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Teze doktorské práce[1]
Dissertation thesis summary

Název / Title	Three Essays on Empirical Analysis of Economic Policy
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Studijní program / Study program	Ekonomické teorie
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Abstrakt / Abstract[2]

Tato disertační práce je zaměřena na empirickou analýzu měnové a fiskální politiky s využitím nelineárních modelů. Skládá se ze tří částí, první dvě části se věnují analýze měnové politiky pomocí odhadnuté reakční funkce centrálních bank s časově proměnlivými parametry. Třetí část předložené práce je zaměřena na hledání odpovědí na otázku, jestli je možné finanční nestabilitu a související nízký růst HDP překonat pomocí expanzivní fiskální politiky.

V první části se zabývám analýzou vývoje měnové politiky v zemích s inflačním cílováním (Austrálie, Kanada, Nový Zéland, Švédsko a Británie). Díky využití nelineárního přístupu, tj. modelu s parametry, které se v čase mění, můžeme zkoumat, jak velký dopad mělo zavádění inflačního cílování na skutečnou politiku centrálních bank a částečně můžeme i ukázat, jak inflační cílování ovlivnilo dynamiku inflace. Z pohledu metodologie analýza stojí na empirickém odhadu měnového pravidla s endogenními regresory a s koeficienty, jejichž dynamika sleduje náhodnou procházku. Samotný odhad je proveden pomocí momentového odhadu. Ukazuji, že zavedení inflačního cílování není v odhadnutých parametrech patrné jako náhlý zlom, ale jejich dynamika spíše ukazuje, že zavedení inflačního cílování byl postupný proces. V tomto ohledu se projevuje přednost zvoleného přístupu, které umožňuje zachytit jak náhlé strukturální změny, tak postupné změny dynamiky. Za druhé, mé výsledky vedou k nízkým hodnotám vyhlazování úrokové míry, zejména ve srovnání s modely s konstantními koeficienty. A konečně, výsledky neukazují, že by inflační cílování bylo provázeno restriktivnější měnovou politikou, ale spíše naopak. Stabilní inflace je tak spíše důsledkem vyšší kredibility centrálních bank a schopností ovlivnit inflační očekávání, než restriktivní politikou.

[1]Příloha přihlášky k obhajobě disertační práce. Submit together with the application to the Study Department of the FSV UK.

[2] Pro disertace napsané česky vložte abstrakt anglicky. Pro disertace psané anglicky vložte abstrakt česky. / For thesis in Czech fill in abstract in English. For thesis in English fill in abstract in Czech.

Cílem druhé části je analýza, zda a jak v posledních třech desetiletích reagovaly vybrané centrální banky v obdobích finanční nestability na finančních trzích. Analýza využívá modelu odhadu měnově-politických pravidel s časově proměnlivými parametry a tato metodologie je společně s indexem finančního stresu, který byl nově vyvinut Mezinárodním měnovým fondem, aplikována na Austrálii, Kanadu, Švédsko, Velkou Británii a USA. Empirická analýza umožňuje nejen otestovat, zda centrální banky těchto zemí na finanční nestabilitu vůbec reagovaly, ale i kvantifikovat intenzitu jejich reakce. Z výsledků studie vyplývá, že období finanční nestability centrální banky často měnily měnově-politické sazby, a to převážně směrem dolů. Intenzita reakce měnové politiky je nicméně v čase i mezi zeměmi značně heterogenní, přičemž finanční krize 2008-2009 je obdobím nejsilnější a nejvíce rozšířené reakce.

Třetí část je zaměřena na fiskální politiku v době finanční nestability a nižšího nebo dokonce záporného hospodářského růstu. S pomocí nelineárního vícerovnicového modelu (tzv. Threshold VAR model) hledám odpověď na otázku, jestli je možné snížit finanční nestabilitu a zvýšit růst pomocí expanzivní fiskální politiky. Model obsahuje dva režimy. První režim je charakterizovaný stabilními finančními trhy a růstem HDP, druhý režim zahrnuje období finanční nestability. Druhý režim je identifikovaný tak, že obsahuje i všechna období spojená s recesí. Ukazuji, že model se dvěma režimy je statisticky významně odlišný od jednoduchého dynamického modelu bez nelinearity. Dále zjišťuji, že pro USA, Británii, Německo a Itálii, hospodářský růst reaguje rozdílně na fiskální politiku a že multiplikátor fiskální politiky je během současné krize významnější, než v minulých obdobích.

Teze doktorské práce / Dissertation summary

Introduction

This dissertation thesis is focused on the empirical analysis of monetary and fiscal policies. It contains three essays, each of them is independent on the others. However, they all share an utilization of nonlinear empirical methods that capture time-varying and possibly asymmetric behaviour of macroeconomic policies and their effects.

The first two essays deal with the analysis of monetary policy under inflation targeting. The first essay discuss the effects of adoption and implementation of inflation targeting from the perspective of time variation in coefficients of the monetary policy rule. More specifically, it estimates the monetary policy rules in Australia, Canada, New Zealand, Sweden and the United Kingdom and it examines to what extent these rules change over time.

Prior to adoption of inflation targeting in developed countries, there was some disagreement among economists what inflation targeting would bring in practise. Inflation targeting is not rule-based policy, neither pure discretion and it used to be unclear, whether inflation targeting means more or less restrictive monetary policy. Almost twenty years later, an empirical analysis can be undertaken to shed some light on this discussion using estimated time-varying monetary policy rules, as these policy rules allow evaluation of interest rates responses to both inflation and output, that are usually associated with restrictiveness of policy. We show, that in terms of monetary policy rules, monetary policy was always less restrictive in those countries after adoption of inflation targeting and at the same time, stable rates of inflation were maintained.

This result might be perceived as paradox: less restrictive monetary policy achieved goal that used to be infeasible before. My results suggest, that it can be explained if we discuss the elements of inflation targeting in more details and overcome the simplistic rules vs. discretion perspective. First, it is important to know that under inflation targeting, the central bank's policy is concentrated on achieving targeted inflation rate via different policy instruments. Among them, interest rate setting, forecasting and communication play a dominant role, although currently in times of the Great Recessions, balance sheet policies returned to a central bank's toolkit after several decades again. The decrease of both interest rates and inflation shows that in comparison to a view implied by simple monetary policy rules, the other instruments beside the interest rate setting are perhaps equally or even more important via the expectations channel. Nevertheless, along with changes in economic policy, volatility of shocks seems to decreased during the eighties and nineties, so part of the achievement of low interest rates and low inflation shall be attributed to a “good-luck” hypothesis of changes in global economy not caused by policies of individual countries.

The other interesting feature of the results is that in these countries the changes in monetary policy are rather gradual and coincide either with important institutional reforms such as the changes in monetary policy regime or with the periods of disinflation. Hence, implementation of inflation targeting is a process rather than shift in policy, and narrative evidence included in the paper supports this view.

In the second essay the analysis of time-variance in monetary policy rules is extended for the analysis of central bank policies under financial instability. It is analysed, whether the central banks under inflation targeting adjust their policy rates not only with respect to expected deviation between inflation and inflation target, but also with respect to financial stability. For this purpose, the time-varying monetary policy rule is extended for an indicator of financial stress, in order to show the departures of policy rules under financial instability. To measure the financial stress, a new financial stress index is used, developed by the International Monetary Fund. This particular choice not only allows testing whether central banks responded to financial stress or not, but also detects the periods and types of stress that were the most worrying for monetary authorities and quantifies the intensity of the policy response.

Although theoretical studies disagree about the viability of considering financial instability for interest-rate setting, the results show that monetary policy is likely to react to financial instability by decreasing their policy rates. However, the size of the policy response varies substantially over time as well as across countries, with the 2008–2009 financial crisis being the period of the most severe and generalized response. The results also point to the usefulness of augmenting the standard version of the monetary policy rule by some measure of the financial conditions to get a better understanding of the interest-rate setting process, especially when financial markets are not stable.

