BANK OF ENGLAND

External MPC Unit

Discussion Paper No. 45

Monetary policy and the current account: theory and evidence

Ida Hjortsoe, Martin Weale and Tomasz Wieladek

March 2016

This document is written by the External MPC Unit of the Bank of England

BANK OF ENGLAND

External MPC Unit

Discussion Paper No. 45

Monetary policy and the current account: theory and evidence

Ida Hjortsoe,[(1)] Martin Weale[(2)] and Tomasz Wieladek[(3)]

Abstract

Does the current account improve or deteriorate following a monetary policy expansion? We examine this issue theoretically and empirically. We show that a standard open economy DSGE model predicts that the current account response to a monetary policy shock depends on the degree of economic regulation in different markets. In particular, financial (product market) liberalisation makes it more likely that the current account deteriorates (improves) following a monetary expansion. We test these theoretical predictions with a varying coefficient Bayesian panel VAR model, where the coefficients are allowed to vary as a function of the degree of financial, product and labour market regulation on data from 1976 Q1–2006 Q4 for 19 OECD countries. Our empirical results support the theory. We therefore conclude that following a monetary policy expansion, the current account is more likely to go into deficit (surplus) in countries with more liberalised financial (product) markets.

Key words: Balance of payments, current account, Bayesian panel VAR, economic liberalisation, monetary policy.

JEL classification: F32, E52, C11, C23.

(1) Corresponding author. External MPC Unit, Bank of England. Email: ida.hjortsoe@bankofengland.co.uk
(2) External MPC Unit, Bank of England. Email: martin.weale@bankofengland.co.uk
(3) Barclays and CEPR. Email: tomaszwieladek@gmail.com

These Discussion Papers report on research carried out by, or under supervision of the External Members of the Monetary Policy Committee and their dedicated economic staff. Papers are made available as soon as practicable in order to share research and stimulate further discussion of key policy issues. However, the views expressed in this paper are those of the authors, and not necessarily those of the Bank of England or the Monetary Policy Committee. Tomasz Wieladek's analytical contribution to this paper was completed while employed by the Bank of England. Thanks to Stephane Guibaud, participants at the ECB/Bundesbank/Goethe University Frankfurt seminar, participants at the Bank of England/Banque de France International Macro Workshop and colleagues at the Bank of England. All errors are ours.

Information on the External MPC Unit Discussion Papers can be found at
www.bankofengland.co.uk/monetarypolicy/Pages/externalmpcpapers/default.aspx

External MPC Unit, Bank of England, Threadneedle Street, London, EC2R 8AH

ISSN 1748-6203 (on-line)

1. Introduction

Does the current account improve or deteriorate following a monetary policy expansion? Neither theory nor empirical analysis offers a clear answer to this question, which is at the heart of the current debate about the international monetary system.[1] Papers which focus on the US such as Kim (2001a) or Barnett and Straub (2008) find that a US monetary loosening weakens the current account, while papers which consider a set of countries such as Kim (2001b) or Lee and Chinn (2006) find that an expansion of monetary policy tends to be followed by an improvement in the current account. This paper reconciles those findings by showing that the impact of monetary policy on the current account is likely to differ across countries and over time depending on certain economic features. In particular, our results suggest that the sign of the current account response following a monetary policy expansion depends on the degree of regulation in certain markets.

First, we show that the impact of monetary policy on the current account in an open economy DSGE model depends on the structural features of the economy, specifically the degree of regulation in different markets. We examine how the channels through which monetary policy is transmitted to the current account are affected by regulation in financial, product and labour markets. The model delivers predictions about the impact of liberalisation in each of these markets on the current account response to monetary policy. We then use a Bayesian panel VAR to test those predictions. The coefficients in the VAR are allowed to vary stochastically as a function of the degree of regulation in the different markets, making it possible to estimate empirically the impact of liberalisation in each of the markets on the current account response to a monetary policy shock.

Our work expands on previous work analysing the effect of economic liberalisation on the monetary policy transmission mechanism by focusing on the open economy consequences of economic liberalisation and in particular on the implications for the current account. Moreover, we consider economic liberalisation in three different markets separately. We can do so as our DSGE model is rich enough to serve as a common framework to study the effects of each type of liberalisation on the monetary policy

[1] For example, King (2009) suggests that global imbalances were an important factor behind the global financial crisis of 2008/2009 and could have been addressed through global coordination of monetary policy.

transmission mechanism. Similarly, our econometric approach allows us to estimate the impact of liberalisation in all markets jointly, thereby reducing omitted variable bias.

The DSGE model shows a number of routes by which monetary policy is transmitted to the current account. First, given prices, a temporary monetary expansion induces people to bring forward consumption of imported as well as domestically produced goods (the import absorption channel). This leads to a deterioration of the current account by reducing net exports. Secondly, the consequent exchange rate depreciation makes domestic goods cheap relative to foreign goods and thus induces a rise in the consumption of the former relative to the latter (the expenditure switching channel). The resulting rise in net exports contributes to improving the current account. But the exchange rate depreciation also increases the cost of a given consumption basket and thus has a negative income effect which limits the increase in consumption of imported as well as domestic goods and thus contributes positively to the current account (the purchasing power channel). Finally, to the extent international financial markets lead to some degree of consumption risk sharing across countries, and thus to portfolio diversification, the domestic monetary shock will also affect the rest of the world, leading to some increase in consumption abroad. A current account improvement will result (the portfolio diversification channel). The model shows that which of those channels dominate, and therefore whether the current account improves or deteriorates following a monetary expansion, depends on the structure of the economy considered (characterised inter alia by the degree of regulation in different markets).

We investigate how the degree of financial, labour and product market liberalisation affects the transmission of monetary policy to the current account within the DSGE model, by comparing economies which are tightly regulated with those which are lightly regulated. In our model, the degree of financial regulation is captured by the proportion of households without access to financial markets, consistent with empirical evidence suggesting that financial liberalisation reduces the fraction of liquidity-constrained consumers in an economy. Our measure of product market regulation is negatively related to the elasticity of substitution between the traded and non-traded goods sectors, because we would expect this elasticity to increase with greater competition between goods produced both domestically and internationally, as could result e.g. from reduction in barriers to entry.[2] Finally, we model the degree of labour market regulation by the degree of wage rigidity as the latter should decrease with falling hiring and firing costs. We vary each of these measures of regulation in turn and consider the impact on the impulse responses following a monetary policy shock.

The DSGE model predicts that each type of liberalisation affects the monetary policy transmission and its consequences for the current account. Financial market liberalisation affects the transmission of monetary policy to the current account by amplifying the import absorption channel, so that financial liberalisation means that the current account is more likely to deteriorate after a monetary expansion. Product market liberalisation has the opposite impact on the transmission of monetary policy to the current account: by amplifying the expenditure switching channel it puts upward pressure on the current account response to a monetary policy expansion. These results hold for a wide range of plausible structural parameter values. Finally, the impact of labour market liberalisation on the monetary policy transmission is found to depend on the other structural features of the model. These theoretical predictions are summarised in the first row in Table 1.

We use VAR analysis to test to the predictions of our theoretical model regarding the impact of liberalisation on the transmission of monetary policy. In particular, we use a varying coefficient panel VAR model in which we allow the coefficients to vary with the degree of regulation. We carefully match the statistical measures for each type of regulation to our measures in the theoretical model.

In principle we could test the predictions country by country. A number of authors have used VAR frameworks to look at the implications of economic liberalisation by only exploiting time-series variation. An alternative approach has been to look at cross-sectional variation. If there are countries with similar characteristics, pooling by characteristic may offer a means of determining the structure within those countries better. But if the regulatory changes in question can be quantified in the form of a country-specific and time-varying index, it may appear desirable to estimate a model in which account is taken of both types of variation. Wieladek (2016) proposes a Bayesian

[2] We would expect the degree of substitutability between sectors to be related to product market regulation as the more substitutable are goods across sectors, (1) the lower the barriers to expenditure switching between the two sectors, conceptually corresponding to lower barriers to entry in the non-traded sector, and (2) the less can non-traded goods producers increase prices without losing demand, i.e. the less monopoly power do firms in the non-traded sector have.

shrinkage approach to estimate panel VAR models where the coefficients are a stochastic function of several exogenous variables. The structure resulting from Bayesian shrinkage permits random parameter variation both across countries and over time. Since this approach allows for both stochastic variation and multiple structural characteristics, this is the econometric approach that we choose to follow. It delivers a random effects estimator.

The advantage of this econometric approach is that we can formally test the implications of our theoretical model by comparing the distributions of impulse responses in the presence of high and low degrees of regulation in each market. That makes it easy to understand whether and how, for instance, financial liberalisation has affected the monetary policy transmission to the current account over time. Monetary policy shocks are identified with sign restrictions (See Canova and De Nicolo (2002); Uhlig (2005); Faust and Rogers (2003)), derived from our DSGE model. To ensure robustness to the type of identification, we also examine monetary policy shocks identified with lower-triangular zero restrictions, with consumption and the consumer price index ordered before the short-term interest rate (as in Christiano, Eichenbaum and Evans (1999)).

To our knowledge we are the first to test formally the open economy consequences of a rich body of monetary theory which implies that the reaction of variables to a monetary policy shock should depend on the structural characteristics of the economy considered. Furthermore, no previous work has examined the effect of product market deregulation on the monetary policy transmission mechanism. Finally, by the standards of previous work that studies how changes to structural characteristics affect the transmission mechanism, our econometric methodology allows us to account for a larger number of structural characteristics. As these variables are likely to be correlated, this should reduce the scope for omitted variable bias to produce misleading results.

Our empirical results confirm the DSGE model predictions of the impact of different types of liberalisation: the magnitude of the current account response is highly dependent on the financial and product market regimes. Financial liberalisation leads to a greater current account deficit in response to the same size monetary policy expansion. Conversely product market deregulation tends to put upwards pressure on the current account. As a result, the current account is more likely to improve in response to a monetary policy expansion in economies with liberalised product markets but more likely to deteriorate in economies with highly liberalised financial markets. Our results are summarised in Table I.

These findings have important implications for understanding the impact of economic policy on the current account. Our results suggest that if policy makers set policy with some reference to the current account, they need to take into account the structure of the economy and the extent of regulation in different markets.

Table I. Effect of liberalisation on CA/GDP response to monetary expansion

	Liberalisation of financial markets	Liberalisation of product markets	Liberalisation of labour markets
DSGE model	CA/GDP response deteriorates	CA/GDP response improves	Ambiguous impact on CA/GDP response
VAR (sign restrictions)	CA/GDP response deteriorates	CA/GDP response improves	Insignificant impact on CA/GDP response
VAR (triangular ident.)	CA/GDP response deteriorates	CA/GDP response improves	Insignificant impact on CA/GDP response

The remainder of the paper is structured as follows: Section 2 presents the theoretical model as well as our theoretical results. Section 3 describes our empirical methodology, the data, and our empirical results. Section 4 discusses how the theoretical and empirical results can be reconciled and concludes.

2. Theoretical Results

2.1. The model

The framework we use to investigate the impact of monetary policy on the current account is a standard open-economy DSGE model. It builds on the framework used in Eggertson et al (2014) by incorporating features present in other DSGE models such as the SIGMA model developed by Erceg et al (2006). Our model consists of a world composed of two countries, denoted H (Home) and F (Foreign). There are respectively n and 1-n households in each of these countries. There are two types of households in each country: households who have access to the financial markets and that we name Ricardian or optimizing households (denoted with superscript O); and households who do not have access to financial markets and are therefore constrained to consume their entire income every period. We name the latter households rule of thumb households (denoted with superscript R).[3] While Ricardian consumers face complete financial markets at the domestic level, international financial markets are incomplete in that only nominal bonds are traded internationally. Ricardian households supply differentiated labour inputs and set wages in a staggered fashion, whereas rule-of-thumb households supply their labour input taking wages as given.[4] Firms use these labour inputs to produce differentiated traded and non-traded goods and set prices in a staggered fashion. In what follows, we present the behaviour of agents in the Home country, but analogous relations hold for agents in the Foreign country, unless otherwise specified.

2.1.2. Firms

As in Eggertson et al (2014), firms produce differentiated goods and operate either within the traded goods sector (producing good $k = H$) or within the non-traded goods sector (producing good $k = N$). Technology is linear in labour, and output of domestic firm h in sector k is $y_{k,t}(h) = l_{k,t}(h)$. Firms are monopolistically competitive and set prices in a staggered fashion *à* la Calvo-Yun. That is, firms reset their price at a time-independent random frequency. More specifically, each firm faces the probability 1-α_H^k of being able to reset its price in each period. Firms are owned by domestic Ricardian households.

The differentiated goods produced in country H are assembled into composite traded and non-traded consumption goods by using a Dixit-Stiglitz aggregator.

$$Y_{k,t} = \left[\left(\frac{1}{a_H^k}\right)^{\frac{1}{\theta_H}} \int_0^{a_H^k} y_{k,t}\,(h)^{\frac{\theta_H-1}{\theta_H}} dh\right]^{\frac{\theta_H}{\theta_H-1}}$$

where $a_H^N = 1 - a_H^H$ is the size of the non-traded goods sector relative to the traded goods sector within country H, and θ_H denotes the elasticity of substitution between the

[3] We here follow the literature, e.g. Gali, Lopez-Salido and Valles (2004)

[4] This simplification ensures that the average wage is the same for the two types of households and is also made in Erceg et al (2006).

differentiated goods produced within country H. The part of the traded consumption good, which is consumed in the domestic market is denoted $C_{H,t}$, while the part which is consumed in the Foreign market (i.e. exported) is denoted$C^{*}_{H,t}$.

The optimisation problem of the firm producing good h in sector k and getting the opportunity to reset its price at time t consists in choosing a price $p_{k,t}(h)$ such as to maximize expected discounted future profits:

$$\max_{p_{k,t}(h)} E_t \sum_{s=0}^{\infty} {\alpha_H^k}^s \mu_{t,t+s} \left[\left((1-\tau_H^k) p_{k,t}(h) - \frac{W_{k,t+s}}{P_{t+s}} \right) y_{k,t,t+s}(h) \right]$$

where E_t is the expectations operator, $\mu_{t,t+s}$ is the stochastic discount factor of the firm, and τ_H^k is a tax on sales applied to sector k. W_k is the nominal wage in sector k while P is the consumption price level. $y_{k,t,t+s}(h)$ is the demand at time $t+s$ for good h produced in sector k at the price $p_{k,t}(h)$. Given that firms are owned by the Ricardian households their stochastic discount factor is identical to the stochastic discount factor of the representative Ricardian household: $\mu_{t,t+s} = \beta^s \left({U^O_{C,t+s}}/{U^O_{C,t}} \right) \left({P_t}/{P_{t+s}} \right)$, where β is the households' discount factor and $U^O_{C,t}$ is the Ricardian households' marginal utility from consumption in period t, whereas P_t is the consumer price index.

The resulting first order conditions imply that prices are set according to expectations of future marginal costs and demand in the following way:

$$p_{k,t}(h) = \frac{\theta_H^k}{(\theta_H^k - 1)(1-\tau_H^k)} \frac{E_t \sum_{s=0}^{\infty} (\beta\alpha_H^k)^s U^O_{C,t+s} \frac{W_{k,t+s}}{P_{t+s}} y_{k,t,t+s}(h)}{E_t \sum_{s=0}^{\infty} (\beta\alpha_H^k)^s P^{-1}_{t+s} U^O_{C,t+s} y_{k,t,t+s}(h)}$$

Because all sector k firms that get to reset their price in a given period face the same expectations of marginal costs and demand, they all set the same price. Hence, the price level in sector k, P_k, is given by

$$P_{k,t} = \left[\alpha_H^k P_{k,t-1}^{1-\theta_H^k} + (1-\alpha_H^k) p_{k,t}(h)^{1-\theta_H^k} \right]^{\frac{1}{1-\theta_H^k}}$$

Aggregating output across firms yields $Disp_{k,t} Y_{k,t} = L_{k,t}$ where $Disp_{k,t} \equiv \int_0^n \left(\frac{p_{k,t}(h)}{P_{k,t}} \right)^{-\theta_H^k} dh \geq 1$ is a measure of the degree of price dispersion in sector k. The price setting process of firms introduces a distortion as it causes price dispersion among firms with identical technologies.

2.1.3. Households

There are $1-\lambda_H^R$ Ricardian households and λ_H^R rule of thumb households in the Home country. Both types of households ($i = O$ and $i = R$) get utility from private consumption (c^i) but disutility from working in the non-traded goods sector (l_N^i) and in the traded goods sector (l_H^i), and household i's welfare is given by

$$W_0^i = E_0 \sum_{t=0}^{\infty} \beta^t \{U^c(c_t^i) - \kappa[U^l(l_{N,t}^i) + U^l(l_{H,t}^i)]\}, \quad i = \{O, R\}$$

where E_t denotes the expectations at time t, β is the discount factor, and κ is a parameter determining the weight put on labour vs consumption fluctuations in affecting utility. The functional forms are as follows:

$$U^c(c_t^i) = \frac{c_t^{i1-\sigma_H}}{1-\sigma_H}$$

$$U^l(l_{k,t}^i) = \frac{l_{k,t}^{i1+\eta_H}}{1+\eta_H}, \qquad k = \{H, N\}$$

where $\sigma_H > 0$ is the inverse of the inter-temporal elasticity of substitution and the relative risk aversion coefficient, and $\eta_H > 0$ is the inverse of the Frisch labour supply elasticity. We assume that the disutility from working in either sector is the same.

Household i's consumption of traded goods is a CES index of the composite traded good produced at Home for the Home market, C_H, and the composite traded good produced in the Foreign country for the Home market, C_F:

$$C_{T,t}^i = \left[a_H^{\frac{1}{\varphi_H}} C_{H,t}^{i\frac{\varphi_H-1}{\varphi_H}} + (1-a_H)^{\frac{1}{\varphi_H}} C_{F,t}^{i\frac{\varphi_H-1}{\varphi_H}}\right]^{\frac{\varphi_H}{\varphi_H-1}}, 0 < a_H < 1, \varphi_H > 0, i = \{O, R\}$$

where the constant elasticity of substitution between the home and foreign traded goods is denoted φ_H. a_H is the weight given to consumption of the composite Home traded good and is defined as $a_H \equiv 1-(1-n)op$ where op is a measure of openness. Similarly, $1-a_H \equiv (1-n)op$ is the weight attached to consumption of the composite Foreign traded good. If $op < 1$ so that $a_H > n$, then a home bias in traded consumption is present.

Households choose their relative traded consumption demand such as to maximize utility for given expenditures. The resulting domestic demand for respectively Home and Foreign traded goods is:

$$C_{H,t}^{i} = a_H \left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\varphi_H} C_{T,t}^{i}, \qquad i = \{O, R\}$$

$$C_{F,t}^{i} = (1-a_H) \left(\frac{P_{F,t}}{P_{T,t}}\right)^{-\varphi_H} C_{T,t}^{i}, \qquad i = \{O, R\}$$

where P_H and P_F respectively denote the price of the domestically produced generic traded good C_H and the foreign traded good C_F in domestic currency, whereas P_T denotes the price of the domestic traded consumption basket C_T.

Traded and non-traded goods are assembled into a final consumption basket by using a CES aggregator with elasticity of substitution φ_H^N

$$C_t^i = \left[{a_H^H}^{\frac{1}{\varphi_H^N}} {C_{T,t}^i}^{\frac{\varphi_H^N-1}{\varphi_H^N}} + (1-a_H^H)^{\frac{1}{\varphi_H^N}} {C_{N,t}^i}^{\frac{\varphi_H^N-1}{\varphi_H^N}} \right]^{\frac{\varphi_H^N}{\varphi_H^N-1}}, 0 < a_H^H < 1, \varphi_H^N > 0, i = \{O, R\}$$

Domestic demand for respectively traded and non-traded goods resulting from maximising consumption for given expenditures is:

$$C_{T,t}^{i} = a_H^H \left(\frac{P_{T,t}}{P_t}\right)^{-\varphi_H^N} C_t^i, \quad i = \{O, R\}$$

$$C_{N,t}^{i} = (1-a_H^H) \left(\frac{P_{N,t}}{P_t}\right)^{-\varphi_H^N} C_t^i, \quad i = \{O, R\}$$

where P_N denotes the price of the non-traded consumption good C_N in domestic currency, whereas P denotes the price of the domestic consumption basket C. Note that because preferences are identical across domestic households and they face the same price, the composition of their consumption baskets will be identical.

The consumption-based price indices are defined analogously to the consumption bundles

$$P_t = \left[a_H^H P_{T,t}^{1-\varphi_H^N} + (1-a_H^H) P_{N,t}^{1-\varphi_H^N}\right]^{\frac{1}{1-\varphi_H^N}}$$

$$P_{T,t} = \left[a_H P_{H,t}^{1-\varphi_H} + (1-a_H) P_{F,t}^{1-\varphi_H}\right]^{\frac{1}{1-\varphi_H}}$$

where

$$P_{H,t} = \left[\frac{1}{a_H^H}\int_0^{a_H^H} p_t\,(h)^{1-\theta_H} dh\right]^{\frac{1}{1-\theta_H}}, P_{F,t} = \left[\frac{1}{a_F^F}\int_0^{a_F^F} p_t\,(f)^{1-\theta_F} dh\right]^{\frac{1}{1-\theta_F}},$$

$$P_{N,t} = \left[\frac{1}{1-a_H^H}\int_0^{1-a_H^H} p_t\,(h)^{1-\theta_H} dh\right]^{\frac{1}{1-\theta_H}}$$

where a_F^F denotes the relative size of the traded sector in country F. The terms of trade are defined as the ratio between the price of imports and exports: $TOT_t \equiv \frac{P_{F,t}}{P_{H,t}}$, whereas the real exchange rate is defined as the price of the Foreign consumption bundle in terms of the Home consumption good: $Q_t \equiv \frac{s_t P_t^*}{P_t}$ where s_t is the nominal exchange rate and a starred variable denotes a Foreign variable: P_t^* is the Foreign consumer price index. We assume that the law of one price holds: $p_t(f) = s_t p_t^*(f) \Rightarrow P_{F,t} = s_t P_{F,t}^*$ and similarly for import prices in country F.

Ricardian households

Every period, domestic Ricardian households choose consumption and bond holdings to maximize their expected discounted stream of future utility subject to their budget constraint and their labour income. They face complete financial markets at the domestic level: they own an equal share in every domestic firm and profits are therefore equally distributed among the Ricardian domestic households. Ricardian households also have access to the international financial markets, but these are incomplete: only nominal one-period bonds denominated in Foreign currency are traded across countries. The interest on these internationally traded bonds depends on the Foreign interest rate and the level of external debt: the yields of the bonds are increasing in external debt as in Schmitt-Grohe and Uribe (2003). Apart from implying stationarity of the steady state, modelling financial frictions through a debt-elastic yield on bonds allows for state-contingent yield differences across countries.

Every period, Ricardian households use their labour income, wealth accumulated in domestic and foreign bonds (denominated in Foreign currency), and profits of firms in the domestic economy (PR) to purchase consumption and both domestically issued bonds (B_H) and Foreign bonds (B_F) and pay lump-sum taxes. In the Home country, the representative Ricardian household budget constraint thus amounts to:

$$C_t^O + \frac{B_{H,t}}{P_t(1+i_t)} + \frac{s_t B_{F,t}}{P_t(1+i_t^*)\Phi\left(\frac{s_t B_{F,t}}{P_t}\right)} + T_t$$
$$= \left(1-\tau_{H,H}^w\right)\frac{W_{H,t}}{P_t}L_{H,t}^O + \left(1-\tau_{N,H}^w\right)\frac{W_{N,t}}{P_t}L_{N,t}^O + \frac{B_{H,t-1}}{P_t} + \frac{s_t B_{F,t-1}}{P_t} + PR_t$$

where C_t^O is consumption of the representative Ricardian household, i_t is the nominal interest set by the Home central bank in period t and defines the return on domestically issued bonds denominated in the Home currency (B_H), and i_t^* is the nominal interest set by the Foreign central bank in period t, $W_{k,t}$ is the nominal wage rate in sector k, and $L_{k,t}^O$ is the hours worked in sector k, PR_t denote profits made by domestic firms, $\tau_{k,H}^w$ is the labour income tax rate in sector k, T_t denotes lump-sum taxes paid by the household, and $B_{F,t}$ is the nominal holdings of Foreign bonds (denominated in Foreign currency).

