43 percent of GDP, only jumping up after 2007. Yet, capital gains (in real estate, measured by house price increases) were much higher in Spain and Ireland, from 1998-2007, indicating an asset price boom. The significant annual capital gains led, given the low interest payments in the period 1998-2007, to a significant increase in private borrowing and debt build up. Capital gains helped to service the debt. Yet, Greece also showed high capital gains, with 9.5% on average per year.

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[10]See IMF (2012), Bolton et al (2011), and ZEW Index (2012/13), and De Grauwe (2012).

[11]See Busch et al (2012). This of course created a vicious cycle: With the social cost rising and with the spreading of the view that a default should be an option, the default of some countries (for example Greece) became more likely and the cost of borrowing was rising again, bringing the country closer to default.

[12]See his tables 1-3 and figures 1-3.

	Government Structural Imbalances (% of GDP)	Government Net Debt (% of GDP)	Interest Payments (% of GDP)	Capital Gains (Annual Δ of Real Estate Prices)
Spain	-1.28	43.73	0.53	9.71
Ireland	-2.24	27.3	0.43	13.3
Portugal	-4.5	50.08	1.42	3.3
Greece	-4.76	80.25	1.16	9.5

Table 1: Cause of Debt Crises: Real Estate Debt (Spain, Ireland) and Public Debt (Portugal, Greece), Government Net Debt, Interest Payments, and Capital Gains; Source: see Stein (2011) and own computations4

2.3 Financial Stress in the EU Countries

Next we present some figures of the relation of financial stress and economic regimes. We use the IMF (2011) Financial stability Index (FSI) data to indicate financial stress.[13] The IMF FSI is available for most of the EU Countries and the USA, at monthly frequency from 1981.1-2012.3. The FSI includes: Bank beta+TED spread+Inverted terms spread+corporate bond spread+stock market return+stock market volatility+Exchange rate volatility. We contrast the FSI with the monthly Industrial Production Index (OECD, 2011)

Both measures, the IMF FSI and IP, are shown here for Spain and Germany, see figure 1 and 2.

Spain, see figure 1, as one of the Euro-zone problem countries with respect to high indebtedness now and financial stress, shows a distinctive negative relationship between financial stress regimes and economic activity: Stress is low in expansions, and high in a regime of contraction.

The same pattern can be observed for Germany. Thus such distinct regimes and high (negative) correlation of industrial production activity and financial stress in contractions and expansions are also visible for Germany, see figure 2. Next we study the fiscal consolidation efforts.

2.4 Fiscal Consolidation Policies

What one can observe is that, in terms of timing, fiscal consolidation policies started, 2009/2010, for example in Greece 2010. This occurred in a regime where financial stress had not receded yet, and production activities were only slowly recovering.

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[13]For details see Mittnik and Semmler (2012b).

Figure 1: Financial stress and IP for Spain: Financial stress index (IMF FSI, lower graph) plotted against growth rates of industrial production (3 month moving average, upper graph)
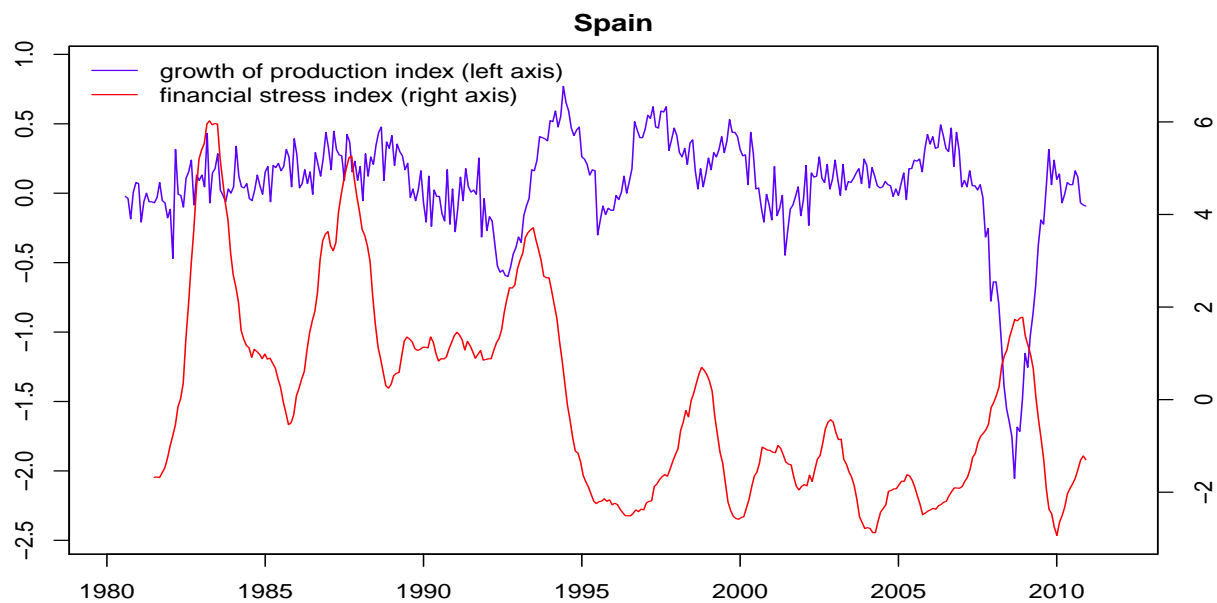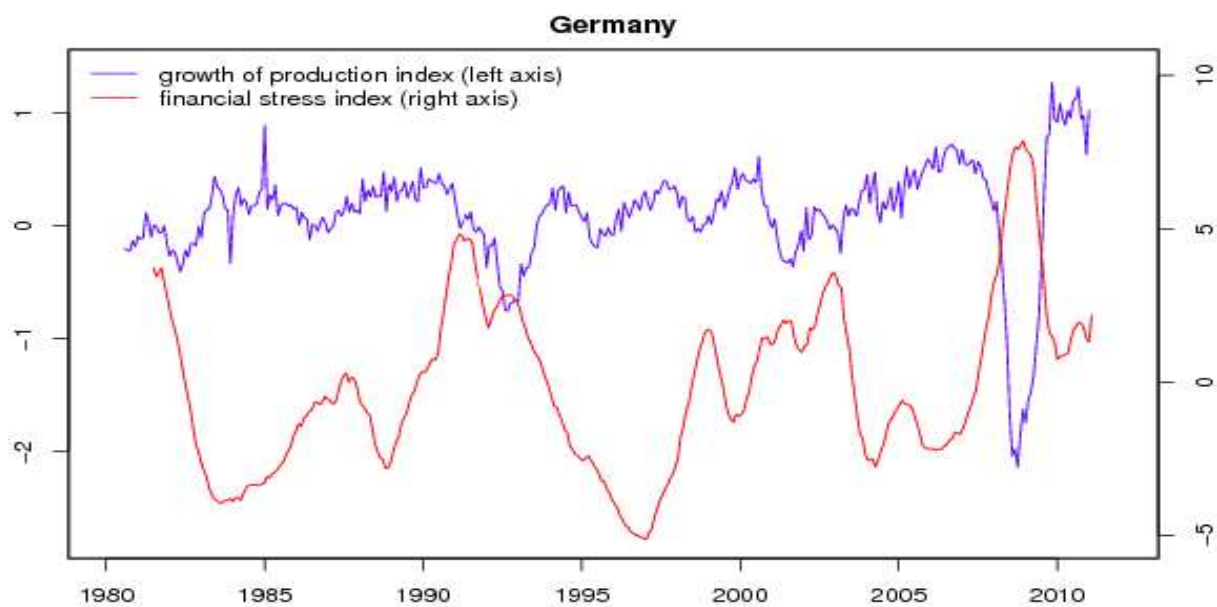

Figure 2: Financial stress and IP for Germany: Financial stress index (IMF FSI, lower graph) plotted against growth rates of industrial production (3 month moving average, upper graph)

	2009	2010	2011	2012	2013
ITALY--Austerity	0.8	-0.6	-0.9	-0.8	-0.4
Deficit/GDP	-4.5	-3.9	-3.8	-2.0	
(Output Gap)	(-4.3)	(-2.5)	(-2.0)	(-2.9)	(-2.3)
Debt/GDP	116	118	120	123.3	118
(Unemployment)	(7.8)	(8.4)	(8.4)	(9.5)	(9.7)
SPAIN—Austerity	3.7	0.2	-2.2	-6.9	-3.5
Deficit/GDP	-11.0	-10.1	-9.7	-6.7	
(Output Gap)	(-4.4)	(-4.6)	(-3.8)	(-4.4)	(-3.6)
Debt/GDP	53	61.2	68.5	80.9	87
(Unemployment)	(18.0)	(20.1)	(21.7)	(24.4)	(25.1)
GREECE—Austerity	4.8	-7.2	-9.1	-11	-9.5
Deficit/GDP	-15.6	-10.3	-9.1	-7.3	
(Output Gap)	(-1.4)	(-3.7)	(-8.4)	(-10.7)	(-9.0)
Debt/GDP	129.0	145	165	160	170
(Unemployment)	(9.5)	(12.6)	(17.7)	(19.7)	(19.6)

Table 2: Aggregate macroeconomic measures for Italy, Spain, and Greece in percentage terms; Deficit/GDP, Output Gap, Debt/GDP, and Unemployment; Source: EU Report (2012).

1. Aggregate effects of EU fiscal consolidations

The role of austerity policies, which is the attempted decrease in the structural budget deficit through fiscal consolidations, is discussed next, see table 2.

Though in the austerity policies the structural deficit[14] was targeted to be reduced. We use here − because of the difficulty to relate the targeted from the final effects - the reduction of public consumption as measure for intended fiscal consolidations. As one can observe in table 2, for the countries considered here the austerity measures did not improve the deficit, output gap, debt and employment and also the debt stabilization effect did not occur, but largely the fiscal and macroeconomic performance of the countries deteriorated.

As the growth declined the impact of growth on the structural deficit − here measured as average deficit for a longer time period − showed up in a higher deficits, see figure 3.

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[14]The structural deficit is the cyclically adjusted deficit, often defined also as fiscal stance. Fiscal stance=Δspb_t; whereby $pb_t = spb_t + cpb_t$, and pb_t=primary balance, spb_t=structural balance, and cpb_t=cyclical component. The latter is computed from the output gap, with $cpb_t = \gamma gap_t$. But in the subsequent presentation we take 6 year averages as proxy for structural deficit.