Finally, the third essay is focused on finding answer to the question, whether the negative effects of the financial instability on economic growth can be overcome by expansionary fiscal policy. During periods of economic downturn or stress in financial markets the effects of fiscal developments on economic activity might be different from what is usually observed in good or normal times. The quality of financial institutions' assets deteriorates, as the share of non-performing loans increases and negative sentiments in the markets depress the value of other financial assets. In some cases, the disruptions in financial markets or problems in the banks' balance sheets may trigger a recession by reducing the flow of credit to the other sectors. Therefore, it is important to assess the effects of fiscal developments and policies during the periods of market stress to check, whether there are some non-linearities at play and if the fiscal multipliers are different.

The main contribution of this paper is that the effects of fiscal policy shocks are estimated using a threshold VAR model (TVAR) with two regimes, determined by a measure representing financial instability, the Financial Stress Index.

Several results of the analysis are worthwhile mentioning. First, the use of a nonlinear framework with regime switches, determined by a financial stress indicator, is corroborated by nonlinearity tests. Second, output reacts mostly positively to a fiscal shock in both financial stress regimes, and the differences in estimated multipliers across regimes are relatively small. However, it is shown that substantial time-variation and the estimated nonlinear impulse responses suggest that the size of the fiscal multipliers is higher than average in the 2008-2009 crisis. Furthermore, a financial stress shock has a negative effect on output and increases the debt.

Chapter 2 How Does Monetary Policy Change? Evidence on Inflation Targeting Countries

This study aims to investigate the evolution of monetary policy for the countries that have had a long experience with the IT regime. In particular, the time-varying monetary policy rules for Australia, Canada, New Zealand, Sweden and the United Kingdom are analysed using the recently developed time-varying parameter model with endogenous regressors (Kim and Nelson, 2006), as this technique allows us to evaluate the changes in policy rules over time, unlike Markov-switching methods does not impose sudden policy switches between different regimes. On the top of that, it also deals with endogeneity of policy rules. Unlike Kim and Nelson (2006) I do not rely on the Kalman filter that is conventionally employed to estimate time-varying models, but employ the moment-based estimator proposed by Schlicht and Ludsteck (2006) for its mathematical and descriptive transparency and minimal requirements as regards initial conditions.

Anticipating the results, I find that monetary policy changes gradually, pointing to the importance of applying a time-varying estimation framework (see also Koop et al., 2009, on evidence that monetary policy changes gradually rather than abruptly). When the issue of endogeneity in time-varying monetary policy rules is neglected, the parameters are estimated inconsistently, even though the resulting errors are economically not large. Second, the interest rate smoothing parameter is much lower than typically reported by previous time-invariant estimates of policy rules. This is in line with a recent critique by Rudebusch (2006), who emphasizes that the degree of smoothing is rather low. External factors matter for understanding the interest rate setting process for all countries, although the importance of the exchange rate diminishes after the adoption of inflation targeting. Third, the response of interest rates to inflation is particularly strong during periods when central bankers want to break a record of high inflation, such as in the UK at the beginning of the 1980s. Contrary to common perceptions, the response can become less aggressive after the adoption of inflation targeting, suggesting a positive anchoring effect of this regime on inflation expectations or a low inflation environment. This result is consistent with Kuttner and Posen (1999) and Sekine and Teranishi (2008), who show that inflation targeting can be associated with a smaller response of the interest rate to inflation developments if the previous inflation record was favourable.

The original empirical research on monetary policy rules used a linear specification with time-invariant coefficients. Instrument variable estimators such as the GMM gained popularity in this context, because they are able to deal with the issue of endogeneity that arises in the forward-looking specification (Clarida et al., 1998). While a time-invariant policy rule may be a reasonable approximation when the analyzed period is short, structural stability usually fails over longer periods.

The simplest empirical strategy for taking time variance into account is to use sub-sample analysis (Taylor, 1999; Clarida et al., 2000). The drawback of this approach is its rather subjective assumptions about points of structural change and structural stability within each sub-period. An alternative is to apply an econometric model that allows time variance for the coefficients. There are various methods dealing with time variance in the context of estimated monetary policy rules: subsample analysis, Markov-switching models, models with smooth transition and finally, time-varying parameter models.

Methodology

I follow the two-step methodology developed in Kim (2006), hence the monetary policy rule with time-varying coefficients is considered, and additionally, since the expected inflation is proxied by the actual inflation measured at *t+2* and output gap is usually known with delay, there are two additional equations for the expected inflation and output gap and their instruments in order to treat potential endogeneity issue.

$$r_t = (1-\rho_t)[\alpha_t+\beta_t(\pi_{t+i})+\gamma_t y_t+\delta_t x_t]+\rho_t r_{t-1}+\varepsilon_t \quad , \qquad (1)$$

$$\alpha_t = \alpha_{t-1}+v_{1,t} \ , \ v_{1,t} \sim i.i.d.\, N(0,\sigma^2_{v_1}) \quad , \qquad (2)$$

$$\beta_t = \beta_{t-1}+v_{2,t} \ , \ v_{2,t} \sim i.i.d.\, N(0,\sigma^2_{v_2}) \quad , \qquad (3)$$

$$\gamma_t = \gamma_{t-1}+v_{3,t} \ , \ v_{3,t} \sim i.i.d.\, N(0,\sigma^2_{v_3}) \quad , \qquad (4)$$

$$\delta_t = \delta_{t-1}+v_{4,t} \ , \ v_{4,t} \sim i.i.d.\, N(0,\sigma^2_{v_4}) \quad , \qquad (5)$$

$$\rho_t = \rho_{t-1}+v_{5,t} \ , \ v_{5,t} \sim i.i.d.\, N(0,\sigma^2_{v_5}) \quad , \qquad (6)$$

$$\pi_{t+i} = Z'_{t-1}\xi+\sigma_\phi \phi_t \ , \ \phi_t \sim i.i.d.\, N(0,1) \quad , \qquad (7)$$

$$y_t = Z'_{t-1}\zeta+\sigma_\psi \psi_t \ , \ \psi_t \sim i.i.d.\, N(0,1) \quad , \qquad (8)$$

The consistent estimates of the coefficients in Eq. (1) are obtained in two steps. In the first step, I estimate equations (7) and (8) and save the standardized residuals φ_t and ψ_t. In the second step, I estimate Eq. (9) below along with Eqs. (2)–(6). Note that (9) now includes bias correction terms, i.e. the (standardized) residuals from Eqs. (7) and (8), to address the aforementioned endogeneity of the regressors. Consequently, the estimated parameters in Eq. (9) are consistent, as instruments u_t is uncorrelated with the regressors.

$$r_t = (1-\rho_t)[\alpha_t+\beta_t(\pi_{t+i})+\gamma_t y_t+\delta_t x_t]+\rho_t r_{t-1}+\kappa_{\phi,\varepsilon}\sigma_{\phi,\varepsilon}\phi_t+\kappa_{\psi,\varepsilon}\sigma_{\psi,\varepsilon}\psi_t+u_t \ , \quad u_t \sim N(0,(1-\kappa^2_{\phi,\varepsilon}+\kappa^2_{\xi,\varepsilon})\sigma^2_{\varepsilon,t}) \qquad (9)$$

The standard framework for estimation is the maximum likelihood estimator via the Kalman filter (Kim, 2006). However, there are several difficulties with the estimation of the Kalman filter (and Kalman smoother) in applied work. First, if the variables are nonstationary, the results often depend on the proper choice of the initial values, but those values are not known in advance. Applying the Kalman smoother alleviates the issue and, for different initial values, the differences in the estimates at the beginning of the sample decrease sharply. Second, the log likelihood function is highly nonlinear and in some cases the optimization algorithm fails to minimize the negative of the log likelihood for several reasons (either it can fail to calculate the Hessian matrix throughout the iteration process or, when the likelihood function is approximated to facilitate the computations, the covariance matrix of the observation vector can become singular for the provided starting values).