The function Φ is assumed to depend positively on deviations of external debt from its steady state level, $\Phi'(\cdot) < 0$, and satisfies $\Phi\left(\frac{sB_F}{P}\right) = 1$ in steady state. We specify the yield premium associated with holding bonds to be linear in deviations of borrowing/lending from steady state: $\Phi(b_t) = 1 - \delta(b_t - \frac{B}{P})$, with $\delta > 0$ and $\frac{B}{P} = \frac{sB_F}{P}$. Note that because $\Phi'(\cdot) < 0$, whenever B_F is low[5], then the yield on debt is high ($\Phi(\cdot) > 1$). On the contrary, when bond holdings are high implying that Home households have claims on Foreign households, then $\Phi(\cdot) < 1$ and the price of bonds is high and purchasing even more bonds is expensive. For simplicity, we assume that individual households do not internalize the effect of changes in their own bond holdings on the yield, i.e. they take the function $\Phi(\cdot)$ as given.

The first-order conditions of the representative Ricardian domestic household's maximisation problem with respect to consumption and bond holdings can be aggregated to yield:

[5] i.e. when external debt is high in the Home country

$$\beta E_t \frac{C_{t+1}^{O-\sigma}}{C_t^{O-\sigma}} \frac{(1+i_t)}{\pi_{t+1}} = 1$$

$$\beta E_t \frac{C_{t+1}^{O-\sigma}}{C_t^{O-\sigma}} \frac{(1+i_t^*)}{\pi_{t+1}^*} \frac{Q_{t+1}}{Q_t} = \frac{1}{\Phi\left(\frac{s_t B_{F,t}}{P_t}\right)}$$

where $\pi_t \equiv \frac{P_t}{P_{t-1}}$ and $\pi_t^* \equiv \frac{P_t^*}{P_{t-1}^*}$ denote CPI inflation respectively in the Home and in the Foreign country, and $Q_t \equiv \frac{s_t P_t^*}{P_t}$ is the real exchange rate. These Euler equations determining the inter-temporal allocation of domestic Ricardian consumption result from the first order condition with respect to domestic bond holdings and Foreign bond holdings.[6]

Ricardian agents supply differentiated labour inputs to each sector ($\theta_{k,H}^w$ is the elasticity between different labour inputs in sector k) and set wages in a staggered fashion. In particular, they get to renegotiate their wage $w_{k,t}$ in sector k with the same probability $1-\alpha_{k,H}^w$ every period. In periods where they get to renegotiate their wage they set it such as to maximise their expected discounted stream of future utility subject to the demand for their labour, as determined by the wage elasticity. The optimality condition implies the following wage setting equation in sector k:

$$\left(\frac{w_{k,t}}{W_{k,t}}\right)^{1+\theta_{k,H}^w} = \frac{\theta_{k,H}^w}{\theta_{k,H}^w - 1} \frac{E_t \sum_{s=0}^{\infty} (\beta \alpha_{k,H}^w)^s \left(\frac{L_{k,t+s}^O}{a_H^k}\right)^{1+\eta_H} {\pi_{k,t+s}^w}^{\theta_{k,H}^w (1+\eta_H)}}{E_t \sum_{s=0}^{\infty} (\beta \alpha_{k,H}^w)^s (1-\tau_k^w) \left(\frac{L_{k,t+s}^O}{a_H^k}\right) C_{t+s}^{O-\sigma} {\pi_{k,t+s}^w}^{\theta_{k,H}^w - 1}}, k = H, N$$

<u>Rule of thumb households</u>

Rule of thumb households do not have access to financial markets and take wages set by Ricardian households as given.[7] They choose consumption and labour supply to maximize their expected discounted stream of future utility subject to their budget

[6] Note that the Foreign Ricardian household only faces one Euler equation as it holds only its own internationally traded bonds. This assumption can be justified by the fact that most small open economies have the majority of their international debt denominated in the currency of a larger economy. Allowing for international trade in a second bond denominated in the Home currency would not change the results.

[7] This assumption is also used in Erceg et al (2006) and ensures that the average wage is identical across household types. Note that fixing the labour supply of rule-of-thumb households instead of allowing an endogenous response does not change our results.

constraint $P_t C_t^R = W_{H,t} L_{H,t}^R + W_{N,t} L_{N,t}^R$. The first-order conditions of the representative rule of thumb household can be aggregated to yield:

$$\frac{\left(\frac{L_{k,t}^R}{a_H^k}\right)^{\eta_H}}{C_t^{R-\sigma}} = \frac{W_{k,t}}{P_t}, \qquad k = H, N$$

Using the budget constraint, we get

$$C_t^R = a_H^H \left(\frac{W_{H,t}}{P_t}\right)^{\frac{1+\eta_H}{\eta_H}} + (1 - a_H^H)\left(\frac{W_{N,t}}{P_t}\right)^{\frac{1+\eta_H}{\eta_H}}$$

Aggregation

Aggregating across households, Home labour supply in sector k amounts to

$$L_{k,t} = (1 - \lambda_H^R) L_{k,t}^O + \lambda_H^R L_{k,t}^R$$

Similarly, aggregating demand for goods across households implies that

$$C_t = (1 - \lambda_H^R) C_t^O + \lambda_H^R C_t^R$$

2.1.4. Fiscal policy

Labour income and sales taxes are fixed to ensure that the steady state is efficient:

$$\tau_H^k = \frac{1}{1 - \theta_H^k}, \qquad k = H, N$$

$$\tau_{k,H}^w = \frac{1}{1 - \theta_{k,H}^w}, \qquad k = H, N$$

The government is assumed to balance its budget every period implying that the taxes it levies on Ricardian households and firms are redistributed back to them through lump sum transfers.

$$-T_t = \tau_{H,H}^w \frac{W_{H,t}}{P_t} L_{H,t}^O + \tau_{N,H}^w \frac{W_{N,t}}{P_t} L_{N,t}^O + \tau_H^H P_{H,t} Y_{H,t} + \tau_N^H P_{N,t} C_{N,t}$$

2.1.5. Monetary policy

We abstract from monetary frictions and can thus consider a "cashless economy" as in Woodford (2003). The domestic monetary policy instrument is the nominal interest rate paid on one-period bonds, denoted i. The monetary policy authority sets the interest rate on domestic bonds with an aim to stabilize domestic CPI inflation and smooth interest rate changes as well as target the nominal exchange rate. In particular, the Home monetary authority follows a rule of the following form:

$$\log\left(\frac{1+i_t}{\bar{\iota}}\right) = (1-\alpha_H^{FIX})\left[\alpha_H^R \log\left(\frac{1+i_{t-1}}{\bar{\iota}}\right) + \alpha_H^{\pi}\log\left(\frac{\pi_t}{\bar{\pi}}\right)\right] + \alpha_H^{FIX}\log\left(\frac{(1+i_t^*)\Phi\left(\frac{s_t B_{F,t}}{P_t}\right)}{\bar{\iota}}\right) + \psi_t^I$$

where $1-\alpha_H^{FIX}$ indicates the amount of exchange rate flexibility in the Home country. If $\alpha_H^{FIX} = 0$, then monetary policy is not constrained by exchange rate stabilization.[8] $(1-\alpha_H^{FIX})\,\alpha_H^{\pi}$ indicates the weight put on stabilizing CPI inflation, and $(1-\alpha_H^{FIX})\alpha_H^R$ indicates the relative weight put on interest rate smoothing. ψ_t^I is a monetary policy shock.[9] The Foreign monetary authority follows an analogous monetary policy rule. Monetary policy affects the real economy in the presence of nominal rigidities, and through its effect on the debt burden of countries.

2.1.6. Market clearing and aggregation

Aggregate demand facing domestic producers of traded goods amounts to:

$$Y_{H,t} = a_H\left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\varphi} C_{T,t} + \frac{1-n}{n}(1-a_F)\left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\varphi}\left(\frac{s_t P_{T,t}^*}{P_{T,t}}\right)^{\varphi} C_{T,t}^*$$

and aggregate demand for foreign traded goods amounts to:

[8] If instead, $\alpha_H^{FIX} = 1$, then the monetary authority ensures a fixed exchange rate. Indeed, the Home consumption Euler equations imply that $\beta E_t \frac{C_{t+1}^{O-\sigma}}{C_t^{O-\sigma}}\frac{(1+i_t)}{\pi_{t+1}} = \beta E_t \frac{C_{t+1}^{O-\sigma}}{C_t^{O-\sigma}}\frac{(1+i_t^*)}{\pi_{t+1}^*}\frac{Q_{t+1}}{Q_t}\Phi\left(\frac{s_t B_{F,t}}{P_t}\right)$ so that $(1+i_t) = (1+i_t^*)\frac{s_{t+1}}{s_t}\Phi\left(\frac{s_t B_{F,t}}{P_t}\right)$. To ensure a fixed exchange rate ($\frac{s_{t+1}}{s_t} = 1$), the monetary policy makers must set the interest rate according to $(1+i_t) = (1+i_t^*)\Phi\left(\frac{s_t B_{F,t}}{P_t}\right)$, i.e. $\log\left(\frac{1+i_t}{\bar{\iota}}\right) = \log\left(\frac{(1+i_t^*)\Phi\left(\frac{s_t B_{F,t}}{P_t}\right)}{\bar{\iota}}\right)$.

[9] Given that we are only interested in studying the impact of monetary policy shocks in this model, we do not introduce other shocks for the purpose of this analysis.

$$Y_{F,t} = \frac{n}{1-n}(1-a_H)\left(\frac{P^*_{F,t}}{P^*_{T,t}}\right)^{-\varphi}\left(\frac{s_t P^*_{T,t}}{P_{T,t}}\right)^{-\varphi} C_{T,t} + a_F\left(\frac{P^*_{F,t}}{P^*_{T,t}}\right)^{-\varphi} C^*_{T,t}$$

Output is demand-determined in equilibrium, and, hence, the above equations can also be viewed as goods market clearing conditions.

Aggregate output in country H amounts to

$$Y_t = \left(\frac{P_{H,t}}{P_t}\right) Y_{H,t} + \left(\frac{P_{N,t}}{P_t}\right) C_{N,t}.$$

Equilibrium in the financial markets requires that bonds and assets issued in the Home economy are in zero net supply within the domestic economy,

$$B_{H,t} = 0,$$

and that internationally traded bonds issued in Foreign currency by the Foreign country are in zero net supply:

$$nB_{F,t} + (1-n)s_t B^*_{F,t} = 0$$

where $B^*_{F,t}$ denotes Foreign holdings of the Foreign bond.

An aggregate resource constraint for each country can be obtained by combining the households' budget constraints, the government budget constraint, and using the bond market equilibrium conditions:

$$C_t + \frac{Q_t \frac{B^*_{F,t}}{P^*_t}}{P_t(1+i^*_t)\Phi\left(\frac{s_t B_{F,t}}{P_t}\right)} = Y_t + \frac{Q_t \frac{B^*_{F,t-1}}{P^*_{t-1}}}{\pi^*_t}$$

This constraint characterizes the evolution of the current account. We define the current account as the change in real Foreign bond holdings:[10]

$$CA_t \equiv \frac{B_{F,t}}{P_t} - \frac{B_{F,t-1}}{P_{t-1}}$$

[10] We can rewrite this definition as:

$$CA_t \equiv \frac{Q_t \frac{B^*_{F,t}}{P^*_t}}{P_t} - \frac{Q_t \frac{B^*_{F,t-1}}{P^*_{t-1}}}{\pi^*_t}$$

2.1.7. Parameterization

In our theoretical analysis of the transmission of monetary policy we do not restrict ourselves to a specific set of model parameter values, as we want to ensure that our conclusions are not dependent on the particular structural features of the model. Therefore we consider a range for each of the structural parameters in our model simulations. In particular, in order to examine the impact of a monetary policy shock, we simulate that shock many times each time choosing different parameter values from the specified ranges, assuming that the parameters are independently and uniformly distributed over those ranges. As a result of these simulations, we get a distribution of impulse responses to a monetary policy shock which reflect different economic structures.

The parameter ranges are shown in Table 2. The model is calibrated at a quarterly frequency. For simplicity, we fix some parameters: the size of the Home country constitutes 10 percent of the World, the quarterly discount factor ensures a steady state annual interest rate of 4 percent, and the yield sensitivity to debt is fixed to 0.01 such that the annual yield increases by 0.01 percentage point for every 1 percent increase in external debt.[11] We allow all other Home and Foreign parameters to take on values within a relatively broad range, and we do not restrict those parameters to be identical across countries. The degree of openness is allowed to take on any value between 20 and 40 percent, the elasticity of labour supply between 0.4 and 0.7, and the risk aversion coefficient between 1 and 1.2. Both prices and wages within each sector are sticky, but the degree of stickiness and associated monopoly powers are allowed to take on values ranging widely.

The elasticity of substitution between traded goods takes on values between 0.5 and 1. The lower end of the range encompasses methods of moments estimates by Corsetti et al (2008) as well as time series estimates by Hooper et al (2000), whereas the upper end of the range encompasses the estimate found by Heathcote and Perri (2002), and calibrations used in Stockman and Tesar (1995). The traded goods are substitutes in the Pareto-Edgeworth sense when the trade elasticity is higher than the inter-temporal

[11] We fixed the size of the country as we are not interested in understanding how the size of countries affects the transmission. A non-zero yield sensitivity ensures that the model is stationary and determines the pace with which the current account returns to steady state. Our results are not sensitive to changes in that parameter.

elasticity ($\phi_H > \frac{1}{\sigma_H}$), so the chosen range ensures that the traded goods can be either complements or substitutes.[12] The elasticity of substitution between traded and non-traded goods can take on values between 0.4 and 1, consistently with evidence by Stockman and Tesar (1995) or Mendoza (1992).

The proportion of rule-of-thumb households take on values between 10 and 40 percent, based on evidence pointed out in Section 2.3.2 below. Finally, we allow for different degrees of persistence and inflation targeting in the central bank's rule, and potentially some degree of exchange rate targeting.

Table 1. Parameter ranges

Description	Parameter	Range
Population in Home country	n	0.1
Discount factor	β	0.99
Yield sensitivity to external debt	δ	0.01
Home/Foreign country parameters:		
Degree of openness	op_H, op_F	[0.2,0.4]
Inverse of the Frisch elasticity of labour supply	η_H, η_F	[1.5,2.5]
Risk aversion coefficient	σ_H, σ_F	[1,1.2]
Price stickiness parameter in sector k	α_H^k, α_F^k	[0.25,0.9]
Wage stickiness parameter in sector k	$\alpha_{k,H}^w, \alpha_{k,F}^w$	[0.25,0.9]
Intra-temporal elasticity of substitution in sector k	θ_H^k, θ_F^k	[3,11]
Elasticity of substitution between labour inputs in sector k	$\theta_{k,H}^w, \theta_{k,F}^w$	[3,11]
Elasticity of substitution between traded H and F goods	ϕ_H, ϕ_F	[0.5,1]
Elasticity of substitution between traded and non-traded goods	φ_H^N, φ_F^N	[0.4,1]
Proportion of rule of thumb households	λ_H^R, λ_F^R	[0.1,0.4]
Home/Foreign monetary policy rule parameters:		
Interest rate persistence	α_H^R, α_F^R	[0.5,0.9]
Interest rate sensitivity to CPI inflation	$\alpha_H^\pi, \alpha_F^\pi$	[1.2,3]
Degree of exchange rate targeting	$\alpha_H^{FIX}, \alpha_F^{FIX}$	[0,0.3]

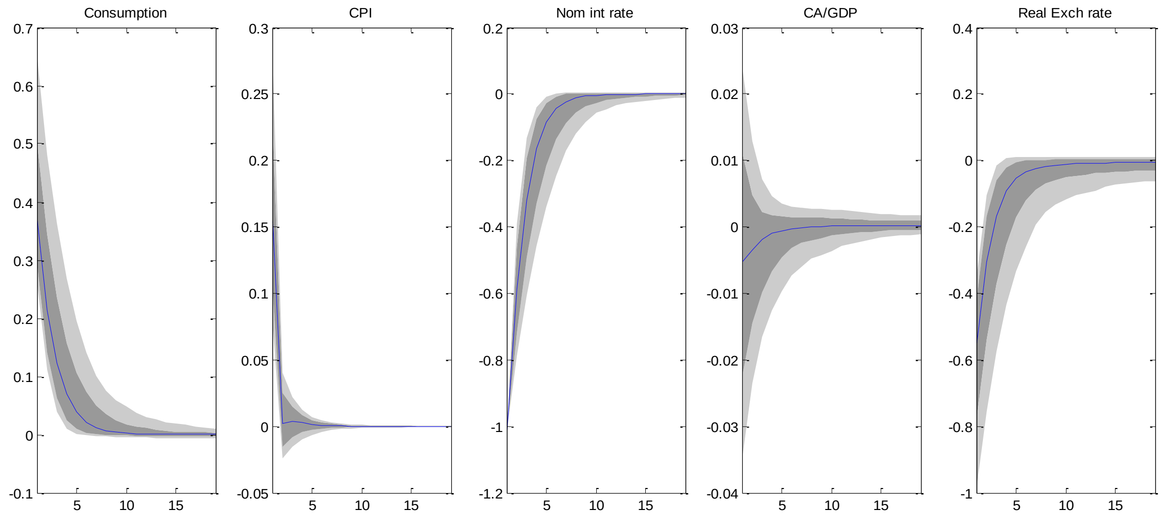
2.2. The transmission of monetary policy to the current account

A one percentage point fall in the nominal interest rate in the described DSGE model leads to an increase in consumption, CPI and a real exchange rate depreciation, in line with standard DSGE models. This is illustrated in Figure 1 below which shows the impulse response functions of selected variables to a one percentage point fall in the nominal interest rate. The impulse responses are computed by solving the model 1000

[12] For a detailed analysis of the importance of substitutability for the international transmission of shocks see Corsetti et al (2010).

times, each time drawing all the parameters randomly from a uniform distribution over the parameter ranges specified in Table 2. From the obtained impulse responses, Figure 1 reports the median impulse response from the 1000 simulations in blue as well as the central 90 and 68 percent of the distribution of impulse responses (in different shades).

Figure 1: Impact of a monetary policy expansion



Note: Figure 1 shows the effect of an unexpected monetary policy expansion corresponding to a 100 basis point fall in the nominal interest rate. The subplots show the impulse responses following the monetary expansion of real consumption, the CPI inflation rate, the nominal interest rate, the current account to GDP ratio and the real exchange rate, with all parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2. For all variables percentage deviations from steady state are depicted, except for the annual nominal interest rate and the current account to GDP ratio where the percentage points deviations are depicted. The blue line corresponds to the median impulse response from 1000 simulations each using different parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2, whereas the shaded areas depict the central 68 and 90 percent of of the impulse responses.

While the response of consumption, CPI and the real exchange rate is qualitatively similar across all the different combinations of parameter values considered, the sign of the CA/GDP response depends on the structural parameters of the economy. Indeed, while the median response is negative, the bands are wide and cover both positive and negative values. This supports the idea that the response of the current account to a monetary policy change will depend on the structure of the economy considered, and potentially on the degree of economic liberalisation.

The CA/GDP response to a monetary expansion depends on which of the channels of monetary policy transmission dominates. If the import absorption channel dominates, then a monetary expansion worsens the current account. However, if the other channels

- and in particular the expenditure switching channel - are strong, then a monetary expansion improves the current account position. Figure 1 shows that which of those channels dominate depends on the structure of the economy considered, and therefore potentially on the degree of liberalisation. We now explore whether economic liberalisation in the financial, product and labour markets affects the power of either of the transmission channels and therefore the overall impact of monetary policy on the current account.

2.3. The effect of economic liberalisation

By varying the structural parameters in our DSGE model we can study the implications of different types of economic liberalisation on the monetary policy transmission mechanism. We do so by comparing the dynamics of different variables following a monetary policy expansion across two cases: one in which the parameter of interest is fixed to a value corresponding to a relatively strong degree of regulation and one in which it is fixed to a value corresponding to a lower degree of regulation.

2.3.1 Financial liberalisation

To study the implications of financial liberalisation we vary the proportion of non-Ricardian households i.e. the proportion of households without access to both the domestic and international financial markets. This approach to modelling financial liberalisation relies on findings from previous empirical work. In particular, Bayoumi and Koujianou (1989) provide evidence that financial liberalisation decreased liquidity constraints across a range of industrialised countries[13], and Jappelli et al (1998) show, using US data, that the more likely is a household to be liquidity constrained the more sensitive is its consumption to income. This relation between liquidity constraints and excess sensitivity of consumption is confirmed by Benito and Mumtaz (2006) who use microdata on UK households for 1992-2002 and find that the probability of excess sensitivity of consumption is higher for those households without asset income and for those with fewer liquid assets relative to their income. Taken together, this literature thus suggests that financial liberalisation reduces the excess sensitivity of consumption to

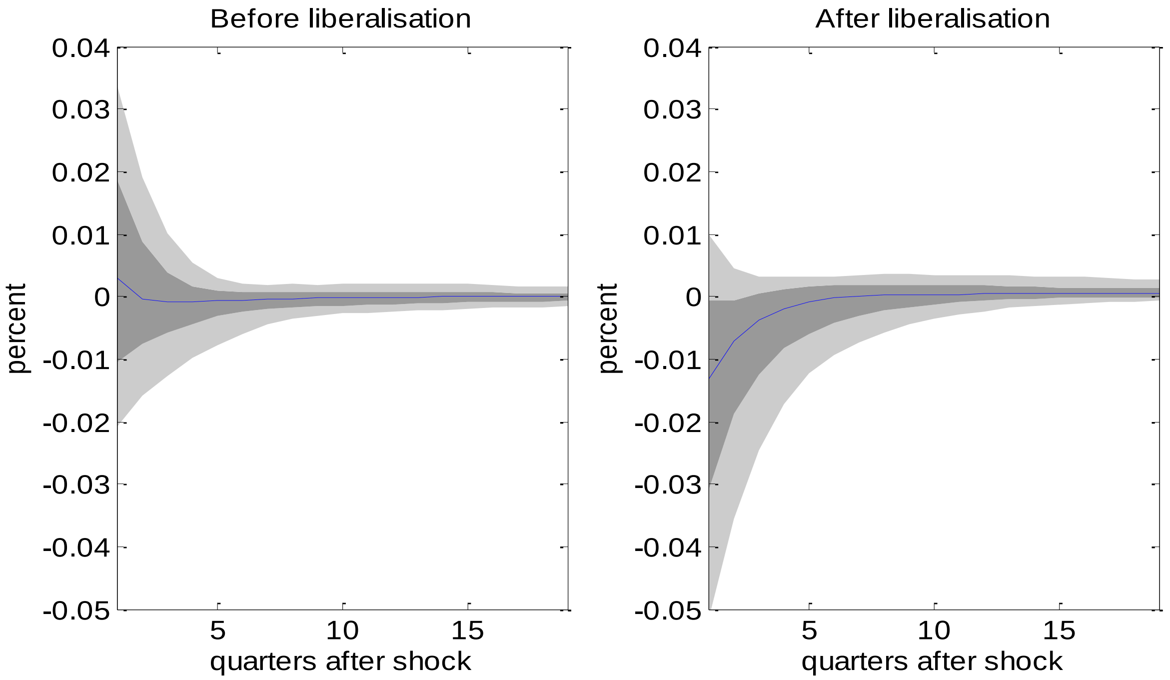
[13] Also, Bayoumi (1993a,b) and Sarno and Taylor (1998) provide evidence that financial liberalisation in the UK in the 1980s decreased liquidity constraints.

income exhibited by non-Ricardian households.[14] We therefore proxy financial liberalisation by a fall in the proportion of non-Ricardian households i.e. households who do not have access to domestic and international financial markets. In our theoretical model this proportion is denoted λ_H^R. So, to analyse the implications of financial liberalisation on the monetary policy transmission mechanism we vary λ_H^R.