Cost of Austerity: x axis-Fiscal Change (% of GDP), y axis-GDP Change (average 2009-2014)
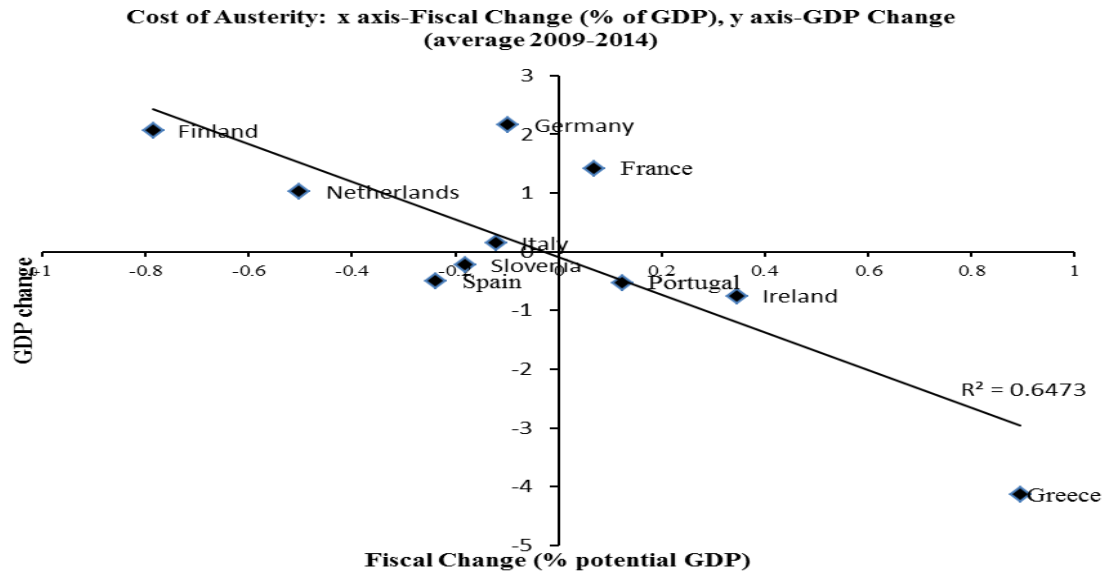
Figure 3: Growth and deficit; Source: OECD (2012); own computation

The figure 3 shows for ten EU countries the relationship of economic growth and structural deficit for the time period 2009 to 2014 (projected), average rates. As the regression line for the ten countries demonstrates, a clear negative relationship emerges. So, overall, we can observe from table 2 and figure 3 that the fiscal consolidation policy did not seem to be successful in sovereign deficit reductions – output was falling, output gap was rising and structural deficit increased or at least kept staying high.

Figure 4 shows for the critical five countries of Southern Europa the relationship of 5 year averages (2008-2012) of deficits and sovereign bond yield spreads over the German Bund. Though the results can be interpreted as showing that higher deficits generate higher bond yields, it also can be seen as confirming the view that higher cost of sovereign borrowing drive up public deficits.

Overall, with the consolidation policies enacted, the structural deficit did not fall, and the higher deficits created higher bond yields driving up again the cost of sovereign debt and thus rendering the deficit reduction unsuccessful. This issue will be further discussed below in sect. 5.

2. Composition of the consolidation programs

Next we want to look at the composition of fiscal consolidations. It is not only the distinction between public consumption, and public investment, see EU report (2012:165), which is relevant, but also the effects of the austerity on health, education, physical and other infrastructure, as well as public sector wages and salaries if one considers the effect of fiscal consolidations.[15] Consolidations were done in haste and done in a wrong way and distributional impacts neglected. Now some authors raise the issue of damages being done to Europe's social model. Unfortunately there is no EU report tracking the consolidation in those kind of areas. A relevant publication on this issue is, however, Busch

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[15]The composition effects of fiscal spending and its effect on growth is discussed in more detail in Semmler et al. (2011).
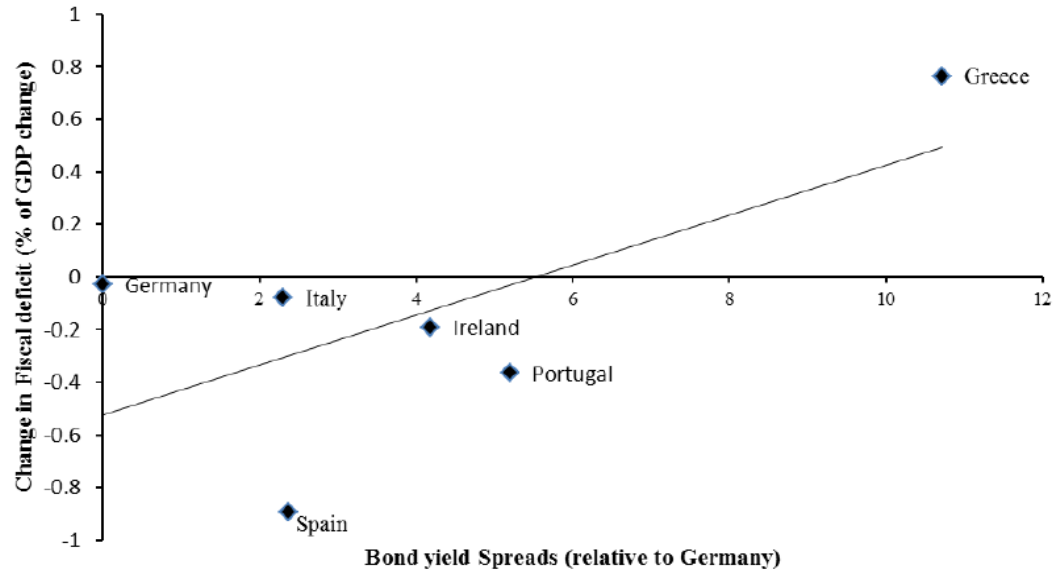
Figure 4: Public deficits and yields; Source: OECD (2012).

et al. (2012). They consider the distributional effects of the austerity programs, for example the public sector wage freeze, the downward adjustments of social security, decentralization of collective bargaining,privatization efforts and reduction of public consumption. The distributional effects of austerity are also extensively discussed in a recent IMF paper, see Woo et al (2013).

Through the consolidation program one expected consolidation effects and internal adjustments through confidence building, (interest rate decline), lower public investment and consumption expenditure, changing bargaining agreements, lowering public sector wages and decreased future social security payments and lower replacement wage, see table 3. Yet, the socially unbalanced income and wage adjustments policies met wide resistance. In some countries the wide-spread view arose to default on public debt rather than go along with the consolidation programs which made the debt crises worse by driving up credit spreads further. Recently, in many countries the austerity programs have been halted, but in some countries the efforts have become part of the labor market or structural reform programs. The effects will be discussed below.

2.5 Interest Rate and Unconventional Monetary Policy

Next we will briefly discuss to what extent the fiscal consolidation policy was accompanied by an ECB monetary policy. What has the ECB pursued as conventional and unconventional monetary policies?

- First the ECB started with fixed-rate, full-allotment liquidity provision. Eligible were euro area financial institutions that have unlimited access to central bank liquidity at the main refinancing rate, subject to adequate collateral. The ECB may decide in advance to allot the full amount of liquidity that banks request at a fixed interest rate.

- Longer-term liquidity provision were provided. In addition to the increase in amount of the

longer-term refinancing operations (LTRO) with maturities of three and six month, the maturities of the LTRO were temporarily extended to 12 month, later to 3 years, to reduce uncertainty and encourage banks to provide credit to the economy. Furthermore, these measures were expected to contribute to keeping the money market rate at low levels.

- The ECB then undertook an expansion of a list of assets eligible as collateral during the financial crisis, the list of eligible collaterals, accepted in Eurosystem refinancing operations, was extended and includes e.g. ABS to enable refinancing of illiquid assets though the central bank to overcome liquidity shortages due to sudden halt in interbank lending.

- Currency swap agreements were changed. The Eurosystem provides liquidity in foreign currency in cooperation with other central banks at various maturities. This measure supported banks with limited access to foreign currencies, most notably US dollars.

- Covered bond purchase programs were undertaken. Instead of accepting the debt securities as collateral, the Eurosystem can also purchase certain assets outright. To revive the covered bond market, the Eurosystem purchased euro-denominated CB issued in the euro-area at a value of €60 bn.

- Securities Markets Program (SMP) was enacted. In response to the tensions in the euro area sovereign bond markets, in May 2010, the Eurosystem purchased government bonds. Moreover in 2012 the OTM (Outright Monetary Transaction program) was created, allowing the ECB to purchase sovereign bonds on the secondary market. An important effect had the announcement by Dragi "to do what it takes" to rescue the Euro.

- Furthermore the ECB is now leading the discussion on supervision of an EU Banking Union, see IMF Fiscal Monitor (2012:28), and the ECB's holdings of sovereign debt on its balance sheets has become high, but overall – as measured against the FED response after 2008/9, the ECB responded only weakly to the arising sovereign debt crises.

2.6   Fiscal Consolidation and Re-Emergence of Financial Stress

As one can observe from figure 5, after 2008/9, the EU countries slightly recovered from the period of financial stress and economic contraction. Yet the extended efforts of fiscal consolidation generated new recessionary trends and the financial stress rose again significantly, see the rise of financial stress since 2010. Also the banking stress re–emerged again, even in a stronger form.

The figure 5 uses a measure of financial stress that includes more balance sheets variables of EU banks than the IMF FSI. The stress index is created by the ZEW Mannheim and uses a combination of the IMF FSI index and further banking indicators.[16] From a multi-variable index for each of the above countries, an aggregate index is constructed that employs Principle Component Analysis, using the first component. It is interesting to note that the index does not only move in tandem for all the EU countries but shows quite distinctively the two periods of extensive financial stress after 2007. In particular it is observable that the there is a re-emergence of the financial crisis after the consolidation measures have been enacted.

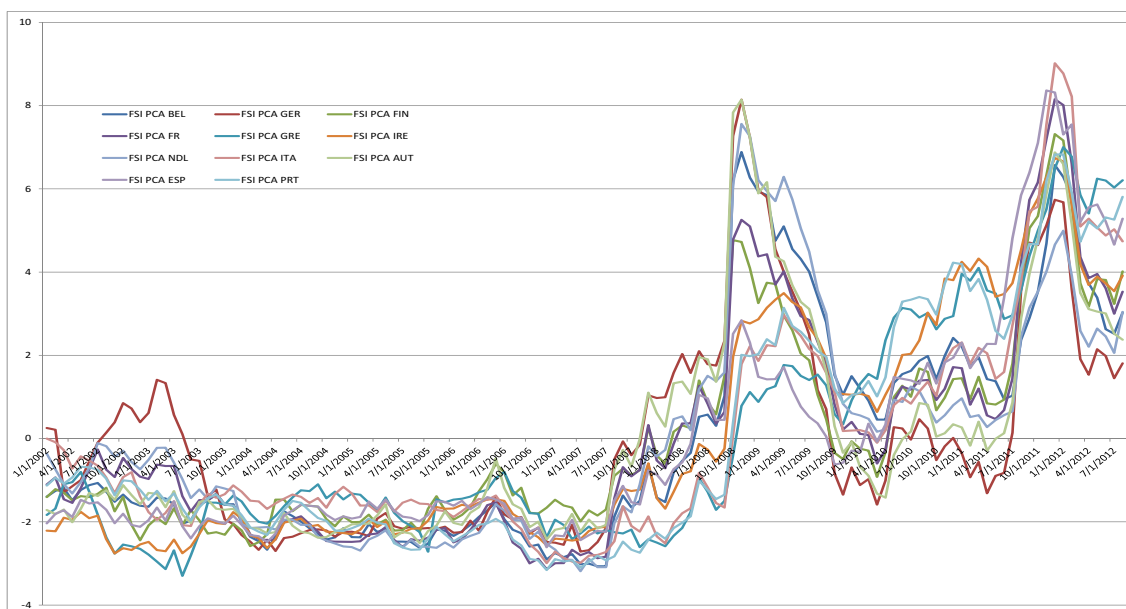[16]For details see Schleer and Semmler (2013)

Figure 5: Re-Emergence of financial stress, after fiscal consolidation efforts; recent financial stress in 11 EU countries, financial stress measure includes banking sector stress. Source: Figure provided by Frauke Schleer, data from Schleer and Semmler (2013).