In this paper, the "varying coefficients" (VC) method is utilised (Schlicht and Ludsteck, 2006). The VC method generalizes the standard ordinary least squares approach. In fact, instead of minimizing the sum of the squares of the residuals , $\sum_{t=1}^{T} u_t^2$ it uses minimization of the weighted sum of the squares:

$$\sum_{t=1}^{T} u_t^2 + \theta_1 \sum_{t=1}^{T} v_{1,t}^2 + \theta_2 \sum_{t=1}^{T} v_{2,t}^2 + \ldots + \theta_n \sum_{t=1}^{T} v_{n,t}^2 \tag{10}$$

where the weights θ_i are the inverse variance ratios of the regression residuals u_t and the shocks in time-varying coefficients v_t , that is $\theta_i = \sigma^2 / \sigma_i^2$. Hence it balances the fit of the model and the parameter stability. Additionally, the time averages of the regression coefficients estimated by such weighted least squares estimator are identical to the GLS estimates of the corresponding regression with fixed coefficients, that is, $\frac{1}{T} \sum_{t=1}^{T} \hat{a}_t = \hat{a}_{GLS}$.

The VC method has a number of advantages. First, it does not require initial conditions even for non-stationary variables prior to the estimation procedure. Instead, both the variance ratios and the coefficients are estimated simultaneously. Second, the property of the estimator that the time averages of the estimated time-varying coefficients are equal to their time-invariant counterparts permits easier interpretation of the results by comparison with time-invariant results. The features of the VC method make it feasible for our analysis: we deal with a time-varying model where the coefficients are assumed to follow a random walk, there is no *a priori* information about the initial values and the time series are rather short.

Results

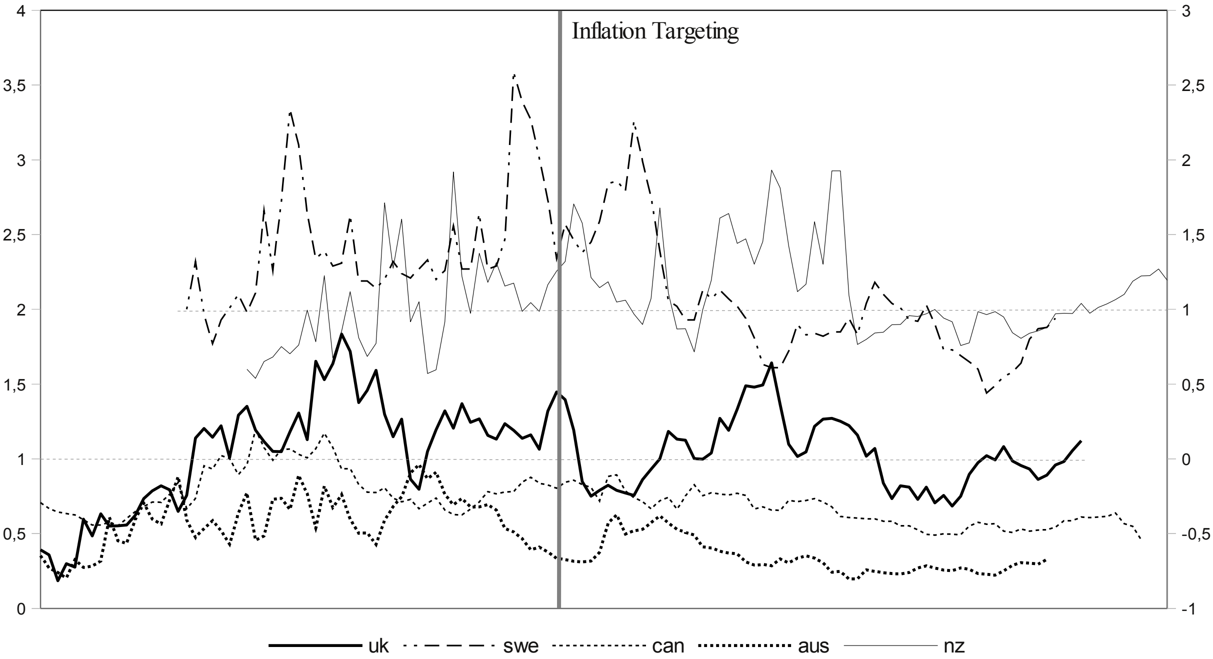
This sub-section summarizes the main policy-relevant findings of this paper: monetary policy aggressiveness and and inflation targeting; interest rate smoothing and finally the inflation persistence and inflation targeting.

Figure 1 presents the monetary policy aggressiveness (defined as the estimate of the response of interest rates to expected inflation) in periods before and after the introduction of inflation targeting. It can be seen that in no country did the aggressiveness parameter increase after the adoption of inflation targeting. In fact, this aggressiveness substantially decreased in the UK, Australia and Sweden. If we look at the link between aggressiveness and expected inflation within the IT period, the results suggest that in most countries the aggressiveness is higher the more expected inflation deviates from its target. This broadly corresponds to the findings of Davradakis and Taylor (2006), who document a non-linear policy rule for the UK of a similar pattern. Similarly, Demers and Rodriguez (2002) in their analysis of monetary policy in Canada argue, that as long as inflation remains within the target band, it is possible to have a coefficient on inflation equal to zero as agents strongly believe that the monetary policy is credible. Nevertheless, insignificant responses to inflation are not common in the literature. With respect to the fact that inflation becomes more and more a forward-looking phenomenon, affected by expectations along with the interest rate setting, and considering stability of both inflation and interest rates, lower estimated response of interest rates to inflation becomes reasonable.

The evolution of the estimated interest rate smoothing parameter in comparison to the time-invariant estimates for the UK in 1979–1990 by Clarida et al. (2000) is available in Figure 2. Our time-varying estimates of interest rate smoothing are well below the time-invariant one, which seems reasonable in the light of the recent critique by Rudebusch (2006), who puts forward that the degree of interest rate smoothing is actually low. While omitted variables or persistent shocks were deemed to be behind the implausible degree of policy inertia, our empirical results suggest that omission of the time-varying nature of the response coefficient may be another reason for the overestimation of smoothing coefficient ϱ in time-invariant policy rules. In time-varying framework, the time-varying intercept, that can be linked to a policy neutral rate, captures an important part of long-term dynamics of interest rates such as downward sloping trend in disinflation periods. Removing this information in fact plays a similar role as detrending usually does and persistence of deviations from time-varying trend decreases.

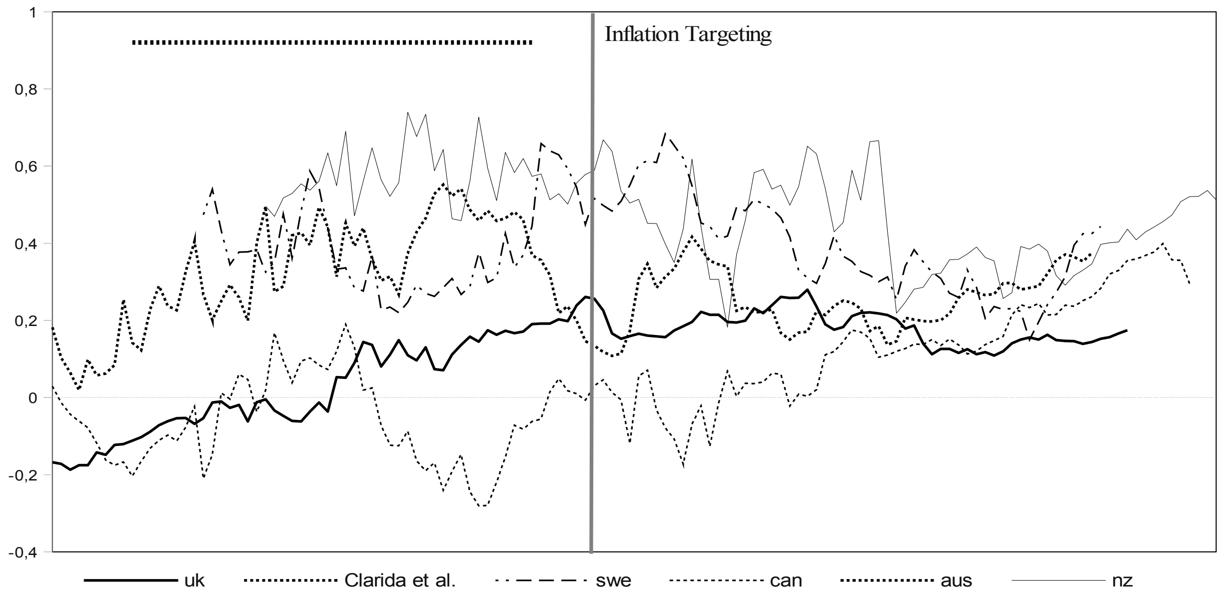
This hypothesis can be justified by observing results in the literature. Leigh (2008) estimates the FED implicit inflation target under the assumption of its time-varying nature. In terms of the Taylor rule it implies estimation of time varying intercept. Then, his smoothing parameter is 0,75 – lower than in most time-invariant studies. Boivin (2006) estimates the time-varying monetary policy rule for the United States and he reports lower values of inflation smoothing parameter for specifications.