The plots in Figure 2a show the current account to GDP response to a monetary policy expansion corresponding to a 1 pp fall in the nominal interest rate in two economies: a financially repressed economy, and a financially liberalised economy. In the financially repressed economy, the proportion of non-Ricardian households is 40% ($\lambda_H^R = 0.4$). This number is in line with estimates by Campbell and Mankiw (1989) using US data over the period 1953-1986, before the process of financial liberalisation was complete. The number is also consistent with findings by Benito and Mumtaz (2006) for the UK: the upper end of their estimates of the proportion of UK households who exhibited excessive sensitivity over the period 1992-2002 is 40%. The financially liberalised economy is characterised by only 10% of households behaving in a non-Ricardian way ($\lambda_H^R = 0.1$). This is a little lower than the lower range of the estimates of the proportion of UK households who exhibited excessive sensitivity over the period 1992-2002 found by Benito and Mumtaz (2006), reflecting that financial liberalisation might have proceeded further since then. A comparison of the first and second plots shows that the current account response to the monetary expansion is clearly affected by the degree of financial liberalisation proxied by a fall in the proportion of Ricardian households. While economies before financial liberalisation are more likely to experience a current account improvement following a monetary policy expansion, economies after financial liberalisation are more likely to see their current account deteriorate following a monetary policy expansion.

[14] Bandiera et al (2000) also associate financial liberalisation with a fall in the proportion of liquidity constrained households, and relate that proportion to the fraction of households deviating from optimal Ricardian consumption behaviour as determined by the consumption Euler equation. Similarly, Gali et al (2007) mention that evidence of non-Ricardian consumption behaviour might reflect the presence of liquidity-constrained households with zero net worth.

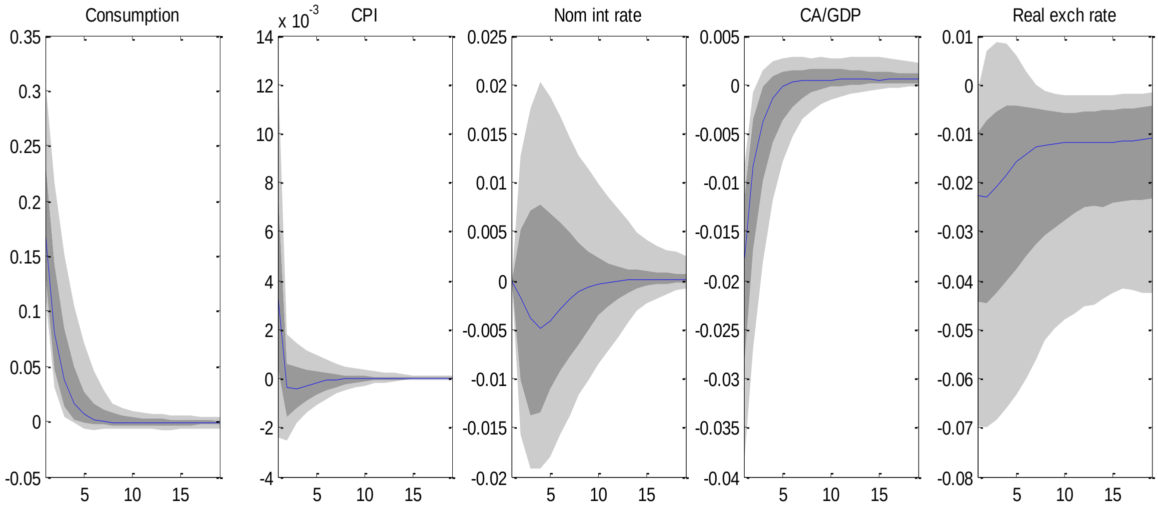
Figure 2a: CA/GDP response to a monetary expansion before and after financial market liberalisation - DSGE model



Note: The plots in Figure 2a show the distribution of the CA/GDP responses to an unexpected monetary policy expansion corresponding to a 100 basis point fall in the nominal interest rate in a financially repressed economy (before financial liberalisation) and in a financially liberalised economy (after financial liberalisation) respectively. The blue line corresponds to the median impulse response from 1000 simulations each using different parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2 (except for the parameter proxying for the degree of liberalisation), whereas the shaded areas depict the central 68 and 90 percent of the impulse responses.

Figure 2b shows the *difference* between the responses of selected variables to a monetary expansion corresponding to a 1 pp fall in the nominal interest rate in an economy where the degree of financial regulation is reduced from high to low, keeping all other structural parameters constant. The fourth plot shows that financial liberalisation unambiguously makes the current account response to a monetary policy expansion more negative/less positive in the first quarters following the shock. After financial liberalisation, a higher proportion of households can bring forward consumption in the face of a fall in interest rates, meaning that the rise in aggregate domestic consumption following a monetary policy expansion is greater. This is shown in the first plot. By strengthening the response of consumption to a given monetary policy expansion, financial liberalisation also leads to a larger increase in imports. Therefore, financial liberalisation amplifies the import absorption channel and thus puts downward pressure on the current account. This effect of financial liberalisation on the current account response is consistent across all of the parameter value combinations considered, as illustrated by the shaded areas.

Figure 2b: The effect of financial liberalisation on the monetary policy transmission - DSGE model



Note: Figure 2b shows the effect of financial market liberaliation on the transmission of an unexpected monetary policy expansion corresponding to a 100 basis point fall in the nominal interest rate. The subplots show the difference in the impulse responses following the monetary expansion of real consumption, the CPI inflation rate, the nominal interest rate, the current account to GDP ratio and the real exchange rate, between the case where the proportion of Home rule of thumb households is 10%, with all the other parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2, and the case where the proportion of Home rule of thumb households is 40%. The blue line corresponds to the median impulse response from 1000 simulations each using different parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2, whereas the shaded areas depict the central 68 and 90 percent of the impulse responses. All differences between impulse responses depicted are in percentage points.

2.3.2. Product market liberalisation

Product market liberalisation is associated with reforms reducing barriers to entry, leading to privatisation of government monopolies, and other reforms aimed at increasing competition and opening up traditionally non-traded sectors (e.g. electricity or telecommunications) to both domestic and international competition. Product market liberalisation is thus linked to increased competition between firms producing non-traded goods and firms producing traded goods, whether these firms are domestic or foreign. Such increased competition implies that it is easier for agents to substitute demand between non-traded goods produced by domestically-focused firms and traded goods produced by internationally-focused firms (whether domestic or foreign), and therefore we proxy the degree of competition in the non-traded sector by the elasticity of substitution between traded and non-traded goods, denoted φ_H^N.[15] This is our measure of product market regulation.[16]

To illustrate how the impact of a monetary policy expansion varies with the degree of regulation in product markets, as proxied by the elasticity of substitution between traded and non-traded goods, we consider two cases, before and after product market liberalisation. In the first case, before product market liberalisation, the elasticity of substitution between traded and non-traded goods is set equal to 0.4. This estimate is close to the value estimated by Stockman and Tesar (1995) who calculate it using a sample of 30 countries including both developed and developing economies over the period 1970-1985, a period and country-sample probably consistent with a relatively high degree of product market regulation. Using the same methodology but focusing on developed countries, Mendoza (1992) estimates a higher elasticity of 0.74, consistently with our prior that countries with lightly-regulated product markets have a higher elasticity. Given that further product market reforms have been implemented since the time period considered in those two studies, our choice of elasticity value to proxy for after product market liberalisation is a little higher and equal to 1.

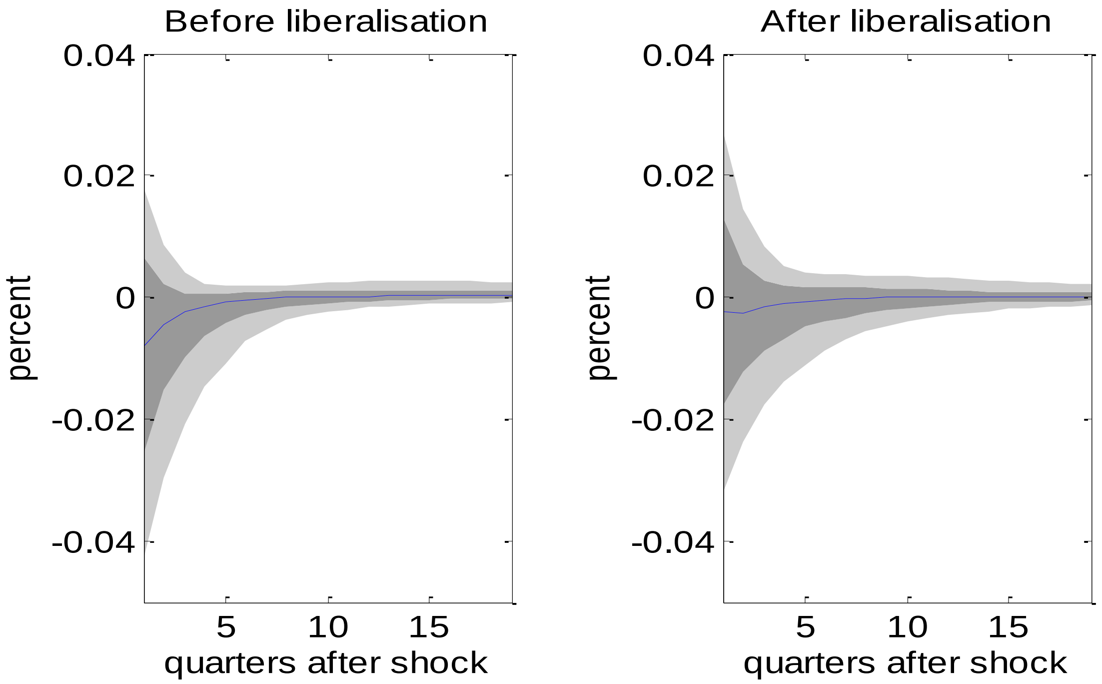
Figure 3a shows that product market liberalisation affects the transmission of monetary policy to the current account. The first plot in that figure shows the current account to GDP response to a monetary policy expansion in the case where the elasticity of substitution between traded and non-traded sectors is 0.4, which corresponds to an economy before product market liberalisation; the second plot shows the response in the case where the elasticity of substitution between traded and non-traded goods is 1, corresponding to a situation after product market liberalisation. The plots show that the more liberalised are product markets, the less likely is the current account to exhibit a deficit following a monetary policy expansion.

---

[15] One sector where such product market liberalisation has increased the substitutability between services provided by domestically-focused firms and internationally-focused firms is air travel. Before that sector liberalised, customers who were looking to fly from London to Edinburgh had no choice but to fly with British Airways, a domestically-focused firm. Was BA to increase prices, then there was no alternative for customers. With the sector having liberalised, customers can now easily switch to other internationally-focused firms if they offer a more attractive price – whether domestic (such as EasyJet) or foreign (such as RyanAir or FlyBe).

[16] An increase in the trade elasticity could capture the consequences of international product market liberalisation, but would not capture the consequences of domestic product market liberalisation simultaneously, and therefore our preferred measure of liberalisation – capturing features of both domestic and international product market liberalisation – is the elasticity of substitution between traded and non-traded goods.

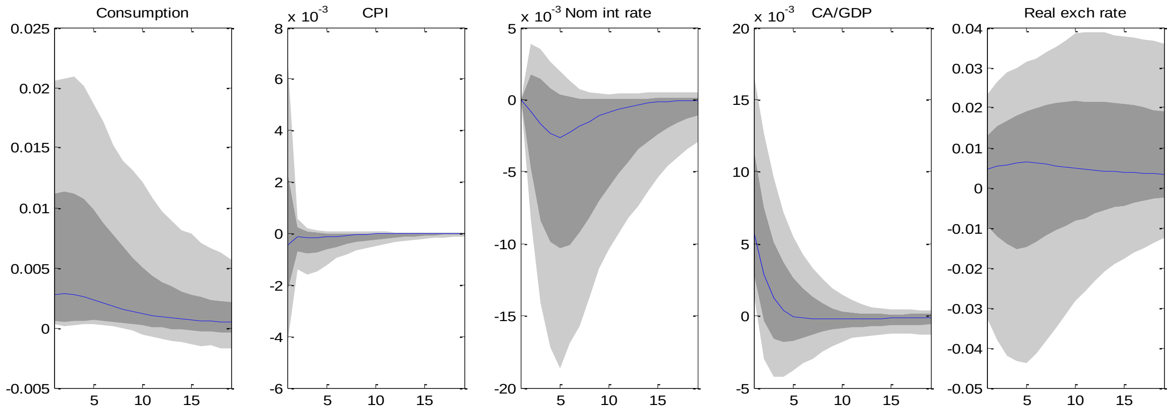
Figure 3a: CA/GDP response to a monetary expansion before and after product market liberalisation - DSGE model



Note: The plots in Figure 3a show the distribution of the CA/GDP responses of an unexpected monetary policy expansion corresponding to a 100 basis point fall in the nominal interest rate in economies before product market liberalisation and in economies after product market liberalisation. The blue line corresponds to the median impulse response from 1000 simulations each using different parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2 (except for the parameter proxying for the degree of liberalisation), whereas the shaded areas depict the central 68 and 90 percent of the impulse responses.

The more liberalised are product markets, the more does demand switch towards the more competitive goods. A given depreciation resulting from a monetary policy expansion will therefore lead to a larger increase in net exports the more liberalised are product markets. That is, the expenditure-switching channel is amplified by product market liberalisation, and the current account response to a monetary expansion therefore increases with product market liberalisation in the first quarters following the expansion, as illustrated in the fourth plot in Figure 3b. That plot shows that, for the considered range of parameters, product market liberalisation unambiguously pushes up the current account response to a given monetary policy expansion in the first quarters following the shock.

Figure 3b: The effect of product market liberalisation on the monetary policy transmission mechanism – DSGE model



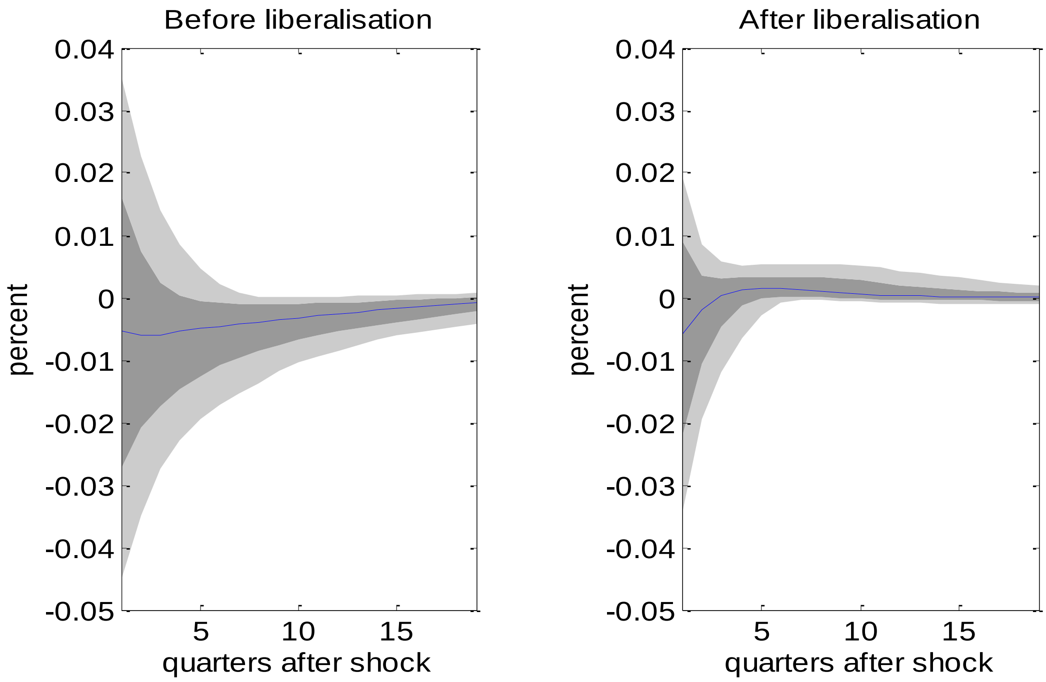
Note: Figure 3b shows the effect of product market liberaliation on the transmission of an unexpected monetary policy expansion corresponding to a 100 basis point fall in the nominal interest rate. The subplots show the difference in the impulse responses following the monetary expansion of real consumption, the CPI inflation rate, the nominal interest rate, the current account to GDP ratio and the real exchange rate, between the case where the elasticity of substitution between traded and non-traded goods is 1, with all the other parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2, and the case where the elasticity of substitution between traded and non-traded goods is 0.4. For all variables percentage deviations from steady state are depicted, except for the nominal interest rate where the annual interest rate in percent is depicted. The blue line corresponds to the median impulse response from 1000 simulations each using different parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2, whereas the shaded areas depict the central 68 and 90 percent of of the impulse responses.

2.3.3. Labour market liberalisation

Labour market liberalisation measures are intended to increase labour mobility and lead to a less rigid wage structure, e.g. through the implementation of reforms reducing hiring and firing costs and decentralising wage bargaining. Like a less rigid wage structure, greater labour mobility should increase the sensitivity of wages to economic conditions given that the wage of a worker within a given job is not very sensitive to economic conditions, but the wage of a worker starting a new job is much more so, as shown in Pissarides (2009) and Haefke et al (2013). Labour market liberalisation should therefore increase the flexibility of wages and their sensitivity to economic conditions. In our model, the flexibility and sensitivity of wages to economic conditions is increasing in the fraction of wages being reset each period. Therefore, to study the effect of labour market liberalisation on the monetary policy transmission to the current account, we proxy labour market regulation by the degree of wage rigidity, $\alpha^{w}_{k,H}$.[17]

Figure 4a and 4b show what difference labour market liberalisation makes to the transmission of monetary policy. In the first plot in Figure 4a, wages are relatively sticky: on average workers get the opportunity to bargain over their wage only every 10 quarters ($\alpha^{w}_{k,H} = 0.9$). In the second plot, wages are much more flexible in that workers have 75 percent chance of getting to reset their wage every quarter ($\alpha^{w}_{k,H} = 0.25$). By looking at Figure 4a, it is not clear what direction this marked process of labour market liberalisation pushes the current account response to a monetary policy expansion.

Figure 4a: CA/GDP response to a monetary expansion before and after labour market liberalisation - DSGE model

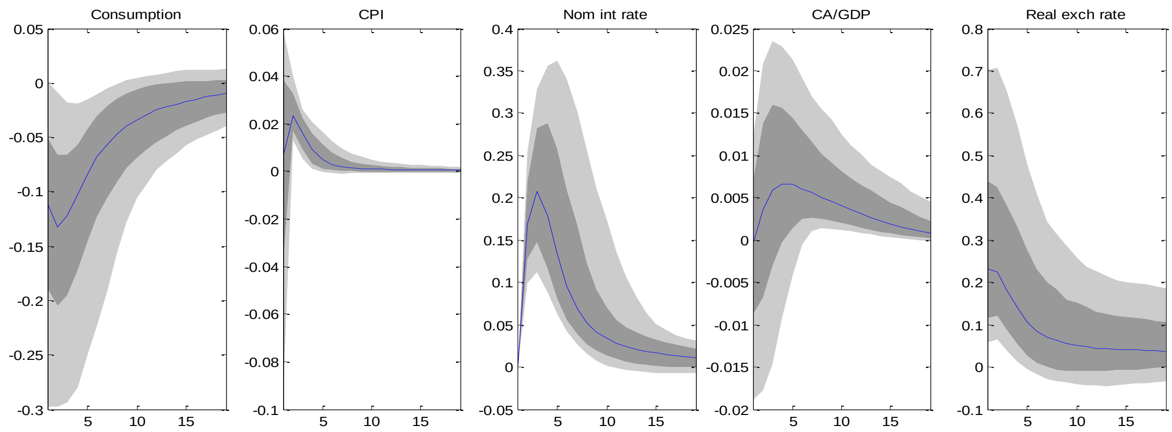


Note: The plots in Figure 4a show the distribution of the CA/GDP responses of an unexpected monetary policy expansion corresponding to a 100 basis point fall in the nominal interest rate in economies before labour market liberalisation and in economies after labour market liberalisation respectively. The blue line corresponds to the median impulse response from 1000 simulations each using different parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2 (except for the parameter proxying for the degree of liberalisation), whereas the shaded areas the central 68 and 90 percent of the impulse responses.

[17] Wage flexibility is a good indicator of the degree of rigidities in the labour markets as it can be thought of as an indicator of the degree of labour mobility, how often wages are negotiated, how often workers change job (hiring and firing ease), how easy it is for employers to reduce their wage bill in the face of a negative shock, etc.

Figure 4b shows that labour market liberalisation, as summarised by wage flexibility, matters for the transmission of monetary policy shocks (consumption always increases less in response to a monetary policy expansion the more liberalised are labour markets). But how it affects the current account response depends on other structural features of the economy.[18] We therefore conclude that the impact of labour market liberalisation on the current account response to a monetary policy expansion is ambiguous.

Figure 4b: The effect of labour market liberalisation on the monetary policy transmission mechanism – DSGE model



Note: Figure 4b shows the effect of labour market liberaliation on the transmission of an unexpected monetary policy expansion corresponding to a 100 basis point fall in the nominal interest rate. The subplots show the difference in the impulse responses following the monetary expansion of real consumption, the CPI, the nominal interest rate, the current account to GDP ratio and the real exchange rate, between the case where the wage stickiness parameter is 0.25, with all the other parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2, and the case where the wage stickiness parameter is 0.9. For all variables percentage deviations from steady state are depicted, except for the nominal interest rate where the annual interest rate in percent is depicted. The blue line corresponds to the median impulse response from 1000 simulations each using different parameter values randomly selected from a uniform distribution over the parameter ranges specified in Table 2, whereas the shaded areas depict the central 68 and 90 percent of of the impulse responses.

3. Empirical Results

3.1. Methodology and Data

In this section we describe the data we use, the varying coefficient Bayesian panel VAR model and our identification approach.