3 Regime Dependence of Policies

Next, we study to what extent the effects of fiscal and monetary policies are in fact regime dependent.

3.1 Recent Empirical Studies on Fiscal Policies

Traditional empirical results of recent fiscal multiplier studies are more extensively surveyed in Mittnik and Semmler (2012a). Here a brief summary is given:

- Earlier Keynesian literature estimated a fiscal multiplier greater than unity. Recently Romer and Bernstein (2009) estimate a multiplier of roughly 1.5, see also Ramey (2009) for a multiplier greater than unity

- In the literature, based on the DSGE model, responding to those estimations a quite small multiplier was estimated; For example Cogan et al (2009) suggest a multiplier of 0.7; due to expected higher interest rates and wealth effects (with expected future taxation for Ricardian consumers)

The more recent studies, stressing new empirics, emphasize that multiplier effects depend on situations, environment and timing. What is stressed is:

- Accommodative monetary policy (with zero bound) increases the multiplier, see Christiano et al (2011), Hall (2009), Woodford (2011), in particularly due to low interest rates and credit expansion

- The existence of constrained consumers increases the multiplier: If the fraction of "rule of thumb" consumers increases in recessions, Gali et al ((2007), the multiplier will be greater than unity; see also Corsetti et al (2012). In this context, deleveraging consumers may make a downward trend stronger, see Eggertsson and Krugman (2011)

- High sovereign debt, measuring the state of the fiscal situation, decreases the multiplier, see Corsetti et al (2012) who state a threshold value of the debt to GDP ratio of 100 percent[17]

- High financial and banking system risk premia and high financial stress decrease the multiplier, see Batini et al. (2012), Mittnik and Semmler (2012a, 2013) as well as Corsetti et al (2012), Blanchard et al. (2013) and Bolten et al (2012). The latter point to the fragility arising from the sovereign debt holdings by banks.

- An open economy, with flexible exchange rates, and high foreign debt decreases the multiplier, see Ilzetzki et al (2010), and Erceg et al (2012), on the other hand the support of external demand may be favorable for the multiplier

- Labor market wage setting and wage rigidities may have ambiguous effects on the multiplier, see Boyer (2012), Charpe et al (2013), on the one hand and Monacelli et al (2011) on the other

- Multipliers are often defined with respect to "good and bad times", in bad times being stronger than in good times, see De Long and Summers (2012) who stress persistent effects of multipliers, see also Auerbach et al (2011/12) and Fazzari et al (2012)

- Multipliers, specifically for expansions and recessions, are considered in Baum et al (2012), in terms of the output gap, and Batini et al. (2012), in terms of output growth. The latter consider both expenditure shocks as well as revenue shocks, for a further discussion see below.

- Furthermore, asymmetries of the multiplier effects in booms and recessions, as well as the effects of multipliers depending on the size of shocks, are explored in Mittnik and Semmler (2012a, 2013), Chen and Semmler (2012), and Schleer and Semmler (2013), the latter using the ZEW Index, that includes banking variables, see also below.

3.2   Methods of Estimating Multi-Regimes

As to estimating multiplier regimes there are currently three different methods at the forefront. We here briefly will discuss the three methods.

The Markov Regime Switching Model

Many studies employ the Hamilton regime switching model. What is explored here is the probability of recessions.

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[17]In the light of the extensive criticism of the 90 % threshold of Reinhart and Rogoff, this statement might need to be reviewed as well.

$$y_t = c\left(s_t\right) + \sum_{i=1}^{p} A_i\left(s_t\right) y_{t-i} + \varepsilon_t, \ \ \varepsilon_t | s_t \sim NID\left(0, \sum\left(s_t\right)\right)$$

$$\theta\left(s_t\right) = \left\{ \begin{array}{c} \theta_1 \ if \ s_t = 1 \\ \theta_2 \ if \ s_t = 2 \\ : \\ : \\ \theta_s \ if \ s_t = M \end{array} \right\} \quad P = \left[\begin{array}{ccccc} p_{11} & .. & .. & .. & p_{1M} \\ : & & & & \\ : & & & & \\ : & & & & \\ p_{M1} & .. & .. & .. & p_{MM} \end{array} \right]$$

$$p_{ij} = Pr(s_{t+1} = j | s_t = i) \sum p_{ij=1}$$

Markov Regime Switching Model; Hamilton and Lin (1996)

The above describes the Markov regime switching method. One might, however, argue, that the regime change results from the entire system dynamics, and one does not know which variable is switching, and which variable to refer to for policy purposes. From the point of view of policy action one might want to know which variable, or variables, move into a precarious territory.

Smooth Transition Regression Model

Another method is the Smooth Transition Regression (STR) model, or in vector form called VSTAR. A transition function is defined as in figure 6.

The STR or VSTR method is a more practical one using more information on the essential variables. One in fact can observe the switching variable, or variables. On the other hand, it is limited in terms of the number of variables that can be used to study regime switching.

The Method of a Multi-Regime VAR

Another econometric multi-regime model uses pre-defined thresholds of the Tong and Tsay type. This is used by Mittnik and Semmler (2011, 2012a, 2013) in their studies. Multi Regime VAR (MRVAR) of the Tong and Tsay type is used in Mittnik and Semmler (2012a),[18]

$$y_t = c_i + \sum_{j=1}^{p_i} A_{ij} y_{t-j} + \epsilon_{it}, for \ y_{i...n} < threshold \ r \leq y_{m...p}$$

One uses a pre-defined threshold for a regime change at r (growth or financial stress regimes) rather than estimating (best-fitting) thresholds. The advantage is that it allows for (i) Piecewise linearization around "interesting locations", (ii) Straightforward linear least-squares estimation and (iii) Multi-Regime Impulse-Response.The issue becomes here, what to take as threshold, growth regimes, characterizing business cycles, or stress regimes, using an financial stress index as regime defining variable.

Also, it is crucial what does one take as model selection criterion to distinguish between the linear and the non-linear model? Mittnik and Semmler (2012a, 2013) suggest the AIC criterion. A further problem is the Impulse-Response (IR) function. Using a predefined threshold, the IR function can be

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[18]See also recent studies by Benati et al. (2012) and Baum et al. (2012).

$$F(z_{i(t-d_j)} - c_j) = [1 + \exp(-\gamma_j(z_{i(t-d_j)} - c_j))]^{-1}, \quad \gamma_j > 0;$$
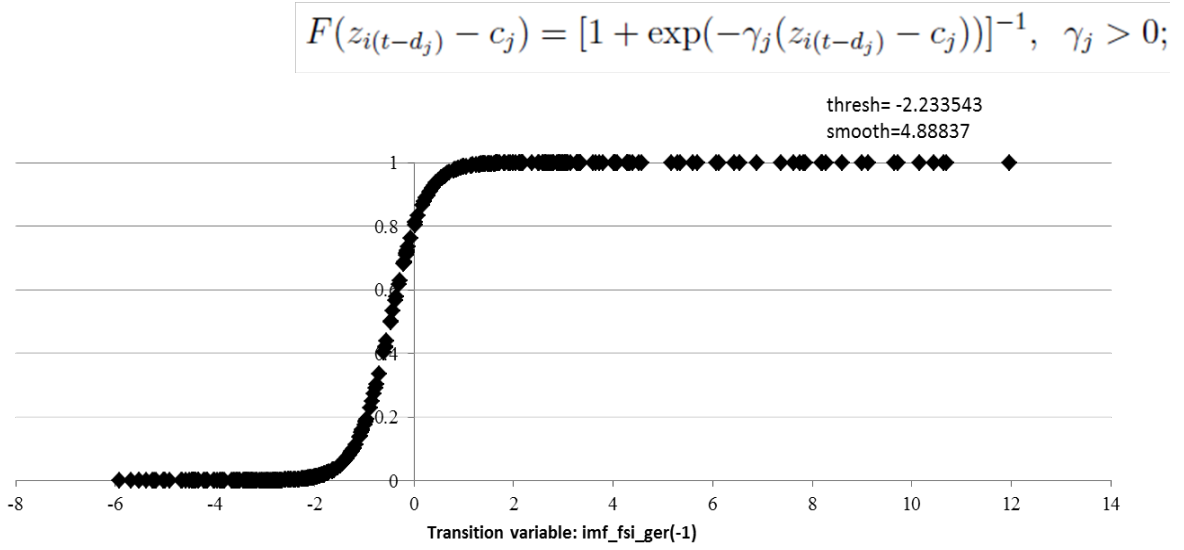

Figure 6: Smooth Transition Regression (VSTAR) Model; using the ZEW Index, see Schleer and Semmler (2013)

studied for certain regimes but after shocks, there are within regime responses or migration to other regimes. This issue can however be resolved by simulation techniques.

3.3 Regime Dependence of Fiscal Policy

Next we want to report further details on the multiplier study by Mittnik and Semmler (2012a). The MS method is based on a similar regime definition such as one would get from Gali et al. (2007) who refer to Ricardian and „rule of thumb" consumers, whereby for the latter case holds that consumption spending is income dependent. It is also assumed that the interest rate is kept low, as in Christiano et al. (2011) who obtain, with a zero bound interest rate, a multiplier of roughly 3. It resembles also the Hall (2009) multiplier study, who obtain a multiplier of about 1 with countercyclical mark up on industry pricing, elastic labor supply, complementarity of consumption and labor income, and zero interest rate bound.

The model background in Mittnik and Semmler (2012a) is similar: Non-clearing markets based on a two regime model with corresponding less or more constrained agents. This relates to a two-regime model[19] in the Malinvaud tradition. In a first regime of decision making, there is relatively unconstrained consumption - employment choice (similar to Gali et al. 2007 and their Ricardian consumers). This stage can be associated with a high growth regime.