Figure 1 – Monetary Policy Aggressiveness and Inflation Targeting



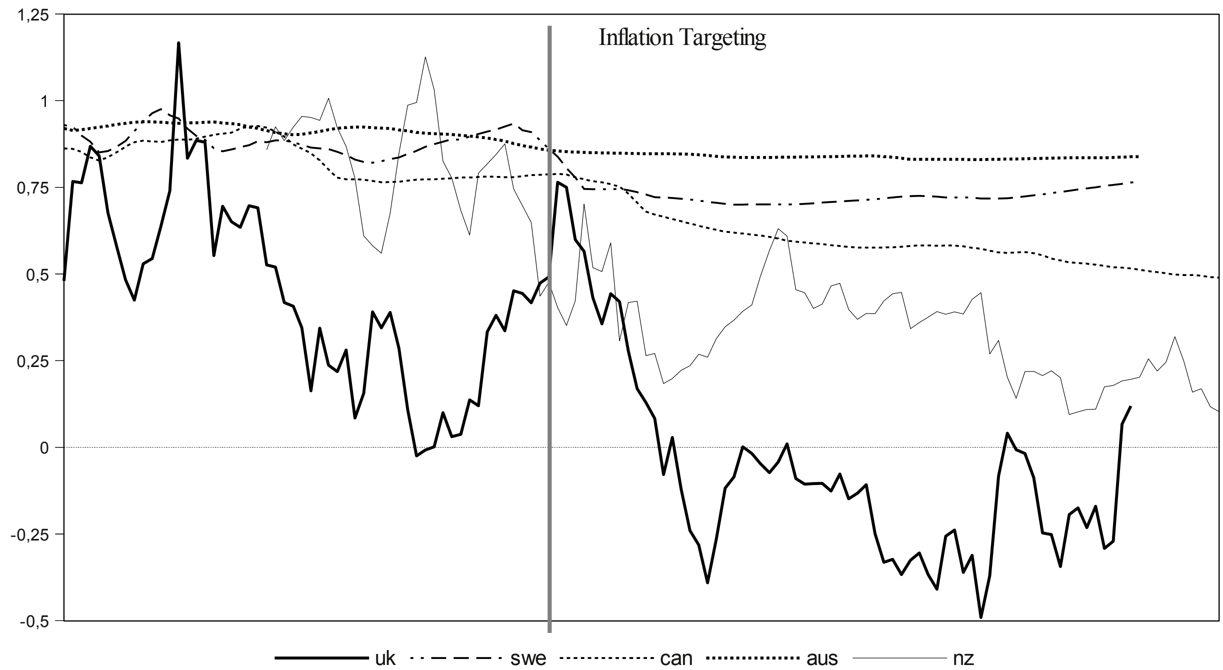
Note: The y axis depicts the evolution of the estimated parameter β (the response of interest rates to expected inflation) and the x axis represents time, with the year of inflation targeting adoption denoted by a black vertical line. The values of β for New Zealand and Sweden are plotted on the right-hand axis.

Figure 14 – Interest Rate Smoothing



Note: The figure presents the evolution of the estimated interest rate smoothing parameter ϱ over time in comparison to the interest rate smoothing parameter estimated in the time-invariant model of Clarida et al. (2000) for the UK.

Figure 15 – Inflation Targeting and Inflation Persistence



Note: The y axis depicts the evolution of the estimated inflation persistence parameter and the y axis represents time, with the year of inflation targeting adoption denoted by a black vertical line.

Finally, the results in Figure 3 plot the estimates of inflation persistence over time for all countries with respect to the inflation targeting adoption date. The results suggest that inflation persistence decreased after the adoption of inflation targeting, with a very distinct fall in the UK and New Zealand.

Chapter 3 Time-Varying Monetary-Policy Rules and Financial Stress: Does Financial Instability Matter for Monetary Policy?

This paper seeks to analyse whether and how monetary policy interest rates evolved in response to financial instability over the last three decades. The monetary policies of central banks are likely to react to financial instability in a non-linear way (Goodhart et al., 2009). When a financial system is stable, the interest-rate-setting process largely reflects macroeconomic conditions, and financial stability considerations enter monetary policy discussions only to a limited degree. On the other hand, central banks may alter their monetary policies to reduce financial imbalances if these become severe. In this respect, Mishkin (2009) questions the traditional linear-quadratic framework1 when financial markets are disrupted and puts forward an argument for replacing it with non-linear dynamics describing the economy and a non-quadratic objective function resulting in non-linear optimal policy.

To address the complexity of the nexus between monetary policy and financial stability as well as to evaluate monetary policy in a systematic manner, this paper employs the recently developed time-varying parameter estimation of monetary-policy rules, appropriately accounting for endogeneity in policy rules. This flexible framework, together with a new comprehensive financial stress dataset developed by the International Monetary Fund, will allow not only testing of whether central banks responded to financial stress, but also quantification of the magnitude of this response and detection of the periods and types of stress that were the most worrying for monetary authorities.

I proxy financial stress by means of the FSI provided recently by the IMF (Cardarelli et al., 2011), which is a consistent measure for a wide range of countries but, at the same time, is sufficiently comprehensive to track stress of a different nature. It includes the main components of financial stress in an economy and is available for a reasonably long period to be used for our empirical analysis (see Figure 1). I use both the overall index, which is a sum of seven components, as well as each sub-index and component separately:

i. Banking-related sub-index components: the inverted term spread (the difference between short-term and long-term government bonds), TED spread (the difference between interbank rates and the yield on Treasury bills), banking beta (12-month rolling beta, which is a measure of the correlation of banking stock returns to total returns in line with the CAPM);
ii. Securities-market-related sub-index components: corporate bond spread (the difference between corporate bonds and long-term government bond yields), stock-market returns (monthly returns multiplied by -1), time-varying stock-return volatility from the GARCH(1,1) model;
iii. Foreign-exchange-related sub-index: the time-varying volatility of monthly changes in NEER, from the GARCH (1,1) model.

The following model is estimated in time-varying framework (with endogeneity bias correction terms for inflation and gap skipped):

$$r_t = (1-\rho)[\alpha+\beta(\pi_{t+i}-\pi^*_{t+i})+\gamma y_t]+\rho r_{t-1}+\delta x_{t+k}+\varepsilon_t \qquad (11)$$

Note that the financial stress index x_{t+k} does not appear within the square brackets. This is because it is typically not included in the loss function of central banks' monetary policy but it is rather a factor such as the lagged interest rate, i.e., it may explain why the actual interest rate r_t deviates from the target. Moreover, by placing it in the regression at the same level as a lagged interest rate, we can directly test whether this variable representing ad-hoc policy decisions decreases the interest-rate inertia ϱ, as suggested by Mishkin (2009). At the same time, the response on the coefficient δ can increase, as central banks are more likely to react to financial stress when stress is high. Consequently, it is possible that ϱ and δ move in opposite directions because the central bank either smoothes the interest-rate changes or adjusts the rates in the face of financial stress. In the latter case, the response is likely to be quick and substantial.