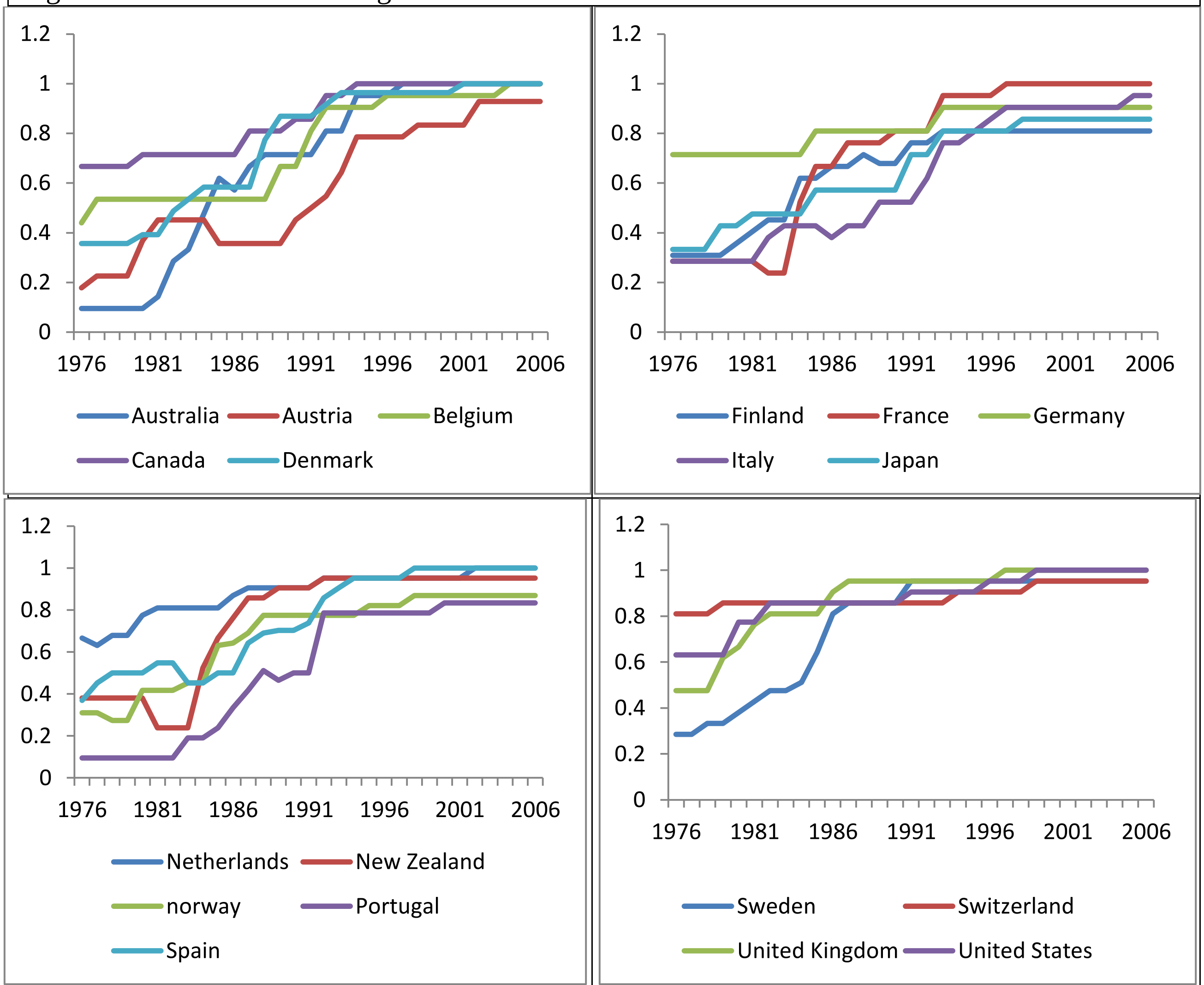
[18] In fact, while the income-absorption channel of transmission implies that labour market liberalisation puts upward pressure on the current account following a loosening of monetary policy, labour market liberalisation puts downward pressure on the current account following an expansionary monetary policy shock through the expenditure-switching and portfolio diversification channels. Which of the channels dominate depends on other structural characteristics.

3.1.1. Data

We use data for 19 OECD countries over the period 1976-2006 to explore whether the VAR coefficients in our empirical model vary with indices relating to the degree of financial, labour and product market deregulation.

Figure 5 shows the financial regulation index. It is taken from Abiad et al (2010) and has seven different components: credit controls, interest rate controls, entry barriers, state ownership in the banking sector, prudential regulation, securities market policy and capital account restrictions. Each component can take the values {0,1,2,3} with higher values meaning fewer restrictions. We sum all components to come up with the aggregate financial regulation index we use in our empirical exercise. This index is normalised to range between 0 and 1. Figure 5 shows the values of that index for the 19 OECD countries. They vary both across countries and over time.

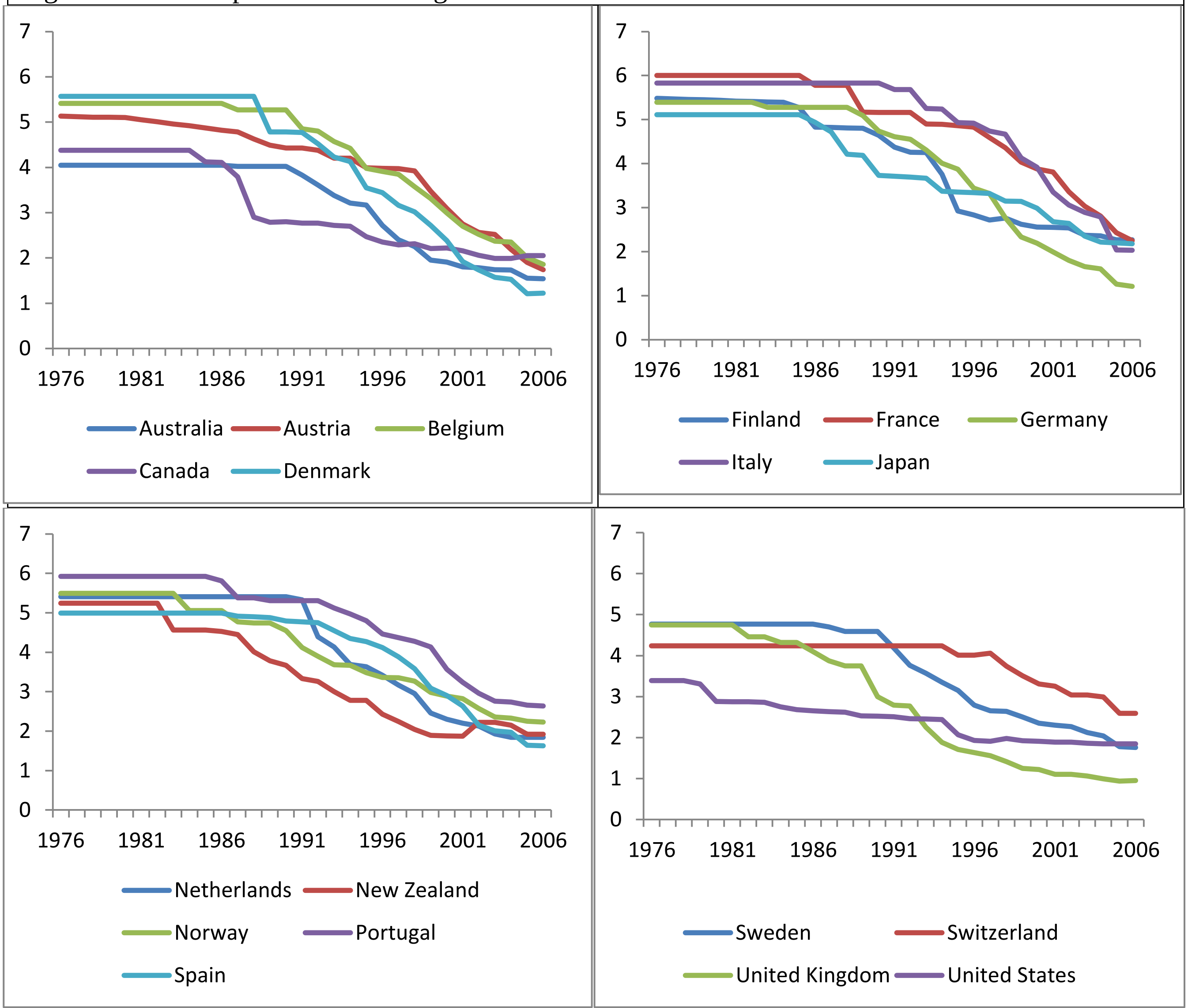
Figure 5: Index of financial regulation in 19 OECD countries



Sources & Notes: Abiad et al (2010). Low value indicates tight regulation.

As a proxy for product market regulation we use the ETCR index constructed by Conway and Nicoletti (2006), which is shown in figure 6. It captures the level of regulation in seven non-manufacturing sectors: airlines, telecommunication, electricity, gas, post, rail and road freight. These sectors represent a substantial proportion of economic activity and constitute the area in which domestic economic regulation is most concentrated and has the greatest impact due to limited import competition. The index takes into account characteristics such as the presence of barriers to entry, public ownership, vertical integration, monopolies and the presence of legally imposed price controls, which can distort competition.

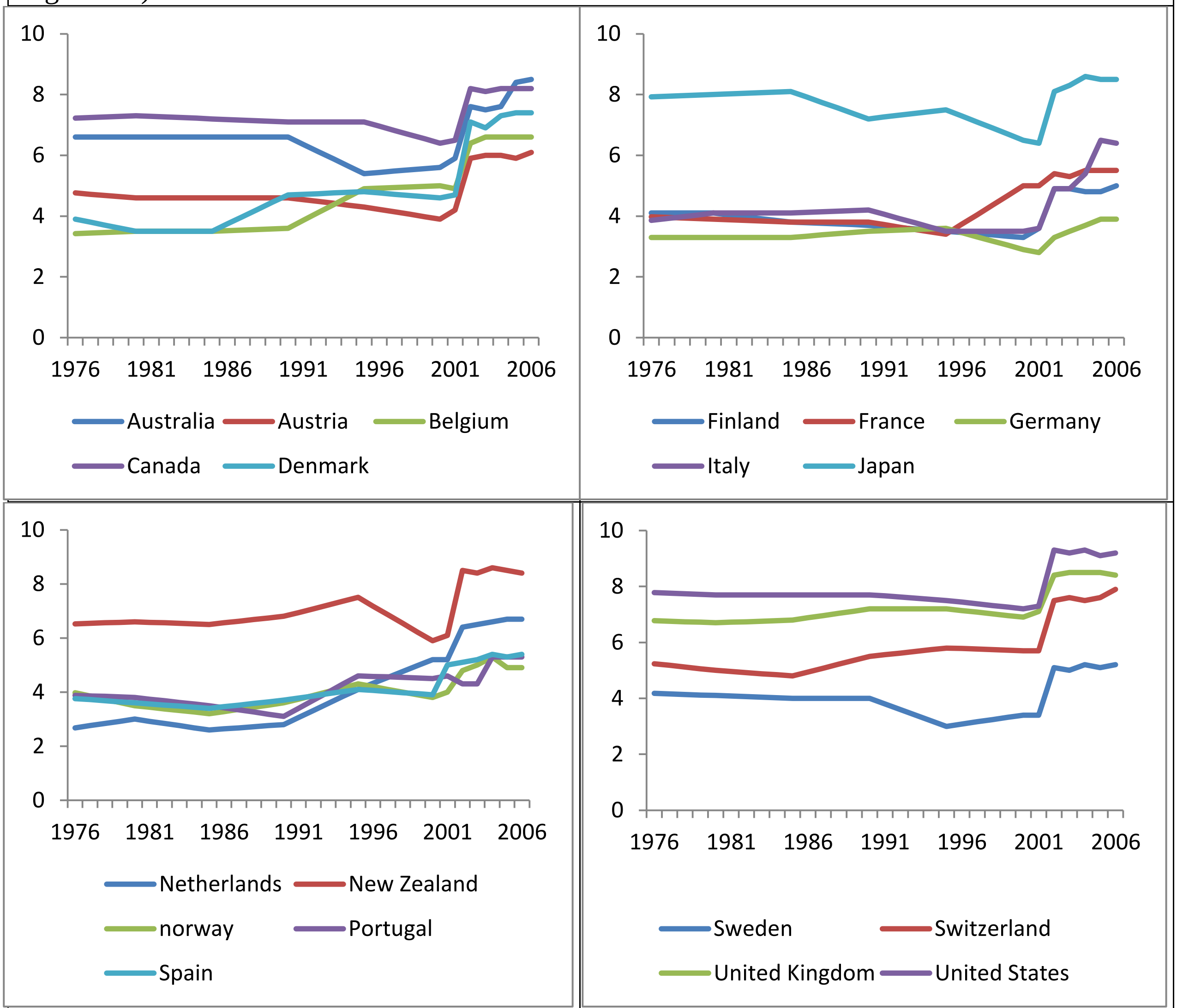
Figure 6: Index of product market regulation in 19 OECD countries



Sources & Notes: Conway and Nicoletti (2006). Lower values indicate less regulation.

Figure 7 shows the index of labour market regulation that we use. This is provided by the Fraser Institute and broadly reflects minimum wage regulation, hiring and firing practices, the share of the labour force whose wages are set by centralized collective bargaining, unemployment benefits and use of conscription to obtain military personnel.[19]

Figure 7: Index of labour market regulation in 19 OECD countries (low value indicates tight regulation)



Sources & Notes: Fraser Institute. Higher values mean less regulation. Up until 2000, these are only available every 5 years, and the chart shows linearly interpolated values.

[19] For more details, see Fraser Institute (2013). For Australia, the data for the labour market only begin in 1990. We interpolated the data back in time to 1975 for this country. Intuitively, this should not make a big difference since the data for most other countries only change very slowly during this time period. For robustness, we checked that this does not make a significant difference to our results.

Finally, our VAR model consists of six endogenous variables: : quarterly growth in real imported commodity prices, quarterly real consumption growth, CPI inflation, the short-term interest rate, the current account to GDP ratio and the change in the real effective exchange rate. All variables are in logs, except for the interest rate and the current account to GDP ratio. CPI and real exchange rate data are from the OECD Main Economic Indicators and the BIS effective exchange rate database, respectively. The remaining variables are from the OECD Economic Outlook database. It is to account for fluctuations in, and monetary policy responses to, commodity prices, that we include quarterly growth in real imported commodity prices.[20]

In our analysis of the impact of liberalisation on the transmission of monetary policy, we also control for exchange rate regime. To do so, we use the index of exchange rate flexibility developed by Ilzetzki, Reinhart and Rogoff (2010). The index is shown in Figure 12 in Appendix A.

3.1.2 The VAR approach

We are interested in examining how changes in the structure of the macro-economy affect the monetary policy transmission mechanism in OECD countries. Previous work addressing this question relied on either time-series information within individual countries or cross-sectional differences across countries. Indeed, a number of authors have used VAR frameworks to look at the implications of economic liberalisation by exploiting only time-series variation.[21] An alternative approach has been to look at cross-sectional variation. If there are countries with similar characteristics, pooling by characteristic may offer a means of determining the structure within those countries better.[22] Finally, if the regulatory changes in question can be quantified in the form of a country-specific and time-varying index, it may appear desirable to estimate a model in

[20] Sims and Zha (2006) argue that commodity prices in a VAR may serve as an important information variable which is a proxy for the information set of the central bank at the time of the policy decision. In other words, to the extent that the central bank reaction function implicit in the VAR might be misspecified due to omission of other variables, the inclusion of commodity prices might, at least to some extent, address this problem. For robustness, we checked that our results are unchanged if this variable is excluded.

[21] Using such an approach, Mertens (2008) finds that the US regulation Q amplified the impact of US monetary policy. Similarly, Olivei and Tenreyro (2007, 2010) examine the impact of wage rigidity in single country VARs for the US, Japan, UK, France and Germany, by exploiting the differences in the timing of annual wage negotiations and find that monetary policy is more powerful in the presence of wage rigidities. Finally, Iacoviello and Minetti (2003) estimate single-country VARs for several countries before and after financial liberalization and find that housing prices respond to a greater extent thereafter.

[22] Assenmacher-Wesche and Gerlach (2010) estimate panel VARs for two groups of countries and find that monetary policy has a greater impact on property prices in countries with 'more' flexible financial markets. Using a similar approach, Calza et al (2013) find that property prices in countries with more developed mortgage markets show a greater reaction to an equivalently sized monetary policy shock.

which account is taken of both types of variation. This does not require the sample to be split into separate groups; it needs to be done from a single pooled dataset. Some recent work has used this 'interacted panel VAR' approach (IPVAR) to explore the role of changes in economic institutions (Abritti and Weber (2010), Towbin and Weber (2013)) in the transmission of commodity price shocks. But this approach assumes that the VAR coefficients are a deterministic function of the structural characteristics in question. Unlike with stochastically varying coefficients, this assumption may result in smaller confidence bands and hence misleading inference, as demonstrated in the commodity price shock application in Wieladek (2016).

One way to allow for VAR coefficients to vary stochastically is the mean group estimator, first proposed by Pesaran and Smith (1995). Sa, Towbin and Wieladek (2014) follow this approach, but since it requires estimation country-by-country, degrees of freedom considerations typically constrain the number of structural characteristics that can be analysed to a maximum of two. Wieladek (2016) proposes Bayesian shrinkage as a means of estimating panel VAR models where the coefficients are stochastic functions of several exogenous variables. Since this approach allows for both stochastic variation and multiple structural characteristics, this is the econometric approach that we choose to follow. It delivers a random effects estimator; the structure resulting from Bayesian shrinkage permits random variation both across countries and over time.

The advantage of this econometric approach is that we can formally test the implications of our theoretical model by comparing the distributions of impulse responses in the absence and presence of one particular structural characteristic. That makes it easy to understand whether and how, for instance, financial liberalisation has affected monetary policy transmission to the current account over time. Monetary policy shocks are identified with sign restrictions (See Canova and De Nicolo (2002); Uhlig (2005); Faust and Rogers (2003)), derived from our DSGE model. To ensure robustness to the type of identification, we also examine monetary policy shocks identified with lower-triangular zero restrictions, with consumption and CPI ordered before the short-term interest rate (as in Christiano, Eichenbaum and Evans, 1999).

Clearly, the VAR approach is not the only way to examine non-linearity in the transmission of economic shocks. Indeed, several papers use the local projections methods first introduced in Jorda (2005) for this purpose. Recent applications of this method range from monetary policy (Tenreyro and Thwaites, 2016), fiscal policy (Born, Pfeiffer and Mueller, 2015) to credit booms and busts (Jorda, Schularick and Taylor, 2014). But to apply this approach, it is necessary to observe the shock of interest. This is e.g. possible for US monetary policy, where Romer and Romer (2004) provide a suitable narrative series of monetary policy shocks, which is the main variable of interest in the Tenreyro and Thwaites (2016) paper. But monetary policy shocks cannot be observed directly in most countries. Indeed, the most important reasons why we use the VAR framework, as opposed to the local projections approach, is that the former helps us to identify monetary policy shocks directly.

3.1.3. The Varying Coefficient Bayesian panel VAR model

We follow the approach outlined in Wieladek (2016) and model the individual VAR coefficients as a function of financial, labour and product market regulation in a given country within a panel data structure. We also control for the exchange rate regime; see Appendix A for more details. In particular, we estimate the following panel VAR model:[23]

$$\boldsymbol{Y_{c,t} = k_{c,\tau} + X_{c,t}B_{c,\tau} + e_{c,t}} \qquad \boldsymbol{e_{c,t} \sim N(0, A_{c,\tau}^{'}\Sigma_c A_{c,\tau})} \qquad (1)$$

$$\boldsymbol{k_{c,\tau} = k_0 + D_{c,\tau}\delta_k + u_{kc,\tau}} \qquad \boldsymbol{u_{kc,\tau} \sim N(0, \Lambda_{kc})} \qquad (2)$$

$$\boldsymbol{B_{c,\tau} = B_0 + D_{c,\tau}\delta_B + u_{Bc,\tau}} \qquad \boldsymbol{u_{Bc,\tau} \sim N(0, \Lambda_{Bc})} \qquad (3)$$

$$\boldsymbol{A_{c,\tau} = A_0 + D_{c,\tau}\delta_A + u_{Ac,\tau}} \qquad \boldsymbol{u_{Ac,\tau} \sim N(0, \Lambda_{Ac})} \qquad (4)$$

where $\boldsymbol{Y_{c,t}}$ is a matrix with $\boldsymbol{N}$ endogenous variables in the columns at time $\boldsymbol{t}$, in country $\boldsymbol{c}$, with the total number of countries $\boldsymbol{C}$. $\boldsymbol{Y_{c,t}}$ consists of the quarterly growth in real imported commodity prices, the quarterly growth rate of real consumption, quarterly CPI inflation, the short-term interest rate, the current account to GDP ratio and the log change in the real exchange rate. $\boldsymbol{X_{c,t}}$ contains the lags of the variables in $\boldsymbol{Y_{c,t}}$ for country $\boldsymbol{c}$ at time $\boldsymbol{t}$. $\boldsymbol{B_{c,\tau}}$ is the array of associated coefficients for country $\boldsymbol{c}$ at time $\boldsymbol{\tau}$. $\boldsymbol{k_{c,\tau}}$

[23] The description of most of the components of our proposed model closely follows the presentation of Jarocinski (2010) and Wieladek (2016). See their work for more details.

is a constant term. We assume that the corresponding vector of VAR residuals $\boldsymbol{e}_{c,t}$ is distributed with a zero mean and a co-variance matrix that is the product of the lower triangular matrix $\boldsymbol{A}_{c,\tau}$ and a diagonal matrix of structural shocks $\boldsymbol{\Sigma}_{c}$, which is assumed to be normally distributed. $\boldsymbol{B}_{c,\tau}$ and $\boldsymbol{A}_{c,\tau}$ are modelled as linear functions of pre-determined variables $\boldsymbol{D}_{c,\tau}$ with the associated coefficients $\boldsymbol{\delta}_{B}$ and $\boldsymbol{\delta}_{A}$, respectively. Note that the coefficients vary with $\boldsymbol{\tau}$, as oppose to, $\boldsymbol{t}$. This mixed frequency structure is an advantage of our framework, since indices of economic regulation in $\boldsymbol{D}_{c,\tau}$ are available only at an annual, as opposed to quarterly frequency. And the labour market index is available only every 5 years up until 2000. We therefore set $\boldsymbol{D}_{c,\tau} = \frac{\sum_{l=1}^{Z} \boldsymbol{D}_{c,t-l}}{\Xi}$, where $\boldsymbol{\Xi} = \mathbf{20}$, meaning all of the other indices are 5-year averages of the corresponding annual figures. In other words, since the sample period starts in 1976, then $\boldsymbol{D}_{c,\mathbf{1}}$ is the average for 1976-1980, $\boldsymbol{D}_{c,\mathbf{2}}$ the average for 1981-1985 and so forth. $\boldsymbol{B}_{c,\mathbf{1}}, \boldsymbol{B}_{c,\mathbf{2}}$ and $\boldsymbol{A}_{c,\mathbf{1}}, \boldsymbol{A}_{c,\mathbf{2}}$ would then be the corresponding arrays of coefficients for that period. A second advantage of this approach is that 5-year averages of these indicators are less likely to be endogenous with respect to the business cycle and monetary policy specifically, and hence more likely to satisfy the model assumption that these variables are predetermined. In sum, $\boldsymbol{D}_{c,\tau}$ contains the exchange rate, financial, labour and product market regulation indices. In the description of the Gibbs sampler in Appendix A, we include the vector of constant terms, $\boldsymbol{k}_{c,\tau}$, in $\boldsymbol{B}_{c,\tau}$ and redefine $\boldsymbol{\delta}_{B}$ and $\boldsymbol{\delta}_{A}$ to include $\boldsymbol{B}_{\mathbf{0}}$ and $\boldsymbol{A}_{\mathbf{0}}$, respectively. In this case, equations **(1) – (4)** simplify to $\boldsymbol{Y}_{c,t} = \boldsymbol{X}_{c,t}\boldsymbol{B}_{c,\tau} + \boldsymbol{e}_{c,t}$, $\boldsymbol{B}_{c,\tau} = \boldsymbol{D}_{c,\tau}\boldsymbol{\delta}_{B} + \boldsymbol{u}_{Bc,\tau}$ and $\boldsymbol{A}_{c,\tau} = \boldsymbol{D}_{c,\tau}\boldsymbol{\delta}_{A} + \boldsymbol{u}_{Ac,\tau}$, respectively.

3.1.4. Identification

We adopt the sign restrictions identification approach, pioneered by Canova and De Nicolo (2002) and Uhlig (2005), to search over all possible decompositions of $\boldsymbol{A}_{c,\tau}$, which produce orthogonal error terms, and retain those which generate impulse responses that are consistent with the expected signs for that particular shock. Fry and Pagan (2011) argue that the median impulse response recovered with sign restrictions may be different from the true data generating process, though Canova and Paustian (2011) show that this is not the case so long all reasonable restrictions are imposed. This is exactly why we identify all plausible shocks, though we are only interested in impulse responses to monetary policy shocks.