In a second regime of decision making, the labor market is not cleared, there are constrained choices, consumption depends on actual employment, and firms' production depends on actual demand. In the recessionary stage, government expenditure is expected to have strong effects. When firms face sales

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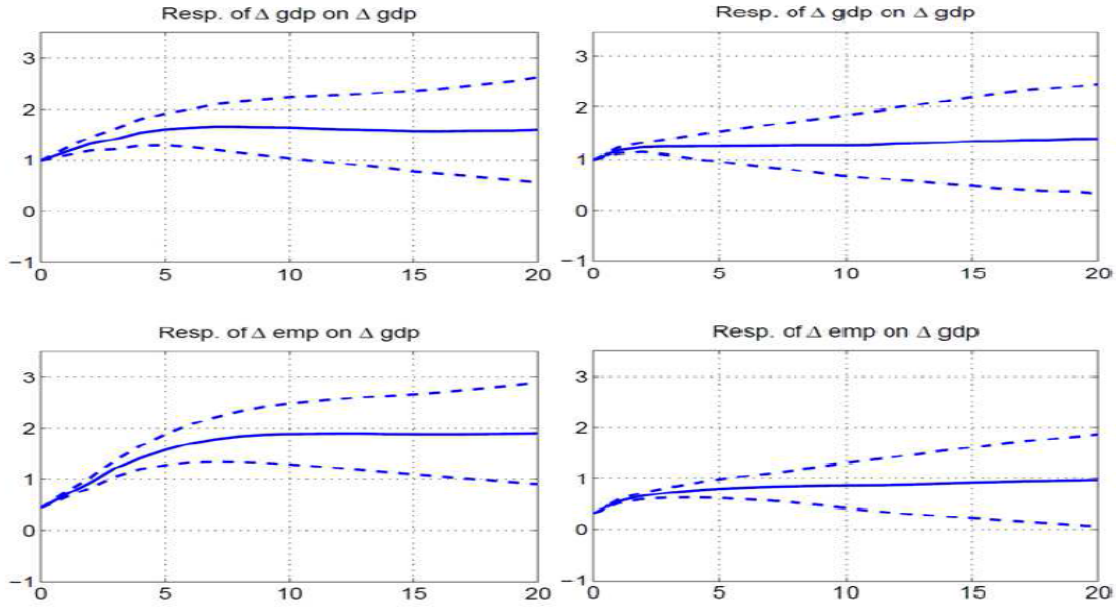[19]For details see, Gang and Semmler (2006).

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Figure 7: Fiscal multiplier for the US: Low growth regime; Cumulative MRVAR responses; fiscal expansion leads to strong effects of the fiscal multiplier on output and employment. (left graph). High growth regime; Cumulative MRVAR responses; fiscal expansion leads to weak effects of the multiplier on output and employment. (right graph); Source: Mittnik and Semmler (2012a)

constraints and households face employment, income and credit constraints, additional spending has strong externality effects: It relaxes income, liquidity and credit constraints— it does so, the more it is supported by liquidity provision and low interest rates.

Employing output growth rates as regime defining variable the MS method allows to make a comparison of (one-regime) VAR and two-regime VARs. The variables are gdp=GDP; emp=employment, the sample period is 1954:1-2008:4. For a two-regime MRVAR MS predefine as threshold the sample mean of output growth rate (3.18%).[20] The IR exercises for the two regime model are as follows, see figure 7.

For the high growth regime, on the left, we can observe the output multiplier (upper figure) and the employment multiplier (lower figure) whereby the threshold variable is output growth. Not only does the fiscal expansion have a stronger effect on growth in the low growth regime, but particularly employment increases significantly through fiscal expansion.

This is somewhat in contrast to the model by Monacelli et al. (2011). They argue that labor market tightness, job finding probabilities and separation rate, extensive and intensive margins of work as well as participation rates reduce the employment multiplier significantly. They do this however not in a two regime model and two regime VAR but in a conventional one regime dynamic model and one regime VAR. For our MRVAR one can clearly observe the state dependence of fiscal policy effects and thus one would predict a different impact of policies on output and employment in the two regimes.

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[20] The model selection criterion taken here is AIC.

We also want to note that correspondingly, for a budget consolidation, a negative fiscal shock, one would expect a larger effect on output and employment than in an expansionary period. Though this exercise was not directly undertaken in MS (2012a), the conclusion is justified to make – though expansionary effects of fiscal policies in recessions may generate a slightly different multiplier as compared to a fiscal contraction in recessions.

In the MRVAR model in MS (2012a) financial stress was not considered yet, which are quite different in expansions than in recessions. A similar study as the one by MS (2012a) can be found in De Long and Summers (2012). There, multipliers are also stronger in "bad times", if timely and temporarily applied. They in addition show that multipliers may have a long-run effect, a hysteresis effect. Other recent studies that have taken into account some of those aspects are Blanchard et al (2013) and Benati et al (2012), those studies are more extensively discussed in sect. 4.

3.4   Regime Dependence of Monetary Policy

One needs to add the financial market and some measure of financial stress to better understand the size of the multiplier effect. Presumably in high financial stress the fiscal consolidations have different effects as compared to low financial stress regimes. In order to explore the role of financial stress for policies, we next study output and the FSI in a regime change (business cycle) model. Financial stress can magnify fiscal contractions and monetary policy can off-set some of the contractionary effects of a fiscal consolidation.

We first define what we mean by financial stress. In this context, we also have to define what one defines with conventional and unconventional monetary policy. There are many traditional VAR studies with accommodating monetary policies. Conventional monetary policy, in terms of the Taylor rule, means lowering interest rates in contractionary periods, yet, recently, some unconventional policies have been pursued by the US Fed and the ECB, see above sect. 2.5.

The MS (2012a) regime change model lets one study the monetary policy effects in expansions and recessions as well. Yet for this, one needs reliable stress measures. There are different financial stress measures developed (St. Louis, Fed, Kansas City, IMF, and the ZEW index by including more banking variables). We first refer to output as threshold and report a MRVAR, then we refer to financial stress as variable to define regimes, financial stress regimes.

Growth Regimes

Next, results are shown for using output as regime defining variable, as in sect. 3.3. We show here estimation results from Mittnik and Semmler (2011, 2012b) who study real and financial shocks in different output regimes, in high and low growth regimes. We use the IMF FSI, as discussed in sect. 2.3, as stress variable, and IP, the monthly production index, as real variable for numerous countries. We here want to particularly focus on the effects of monetary policy, which needs to be more of an unconventional type with strong asset market effects to bring down financial stress.

The figures 8-9 for Italy and Spain show us that in a high growth regime, financial stress reduction creates little growth effects but in a low growth regime expansionary effects on output are quite visible. On the other hand, one can conclude that stress increase in low growth regimes will have a stronger growth contraction than in high growth regimes. This also means that if there is fiscal consolidation, and financial stress rises, the contractionary effects will be rather strong. We also can observe not only asymmetries but also size dependence of shocks: large stress shocks matter more, for details
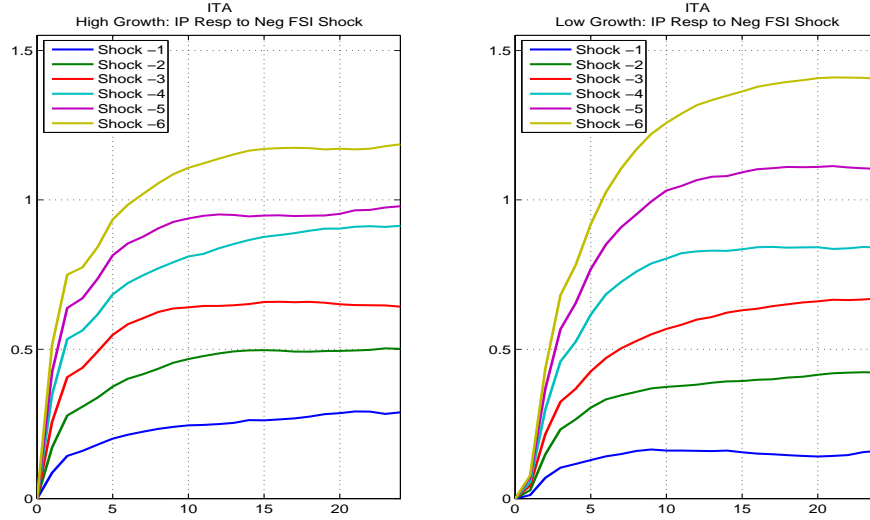
ITA
High Growth: IP Resp to Neg FSI Shock

ITA
Low Growth: IP Resp to Neg FSI Shock

Figure 8: Growth Regimes; Stress decrease through monetary policy for Italy in a high and low growth regime; Source: Mittnik and Semmler (2012b)

see Mittnik and Semmler (2012a). Monetary policy needs to very active, and significant, in order to generate improvements in output.

Stress Regimes

Next we are discussing monetary policy effects for different stress regimes. Monetary policy may be more effective in high financial stress regimes than in low financial stress regimes, see Mittnik and Semmler (2012b 2013). There, threshold variables are estimated through an AIC procedure, for a large number of EU countries, in terms of a financial stress using the third method above.

As our above example for Italy shows, there are strong cumulative responses in the high stress regime when there is a negative stress shock. The latter is equivalent to an active unconventional policy aiming at reducing financial market stress. On the other hand, monetary policy actions, reducing stress, have very little effect in the low stress regime. We also report the size effects of monetary policy actions: the IR are studied with weak and strong monetary policy actions, see figure 10. We can observe a strong size dependence of the monetary policy actions. So note that (unconventional) monetary policy is important in this context.

Thus monetary policy becomes very important, since it can considerably weaken the strong downward multiplier effects, and thus weaken the contractionary effect engineered through fiscal consolidation. So far, however, we have not explicitly reported results on the opposite, namely negative output shocks, from austerity policies, in a regime of high financial stress. If this occurs positive stress shocks in turn can have high output losses in a high stress regime and so on, generating a vicious cycle. Those aspects are studied in Chen and Semmler (2012). The methodology to find a threshold by estimating
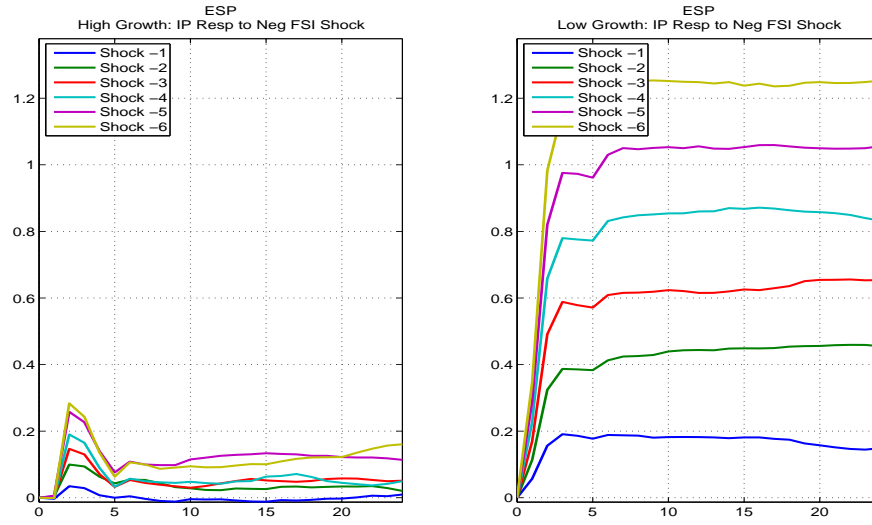
Figure 9: Growth regimes; Stress decrease through monetary policy for Spain in a high and low growth regime; Source: Mittnik and Semmler (2012b)
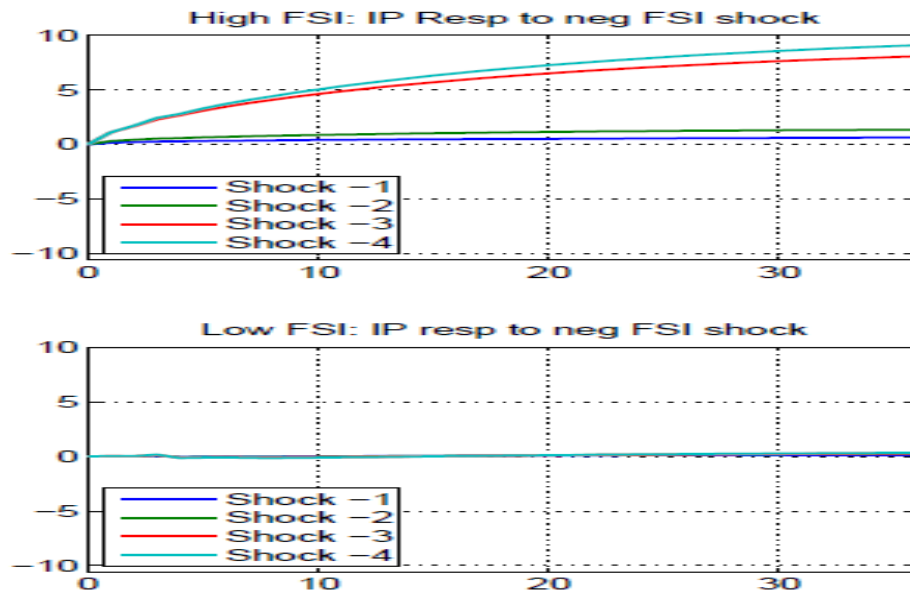