Results

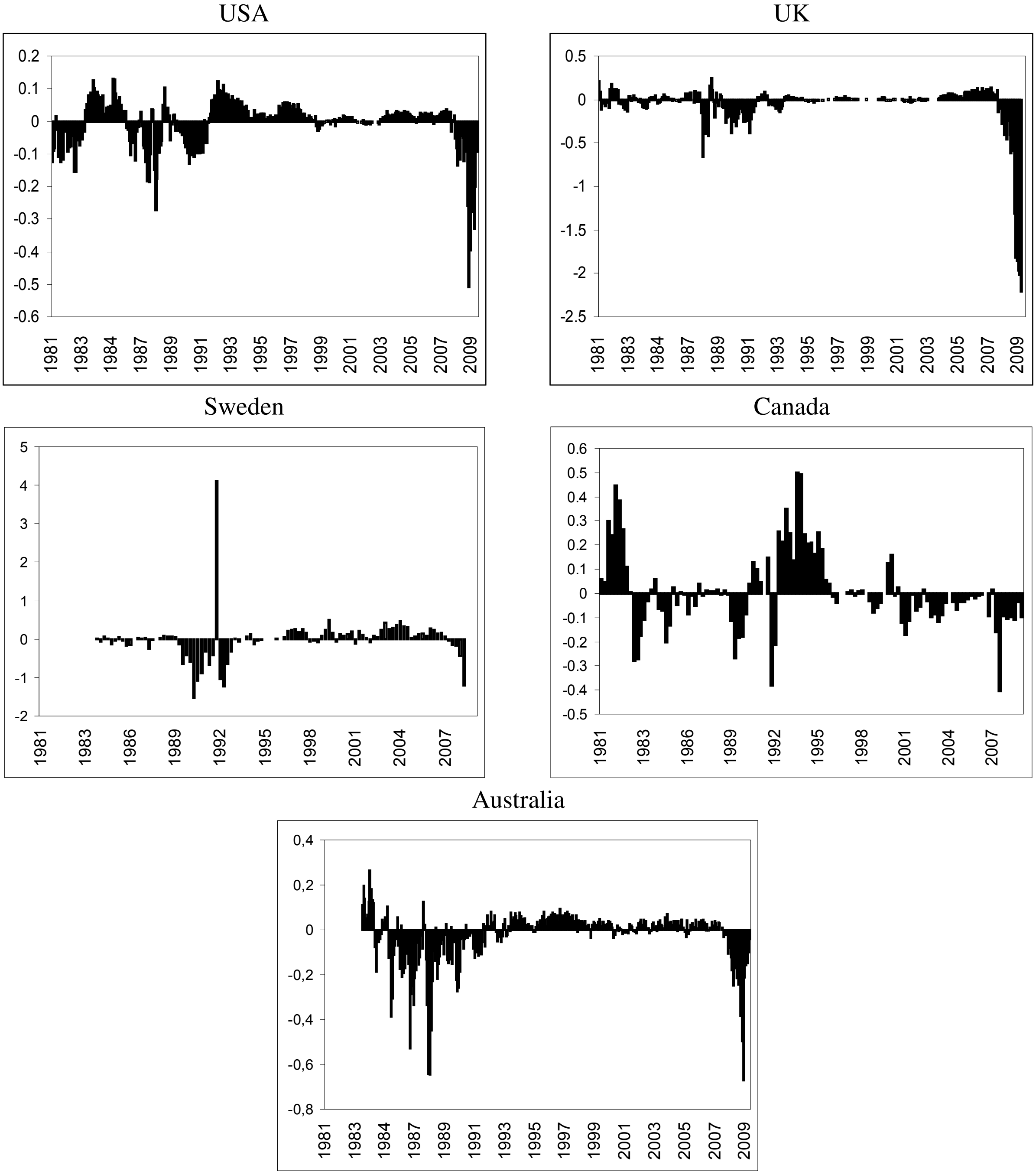
Figure 1 presents our results on the effect of financial stress on interest-rate setting in all five countries (referred to as the *financial-stress effect* hereinafter). Although there is some heterogeneity across countries, some global trends in the effect of financial stress are apparent. Whereas in good times, such as in the second half of the 1990s, financial stress has virtually no effect on interest-rate setting or is slightly positive, the reaction of monetary authorities to financial stress was highly negative during the 2008–2009 global financial crisis. While the previous evidence on the effect of financial stress on monetary policy is somewhat limited, our results broadly confirm the time-invariant findings of Cecchetti and Li (2008), who show that the US Fed adjusted interest rates to the procyclical impact of bank capital requirements in 1989–2000. Similarly, Belke and Klose (2010) estimate the Taylor rule on two sub-samples (before and during the 2008–2009 global financial crisis) and find that the Fed reacted systematically not only to inflation and the output gap, but also to asset prices, credit, and money.

The size of financial-stress effects on interest-rate setting during the recent financial crisis is somewhat heterogeneous, with the strongest reaction found for the UK. The results suggest that all central banks except the Bank of England maintain policy rates at approximately 50–100 basis points lower compared to the counterfactual policy of no reaction to financial stress. The size of this effect for the UK is assessed to be approximately three times stronger (i.e., 250 basis points). This implies that approximately 50% of the overall policy-rate decrease during the recent financial crisis was motivated by financial-stability concerns in the UK (10%–30% in the remaining sample countries), while the remaining half falls to unfavorable developments in domestic economic activity. This finding complements previous results suggesting that the BoE's consideration of expected inflation over the last decade has been very low (as found by Baxa et al., 2010, using the time-varying model and by Taylor and Davradakis, 2006, in the context of the threshold model) by evidence that it further decreased during the current crisis. It is also evident that the magnitude of the response is unusual for all five central banks. However, the results for Australia, Canada, and Sweden show a similar magnitude of response to financial stress during the recent financial crisis compared to that observed in previous periods of high financial stress.

The question of which components of financial stress influence interest-rate setting is addressed in Figure 2. In this case, we estimate the model using each FSI subcomponent separately (the bank stress effect, the exchange-rate stress effect, and the stock-market stress effect) instead of the overall FSI and report the financial-stress effect attributable to each subcomponent. Some heterogeneity across countries is again apparent, although it seems that bank stress and stock-market stress dominated central bankers' considerations in less open economies. On the other hand, exchange-rate stress matters in more open economies such as Canada and Sweden.