The sign restrictions we impose for identification are shown in Table 3. These are based on the theoretical predictions from our DSGE model and are thus consistent with the impulse responses shown in Figure 1. We assume that an expansionary monetary policy shock leads to fall in the short-term rate and an increase in the level of consumption and prices. A positive aggregate demand shock leads to a rise in prices, consumption and the short-term rate, as the central bank reacts to this to contain inflation expectations. Finally, a positive aggregate supply shock is assumed to lead to a fall in prices and a rise in consumption. As most of the countries in our study can be considered small open economies, we also add a restriction on the real exchange rate, namely that it depreciates (appreciates) in response to an expansionary monetary policy (aggregate demand) shock. These are imposed contemporaneously and for one period thereafter.

Table 3. Sign restrictions

	y Consum- ption	p Consumer prices	i_t interest rates	ca_t Current Account	q Real exchange rate
Supply Shock	+	−			
Demand Shock	+	+	+		+
Monetary Policy Shock	+	+	−		−

Clearly, the sign restrictions approach is not the only way to identify monetary policy shocks. To ensure that our results are robust to identification, we therefore also identify the monetary policy shock via a lower triangular decomposition of $\boldsymbol{A_{c,\tau}}$, with the growth rate of real imported commodity prices ordered first and the remainder of the ordering of presented in the first row of Table 3. Given that the interest rate is ordered after consumption and prices, our identification scheme encompasses the standard assumption that real activity only reacts to monetary policy with a lag. The second implicit assumption in this identification scheme is that the monetary policy authority reacts only with a lag to the real exchange rate and the current account balance.

3.1.5 Assessing the Impact of Changes in Economic Structure

From equations (2) and (3), it is easy to see that cross-sectional and time-variation in the main coefficients of our model, $\boldsymbol{B_{c,\tau}}$ and $\boldsymbol{A_{c,\tau}}$, is a function of

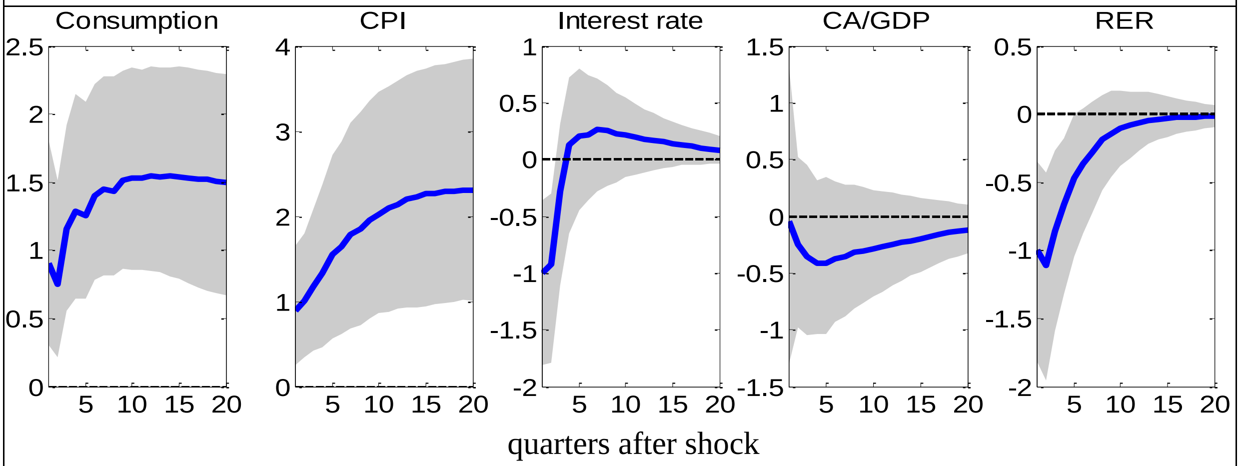
$$\boldsymbol{D_{c,t}} = \left[\boldsymbol{1}\ \boldsymbol{EFX_{c,t}}\quad \boldsymbol{FIN_{c,t}}\ \ \boldsymbol{LABOUR_{c,t}}\ \ \boldsymbol{PROD_{c,t}}\right],$$

where $\boldsymbol{EFX_{c,t}}$, $\boldsymbol{FIN_{c,t}}$, $\boldsymbol{LABOUR_{c,t}}$ and $\boldsymbol{PROD_{c,t}}$ are indices of exchange rate regime flexibility, financial, labour market and product market regulation, respectively. Prior to structural analysis, the individual elements of $\boldsymbol{D_{c,\tau}}$ need to be fixed at certain values. For example, to obtain median VAR coefficients across time and country, it is necessary to evaluate all of the elements of $\boldsymbol{D_{c,\tau}}$ at their median values. From (3) and (4), this would yield draws of $\boldsymbol{B_{c,\tau}^{MED}}$ and $\boldsymbol{A_{c,\tau}^{MED}}$, which can then be used for identification. Similarly, it is possible to examine how these coefficients, and the implied impulse responses, are affected by financial, product and labour market regulation in the following manner. First, evaluate the structural characteristic of interest, for instance financial regulation, at a high value (defined as the 90th percentile of values realised in the sample) with all the other characteristics evaluated at their medians to obtain draws of $\boldsymbol{B_{c,\tau}^{FINHIGH}}$ and $\boldsymbol{A_{c,\tau}^{FINHIGH}}$ and the associated distribution of impulse responses. Repeat the previous step, but this time with a low value of financial regulation(defined as the 10th percentile) to obtain draws of $\boldsymbol{B_{c,\tau}^{FINLOW}}$ and $\boldsymbol{A_{c,\tau}^{FINLOW}}$. A comparison of these two distributions, subject to the same size shock, allows us to infer the effect of financial liberalisation on the monetary policy transmission mechanism. This exercise can be repeated for each structural characteristic in turn to learn about their individual amplification/ propagation properties.

3.2. The transmission of monetary policy to the current account – evidence

In line with the DSGE model, the VAR shows that a one percentage point fall in the nominal interest rate leads to an increase in consumption and in CPI as well as to a fall in the real exchange rate. This is illustrated in Figure 8 below which shows the impulse response functions of selected variables to a one percentage point fall in the nominal interest rate. Also, we again find that the response of consumption, CPI and the real exchange rate is significant while the response of the CA/GDP is negative but insignificant and the bands are wide and cover both positive and negative values. Our VAR model thus supports the theoretical model which showed that the response of the current account to a monetary policy change will depend on the structure of the economy considered, and possibly on the degree of economic regulation.

Figure 8. Impact of a monetary policy expansion - VAR model



Note: Figure 8 shows the transmission of an unexpected monetary expansion, identified with sign restrictions. It shows impulse responses, in percent, to a 100 basis point monetary expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. It shows the responses when all of the exchange rate, financial, labour and product market indices have been evaluated at the sample medians. The median is the blue line and 68% quantiles, which are calculated from 500 draws that satisfy the sign restrictions, are reported in the grey area.

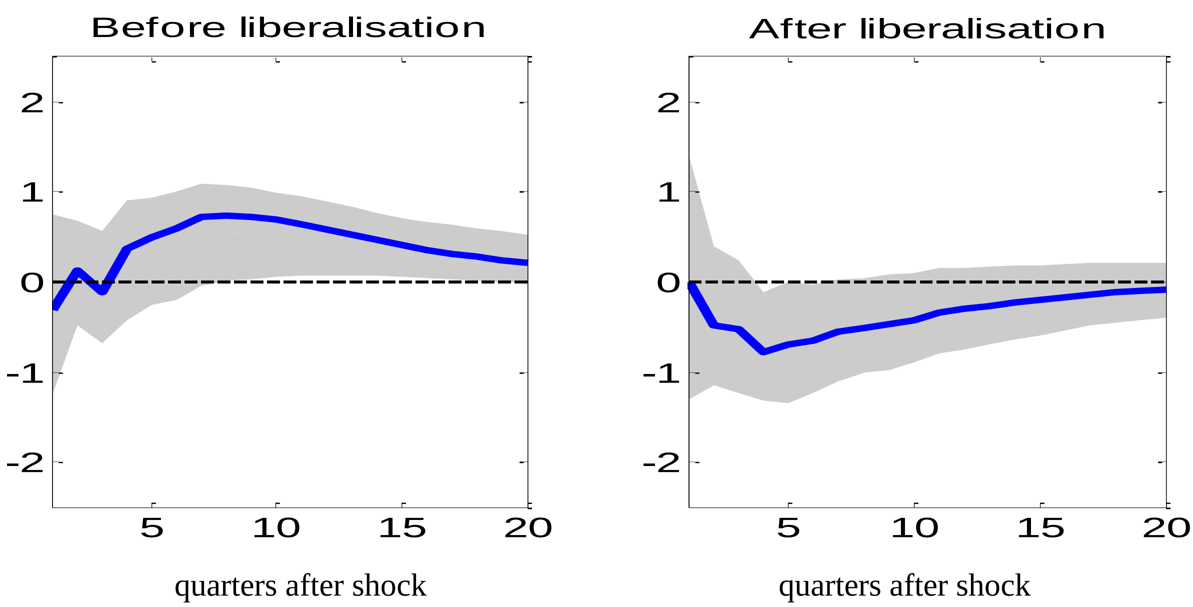
We now consider whether liberalisation of the financial, product and labour markets affects the impact of monetary policy on the current account, as predicted by the DSGE model.

3.3 The effect of liberalisation on the transmission of monetary policy - evidence

3.3.1. Financial market liberalisation

The first plot in Figure 9a shows the estimated CA/GDP response to a monetary policy expansion corresponding to a 1 percentage point fall in the interest rate, when the financial regulation index has been evaluated at the 10th percentile of values realised in the sample, with all the other indices evaluated at their medians. The second plot shows the CA/GDP response to the same monetary policy shock, but when the financial regulation index has been evaluated at the 90th percentile of sample values. The figure clearly shows that, following a monetary policy expansion, the current account improves in countries and time periods where the degree of financial regulation is high, but is likely to deteriorate in countries and time periods in which financial regulation is low. The change in the current account is statistically significant and peaks after 1-2 years.

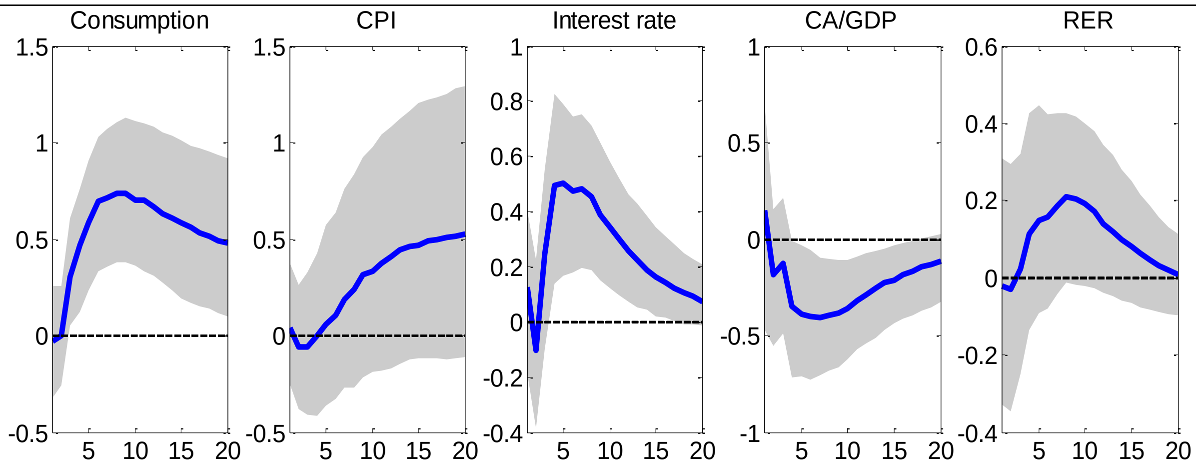
Figure 9a. CA/GDP following a monetary policy expansion before and after financial markets liberalisation - VAR model



Note: Figure 9a shows the effect of financial liberaliation on the transmission of an unexpected monetary policy expansion to CA/GDP, identified with sign restrictions. It shows the impulse response when all of the exchange rate, labour and product market indices have been evaluated at the sample medians, while the financialregulation measure is evaluated at the 10th and 90th percentiles respectively. The median is the blue line and 68% quantiles, which are calculated from 500 draws that satisfy the sign restrictions, are reported in the grey area.

Moreover, the difference between the two cases is statistically significant, as shown in Figure 9b which reports the median and 68% quantiles based on the *difference* in impulse responses between the low and high financial regulation cases described above. As predicted by the theoretical model, the reaction of consumption is stronger in a financially liberalised economy and this is statistically significant. The difference in current account reaction is negative and statistically significant, which suggests that the import-absorption channel dominates in a more financially liberalised economy.

Figure 9b: The effect of financial liberalisation on the monetary policy transmission mechanism – Identified with sign restrictions



Note: Figure 9b shows the effect of financial liberaliation on the transmission of an unexpected monetary policy expansion, identified with sign restrictions. It show the difference in impulse responses to a 100 basis point monetary policy expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate between the case where financial regulation is low and the case where it is high. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. The median is the blue line and 68% quantiles, which are calculated from 500 draws that satisfy the sign restrictions, are reported in the grey area.

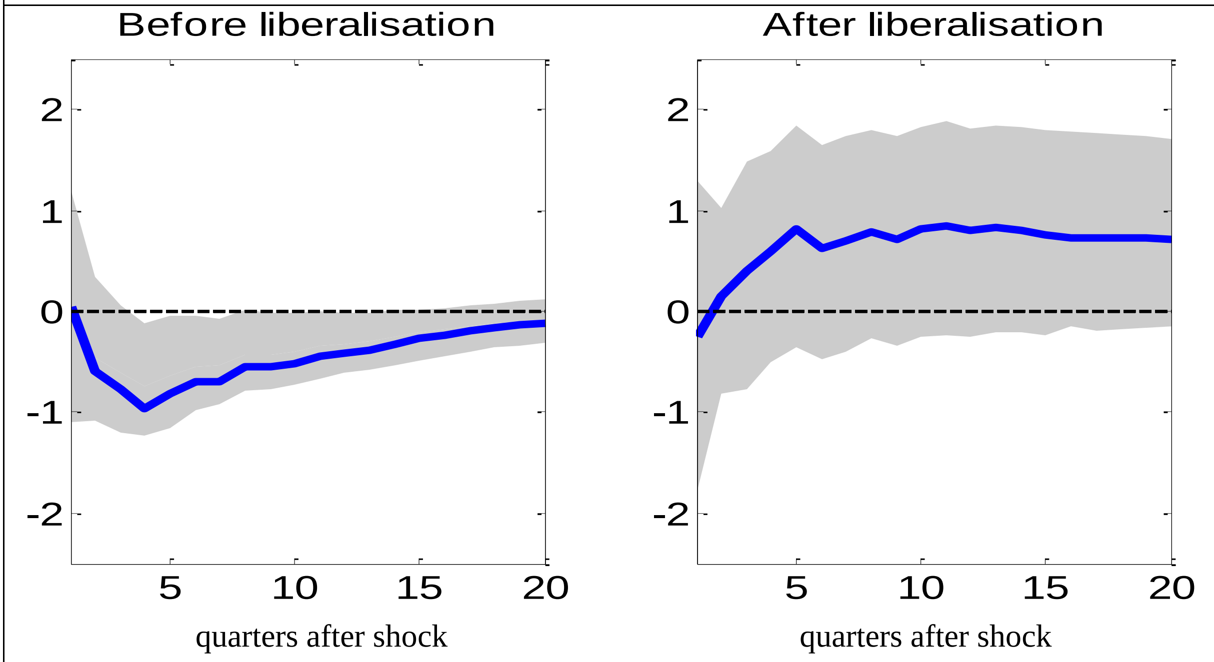
Overall, these impulses responses are in line with the predictions of our open-economy DSGE model, though the current account response is more sluggish in the empirical than in the theoretical model.[24] Our empirical results confirm that the current account is more likely to deteriorate in response to a monetary policy expansion in a more financially liberalised economy, and that this appears to be driven by the consumption response.

[24] This is not surprising given that the theoretical model does, for simplicity, not include features such as habits in consumption which would result in a more sluggish adjustment.

3.3.2 Product market liberalisation

Figure 10a presents the VAR results for the deregulation of the product market. It shows that the CA to GDP ratio is likely to deteriorate following a monetary policy expansion when product markets are relatively tightly regulated, but more likely to improve if product markets have been liberalised.

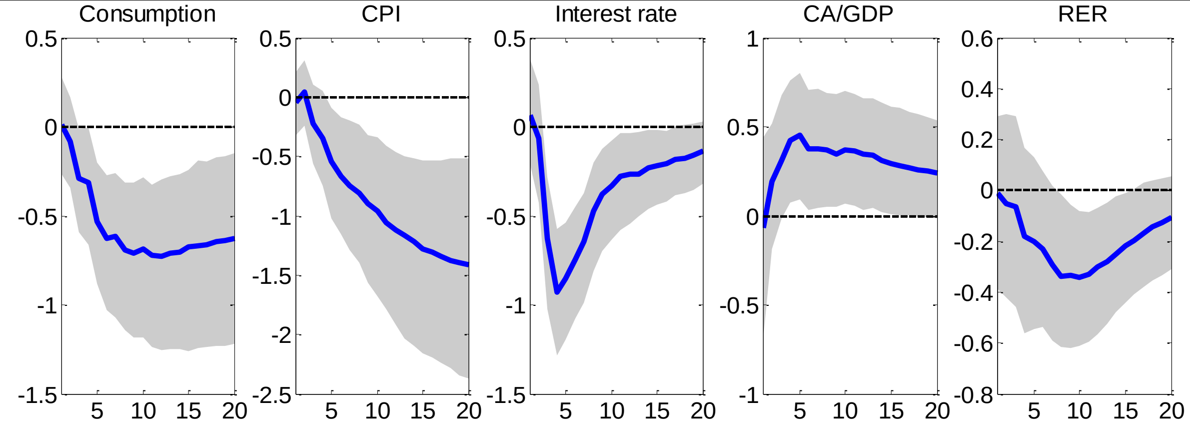
Figure 10a. CA/GDP following a monetary policy expansion before and after product market liberalisation - VAR model



Note: Figure 10a shows the effect of product market liberalisation on the transmission of an unexpected monetary expansion to CA/GDP, identified with sign restrictions. It shows the impulse response when all of the exchange rate, labour and product market indices have been evaluated at the sample medians, while the product market regulation measure is evaluated at the 10th and 90th percentiles respectively. The median is the blue line and 68% quantiles, which are calculated from 500 draws that satisfy the sign restrictions, are reported in the grey area.

Figure 10b shows that product market liberalisation significantly improves the current account response to a monetary policy expansion, implying that the current account is more likely to go into a surplus when product markets are lightly regulated. The figure also shows that real consumption reacts less to an equivalent monetary policy expansion in economies with liberalised product markets. This finding is consistent with the predictions from the DSGE model, suggesting that the expenditure switching channel dominates the monetary policy response when product markets have been liberalised.

Figure 10b: The effect of product market liberalisation on the monetary policy transmission mechanism – Identified with sign restrictions

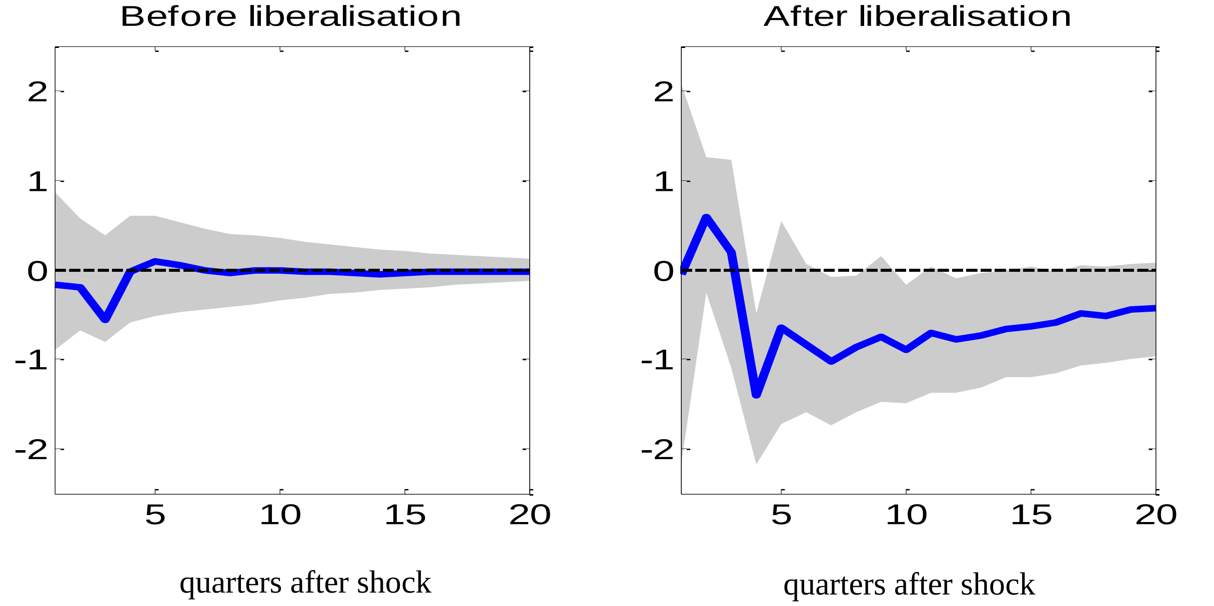


Note: Figure 10b shows the effect of product market liberalisation on the transmission of an unexpected monetary expansion, identified with sign restrictions. It shows the difference in impulse responses to a 100 basis point monetary policy expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate between the case where product market regulation is low and the case where it is high. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. The median is the blue line and 68% quantiles, which are calculated from 500 draws that satisfy the sign restrictions, are reported in red.

3.3.2 Labour market liberalisation

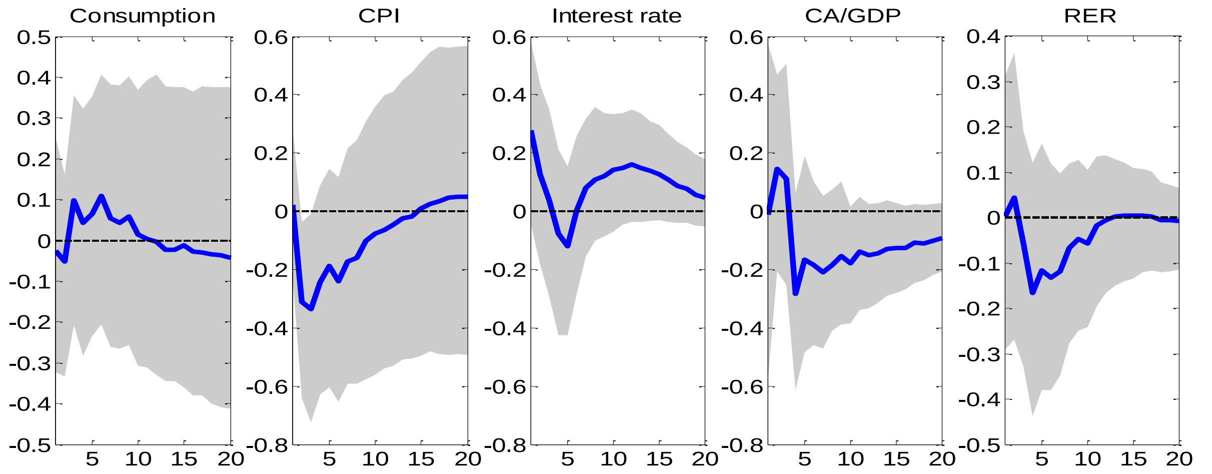
Figure 11a and 11b repeat the exercises carried out above, but for labour market liberalisation. In line with the DSGE results, our VAR model indicates that the impact of labour market liberalisation on the current account response to monetary policy is, in contrast to the results found with financial and product market liberalisation, not statistically significant.