Figure 10: Stress Regimes for Italy; stress reduction through monetary policy in high and low financial stress regimes; Source: Mittnik and Semmler (2012b)
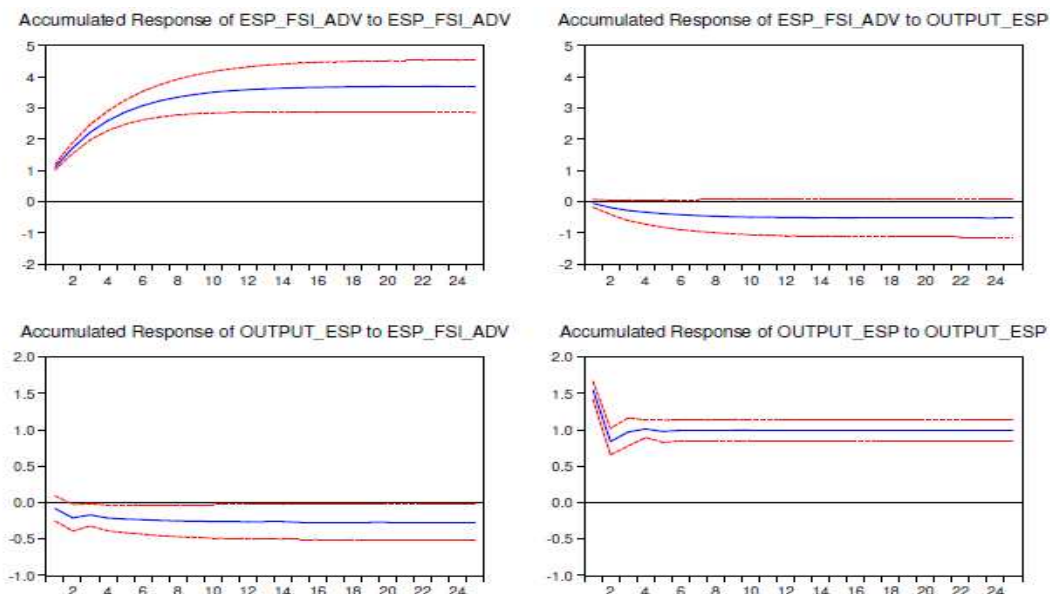
Figure 11: Effects of FSI shocks and output shocks in Spain; Source: Chen and Semmler (2012)

financial stress thresholds is similar to Mittnik and Semmler (2012b). The results are worth reporting here.

As Chen and Semmler (2012) show in detail and as is visible from figure 11, a positive FSI shock has a strong effect on themselves (upper left) in a high stress regime, and stress shocks negatively affect output (lower left). A negative output shock has in turn a significant negative effect on financial stress (upper right). Thus, fiscal consolidation may run into this vicious cycle as illustrated in sect. 2.4.1: financial stress increases, and stress reduces output, output contractions can lead to more financial stress and so on.

A study using the third method above, employing an VSTAR methodology, to determine thresholds in terms of a financial stress variable and undertaking IR is reported in Schleer and Semmler (2013) using the ZEW financial stress index. The regimes are defined as stress regimes. The stress regimes are estimated through VSTAR, as discussed in sect. 3.2. The results reported there are for many EU countries. As can be observed there, with the new estimation of the thresholds through VSTAR, the IR show quite expected results for many countries. In a low stress regime, reducing the financial stress increases output little, whereas a stress increase in a high stress regime generates roughly twice as much output losses than a stress shock in a low stress regime.

Thus output losses of fiscal contractionary policies are expected to have more negative effects on output if also the financial stress rises, which in turn will reduce output. In particular when the banks hold sovereign risky bonds, financial stress is likely to be higher if sovereign risk rises.[21] Thus, in the last years, in the EU, monetary policy faced a strong downward multiplier effect. This appeared to have occurred due to both a contractionary effect through fiscal consolidation programs but also

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[21]See the notion of a diabolic loop, Brunnermeier and Oehme and Bolton et al (2012).

through the financial stress in the EU financial and banking system. Hereby the ECB policy turned out not to be very mitigating.

As summary so far we can state that many studies point to the view that downward pressures occur with fiscal consolidation arising from: 1) constraints in product markets and constraints in the labor markets, 2) financial stress in the financial sector, due to sovereign bond risk and banking risk, see Brunnermeier et al (2012), 3) Holding of bad debt (for example, sovereign debt holdings) by banks, see Bolton et al (2011) who point to the danger of a "diabolic cycle", 4) Precarious price dynamics and deflation trends (Fisher deflation effect), 5) Increase of the fraction of households deleveraging, see Eggertson and Krugman (2011), and 6) Loss of wage income and demand (depending on wage or profit led economy).[22] Next we want to discuss other recent studies and the extent to which they have taken those amplifying mechanism into account.

4   Other Multiple Regime Studies

There are a number of recent empirical multiple regime studies that are somewhat similar to the ones reported above. For example, as mentioned, De Long and Summers (2012) study the fiscal multiplier, namely the multiplier in "good" and "bad" times. They discuss also the persistent effects of not undertaking fiscal policy actions in a recession. Fazzari et al. (2012) use an indicator function to estimate thresholds while employing only real variables. As mentioned before, there has also been a considerable change in IMF studies in recent times. These studies also consider that the effects of consolidation efforts are state dependent.[23] We will limit our more detailed discussion to a few important recent quantitative studies on asymmetries of the effects of fiscal actions in expansions and contractions. Some of the studies show indeed distinctively that the (upfront) fiscal consolidation in recessions is likely to be contractionary. We discuss here briefly four studies.

An important recent study is the one by Blanchard and Leigh (2013). Though the study does not use a multi-regime model, and does not explicitly take into account the state of the financial sector, it points to the existence of different regimes in a multiplier study. Blanchard and Leigh (2013) regress the forecast error[24] on the forecast in the following way:

$$Forecast\ Error\ of\ \Delta Y_{i,t:t+1} = \alpha + \beta\ Forecast\ of\ \Delta F_{i,t:t+1/t} + \epsilon_{i,t:t+1}$$

$$with\ forecast\ error = \Delta Y_{i,t:t+1} - f\{\Delta Y_{i,t:t+1/t}|\Omega_t\}$$

Fiscal consolidation is measured as structural deficit reduction, as positive number. The result is, for example, that for Greece, Ireland and Portugal there is a $\beta = -0.82$ and significant. This means that a forecast error, due to the actual drop of the GDP growth $\Delta Y_{i,t:t+1}$, is large and it can essentially be attributed to a large contractionary effect due to a large multiplier.

A different multiplier in expansions and contractions is also found in Auerbach et al. (2012a, b). To estimate the threshold for expansions and recessions they estimate the appropriate regimes with an indicator function. The time periods and the estimated multiplier effects are listed in table 3, upper part. As can be seen the multiplier effect is always stronger in recessions than in expansions. The

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[22]In a profit led economy wage decrease might allow for rebalancing and in a wage led economy a reduction of real wages is likely to generate a further downward spiral, for details see Charpe et al (2013).

[23]See for example the remark: "In all countries, a fiscal consolidation is substantially more contractionary if made during a recession than during an expansion." Batini et al. (2012: 23).

[24]See also IMF Oct 2012: p. 1

				4 qrts	8 qrts
Auerbach-Gorodnichenko (2012a)*	1947-2008	U.S. Spending	Expansion	0.0	-0.1
			Recession	1.4	1.8
Auerbach-Gorodnichenko (2012b)*	Half-year data Old members: 1985-2010. Newer members: mid-1990s-2010	OECD Spending	Expansion	-0.3	-0.3
			Recession	0.5	0.4
Batini et al. (2012)	1975-2010	U.S. Spending	Expansion	0.3	-0.5
			Recession	2.2	2.2
		Revenue	Expansion	0.2	0.7
			Recession	0.2	0.7
	1985 - 2009	Euro Area Spending	Expansion	0.4	0.1
			Recession	2.6	2.5
		Revenue	Expansion	-0.2	-0.1
			Recession	0.4	0.4

* Multipliers reported here reflect the real GDP response (in percent) to a 1 percent spending shock.

Table 3: Results from Auerbach et al (2012a,b) and Batini et al. (2012)

authors study the spending multiplier in expansions and recessions for a number of countries, see table 3.

As can be seen there are distinctive results for expansions and recessions – the multiplier being stronger in a recession than in an expansion. There are also distinctive results for the spending and revenue multiplier.[25]

Beside the important studies by Auerbach and Gorodnichenko (2012a, b) where quite a difference of the multiplier effects can be seen in expansions and contractions, a further relevant study for our topic is the study is by Batini et al (2012) who also define regimes by the use of an indicator function, for both see table 4. The latter take growth rates, a real variable, to define regimes. The expenditure multiplier is in general stronger than the tax multiplier. They find multipliers of 2.2 and 2.6 for expenditure shocks, for the US and EU, and 0.2 to 0.4 for tax shocks. Their model, in terms of growth regimes, shows that IRs are asymmetric, depending on the regime the economy is in. They are using a non-linear VAR and find strong nonlinearities. They undertake, beside US and the Euro Area, reported in table 4, further country studies for Japan, Italy and France, showing also asymmetric effects of fiscal consolidations in expansions as compared to recessions.

Lastly the study by Baum et al (2012) takes the output gap as the real variable and defines the threshold in terms of an output gap. They undertake a regime change estimation also by the use of an indicator function. When Baum et al (2012) use the output gap it is based on OECD estimates for most countries, for some other countries they take the HP-filter, but financial stress variables are neglected in their estimates. Their research shows the greatest contraction occurring with an up-front decrease in fiscal spending when the output gap is negative, followed by a stretched out fiscal austerity over 2 years. Less contractions are generated if there is a fiscal consolidation under the condition of a positive output gap.