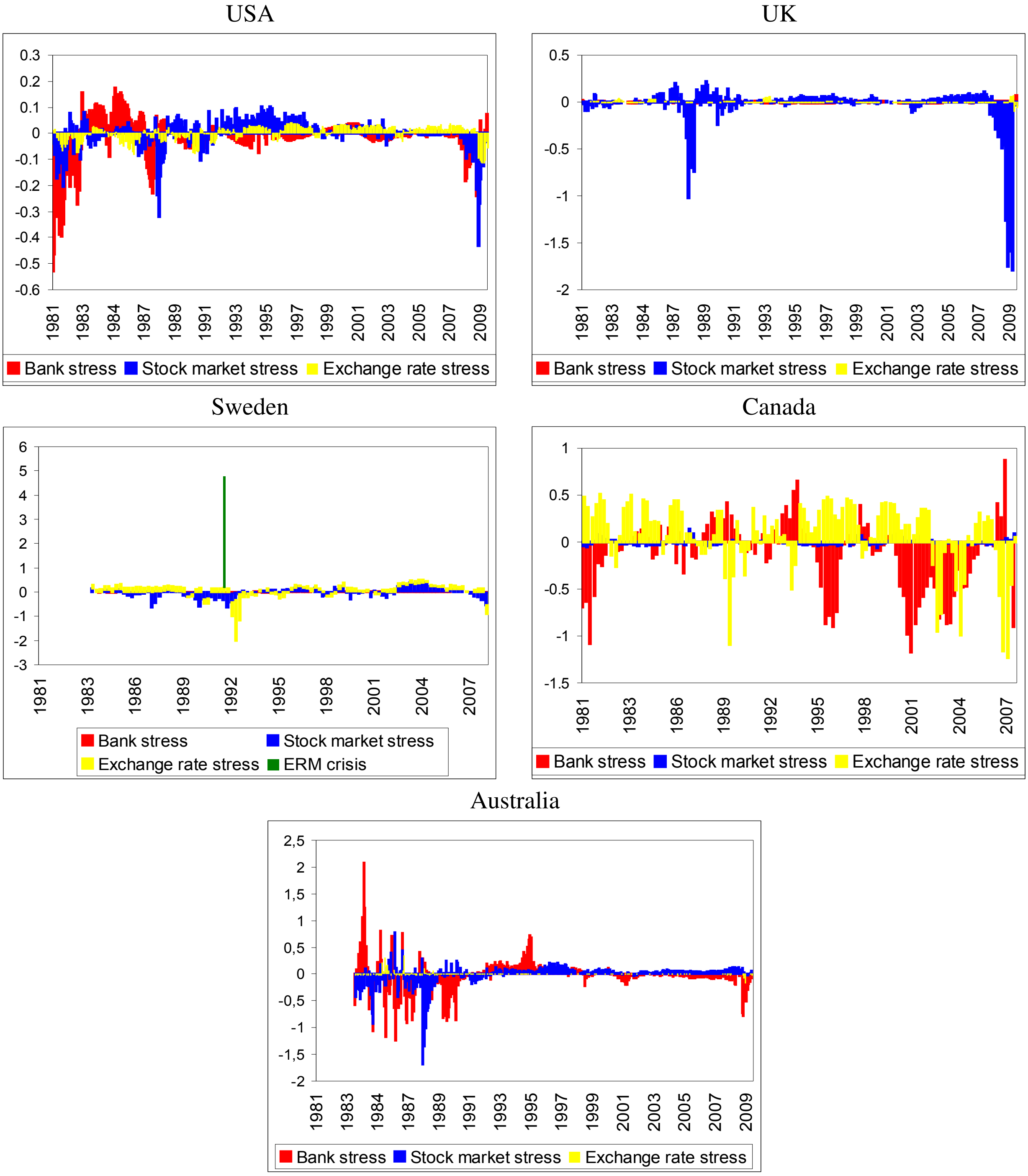
Overall, our results point to the usefulness of augmenting the standard version of monetary-policy rules by some measure of financial conditions to obtain a better understanding of the interest-rate-setting process, especially when financial markets are unstable. The empirical results suggest that the central banks considered in this study altered the course of their monetary policy in the face of financial stress. The recent crisis seems truly to be an exceptional period, in the sense that the response to financial instability was substantial and coincided in all the countries analyzed, which is evidently related to intentional policy coordination absent in previous decades. However, we have also observed that previous idiosyncratic episodes of financial distress were, at least in some countries, followed by monetary-policy responses of similar, if not higher, magnitude.

Figure 2 – The Effect of Financial Stress on Interest-Rate Setting



Notes: The figure depicts the evolution of the financial-stress effect. The stress effect (y-axis) is defined as the product of the estimated coefficient on the financial-stress indicator in the monetary-policy rule and the value of the IMF financial-stress indicator (δx). The stress effect shows the magnitude of the interest-rate reaction to financial stress in percentage points.

Figure 3 – The Effect of Financial Stress Components on Interest-Rate Setting:
Bank Stress, Exchange-Rate Stress, and Stock-Market Stress



Notes: The figure depicts the evolution of the components of the financial-stress effect, namely, the bank-stress effect, the exchange-rate stress effect, and the stock-market stress effect. The stress effect (y-axis) is defined as the product of the estimated coefficient on the given component of the financial-stress indicator in the monetary-policy rule and the value of the corresponding component of the IMF financial-stress indicator (δx). The stress effect shows the magnitude of the interest-rate reaction to financial stress in percentage points.

Chapter 4 Fiscal developments and financial stress: A threshold VAR analysis

During periods of economic downturn or stress in financial markets the effects of fiscal developments on economic activity might be different from what is usually observed in good or normal times. Evidence shows that economic downturns are often associated with periods of financial stress or even with financial crisis. Under those circumstances, the share of non-performing loans increases and negative sentiments in the markets depress the value of other financial assets. In some cases, the disruptions in financial markets or problems in the bank balance sheets may trigger a recession by reducing the credit flow to the other sectors. Therefore, it is important to assess the effects of fiscal developments during the periods of market stress to check, notably whether there are non-linearities at play and if fiscal multipliers are different.

Fiscal policy can contribute to financial instability if, for instance, the issuance of substantial amounts of sovereign debt causes fiscal stress and a potential fiscal and/or financial crisis. In particular, unsustainable fiscal policies may undermine sovereign debt credibility and financial markets may refuse to buy new government debt, while transactions in the secondary market may also become less frequent. The inability to sell government bonds reduces its liquidity and weakens the balance sheet of the banks and of other financial institutions that hold government debt. The balance sheet losses related to the price drops in government debt securities negatively affect the lending capacities of the banks, which consequently might reduce the flow of credit to the private sector. Moreover, some related discussion drawing on the fiscal theory of price level (Leeper, 1991, Sims, 1994, and Woodford, 1994, 1995), and its application to Krugman's model of financial crisis (1979) as introduced in Daniel (2001) and Corsetti and Mackowiak (2006) also highlights such possible links.

The effects of fiscal policy can differ in times of financial instability. This links with the Keynesian-like story about countercyclical economic policy, and the possible positive impacts of fiscal stimuli. The idea is that the government steps in to compensate the decline in private sector demand in order to stabilize aggregate demand. Almunia et al. (2009), who compared the policies during the Great Depression and the 2008-09 crisis concluded that when fiscal policy was used in the 1930s it worked, while the evidence for the effectiveness of the monetary policy is rather mixed.

Methodology

I include a threshold variable in the fiscal VAR, for which the financial stress index (FSI) is chosen. The TVAR model has a number of interesting features that make it attractive for our purposes. First, it is a relatively simple way to capture possible nonlinearities such as asymmetric reactions to shocks or the existence of multiple equilibriums. Because the effects of the shocks are allowed to depend on the size and the sign of the shock, and also on the initial conditions, the impulse response functions are no longer linear, and it is possible to distinguish, for instance, between the effects of fiscal developments under different financial stress regimes.

Second, another advantage of the TVAR methodology is that the variable, by which different regimes are defined (s_t), can be an endogenous variable included in the VAR. Therefore, this makes it possible that regime switches may occur after the shock to each variable. In particular, the fiscal policy shock might either boost the output or increase the financial stress conditions that harm the prospects of economic growth, and the overall effect GDP of a fiscal expansion might became negative.

The threshold VAR can be specified as follows:

$$Y_t = A^1 Y_t + B^1(L) Y_{t-1} + \left(A^2 Y_t + B^2(L) Y_{t-1}\right) I\left[s_{t-d} > \gamma\right] + U_t \ , \qquad (12)$$

where Y_t is a vector of endogenous (stationary) variables, I is an indicator function that takes the value of 1 if, in our case, the financial stress s_t is higher than the threshold value γ, and 0 otherwise. The time lag d was set to 1. $B^1(L)$ and $B^2(L)$ are lag polynomial matrices, A^1Y_t and A^2Y_t represent the contemporaneous terms, because contemporaneous effects might also differ across the regimes. U_t are structural disturbances. We assume that the matrices A^1 and A^2 have a recursive structure.

We have used a recursive identification scheme for the VAR and included the following variables: GDP growth (y), inflation (π), the fiscal variable (f), the short-term interest rate (i), and the indicator for financial market conditions (s), for which we will use the Financial Stress Indicator (FSI). The VAR model in standard form is

$$Y_t = c + \sum_{i=1}^{p} V_i Y_{t-i} + \varepsilon_t \quad , \tag{13}$$

where Y_t denotes the (5×1) vector of the m endogenous variables given by $Y_t = \{y_t\ \pi_t\ f_t\ i_t\ s_t\}$, c is a (5×1) vector of intercept terms, V is the matrix of autoregressive coefficients of order (5×5), and the vector of random disturbances ε_t.