Figure 11a. CA/GDP following a monetary policy expansion before and after labour market liberalisation - VAR model



Note: Figure 11a shows the effect of labour market liberalisation on the transmission of an unexpected monetary expansion to CA/GDP, identified with sign restrictions. It shows the impulse response when all of the exchange rate, labour and product market indices have been evaluated at the sample medians, while the labour market liberation measure is evaluated at the 10th and 90th percentiles respectively. The median is the blue line and 68% quantiles, which are calculated from 500 draws that satisfy the sign restrictions, are reported in the grey area.

Figure 11b: The effect of labour market liberalisation on the monetary policy transmission mechanism – Identified with sign restrictions



Note: Figure 11b shows the effect of labour market liberalisation on the transmission of an unexpected monetary expansion, identified with sign restrictions. It shows the difference in impulse responses to a 100 basis point monetary policy expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate between the case where labour market regulation is low and the case where it is high. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. The median is the blue line and 68% quantiles, which are calculated from 500 draws that satisfy the sign restrictions, are reported in red. Australia has been excluded as a result of missing data on labour market reforms.

3.3.3 Robustness

We investigate whether our results are robust to the chosen identification strategy. Using the lower-triangular identification approach described previously, Figures 13-15 in Appendix B repeat the analysis of figures 9-11. One issue with this identification scheme is that prices increase in response to monetary tightening and this 'price puzzle' has been widely documented and studied in previous work (Sims, 1992). Figures 13-15 show that, as in figures 9-11, liberalisation of financial (product) markets leads to a stronger response of consumption and the income-absorption (expenditure-switching) effect dominates the current account response. This implies that the current account response differs according to the degree of regulation in those markets, as in the VAR identified with sign restrictions and as predicted by the theoretical model. Moreover, the difference in the current account response associated with labour market liberalisation is again not statistically significant. Given that impulse responses identified with sign restrictions yield very similar results, this suggests that our empirical results are independent of the chosen identification scheme.

We also explore several other important robustness exercises. First, given that most of the countries in our sample are small open economies, global factors, such as for example global financial liberalisation or global monetary policy shocks could be important omitted variables with an adverse effect on inference in our model. To examine if this is an issue, we include year fixed effects in our model as well. These results are shown in the Appendix C. Figures 18-20 repeat the exercise of 9-11 but including year effects. The results are largely unchanged and quite similar to the baseline.

While we believe that commodity prices are a useful proxy variable for future cost push shocks and this is why we included this variable in our model, we also estimate a version of the model where this variable is excluded. The results from estimating this five variable model are again not affected by dropping the real growth rate in commodity prices from our model.

As previously explained, we set the pre-1990 values to the 1990 value for the labour market index for Australia. This is because data for Australia before this time period are not available. At the same time the labour market index does not change or only very slowly in most other countries before 1990. While we are therefore confident that this is a reasonable way of creating the labour market index for Australia, it is nevertheless interesting to explore the consequences of dropping this country. The results are very similar to the baseline, which means that the inclusion of Australia does not make a significant difference.

Finally, the financial regulation index we use in this paper focuses on domestic financial restrictions. A widely used measure of external financial regulation is the index by Chinn and Ito (2008), which is based on data from the IMF's AEAR exercise. As a robustness check, we also add this indicator as a fifth explanatory variable in our model.[25] Again, the results are similar to the baseline.

Overall, the results from this series of robustness checks suggests that the empirical results are robust to minor perturbations of the baseline model.

4. Discussion and conclusion

Does the current account improve or deteriorate following a monetary policy expansion? Our two-country DSGE model shows that the answer to this question depends on the degree of financial and product market regulation. To test these predictions, we estimate a varying coefficient Bayesian panel VAR model on quarterly data from 19 OECD countries over the period 1976 to 2006. The model's coefficients are allowed to vary stochastically over time as a function of the exchange rate regime, and of financial, labour and product market regulation. This allows us to compare current account responses to the same monetary policy shock under different types of regulation and hence establish whether economic liberalisation affects the transmission of monetary policy to the current account empirically.

Our theoretical model suggests that financial liberalisation amplifies the impact of monetary policy on consumption thus strengthening the income-absorption channel of monetary policy. Consistent with that, our empirical results show a persistent deterioration in the current account following an unexpected monetary expansion in less financially regulated economies. Conversely, the effect of product market liberalisation

[25] It was necessary to drop Switzerland since this indicator does not exist for this country for the whole time period.

appears to strengthen the expenditure-switching channel, thus exerting upward pressure on the current account following a monetary expansion. And the impact of labour market liberalisation on the transmission of monetary policy to the current account is ambiguous in the theoretical model and not statistically significant in our VAR model.

Overall, our findings suggest that the effect of monetary policy on the current account depends on the structure of the economy in question. This might explain why studies considering different time periods or countries haven't found a clear answer to whether monetary policy leads to a current account improvement or to a deterioration. It has important implications for macroeconomic policy if policy makers are tempted to use monetary policy to rectify large and persistent current account imbalances to the extent that these are considered to be undesirable (King, 2009). Our research implies that policy makers need to think carefully about the degree of regulation in different markets to anticipate how monetary policy will affect the current account. This is particularly important for monetary policy makers in the euro area as our research indicates that it is likely that the impact of a monetary policy action by the ECB could lead to different qualitative impacts on the current accounts of the different countries of the area. From a practical perspective, our research implies that any country-by country estimation of the impact of monetary policy on the current account using only time-series data cannot be used to examine how monetary policy affects the current account unless the pattern of regulation has remained unchanged.

Appendix A. More details on the varying-coefficient Bayesian Panel VAR model

Previous work has adopted three different ways of estimating panel VAR models with the structure as set out in **(1) – (4)**. Abritti and Weber (2010) and Towbin and Weber (2013) assume that $\boldsymbol{u}_{\boldsymbol{Bc},\boldsymbol{\tau}} = \mathbf{0}$, which means that $\boldsymbol{B}_{\boldsymbol{c},\boldsymbol{\tau}}$ is a deterministic function the vector of exogenous coefficients. In that case equations **(2), (3)** and **(4)** can be substituted back into equation **(1)** and the model can be easily estimated by OLS, equation by equation. But there is one drawback: unlike with stochastically varying coefficients, this assumption may result in smaller confidence bands and hence misleading inference, as demonstrated in the commodity price shock application in Wieladek (2016).

Sa, Towbin and Wieladek (2014) use the mean group estimator to allow for stochastic variation in $\boldsymbol{B}_{\boldsymbol{c},\boldsymbol{\tau}}$. But to the extent that this approach requires estimation country-by-country, modelling variation in coefficients as a set of more than two exogenous variables is typically not feasible, even in moderately sized VARs, due to degrees of freedom considerations. Wieladek (2016) proposes Bayesian shrinkage for estimating this type of model by extending the hierarchical linear model approach presented in Jarocinski (2010). This is similar to the Litterman (1986) prior assumption popular in economic forecasting, but rather than shrinking towards a random walk, coefficients are shrunk towards a set of explanatory variables, $\boldsymbol{B}_{\boldsymbol{c},\boldsymbol{\tau}}$. $\boldsymbol{B}_{\boldsymbol{c},\boldsymbol{\tau}}$ is modelled as a stochastic function of multiple explanatory variables. Importantly, $\boldsymbol{B}_{\boldsymbol{c},\boldsymbol{\tau}}$ can vary at different frequencies than the actual data. Due to all of these advantages, this is the approach that we choose to adopt. In particular, we assume the following priors for $\boldsymbol{B}_{\boldsymbol{c},\boldsymbol{\tau}}$ and $\boldsymbol{A}_{\boldsymbol{c},\boldsymbol{\tau}}$:

$$\boldsymbol{p}\left(\boldsymbol{B}_{\boldsymbol{c},\boldsymbol{\tau}} \mid \boldsymbol{D}_{\boldsymbol{c},\boldsymbol{\tau}}\boldsymbol{\delta}_{\boldsymbol{B}}, \boldsymbol{\Lambda}_{\boldsymbol{Bc}} \right) = \boldsymbol{N}(\boldsymbol{D}_{\boldsymbol{c},\boldsymbol{\tau}}\boldsymbol{\delta}_{\boldsymbol{B}}, \boldsymbol{\Lambda}_{\boldsymbol{Bc}}) \qquad \textbf{(5)}$$

$$\boldsymbol{p}\left(\boldsymbol{A}_{\boldsymbol{c},\boldsymbol{\tau}} \mid \boldsymbol{D}_{\boldsymbol{c},\boldsymbol{\tau}}\boldsymbol{\delta}_{\boldsymbol{A}}, \boldsymbol{\Lambda}_{\boldsymbol{Ac}} \right) = \boldsymbol{N}(\boldsymbol{D}_{\boldsymbol{c},\boldsymbol{\tau}}\boldsymbol{\delta}_{\boldsymbol{A}}, \boldsymbol{\Lambda}_{\boldsymbol{Ac}}) \qquad \textbf{(6)}$$

where $\boldsymbol{\delta}_{\boldsymbol{B}}, \boldsymbol{\delta}_{\boldsymbol{A}}$ is a matrix of pooled coefficients across countries, which relate the predetermined variables $\boldsymbol{D}_{\boldsymbol{c},\boldsymbol{t}}$ to the individual country coefficients $\boldsymbol{B}_{\boldsymbol{c},\boldsymbol{\tau}}, \boldsymbol{A}_{\boldsymbol{c},\boldsymbol{\tau}}$, with the variances $\boldsymbol{\Lambda}_{\boldsymbol{Bc}}, \boldsymbol{\Lambda}_{\boldsymbol{Ac}}$ determining the tightness of these priors.[26] We follow Jarocinski

[26] In our application, $\boldsymbol{D}_{\boldsymbol{c},\boldsymbol{t}}$ contains indices of exchange rate, financial, labour and product market liberalisation for country $\boldsymbol{c}$ at time τ.

(2010) and parameterize $\boldsymbol{\Lambda_{Bc}} = \boldsymbol{\lambda_B L_{Bc}}$ and $\boldsymbol{\Lambda_{Ac}} = \boldsymbol{\lambda_A L_{Ac}}$. $\boldsymbol{\lambda_B}$ and $\boldsymbol{\lambda_A}$ are treated as hyper parameters and are estimated from the data, based on an inverse gamma distribution, while $\boldsymbol{L_{Bc}}$ and $\boldsymbol{L_{Ac}}$, as explained in detail below, are calibrated pre-estimation. The greater $\boldsymbol{\lambda_B}$ and $\boldsymbol{\lambda_A}$ the larger the degree to which the country-specific coefficients are allowed to differ from the common mean. If $\boldsymbol{\lambda_B} \rightarrow \boldsymbol{\infty}$ and $\boldsymbol{\lambda_A} \rightarrow \boldsymbol{\infty}$, this approach will lead to country-by-country estimates, while $\boldsymbol{\lambda_B} = \mathbf{0}$ and $\boldsymbol{\lambda_A} = \mathbf{0}$ implies pooling across all countries. The parameterisation of $\boldsymbol{\Lambda_{Bc}}$ and $\boldsymbol{\Lambda_{Ac}}$in this manner has the econometrically convenient property that it is necessary only to estimate two hyper-parameters $\boldsymbol{\lambda_B}$ and $\boldsymbol{\lambda_A}$ to determine the degree of heterogeneity in the lagged dependent and contemporaneous coefficients, respectively. But there is of course one drawback: the coefficients in $\boldsymbol{B_{c,\tau}}$ and $\boldsymbol{A_{c,\tau}}$ may have different magnitudes. In specifying a single parameter that determines the degree of heterogeneity, there is therefore the risk that some coefficients are allowed to differ from the common mean by a small fraction of their own size, while others can differ by orders of magnitude. Following the approach proposed in Jarocinski (2010) and Wieladek (2016) and a procedure analogous to the Litterman (1986) prior, $\boldsymbol{L_{Bc}}$ is a matrix of scaling factors used to address this problem. In particular, $\boldsymbol{L_{Bc}(k, n)} = \frac{\boldsymbol{\sigma^2_{cn}}}{\boldsymbol{\sigma^2_{ck}}}$, where $\boldsymbol{c}$ is the country, $\boldsymbol{n}$ the equation and $\boldsymbol{k}$ the number of the variable regardless of lag. $\boldsymbol{\sigma^2_{cn}}$ is the estimated variance of the residuals of a univariate auto-regression of the endogenous variable in equation $\boldsymbol{n}$, of the same order as the VAR, and is obtained pre-estimation. $\boldsymbol{\sigma^2_{ck}}$ is the corresponding variance for variable $\boldsymbol{k}$ and obtained in an identical manner. $\boldsymbol{L_{Ac}}$ is obtained in a similar manner. To the extent that unexpected movements in variables will reflect the difference in the size of VAR coefficients, scaling by this ratio of variances allows us to address this issue.

Wieladek (2016) shows that based on these assumptions, the joint posterior of the model can be written as:

$$\prod_c \prod_t |\boldsymbol{\Sigma_c}| \exp\left(-\frac{1}{2}\sum_t \sum_c (\boldsymbol{y_{c,t}} - \boldsymbol{\widetilde{X}_{c,t}\beta_{c,\tau}})'\left(\boldsymbol{A'_{c,\tau}\Sigma_c A_{c,\tau}}\right)^{-1}(\boldsymbol{y_{c,t}} - \boldsymbol{\widetilde{X}_{c,t}\beta_{c,\tau}})\right)$$

$$\lambda_B^{-\frac{YCNK}{2}} exp(-\frac{1}{2}\sum_\tau \sum_c (\beta_{c,\tau} - \overline{\beta}_{c,\tau})' L_{Bc}^{-1} \lambda_B^{-1} (\beta_{c,\tau} - \overline{\beta}_{c,\tau})) \prod_c \prod_\tau |\Sigma_c|^{-\frac{N+1}{2}} \lambda_B^{-\frac{v+2}{2}} exp(-\frac{1}{2}\frac{s}{\lambda_B})$$

$$\lambda_A^{-\frac{YN(N-1)}{2}} exp(-\frac{1}{2}\sum_\tau \sum_c (a_{c,\tau} - a_{c,\tau})' L_{Ac}^{-1} \lambda_A^{-1} (a_{c,\tau} - \overline{a}_{c,\tau})) \prod_c \prod_\tau |\Sigma_c|^{-\frac{N+1}{2}} \lambda_A^{-\frac{v+2}{2}} exp(-\frac{1}{2}\frac{s}{\lambda_A})$$

where $\widetilde{X}_{c,t} \equiv I_N \otimes X_{c,t}$, $y_{c,t} \equiv vec(Y_{c,t})$, $\beta_{c,\tau} \equiv vec(B_{c,\tau})$, $\overline{\beta}_{c,\tau} \equiv vec(D_{c,\tau}\delta_B)$, $a_{c,\tau} \equiv vec(A_{c,\tau})$, $\overline{a}_{c,\tau} \equiv vec(D_{c,\tau}\delta_A)$ and $Y = \frac{T}{\Xi}$. T is the total number of time series observations and Y is the total number of time periods that $B_{c,\tau}$ and $A_{c,\tau}$ are allowed to vary for. As explained above, we set $\Xi = 20$, which means that with a T of 120, $Y = 6$. Wieladek (2016) shows how to derive the conditional distributions for the Gibbs sampler of this model. For brevity, we outline them below and refer the reader to his paper for more details.

The country-specific VAR coefficients $\beta_{c,\tau}$ are drawn from:

$$p(\beta_{c,\tau} \mid \overline{\beta}_{c,\tau}, Y_c, \Lambda_{Bc}) = N((G_c)^{-1} \left(\left(A'_{c,\tau}\Sigma_c A_{c,\tau}\right)^{-1} \otimes X'_{c,t}\right) y_{c,t} + L_{Bc}^{-1}\lambda_B^{-1}\overline{\beta}_{c,\tau}, (G_c^{-1})) \quad (7)$$

where $G_c = \left(A'_{c,\tau}\Sigma_c A_{c,\tau}\right)^{-1} \otimes X'_{c,t}X_{c,t} + L_{Bc}^{-1}\lambda_B^{-1}$. δ_B is drawn from:

$$p(\delta_B \mid \beta_{c,\tau}, \Lambda_{Bc}) = N((\sum_c \sum_\tau D'_{c,\tau}\Lambda_{Bc}^{-1}D_{c,\tau})^{-1} \sum_c \sum_\tau D'_{c,\tau}\Lambda_{Bc}^{-1}\beta_{c,\tau}, (\sum_c \sum_\tau D'_{c,\tau}\Lambda_{Bc}^{-1}D_{c,\tau})^{-1}) \quad (8)$$

λ_B is treated as a hyper parameter and drawn from the following inverse gamma 2 distribution:

$$p(\lambda_B \mid \overline{\beta}, \beta_c, L_c^{-1}) = IG_2(s + \sum_\tau \sum_c (\beta_{c,\tau} - \overline{\beta}_{c,\tau})' L_{Bc}^{-1} \lambda_B^{-1} (\beta_{c,\tau} - \overline{\beta}_{c,\tau}), YCNK + v) \quad (9)$$

A completely non-informative prior with s and v set to 0 results in an improper posterior in this case. We therefore set both of the quantities to very small positive numbers, which is equivalent to assuming a weakly informative prior. But it is important to point out that λ is estimated from the total number of coefficients that this prior is applied to, namely the product of country (**C**), equations (**N**) and total number of coefficients in each equation (**K**). Given this large number of effective units, any weakly informative prior will be dominated by the data.

Similarly, given that $A_{c,\tau}$ is lower-triangular with ones on the diagonal, it can be shown that $a^j_{c,\tau}$, where j refers to the equation, can be drawn equation by equation from:

$$p(a^j_{c,\tau} \mid \overline{a}^j_{c,\tau}, E_c, \Lambda_{Ac}) = N(F_c^{-1}(\Sigma_c^{-1} \otimes EJ'_{c,t})e_{c,t} + L_{Ac}^{-1}\lambda_A^{-1}\overline{a}^j_{c,t}, F_c^{-1}) \quad (10)$$

where $\boldsymbol{F_c} = \boldsymbol{\Sigma_c^{-1}} \otimes \boldsymbol{EJ'_{c,t}EJ_{c,t}} + \boldsymbol{L_{Ac}^{-1}\lambda_A}^{-1}$, $\boldsymbol{e_{c,t}}$ is the error term of equation j and $\boldsymbol{EJ'_{c,t}}$ contains all of the other relevant $\boldsymbol{e_{c,t}}$'s as explanatory variables for that equation. Given that $\boldsymbol{A_{c,\tau}}$ is lower-triangular, this means that in the case of the second equation, $\boldsymbol{EJ'_{c,t}}$ will consist of one other error term, in the case of the third equation of two ,etc. $\boldsymbol{\delta_A}$ is drawn from:

$$\boldsymbol{p(\delta_A \mid a_{c,\tau}, \Lambda_{Ac})} = \boldsymbol{N}\left(\left(\sum_c \sum_\tau \boldsymbol{D'_{c,\tau}\Lambda_{Ac}^{-1}D_{c,\tau}}\right)^{-1} \sum_c \sum_\tau \boldsymbol{D'_{c,\tau}\Lambda_{Ac}^{-1}a_{c,\tau}}, \left(\sum_c \sum_\tau \boldsymbol{D'_{c,\tau}\Lambda_{Bc}^{-1}D_{c,\tau}}\right)^{-1}\right) \quad \textbf{(11)}$$

$\boldsymbol{\lambda_A}$ is treated as a hyper parameter and drawn from the following inverse gamma 2 distribution:

$$\boldsymbol{p(\lambda_A \mid \bar{a}_{c,\tau}, a_{c,\tau})} = \boldsymbol{IG_2}\left(\boldsymbol{s} + \sum_\tau \sum_c (\boldsymbol{a_{c,\tau}} - \boldsymbol{\bar{a}_{c,\tau}})' \boldsymbol{L_{Ac}^{-1}} (\boldsymbol{a_{c,\tau}} - \boldsymbol{\bar{a}_{c,\tau}}), \boldsymbol{YN(N-1)/2 + v}\right) \quad \textbf{(12)}$$

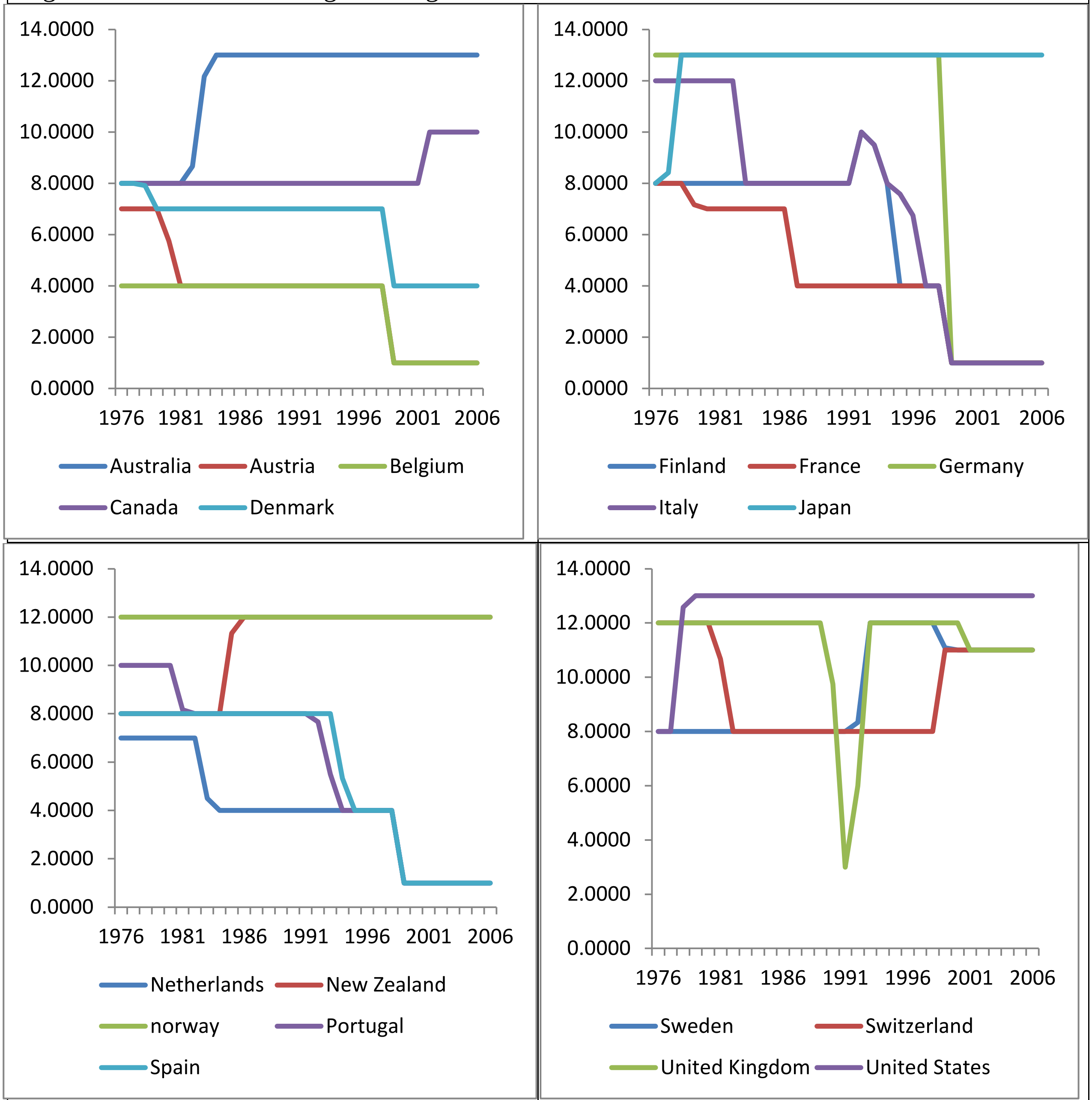
Finally, the country-specific variance matrix of the residuals, $\boldsymbol{\Sigma_c}$, is drawn from an inverse-Wishart distribution:

$$\boldsymbol{p(\Sigma_c \mid A_{c,\tau}^{-1}, \beta_{c,\tau})} = \boldsymbol{IW(U'_c U_c, T_c)} \quad \textbf{(13)}$$

where $\boldsymbol{U_c} = [\boldsymbol{U_{c,1}} \ldots \boldsymbol{U_{c,T}}]'$, $\boldsymbol{U_{c,t}} = \boldsymbol{A_{c,\tau}^{-1}E_{c,t}}$ and $\boldsymbol{T_c}$ is the number of observations for each country. The model is estimated by repeatedly drawing from the posteriors of the Gibbs sampling chain in **(7) – (13)** 150,000 times, discarding the first 50,000 draws as burn-in and retaining every 100th of the remaining draws for inference.