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[25] A further detailed survey of multiplier studies is given in the IMK WP 97 (2012).

All of the above studies are methodologically similar to Mittnik and Semmler (2011, 2012a, 2013), Chen and Semmler (2012), and Schleer et al. (2013). Yet, most of the above regime change models do not take into account asymmetries with respect to the size of shocks and they mostly neglect specific financial market and banking stress variables when the fiscal multiplier effect is studied. Also, the interaction of fiscal and monetary policies, given financial stress – or no financial stress– is not extensively dealt with. Some of those issues are modeled next.

5   A Dynamic Model with Financial Stress Regimes

Next, we will be interested what macro mechanisms might be responsible explaining the success and failure of policies. This is explored in a nonlinear macro model which includes the risk from sovereign debt and financial stress. we will also focus on whether monetary policy partly offsets or mitigates the contractionary pressures from fiscal consolidations? Furthermore, we will pursue the question whether and to what extent we can track if debt stabilization is possible.[26] To answer those questions it is important to model amplification effects in economic and financial regimes.

The model variants introduced here are extensions of the model by Mittnik and Semmler (2012b, 2013), MS, which resembles Brunnermeier and Sannikov (2012), BS.[27] The models by BS and MS solely focus on the banking system which borrows to accumulate assets with returns, while there are preferences over payouts, serving as a consumption stream. When leveraging and payouts are less constrained, and financial stress and risk premia are high, the banking system is vulnerable and more prone to instability. With stronger restrictions, and low interest rates and low credit spreads there is a greater corridor of stability, creating a more stable environment for the banks. On the other hand with less decision constraints, and the banking system facing state dependent risk premia and credit spreads which increases the cost of leveraging of the banks, there is a smaller corridor of stability.

In the here presented extended model there are two state equations, but we take a shortcut with respect to the banking system, and include more extensively – in an open economy model of the type of Blanchard and Fischer (1989, ch. 2) – macroeconomic feedback loops. Those macroeconomic feedback effects could create expansionary periods and booms, but are also likely to create, when the financial sector starts to come under stress, severe macroeconomic amplifications arising from macroeconomic feedback loops which have in detail been discussed in BS, Brunnermeier and Oehmer (2012), BO (2012), and Charpe et al. (2013).[28]

In BO (2012) a vicious cycle or diabolic loop can occur where sovereign debt, held by the banking system, can make the banking system unstable exposing it to financial stress, facing larger credit spreads, and forcing them to cut down on loans, enforcing a downward spiral. See figure 5 in BO (2012) where the feedback effects between sovereign and financial sector risk give rise to a "diabolic loop".

The model presented here refers to two strands of literature. First, to understand the debt issues involved, we refer here to intertemporal models, and thus to multi-period decisions of economic agents. There are several reasons why the choice of a multiperiod model might be useful:

- One needs to track the path of dynamic variables over a longer horizon. The evolution of debt and the sustainability of debt can only be tracked over a longer horizon, though we do not assume

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[26]Similar questions have been raising in the context of different models, see Batini et al. (2012). The latter is an infinite horizon model. We want to answer those questions in a finite horizon model.

[27]See also Stein (2011).

[28]See also Blanchard (2013b)

an infinite horizon here

- Leveraging and the evolution of debt is frequently seen to be interconnected with asset prices or net worth (see Stein 2011). To have a multi-period payoff function either for consumers or firms, is essential in asset pricing theory

- In an open economy context the issue of current account imbalances and external debt sustainability is crucial, so one also needs a multi-period model to study the long period sustainability

- The outcomes of such an intertemporal decision making model can then be compared to standard macro models when one models and estimates policy effects

Second, we also want to take into account amplification and macroeconomic feedback loops that have been known in macroeconomics since long but are severely neglected in DSGE models. In Charpe et al (2013) there are the following amplification effects, possibly arising from contractionary fiscal policies or fiscal consolidations (which are even more important in the presence of financial stress)[29]

- The Harrod-Domar unstable accelerator

- The Fisher debt deflation effect, and a rise of household deleveraging, see also Eggertsson and Krugman (2011)[30]

- A regime dependent loan rate moving counter-cyclically, often described as financial accelerator (different from the interest rate that is following the Taylor rule)

- A real loan rate and price expectation effects as developed in Tobin's (1975) work

- Wage channel effects that can trigger amplifying forces when wages are are affected in the regimes (this depends of course on the shape of the Phillips curve and whether the economy is wage led or profit led).

The financial market and loan rate channel[31] – and the wage channel and other forces affecting effective demand– are currently likely to be the most important ones in the EU macroeconomics.[32] We mainly explore the credit market-macro link, and to some extent the wage and demand channels, using model variants of low and high financial stress.

In our context, as we will show, an infinite horizon model is not needed, we will solve the model with moving finite horizon by a new numerical procedure, the NMPC method, see Gruene et al (2013). This new solution procedure allows for both a multi-period model, but also includes some of well-known macroeconomic feedback and amplification mechanisms.[33]

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[29] The following macroeconomic feedback effects are well known in the history of macroeconomics, see Charpe et al (2013)

[30] They extensively treat the Fisher debt deflation effect in their paper, but they also stress the households' deleveraging effect on demand.

[31] Another self-enforcing mechanism could be that the social cost of austerity lets the fraction of population increase that opts for a sovereign default rather than accepting the severe austerity program– which will increase the probability of default.

[32] Brunnermeier and Oehmke (2012:30) add further destabilizing mechanisms arising from externalities and contagion. They write why does a shock "...propagate across so many sectors of the economy? The reason is amplification. In the presence of implication, even a modest triggering event can cause large spillovers across the financial system. Implication can occur because of direct spillovers, such as so-called domino effects, or indirect spillovers that work through prices, constraints, and the endogenous responses of market participants."

[33] Further details of the method used in the next two sections can be found in Schleer and Semmler (2013).

5.1 Regime of Low Financial Stress

In a first model variant we keep the interest on debt constant and at a low level. This is equivalent to the case of the central bank pursuing a low − or near zero − interest rate policy. By this, in fact it might attempt to keep the economy in a low financial stress regime.[34]

$$V\left(k, d\right) = \max_{c_t, g_t,} \int_0^T e^{-rt} U(c_t) dt \tag{1}$$

s.t.

$$dk_t = (g_t - \delta)k_t dt + \sigma_t k_t dZ_t \tag{2}$$

$$db_t = (rb_t - (y_t - c_t - i_t - \varphi(g_t k_t)))dt \tag{3}$$

In equ. (1) there is preference over log utility. T does not have to be very large, or go to infinity.[35] The policy variables are consumption, and growth rate of capital stock, c_t, g_t.[36]

Equ. (2) represents the capital stock. It increases due to investment but declines due to a capital depreciation rate δ. Brunnermeier and Sannikov (2012) have a stochastic shock in a Brownian motion and volatility dependent asset prices. We can also admit stochastic shocks occurring along the path, represented by the second term in equ. (2). This is the only stochastic shock we have built in (though we will neglect this in in our current version when we solve the model). The equ (3) represents the dynamics of aggregate debt (households and firms).[37] Our debt dynamics is written here in a way which is standard if one allows for external borrowing of the private as well public sectors, see Blanchard and Fischer (1989, ch. 2) and recently Stein (2012, ch. 8).

The interest payment on debt, rb_t, increases debt but the surplus$(y_t - c_t - i_t - \varphi(g_t k_t))$ − negative excess absorption − decreases debt through a surplus. Hereby we have $i = g_t k_t$. Note that since consumption and investment are separate policy variables we allow here for external borrowing. Moreover, $\varphi(g_t k_t)$ is the adjustment cost for investment. Overall the model has two decision variables and two state variables. Note that we have quadratic adjustment cost of investment and we could permit a difference of interest and discount rates.[38]

Note also that we could allow here the income y to be split up into $y =$ normal return on capital + capital gains + wage income.[39] Then the excess return on capital income over the interest rate, generated through capital gains, can be used to service the debt, see Stein (2011). This can hold as long as there is no risk premium included in the interest being paid. Low interest rates and capital

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[34]See Christiano et al. (2011), and Woodford (2011).

[35]For details of such a model with short time horizon, approximating well, models with longer time horizons but needing much less information, see Gruene et al (2013). Those type of models are called Nonlinear Model Predictive Control, see Gruene and Pannek (2011).

[36]Actually in the numerics we can take $\tilde{c} = c/k$, so that the first two choice variables can be confined to reasonable constraints between 0 and 1.

[37]BS have the debt dynamic formulated as a net worth dynamics but a closed economy framework. In our open economy framework, we could also allow for sovereign debt here.

[38]This is done, for example in a two types of agent model, as Eggertsson and Krugman (2011). Though we have in mind in equ. (3) an open economy, but it can also be interpreted as a closed economy where then, as in Eggertssen and Krugman (2011) there are borrowers and lenders.

[39]Note that the capital gains could be positive or negative. If positive over a longer time period, as asset price models propose, see Stein (2011), that is often accompanied by redistribution of labor income to dividend income.
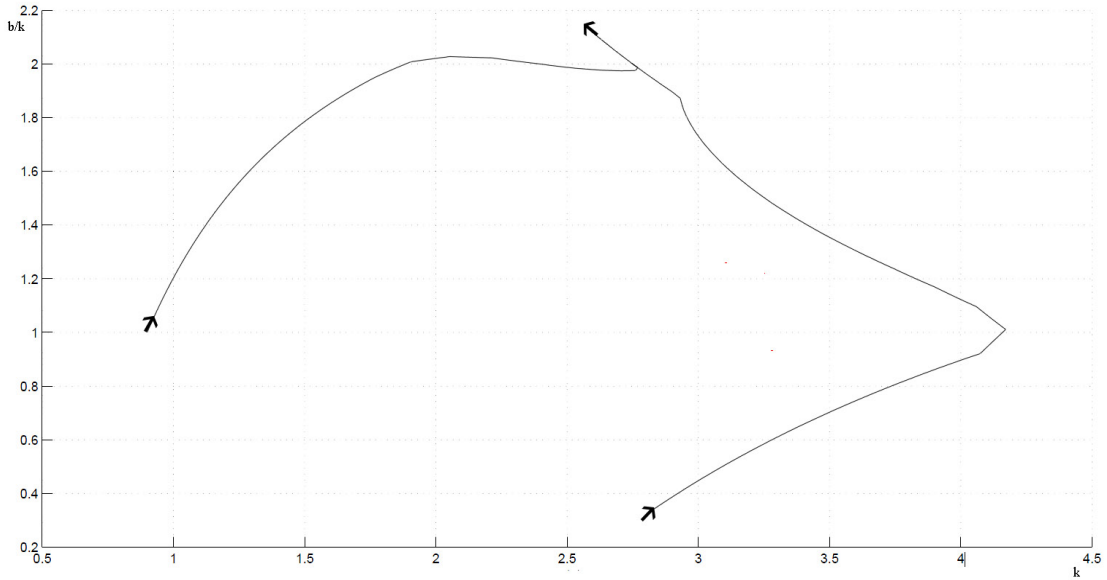
Figure 12: dynamic paths of sovereign debt for constant interest rate, for two initial conditions, $k(0) = 0.9$, $b(0) = 0.9$ (left) $k(0) = 2.8, b(0) = 0.9$ (right), convergence to steady state, with $r = 0.04$. Steady state is at the upper end of the trajectories where the arrow ends.

gains are frequently highly negatively correlated.[40] This is a kind of Minsky scenario where financial fragility may arise in a period of tranquility and thus low or zero risk premia can be observed, as for example were seen in the US from the 1990s to 2007. Implicitly, in this case, on the asset side, as Stein (2011) shows, the present value of the assets will tend to become very large, because there is no correction through a risk premium,[41] as it should be,[42] and capital gains help to service the debt.