This particular ordering reflects some assumptions about the links in the economy. We order the FSI last which implies that the FSI reacts contemporaneously to all variables in the system. We assume that all new changes in both macroeconomic aggregates and economic policy that occur during one quarter are transmitted to financial markets within this quarter. The ordering of the fiscal variable after output is motivated by the need to identify the effects of automatic stabilizers in the economy. Hence, following Blanchard and Perotti (2002), we assume that all reactions of fiscal policy within each quarter (e.g. changes in government debt) are purely automatic because of implementation lags of fiscal policy measures. The interest rate shows up after the fiscal variable since the short-term interest rate can react contemporaneously to fiscal policy, but not vice versa.

In a linear model, the impulse responses can be derived directly from the estimated coefficients and the estimated responses are symmetric both in terms of the sign and of the size of the structural shocks. Furthermore, these impulse responses are constant over time as the covariance structure does not change. However, these convenient properties do not hold within the class of nonlinear models as shown by Potter (1994) and Koop et al. (1996). The moving average representation of the TVAR is nonlinear in the structural disturbances U_t, because some shocks may lead to switches between regimes, and thus their Wold decomposition does not exist. Consequently, in contrast to linear models, we cannot construct the impulse responses as the paths the variables follow after an initial shock, assuming that no other shock hits the system. To cope with these issues, Koop et al. (1996) proposed nonlinear impulse response functions defined as the difference between the forecasted paths of variables with and without a shock to a variable of interest.

Formally, the nonlinear impulse responses functions (NIRF) are defined as

$$NIRF_y = (k, \varepsilon_t, \Omega_{t-1}) = E(Y_{t+k} | \varepsilon_t, \Omega_{t-1}) - E(Y_{t+k} | \varepsilon_t^0, \Omega_{t-1}) \ , \tag{14}$$

where Y_{t+k} is a vector of variables at horizon k, Ω_{t-1} is the information set available before the time of shock t. Note that the ε_t^0 denotes stochastic disturbance at time 0 that would occur under the no-shock scenario. This implies that there is no restriction regarding the symmetry of the shocks in terms of their sizes, because the effects of a ε_t shock depend on the magnitude of the current and subsequent shocks. Moreover, in the high-stress regime, the size of the fiscal shock matters, since a small shock is less likely to induce a change in the regime. Likewise, the impulse responses depend also on the entire history of the variables that affect the persistence of the different regimes.

Therefore, in order to get the complete information about the dynamics of the model, the impulse responses have to be simulated for various sizes and for the signs of the shocks. The algorithm proceeds as follows. First, the shocks for the periods from 0 to q are drawn from the residuals of the estimated VAR model. Then, for each initial value that is, for each point of our sample, this sequence of shocks is fed through the model to produce forecasts conditional on initial conditions. These steps are repeated for the same initial condition and the same set of residuals except for the shock to the variable of interest, which is set to +/-1 standard error and +/-2 standard errors at $t = 0$.

Second, we calculate the forecasts conditional on the shocks and on the initial conditions with and without an additional shock at t=0, and the difference between these two is the impulse response function. This procedure is replicated 500-times for each initial condition and the median, average and quantiles are saved. Then we compute averages over the initial conditions from each regime to get the impulse responses for both regimes.

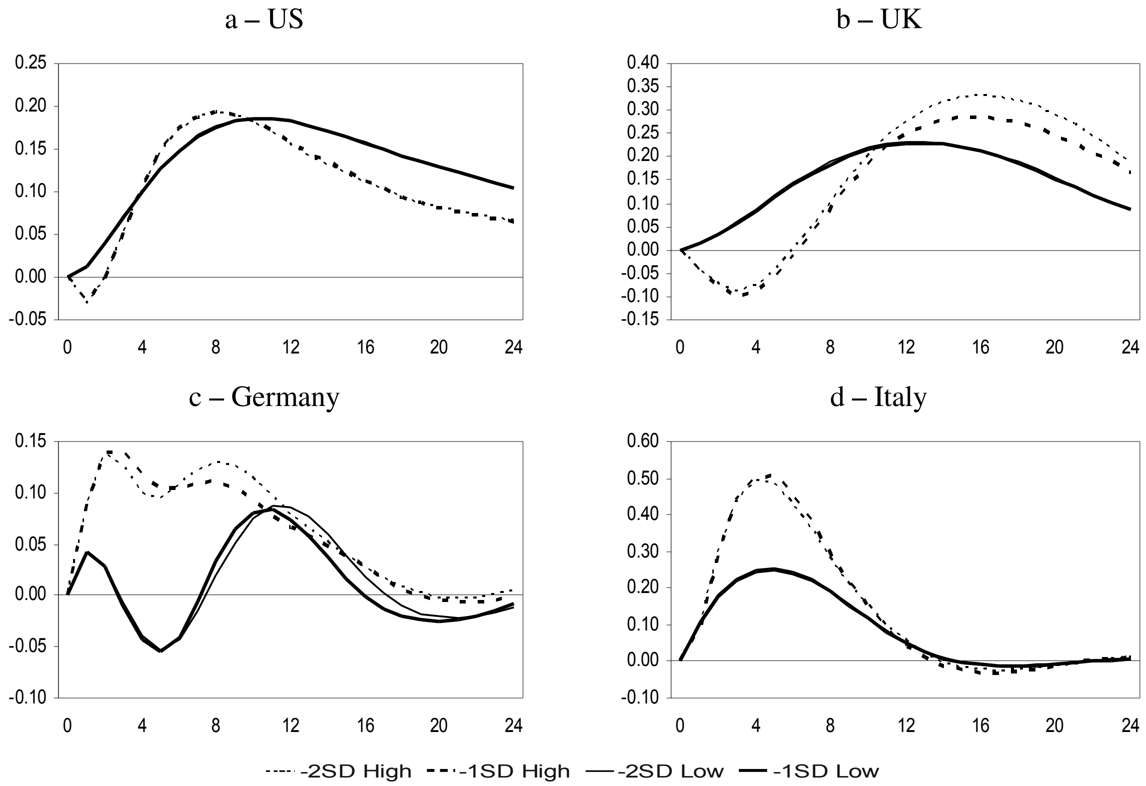
Results

I tested whether the data indicate the presence of a statistically significant threshold γ as defined by the values of the financial stress index, and whether the optimal threshold values are reasonable in terms of identifying high and low stress periods that will be related to output fluctuations. Because the observed persistence of the financial stress index is very low, when comparing to fluctuations of other macroeconomic variables, reasonable values of the threshold would have lead to a segmentation of periods with high financial stress. Therefore, I have determined the threshold from the FSI smoothed by a 3-period moving average. The estimated threshold values range from 0.92 for Germany to 2.38 for the U.S. and the threshold is significant with a p-value often less than 0.0001 for all the Wald statistics (Table 1).

Figure 1 reports the median impulse response functions of a fiscal policy shock, both for a high and for a low financial stress regime. We opted for the median impulse response functions and the respective confidence bands derived from the empirical distribution of the responses rather than from the normal distribution due to the lower number of observations namely in the higher stress regime sample. Broadly, the responses of output growth to a fiscal shock are positive in both regimes and in all countries in our sample, although in some cases the response is either initially negative or uncertain within the first few quarters after the shock.