The VAR also controls for exchange rate regime. The figure below shows the indicator of exchange rate regime flexibility that we use for each of the 19 countries in our study. The index is taken from Ilzetzki, Reinhart and Rogoff (2010).

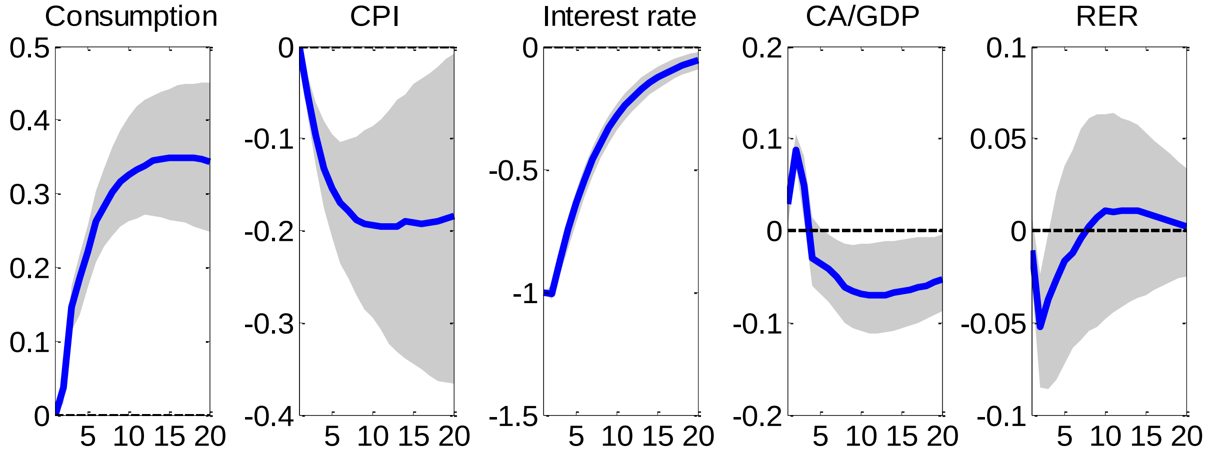
Figure 12: Index of exchange rate regime in 19 OECD countries



Sources & Notes: Ilzetzki, Reinhart and Rogoff (2010). Higher values indicate greater flexibility.

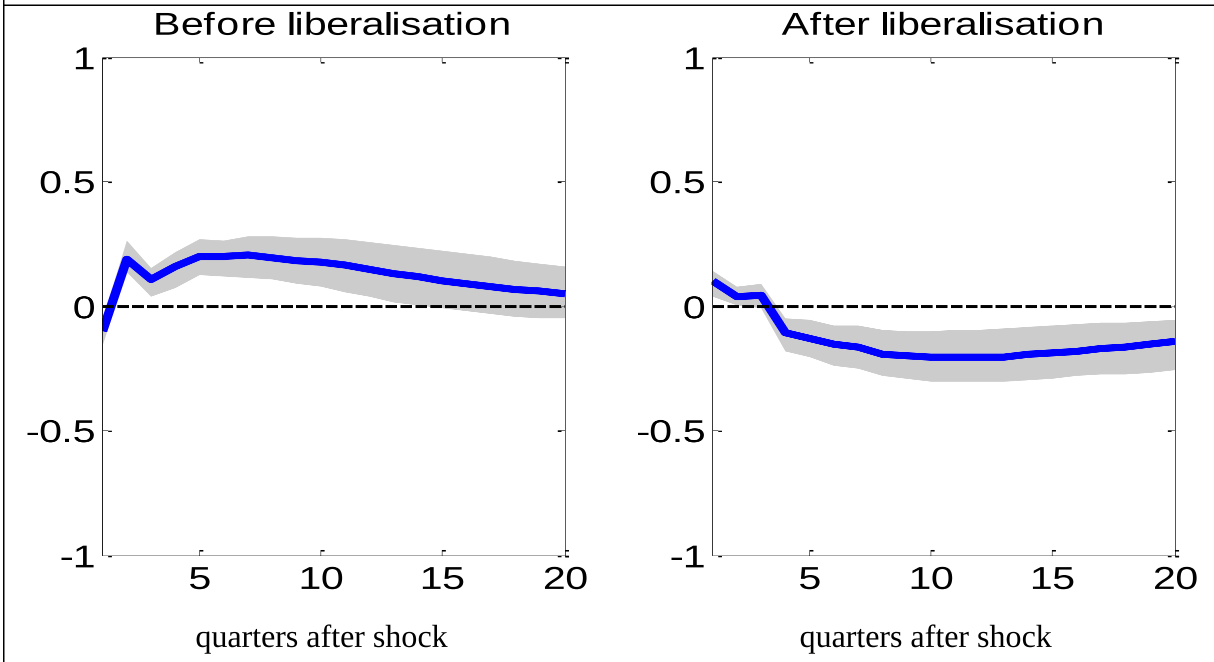
Appendix B. Robustness to triangular identification approach

Figure 13: Impact of a monetary policy expansion - VAR model identified with lower-triangular restrictions



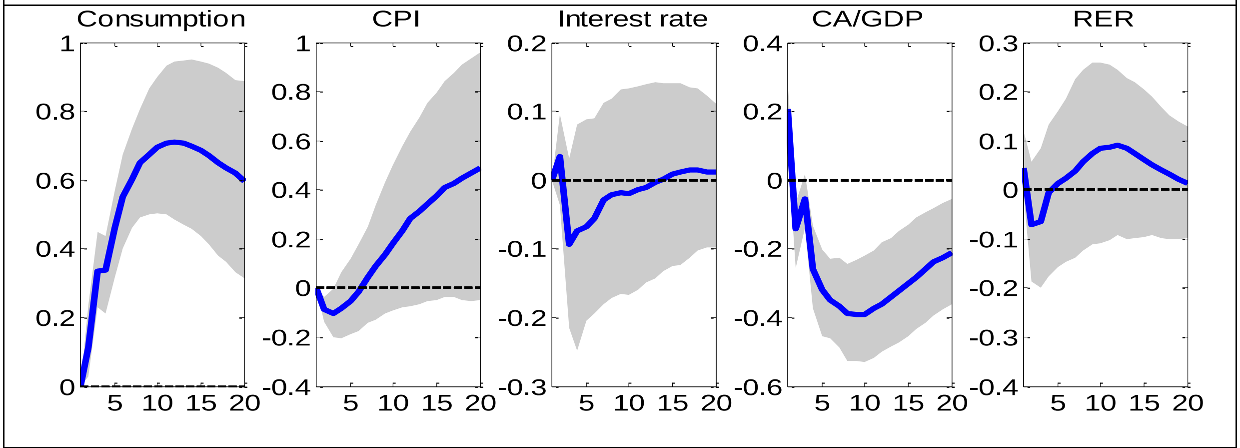
Note: Figure 13 shows the transmission of an unexpected monetary policy expansion, identified with a triangular approach. It shows impulse responses, in percent, to a 100 basis point monetary policy expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. It shows the responses when all of the exchange rate, financial, labour and product market indices have been evaluated at the sample medians. The median is the blue line and 68% quantiles, are reported in the grey area.

Figure 14a. CA/GDP following a monetary policy expansion before and after financial liberalisation - VAR model identified with lower-triangular restrictions



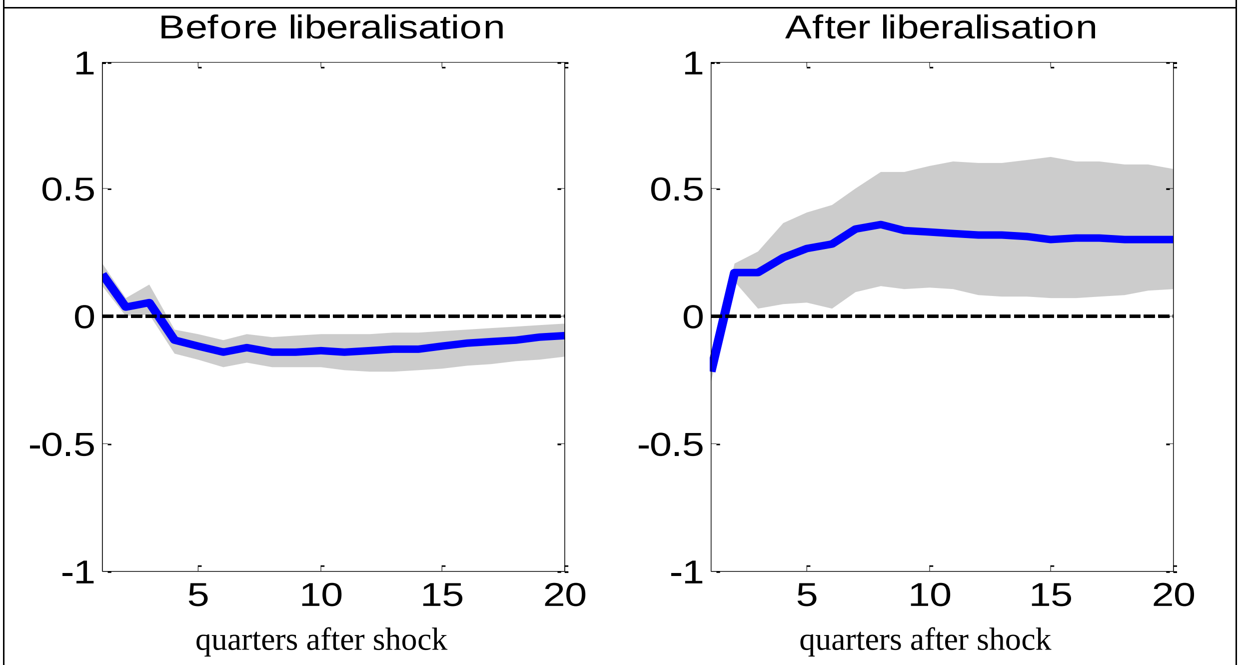
Note: Figure 14a shows the effect of financial liberalisation on the transmission of an unexpected monetary policy expansion to CA/GDP, identified with triangular restrictions. It shows the impulse response when all of the exchange rate, labour and product market indices have been evaluated at the sample medians, while the financial liberation measure is evaluated at the 10th and 90th percentiles respectively. The median is the blue line and 68% quantiles are reported in the grey area.

Figure 14b: The effect of financial market liberalisation on the monetary policy transmission mechanism – VAR model identified with lower-triangular restrictions



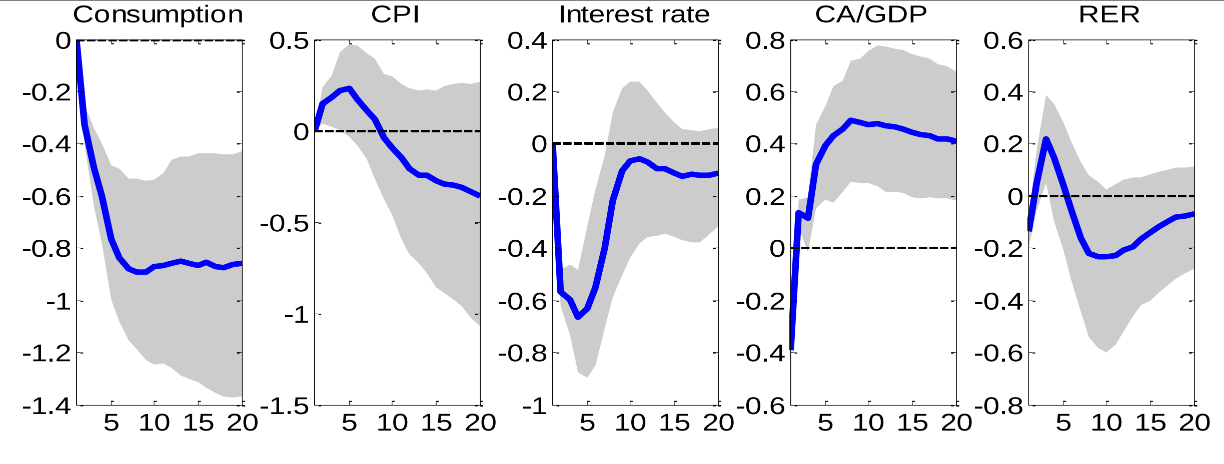
Note: Figure 14b shows the effect of financial market liberalisation on the transmission of an unexpected monetary policy expansion, identified with triangular restrictions. It shows the difference in impulse responses to a 100 basis point monetary policy expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. The median is the blue line and 68% quantiles are reported in red.

Figure 15a. CA/GDP following a monetary policy expansion before and after product market liberalisation - VAR model identified with lower-triangular restrictions



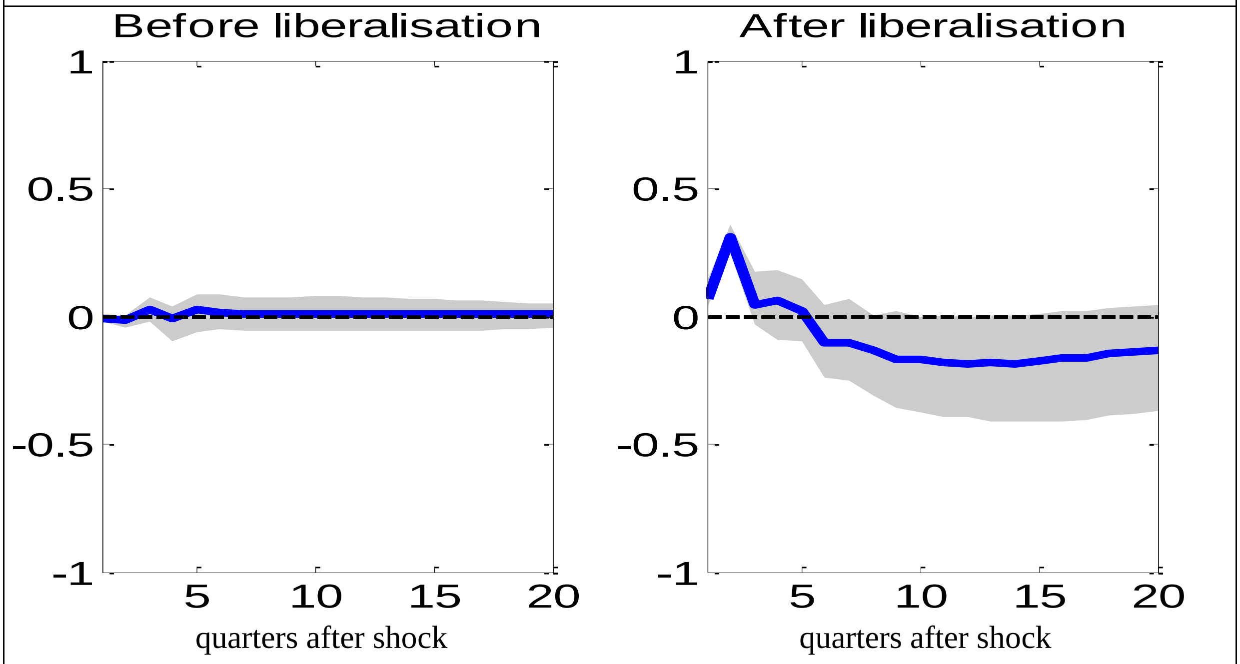
Note: Figure 15a shows the effect of product market liberalisation on the transmission of an unexpected monetary policy expansion to CA/GDP, identified with triangular restrictions. It shows the impulse response when all of the exchange rate, labour and product market indices have been evaluated at the sample medians, while the financial liberation measure is evaluated at the 10th and 90th percentiles respectively. The median is the blue line and 68% quantiles are reported in the grey area.

Figure 15b: The effect of product market liberalisation on the monetary policy transmission mechanism – VAR model identified with lower-triangular restrictions



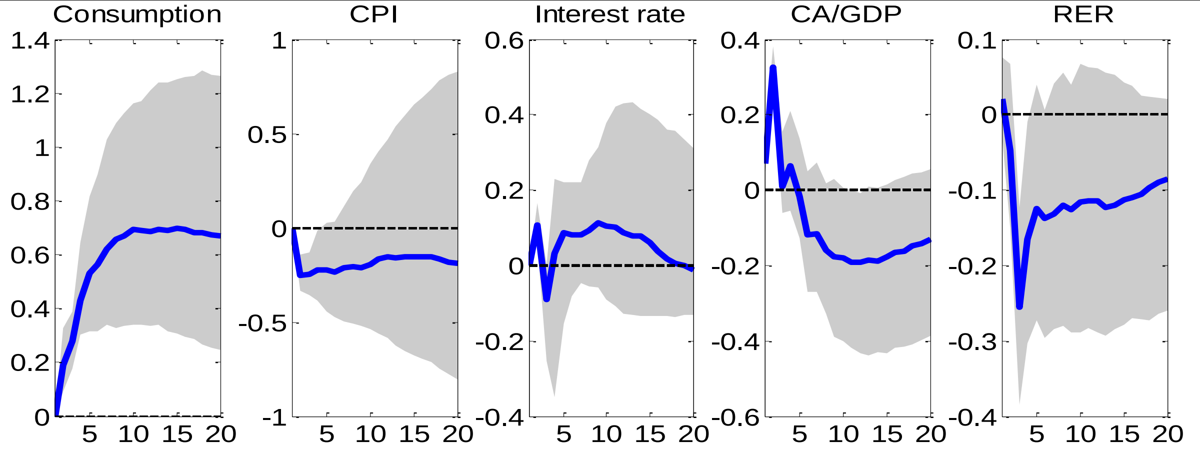
Note: Figure 15b shows the effect of product market liberaliation on the transmission of an unexpected monetary policy expansion, identified with triangular restrictions. It shows the difference in impulse responses to a 100 basis point monetary policy expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. The median is the blue line and 68% quantiles are reported in red.

Figure 16a. CA/GDP following a monetary policy expansion before and after labour market liberalisation - VAR model identified with lower-triangular restrictions



Note: Figure 16a shows the effect of labour market liberalisation on the transmission of an unexpected monetary policy expansion to CA/GDP, identified with triangular restrictions. It shows the impulse response when all of the exchange rate, labour and product market indices have been evaluated at the sample medians, while the financial liberation measure is evaluated at the 10th and 90th percentiles respectively. The median is the blue line and 68% quantiles are reported in the grey area.

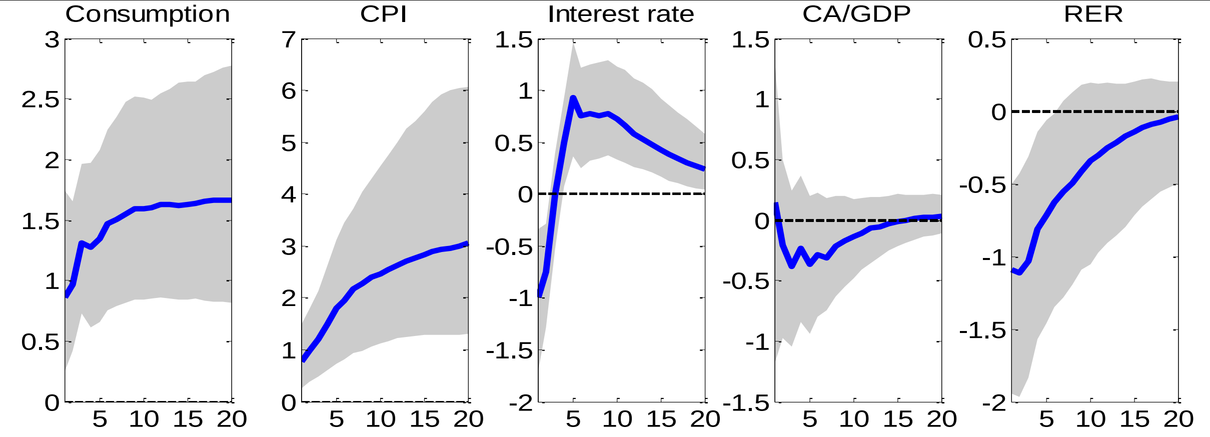
Figure 16b: The effect of labour market liberalisation on the monetary policy transmission mechanism – VAR model identified with lower-triangular restrictions



Note: Figure 16b shows the effect of labour market liberaliation on the transmission of an unexpected monetary policy expansion, identified with triangular restrictions. It shows the difference in impulse responses to a 100 basis point monetary policy expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. The median is the blue line and 68% quantiles are reported in red. The sample includes Australia for which missing values have been extrapolated.

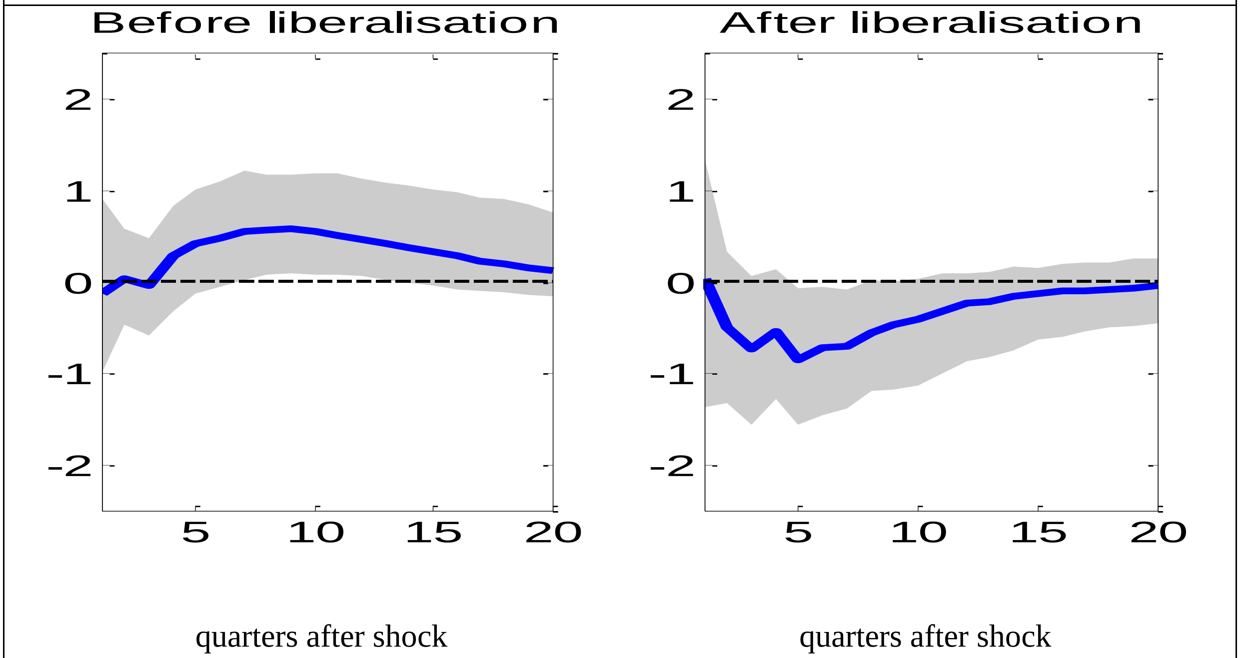
Appendix C. Robustness to year fixed effects

Figure 17: Impact of a monetary policy expansion - VAR model with year fixed effects (identified using sign restrictions)



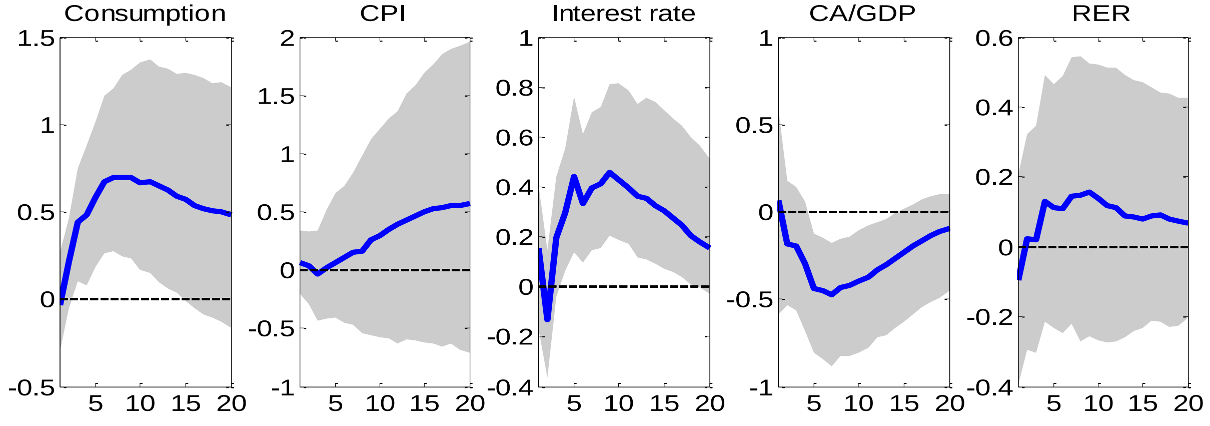
Note: Figure 17 shows the transmission of an unexpected monetary expansion, identified with sign restrictions. It shows impulse responses, in percent, to a 100 basis point monetary expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. It shows the responses when all of the exchange rate, financial, labour and product market indices have been evaluated at the sample medians. The median is the blue line and 68% quantiles, are reported in the grey area.