Now we solve our above model by using NMPC. Assuming here $r = 0.04, \delta = 0.07$ and quadratic adjustment cost of investment, we obtain the following solutions using NMPC, yet, setting the shock equal to zero.

The vertical axis shows the debt to capital stock ratio, the horizontal is the capital stock. Here the paths are shown for different initial conditions. The upper end of the two paths represents the steady state which is unique where both the trajectories end up. The NMPC numerics guarantees that the transversality condition holds – the trajectories are not explosive but converge toward a steady state where the left hand side of equ. (3) is zero, see the arrow in the upper part where the two graphs converge to the steady state (upper end of the trajectories where the arrow ends). So, with the central

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[40]This could be observed in the US during the real estate boom where one could observe low interest rates, low risk premia and low discount rates. Low discount rates in turn generate high asset prices and capital gains, Chen and Semmler (2012).

[41]Stein (2011) suggests then to make corrections by suggesting to take the trends/drifts in capital gains and interest rates in such a model, that would better measure some debt capacity. The borrowing exceeding that debt capacity would amount to excess borrowing

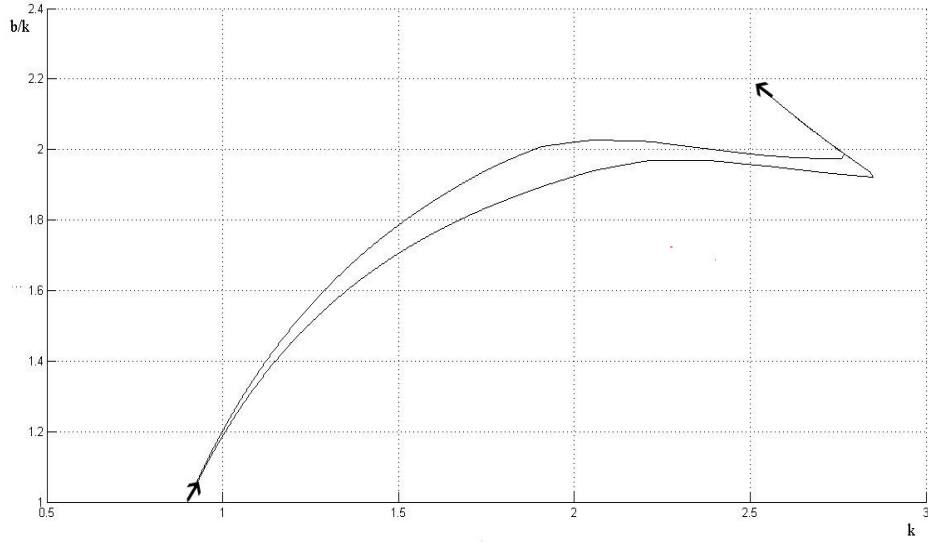[42]See also Chen and Semmler (2012) on the relation of risk premia and asset pricing.

Figure 13: Dynamic paths of sovereign debt for constant interest rate, for two initial conditions, $k(0) = 0.9$, $b(0) = 0.9$, convergence to steady state, with $r = 0.04$ (upper graph), $r = 0.02$ (lower graph).

bank keeping the interest rate low there is a regime of low financial stress with debt sustainability.[43]

Whereas the figure 12 represents the solution paths for two different initial conditions, but the same discount and interest rate, the next example assumes that the central bank is able to reduce the discount rate and interest rate through monetary instruments to $r = 0.02$. The results of the NMPC solution are shown in figure 13, the solutions starting with initial conditions $k(0) = 0.9, b(0) = 0.9$.

As can be observed from figure 13, if the central bank is able to move the discount and interest rate down[44] from to $r = 0.04$ to $r = 0.02$, the simulation shows that the path of the leverage ratio, measured as debt over capital stock, starting out of the steady state, is lower for $r = 0.02$ (lower graph)[45] than for the discount and interest rate $r = 0.04$ (upper graph). Yet the steady states are roughly the same. Here again there are stable scenarios, as long as there are no risk premia or the risk premia are very low, so that possible capital gains can be used for servicing the debt, debt eventually stabilizes about a finite ratio and financial stress is low.

[43]This is consistent with the case put forward by Bohn (1998) that the debt is mean reverting when the reaction coefficient (the response of the surplus with respect to sovereign debt) in his debt dynamics is greater than the interest rate. In his case however the interest rate is a constant, or only slightly varying through the growth rate of marginal utilities, if he takes the latter to determine the discount rate.

[44]This simulation is similar to the case of many studies that discuss the monetary policy performance with zero interest rate bounds, see Gavin et al (2013). We here allow the discount and interest rate to go down to 0.02. Gavin et al. point also to some dangers if the central banks hold the interest too long close to the zero bounds, thought they do not consider the improved sustainability of sovereign debt due to near zero interest rates.

[45]The economic implications of an interest rate held close to the zero bounds are considered in Gavin et al (2013). They argue that deflationary pressures may arise with zero interest rates.

In this first model variant we have kept the interest rate on sovereign debt persistently low, by assuming that the central banks can sufficiently reduce interest rates, and reduce credit spreads and financial stress, and avoid instability of the banking system. The interest rate is kept constant thereafter. Yet, this may generate a tranquil period where there are larger capital gains and an asset price boom, where, risk premia are low and asset prices rising. Yet, when an overleveraging occurs and the bubble bursts and capital gains become negative, then net worth maybe rapidly deteriorating. As the debt ratio rises and the capital gains fall, and interest rates and credit spreads rise − the latter being negatively correlated with the capital gains − net worth of the assets can quickly vanish.[46] State dependent interest rates and credit spreads are discussed next.

5.2   Regime of High Financial Stress

Next, we allow not only the yields on bonds, sovereign or private (measured against the German Bund) to be endogenous, but we permit also endogenous feedback loops of leveraging and bond yields on output and other macroeconomic variables,[47] possibly giving rise to a stage of high financial stress and vulnerability of banks. This is equivalent to the central bank not attempting, or not being able, to pursue an unconventional monetary policy to bring down credit spreads and financial stress.

$$V\left(k,d\right) = \max_{c_t, g_t,} \int_0^T e^{-rt} U(c_t) dt \tag{4}$$

$$dk_t = (g_t - \delta)k_t dt + \sigma_t k_t dZ_t \tag{5}$$

$$db_t = (r(b/k)b_t - (y^a{}_t - c_t^a - i_t^a - \varphi(g_t k_t)))dt \tag{6}$$

The difference to the model of sect. 5.1 is now first that we assume that there are risk premia and the bond yields is a nonlinear function of the debt to capital stock ratio. We may define financial stress by a risk premium driven credit spread $r(b_t/k_t)$ by using a proxy such as an arctan-function:

$$r(b_t/k_t) = \beta arctan(b_t/k_t). \tag{7}$$

This is roughly the function that has been used in Chiarella et al (2009) and one can observe in De Grauwe (2012),[48] but one can also derive from Roch and Uhlig (2012).[49] Here, the interest payment on bonds rises with the debt to capital stock ratio, first slowly, then more rapidly but is finally bounded. We here have set $\beta = 0.1$. Now if we were to look at the asset side of the economy, asset prices are likely to fall or not grow any more and capital gains could become negative. So if the possible capital gains shrink, they cannot be used for debt service, on the contrary, surpluses would shrink, debt service rise and debt sustainability becomes threatened.[50]

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[46]For details of such a scenario, see Stein (2011).

[47]See Blanchard (2013b).

[48]Presenting there EU debt and bond yield data.

[49]Note that the above function of equ. (7), has the same shape as the STR function as shown in figure 6. Because of better properties of (7) in the numerics we use (7) instead of the STR function as in figure 6. In DSGE models the rise of risk premia is often modeled through persistent shocks, see Gilchrist et al (2011), and see also Semmler and Bernard (2012).

[50]For a scenario like this see Stein (2011) where this is exemplified with macroeconomic data for Spain and Ireland.

Moreover, in addition to this difference to the model of sect. 5.1, we here make not only the credit spread a nonlinear function of the debt to capital stock ratio but there is also an endogenous effect of this on aggregate demand. There are now endogenous risk premia, interest rates and utilization of capacity effects. Empirically, these are important macroeconomic feedback loops that one often can observe during periods of financial stress, as for example listed above, see also Hall (2010).

We can make the actual consumption and investment demand depending on credit spread, triggered by rising yields on risky credit and bonds.[51] Then we would have for consumption and investment demand:

$$c_t^a = f(r(b/k))c^{opt} \tag{8}$$

$$I_t^a = g(r(b/k)I^{opt} \tag{9}$$

with the derivatives $\frac{df}{d(b/k)} < 0$ and $\frac{dg}{d(b/k)} < 0$. Though optimal consumption and investment plans are chosen, actual consumption and investment decline due to rising risk premia, credit spread and financial stress. So, overall we may have :

$$y_t^a = u(r(b/k))y^{opt} \tag{10}$$

where again $\frac{du}{d(b/k)} < 0$. We take

$$u(r(b/k)) = (1 - r(b/k)) \tag{11}$$

and then we can refer to the rising credit spread and financial stress as triggering a self-enforcing mechanism reducing output and capacity utilization. The latter is due to lower consumption and investment demand. If capacity utilization falls, income, and thus tax revenue, as well as capital gains and the surplus, to service the debt, fall. This might make then debt - and bond issuing, if bonds are sold on the market − unsustainable, because of further jumps in credit spreads or even credit rationing.[52]

More generally, the stronger macroeconomic feedback loops[53] may arise because of the following:

- There is the wealth effect reducing aggregate demand − when the capital appreciation falls, or becomes negative, both consumption and investment demand are likely to fall

- The share of households that are income and credit constrained, in the sense of Gali et al (2008), and households that are higher leveraged and are under financial stress[54] are significantly rising in a contraction period of the business cycle, see also Mittnik and Semmler (2012a)

- As the financial market forces trigger financial stress,[55] the central bank may have no instruments available − or are not willing − to force the interest rate down further and/or to reduce risk premia

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[51]See Adrian et al . (2010) they show how a rise of an overall macroeconomic risk premia can trigger macroeconomic contractions.

[52]A model with credit constraints is treated in Ernst and Semmler (2012). Yet one might also face insolvencies of banks, in the period of high financial stress, as discussed in sect. 2 and 3, which would amplify the above described contraction.

[53]A systematic study of macroeconomic feedback effect, know from the history of macroeconomics, partly stabilizing partly destabilizing, are extensively discussed in Charpe et al (2013)

[54]The share of those households matte, since there is empirical evidence that the drop in demand will be larger for households with larger debt, that are forced to deleverage more, see Eggertsson and Krugman (2011).