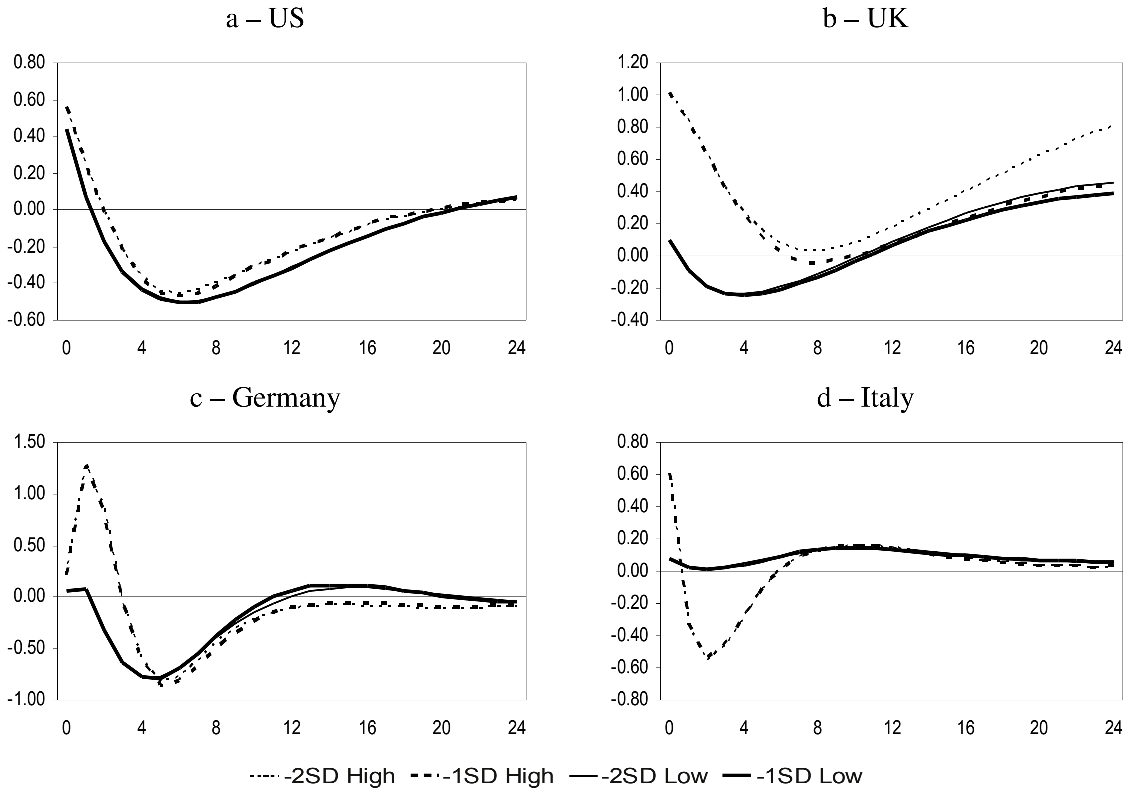
As far as the effects of the size of the fiscal shock are concerned, the results not provide evidence of important asymmetries between small and large shocks with the exception of Germany. Moreover, one and two standard deviations shocks practically coincide in the U.S. and in Italy.

Figure 1 - Fiscal Shock, Response of Output Growth



The responses of financial stress to fiscal shocks are presented in Figure 2. The results show that fiscal policy shocks decrease the financial stress, when the economy is initially in the high stress regime, although there is an initial increase of financial stress within the first few quarters. Only the U.K. is somewhat different, and the impulse response of the FSI does not decrease to negative values but, on the contrary, it implies increased financial stress both in the short and in the long term. This long-term increase of FSI is larger for large positive fiscal shocks, suggesting that fiscal policy does not decrease financial stress in the U.K. In the low stress regime the response of financial stress is negative with a hump-shaped pattern in all countries, except for Italy, where the financial stress indicator reacts only moderately.

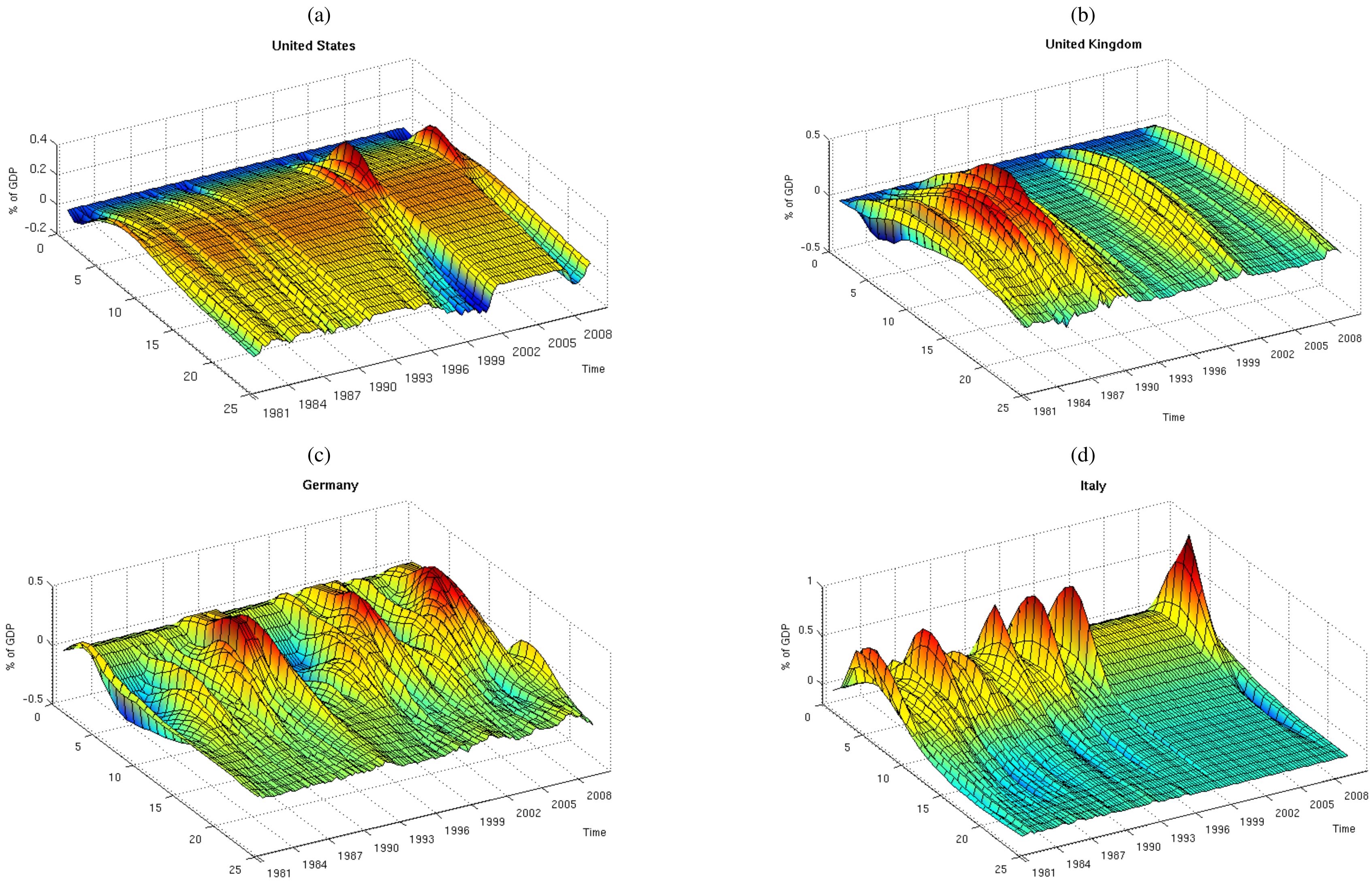
Figure 2 - Fiscal Shock, Response of FSI



Nonlinear impulse responses depend not only on the estimated model coefficients but also on initial conditions, i.e. whether the economy is in the high financial stress regime at the time of the fiscal shock or not. Likewise, the impulse responses depend also on the entire history of the variables. For example, the persistence of financial stress, as well as its size, might affect the ability of fiscal policy to accomplish a switch from a high stress regime back to a low stress regime.

Figure 3 shows the impulse responses of output growth to an initial 1 percentage point of GDP debt increase in all countries. Broadly, the effects of fiscal policy on output growth in the high financial stress regime are larger within the first two and half years, after the shock, than in the low stress regime after 2000 in all countries but the U.K. However, the initially larger effect is offset either by lower persistence of the effect (in the U.S.) or the impact on output growth becomes negative in the long term as in Germany and to some extent in Italy as well. Otherwise, the evidence of a larger positive impact of fiscal policy on output growth in times of higher stress is weak and country specific. Figure A3.2 – Median impulse responses of 1% fiscal shock over time

Figure 3 – Median impulse responses of 1% fiscal shock over time



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