[55]See Schleer and Semmler (2013) for the ZEW banking stress index.

and credit spreads, for example by purchasing sovereign bonds to drive down sovereign risk and risky bond yields[56]

- A fraction of private households start strongly deleveraging which reduces income and liquidity of other households and firms, which might be accompanied by a Fisher debt deflation process, see the above sketched macro mechanisms and Eggertsson and Krugman (2012)[57]

- Finally, there could occur even a worse feedback: a weak financial sector, holding risky sovereign debt, may come under severe stress, because sovereign bonds may go into default and banks reduce lending to the real economy, or worse, may even default[58]

Whereas the first three destabilizing mechanisms have been known in the literature and are often viewed to generating a vicious cycle, the last one, which has recently been discussed, adds a more dangerous mechanism which has been called "diabolic loop".[59]

Next we are undertaking two exercises. First we are setting the macro feedback loops to be very weak. We get the result as demonstrated by the right graph, in figure 14. As the solution path for the capital stock and leveraging in figure 14 shows, right trajectory, the lower interest payments on government bonds first admits a higher capital stock and higher leveraging. Yet as the interest rates – in our case the risky bond yields– reach a certain threshold, we observe that with an increasing leveraging and sovereign risk and risk premia, capital stock stops rising but the leverage ratio is rising further. This is occurring when in the credit spread is moving beyond a certain threshold. So here then finally there is unsustainable debt since the interest payments become higher than the surplus to service the debt, as the equ. (6) indicates.[60]

Next we increase the strength of the macroeconomic feedback loops. We expect, starting with a debt to capital stock ratio roughly above normal, that the above feedback mechanisms lead to higher financial market stress and higher risk yields, higher credit spreads and lower output leading to a contraction in the utilization of the capital stock, and capital stock itself, and to an increasing debt to capital stock ratio.[61]

The debt dynamics with endogenous credit spread and endogenous output and surplus of system (4)-(6) and (7)-(9) are shown in figure 14, left trajectory, again using the NMPC solution method. A situation is sketched here where the central bank cannot – or is not authorized– to bring down the risk premia and credit spreads through asset market interventions.

Figure 14 shows, starting with a debt to capital stock ratio of roughly unity, the feedback mechanisms of higher risk premia and higher yields, higher credit spreads and lower output leading to a contraction of capital stock and to a rapidly increasing debt to capital stock ratio, left graph.[62] Again,

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[56]The ECB in Europe was for example constrained by the Maastricht Treaty not to purchase sovereign bonds. Later this was relaxed by allowing it to purchase sovereign bonds on the secondary market, though there a number of programs that by-passed the Maastricht Treaty.

[57]A detailed discussion of further macroeconomic feedback effects of this type can be found in Charpe et al. (2013).

[58]See Brunnermeier and Oehmke (2012), and Bolton et al (2012), the latter present data on the sovereign debt holdings of banks.

[59]See Brunnermeier and Oehmke (2012), and also Bolton et al (2011).

[60]This maybe be magnified by the reversion of the effect as mentioned before: namely the risk and risk permia rising, discount rates rising and falling (or negative) capital gains, not supporting the debt repayments any more. So debt would rise faster. This seems to be supported by our figures 3 and 4.

[61]This could equivalently create a downward spiral in net worth, if the model is written in terms of net worth, as BS (2012) and Stein (2011).

[62]Note that a strong contractionary effect could also occur if the creditors become unwilling to lend when a certain debt to GDP ratio is reached and new borrowing or rolling over of old debt will be discontinued. For a model including such a sudden rise of credit market constraint, see Ernst and Semmler (2012).
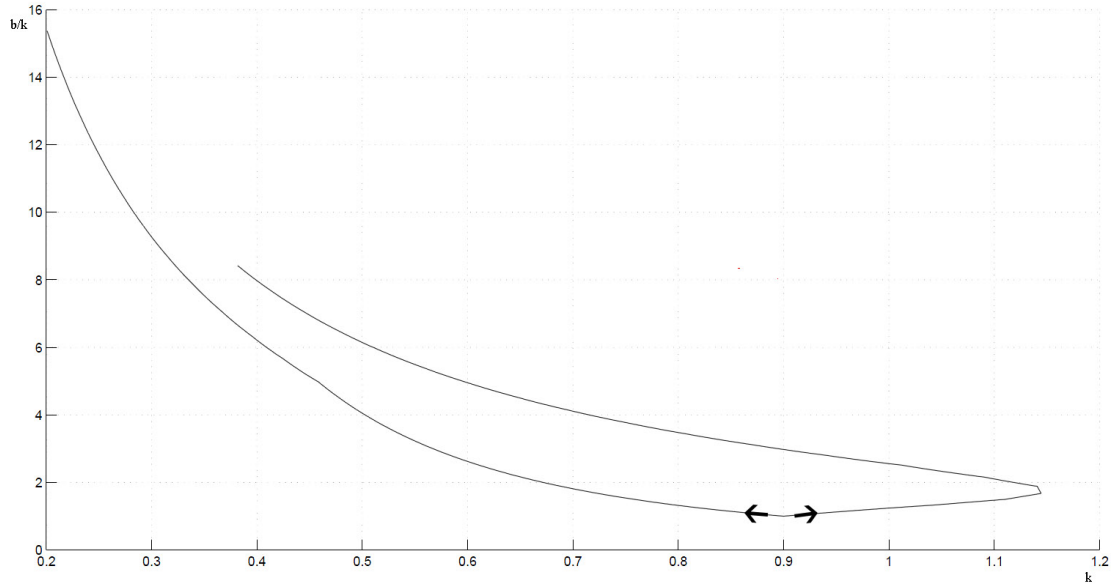
Figure 14: Debt dynamics with endogenous interest rates and weak macro feedback loops (right trajectory), and debt dynamics with endogenous interest rates and strong macro feedback loops (left trajectory), both starting from the initial condition $k(0) = 0.9$, $b(0) = 0.9$.

the right graph represents the case where there are only weak macro feedback loops, as discussed above.[63]

Note that the usual build-in stabilizer − the rising public deficit − and the multiplier effects of deficits are likely not to work easily. Multipliers of deficits become weak, when there is at the same time rising financial stress, risk premia and credit spread, and the vulnerability of the banking system. On the other hand, given financial stress it is likely to be the suddenly arising risk premia and credit spreads that are producing a strong downward multiplier for austerity measures. Negative effects of budget consolidations would be of course much weaker in expansions and booms, as the above studies in sect. 4 and the empirical study by MS (2012a) show.

Note that usually the macroeconomic multiplier would work also in expansions, if interest rates are kept down by the central bank and financial market stress and risk premia do not arise. Also, in a recessionary period, when the interest rate is kept down by monetary policy (MS 2012b), or the interest rate may stay at the zero bound, usually the expansionary multiplier works. Yet in our case of figure 14 above, when the financial stress, risk premia and credit spreads are rising, there is likely to be a sharp reduction of the multiplier effect even when expansionary fiscal policies are attempted.

On the other hand, fiscal consolidation may create a large multiplier effect downward if financial stress, risk premia and credit spreads are high and the macroeconomic mechanisms trigger strong downward macroeconomic feedback effects. If we again refer to our definition of income y inclusive of capital gains, to be split up into $y =$ normal return on capital + capital gains + wage income, now

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[63]See also the empirics of drop of investment and consumption demand in Hall (2011) for the US and Blanchard (2013a).

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the negative capital gains might decrease the sources for debt services even more, making the debt less sustainable.[64] Given those above sketched macro feedback loops it is easily explained why there might be a regime switch from a low to a high stress regime where vulnerabilities increase and a faster deterioration of the economy occurs.

Debt stabilization might work under the condition spelled out in sect. 5.1. and it also might temporally work under the condition shown in the right trajectory of figure 14. Yet, with a larger jump in the risk premia (and discount rate), responding to higher leveraging, with lower net worth, due to capital gains falling, a vulnerable banking system, and central banks failing to undertake an unconventional intervention into asset markets, the strong macro feedback loops are likely to be operating and debt stabilization is likely not to be achieved, as shown in the left trajectory of figure 14.

6 Conclusions

We have shown that in the EU there was a diversity of debt and financial stress dynamics; being different for Ireland and Spain, and Portugal and Greece (the first suffering from excess private debt, the second from public debt). We have stressed that there was no single multiplier for all times. The multiplier effect is state dependent and depends on the economic environment and regimes. Given the experience with the state dependent fiscal multiplier presumably one needs to rethink the Keynesian multiplier theory as it is presented in text books.[65] Also, the success of debt stabilization depends then on regimes and the economic environment – on the financial stress and the vulnerability of the banking system, monetary policy actions, the state of internal and external demand, exchange rates and so on. Stressing the role of financial stress, we have shown that a regime switch from low to high financial stress might occur. We have focused on empirical studies that have employed regime change models and MRVARs for estimating fiscal and monetary policy effects. As in Eggertsson and Krugman (2011) our model suggests that government spending should have a large expansionary effect on output at zero or near zero interest rates, but in contrast to them we stress that monetary policy needs be able to reduce financial stress and credit spreads. The same holds for fiscal consolidation policies which are likely to be strongly contractionary if there is – beside severe labor market and product constraints – also significant financial stress and a vulnerability of the banking system.

We have shown that composition effects of consolidations are also important. Not only are aggregate expenditures and taxes relevant, but also the composition of fiscal consolidation: health education, infrastructure, public consumption.[66] Whether the fiscal multiplier will trigger positive long run effects depends also significantly on productivity of public investments (health, education, infrastructure, public consumption).[67] The hastily enacted EU austerity programs had, and still have, distributional effects and are likely to generate future inequities in the EU, see Boyer (2012) and Busch et al. (2012). Also, with the high social cost of austerity the willingness to default might rise, making default more likely.

Yet one must note that in practice the actual policy was significantly modified through policy

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[64]See Stein (2011)

[65]Keynes himself did not seem to have relied much on the text book multiplier that follows more the work of Kahn in the 1930. Given the construction of the fragile propensity to consume, fragile and uncertain marginal efficiency of capital and volatile liquidity preference, no static and fixed multiplier could be expected in the context of the Keynesian theory, for the latter see Chiarellla et al (2009).

[66]For further details on the composition effect of fiscal policies on growth, see Semmler et al (2011) and Stein (2011)

[67]See Stein (2011) and Semmler et al. (2011).

diversity and in particular popular responses (social unrest and strikes in many concerned countries), but also through EU ex-post policy responses. There are now many policy institutions, IMF and EU voices that point to the dangers and limits of too fast consolidation policies.

A response that many politicians in the EU now call for − as a new component of a deficit consolidation strategy − is to pursue more structural and labor market reforms to increase competitiveness and reestablish fiscal and current account balances in the EU. But one might hesitate to recommend this path in the current environment: As one has observed, there are adverse effects on the labor markets if structural and labor market reforms are swiftly pursued. An example is Germany, where in fact now a dual labor market has been developed, one labor market segment with longer-term labor market contracts and one segment with short-term contracts and a volatile employment situation, see Charpe et al (2013).

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