Figure 18a. CA/GDP following a monetary policy expansion before and after financial markets liberalisation - VAR model with year fixed effects (identified using sign restrictions)



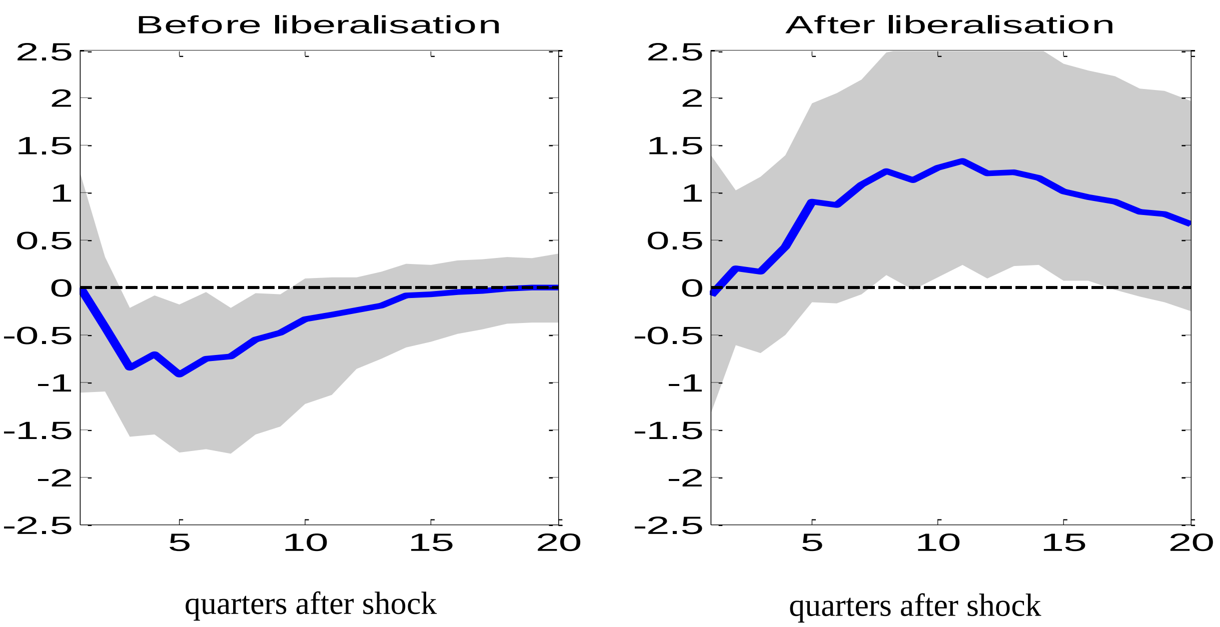
Note: Figure 18a shows the effect of financial liberalisation on the transmission of an unexpected monetary policy expansion to CA/GDP, identified with sign restrictions. It shows the impulse response when all of the exchange rate, labour and product market indices have been evaluated at the sample medians, while the financial liberation measure is evaluated at the 10th and 90th percentiles respectively. The median is the blue line and 68% quantiles are reported in the grey area.

Figure 18b: The effect of financial market liberalisation on the monetary policy transmission mechanism – VAR model with year fixed effects (identified using sign restrictions)



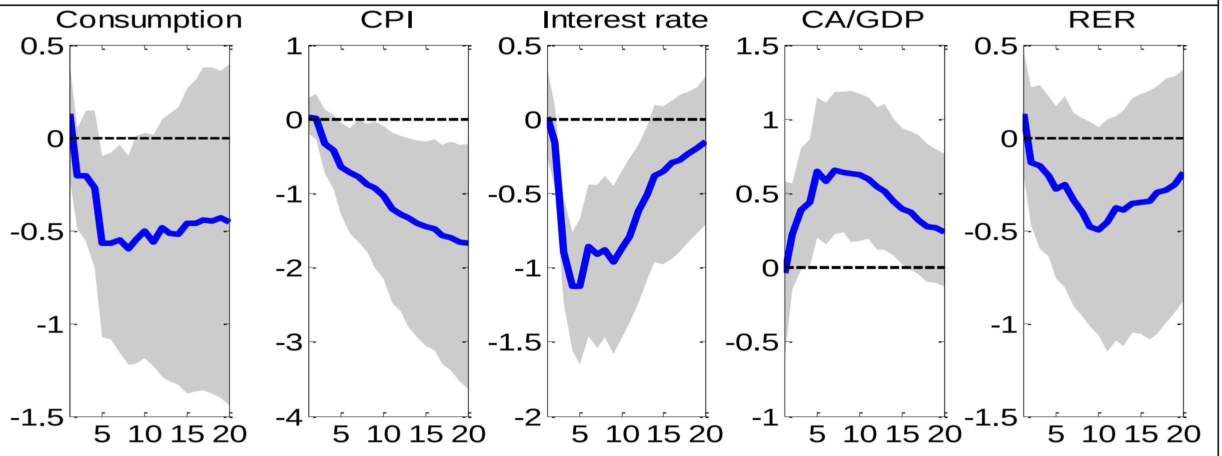
Note: Figure 18b shows the effect of financial market liberaliation on the transmission of an unexpected monetary policy expansion, identified with sign restrictions. It shows the difference in impulse responses to a 100 basis point monetary policy expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate between the low and high regulation cases. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. The median is the blue line and 68% quantiles are reported in red.

Figure 19a. CA/GDP following a monetary policy expansion before and after product market liberalisation - VAR model with year fixed effects (identified using sign restrictions)



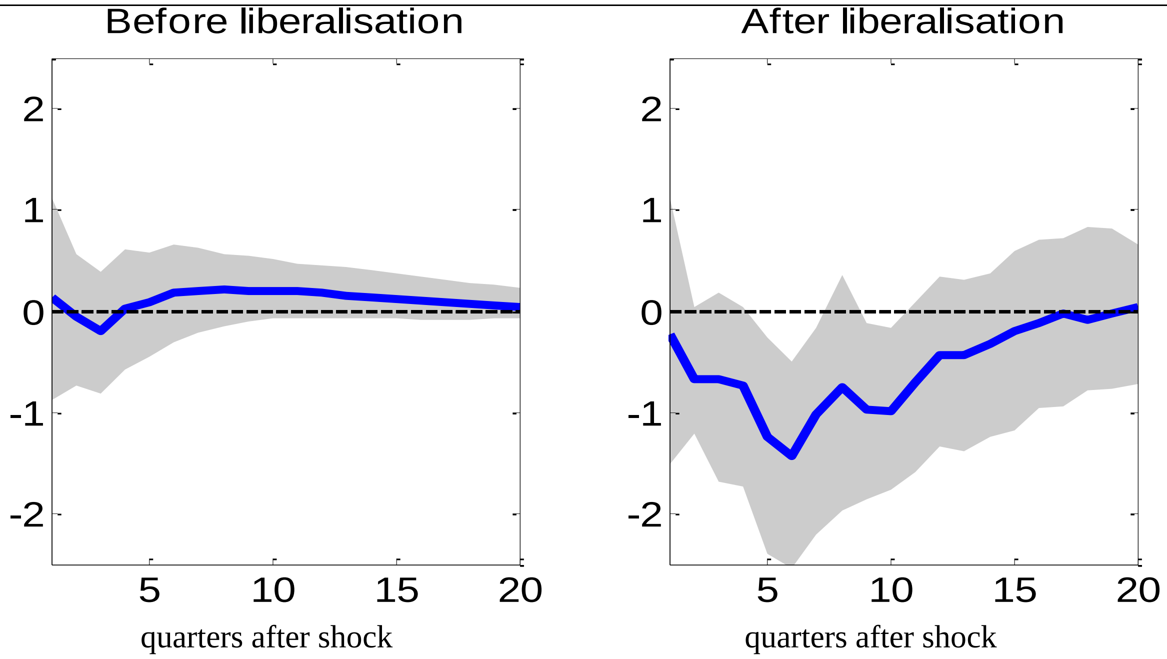
Note: Figure 19a shows the effect of product market liberalisation on the transmission of an unexpected monetary policy expansion to CA/GDP, identified with sign restrictions. It shows the impulse response when all of the exchange rate, labour and product market indices have been evaluated at the sample medians, while the financial liberation measure is evaluated at the 10th and 90th percentiles respectively. The median is the blue line and 68% quantiles are reported in the grey area.

Figure 19b: The effect of product market liberalisation on the monetary policy transmission mechanism - VAR model with year fixed effects (identified using sign restrictions)



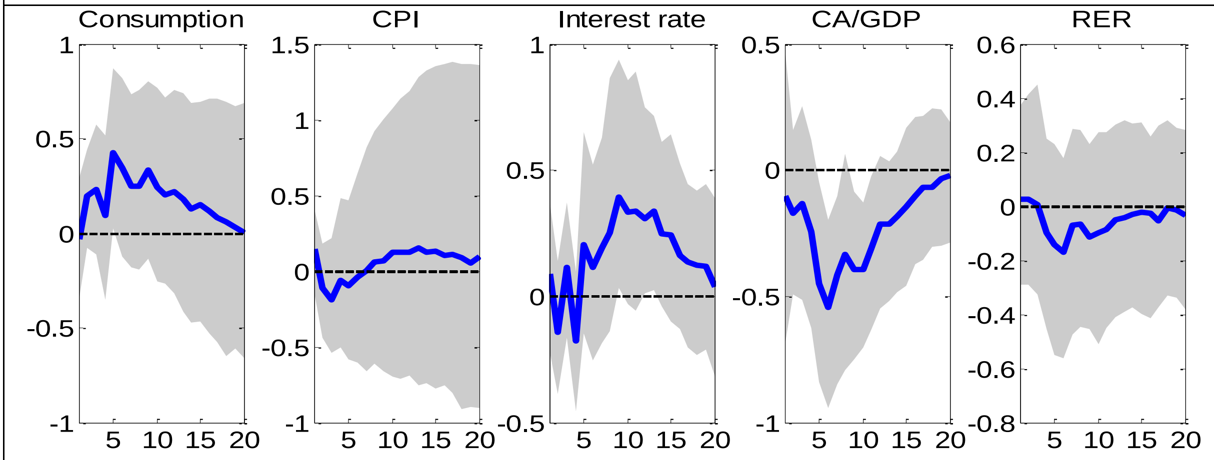
Note: Figure 19b shows the effect of product market liberaliation on the transmission of an unexpected monetary policy expansion, identified with sign restrictions. It shows the difference in impulse responses to a 100 basis point monetary policy expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate between the low and high regulation cases. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. The median is the blue line and 68% quantiles are reported in red.

Figure 20a. CA/GDP following a monetary policy expansion before and after labour market liberalisation - VAR model with year fixed effects (identified using sign restrictions)



Note: Figure 20a shows the effect of labour market liberalisation on the transmission of an unexpected monetary policy expansion to CA/GDP, identified with sign restrictions. It shows the impulse response when all of the exchange rate, labour and product market indices have been evaluated at the sample medians, while the financial liberation measure is evaluated at the 10th and 90th percentiles respectively. The median is the blue line and 68% quantiles are reported in the grey area.

Figure 20b: The effect of labour market liberalisation on the monetary policy transmission mechanism – VAR model with year fixed effects (identified using sign restrictions)



Note: Figure 20b shows the effect of labour market liberaliation on the transmission of an unexpected monetary policy expansion, identified with sign restrictions. It shows the difference in impulse responses to a 100 basis point monetary policy expansion of real consumption, the CPI, the short interest rate, the current account to GDP ratio and the log of the real exchange rate between the low and high regulation cases. For the CPI, real consumption and the real exchange rate, cumulated impulse responses are shown, as these variables enter the model in log differences. The median is the blue line and 68% quantiles are reported in red. The sample includes Australia for which missing values have been extrapolated.

Appendix D. DSGE model equilibrium equations

The equilibrium is a set of stationary processes

$$\left\{\begin{array}{c} Y_t, Y_t^*, Y_{H,t} Y_{F,t}, C_t\ , C_t^*, C_{N,t}, C_{N,t}^*, C_{T,t}, C_{T,t}^*, L_{T,t}^O, L_{N,t}^O\ , L_{T,t}^{O*}, L_{N,t}^{O*}\ , C_t^R, C_t^{R*}, C_t^O, C_t^{O*}, L_{T,t}^R, L_{T,t}^{R*}, L_{N,t}^R, L_{N,t}^{R*}, \\ L_{T,t}, L_{T,t}^*, L_{N,t}, L_{N,t}^* \left(\frac{P_{H,t}}{P_{T,t}}\right), \left(\frac{P_{F,t}^*}{P_{T,t}^*}\right), \left(\frac{P_{T,t}}{P_t}\right), \left(\frac{P_{T,t}^*}{P_t^*}\right), \left(\frac{P_{N,t}}{P_t}\right), \left(\frac{P_{N,t}^*}{P_t^*}\right), \left(\frac{s_t P_{T,t}^*}{P_{T,t}}\right), Q_t, \left(\frac{B_{F,t}}{P_t}\right), \pi_{H,t}, \pi_{F,t}^*, \pi_{N,t}, \pi_{N,t}^*, \\ \left(\frac{W_{T,t}}{P_{T,t}}\right), \left(\frac{W_{T,t}^*}{P_{T,t}^*}\right), \left(\frac{W_{N,t}}{P_t}\right), \left(\frac{W_{N,t}^*}{P_t^*}\right), \pi_{H,t}^W, \pi_{F,t}^{W*}, \pi_{N,t}^W, \pi_{N,t}^{W*}, Disp_t\ , Disp_t^N, Disp_t^*, Disp_t^{N*} \\ x_{1,t}, x_{1,t}^*, x_{2,t}, x_{2,t}^*, x_{1,t}^N, x_{1,t}^{N*}, x_{2,t}^N, x_{2,t}^{N*}, x_{1,t}^W, x_{1,t}^{W*}, x_{2,t}^W, x_{2,t}^{W*}, x_{1,t}^{WN}, x_{1,t}^{WN*}, x_{2,t}^{WN}, x_{2,t}^{WN*}, i_t\ , i_t^* \end{array}\right\}$$

for $t \geq 0$ which satisfy the 69 equilibrium equations below given $\{\psi_t^I, \psi_t^{I*}\}_{t=0}^{\infty}$ and the initial conditions consisting of the variables above for $t < 0$.

Equilibrium equations:

Aggregate demand and output:

$$Y_{H,t} = a_H \left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\varphi} C_{T,t} + \frac{1-n}{n}(1-a_F)\left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\varphi} \left(\frac{s_t P_{T,t}^*}{P_{T,t}}\right)^{\varphi} C_{T,t}^*$$

$$Y_{F,t} = \frac{n}{1-n}(1-a_H)\left(\frac{P_{F,t}^*}{P_{T,t}^*}\right)^{-\varphi} \left(\frac{s_t P_{T,t}^*}{P_{T,t}}\right)^{-\varphi} C_{T,t} + a_F \left(\frac{P_{F,t}^*}{P_{T,t}^*}\right)^{-\varphi} C_{T,t}^*$$

$$Y_t = \left(\frac{P_{H,t}}{P_t}\right) Y_{H,t} + \left(\frac{P_{N,t}}{P_t}\right) C_{N,t}$$

$$Y_t^* = \left(\frac{P_{F,t}^*}{P_t^*}\right) Y_{F,t} + \left(\frac{P_{N,t}^*}{P_t^*}\right) C_{N,t}^*$$

Consumption demand:

$$C_{T,t} = a_T \left(\frac{P_{T,t}}{P_t}\right)^{-\varphi_H^N} C_t$$

$$C_{N,t} = (1-a_T)\left(\frac{P_{N,t}}{P_t}\right)^{-\varphi_H^N} C_t$$

$$C_{T,t}^* = a_T^* \left(\frac{P_{T,t}^*}{P_t^*}\right)^{-\varphi_H^N} C_t^*$$

$$C_{N,t}^* = (1-a_T^*)\left(\frac{P_{N,t}^*}{P_t^*}\right)^{-\varphi_H^N} C_t^*$$

Price equations:

$$\frac{x_{1,t}}{x_{2,t}} = \left(\frac{1-\alpha_H^T \pi_{H,t+1}^{\theta_H^T-1}}{1-\alpha_H^T}\right)^{\frac{1}{1-\theta_H^T}}$$

$$\frac{x_{1,t}^N}{x_{2,t}^N} = \left(\frac{1-\alpha_H^N \pi_{N,t+1}^{\theta_H^N-1}}{1-\alpha_H^N}\right)^{\frac{1}{1-\theta_H^N}}$$

$$x_{1,t} = \frac{\theta_H^T}{(\theta_H^T-1)} Y_{H,t}\, C_t^{O-\sigma_H} \frac{W_{T,t}}{P_{T,t}} \frac{P_{T,t}}{P_t} + \alpha_H^T \beta \pi_{H,t+1}^{\theta_H^T} x_{1,t+1}$$

$$x_{1,t}^N = \frac{\theta_H^N}{(\theta_H^N-1)} C_{N,t}\, C_t^{O-\sigma_H} \frac{W_{N,t}}{P_t} + \alpha_H^N \beta \pi_{N,t+1}^{\theta_H^N} x_{1,t+1}^N$$

$$x_{2,t} = (1+\tau_H^T) Y_{H,t}\, C_t^{O-\sigma_H} \frac{P_{H,t}}{P_{T,t}} \frac{P_{T,t}}{P_t} + \alpha_H^T \beta \pi_{H,t+1}^{\theta_H^T-1} x_{2,t+1}$$

$$x_{2,t}^N = (1+\tau_H^N) C_{N,t}\, C_t^{O-\sigma_H} \frac{P_{N,t}}{P_t} + \alpha_H^N \beta \pi_{N,t+1}^{\theta_H^N-1} x_{2,t+1}^N$$

$$Disp_t = (1-\alpha_H^T)\left(\frac{1-\alpha_H^T \pi_{H,t}^{\theta_H^k-1}}{1-\alpha_H^T}\right)^{\frac{-\theta_H^T}{1-\theta_H^T}} + \alpha_H^T \pi_{H,t}^{\theta_H^T} Disp_{t-1}$$

$$Disp_t^N = (1-\alpha_H^N)\left(\frac{1-\alpha_H^N \pi_{N,t}^{\theta_H^N-1}}{1-\alpha_H^N}\right)^{\frac{-\theta_H^T}{1-\theta_H^T}} + \alpha_H^N \pi_{N,t}^{\theta_H^N} Disp_{t-1}^N$$

$$\frac{x_{1,t}^*}{x_{2,t}^*} = \left(\frac{1-\alpha_F^T \pi_{F,t+1}^{*\theta_F^T-1}}{1-\alpha_F^T}\right)^{\frac{1}{1-\theta_F^T}}$$

$$\frac{x_{1,t}^{N*}}{x_{2,t}^{N*}} = \left(\frac{1-\alpha_F^N \pi_{N,t+1}^{*\theta_F^N-1}}{1-\alpha_F^N}\right)^{\frac{1}{1-\theta_F^N}}$$

$$x_{1,t}^* = \frac{\theta_F^T}{(\theta_F^T-1)} Y_{F,t}\, C_t^{O*-\sigma_H} \frac{W_{T,t}^*}{P_{T,t}^*} \frac{P_{T,t}^*}{P_t^*} + \alpha_F^T \beta \pi_{F,t+1}^{*\theta_F^T} x_{1,t+1}^*$$

$$x_{1,t}^{N*} = \frac{\theta_F^N}{(\theta_F^N-1)} C_{N,t}^*\, C_t^{O*-\sigma_H} \frac{W_{N,t}^*}{P_t^*} + \alpha_F^N \beta \pi_{N,t+1}^{*\theta_F^N} x_{1,t+1}^{N*}$$

$$x_{2,t}^{*} = (1+\tau_F^T)Y_{F,t}\, C_t^{O*-\sigma_H} \frac{P_{F,t}^*}{P_{T,t}^*}\frac{P_{T,t}^*}{P_t^*} + \alpha_F^T \beta \pi_{F,t+1}^{*\theta_F^T-1} x_{2,t+1}^*$$

$$x_{2,t}^{N*} = (1+\tau_F^N)C_{N,t}^*\, C_t^{O*-\sigma_F} \frac{P_{N,t}^*}{P_t^*} + \alpha_F^N \beta \pi_{F,t+1}^{*\theta_F^N-1} x_{2,t+1}^{N*}$$

$$Disp_t^* = (1-\alpha_H^T)\left(\frac{1-\alpha_H^T \pi_{H,t}^{\theta_H^k-1}}{1-\alpha_H^T}\right)^{\frac{-\theta_H^T}{1-\theta_H^T}} + \alpha_H^T \pi_{H,t}^{\theta_H^T} Disp_{t-1}$$

$$Disp_t^{N*} = (1-\alpha_F^N)\left(\frac{1-\alpha_F^N \pi_{N,t}^{*\theta_F^N-1}}{1-\alpha_F^N}\right)^{\frac{-\theta_F^N}{1-\theta_F^N}} + \alpha_F^N \pi_{N,t}^{\theta_F^N} Disp_{t-1}^{N*}$$

$$\pi_{N,t} = \frac{P_{N,t}}{P_t}\frac{P_{t-1}}{P_{N,t-1}}\frac{P_{H,t-1}}{P_{T,t-1}}\frac{P_{T,t}}{P_{H,t}}\frac{P_{T,t-1}}{P_{t-1}}\frac{P_t}{P_{T,t}}\pi_{H,t}$$
$$\pi_{N,t}^* = \frac{P_{N,t}^*}{P_t^*}\frac{P_{t-1}^*}{P_{N,t-1}^*}\frac{P_{F,t-1}^*}{P_{T,t-1}^*}\frac{P_{T,t}^*}{P_{F,t}^*}\frac{P_{T,t-1}^*}{P_{t-1}^*}\frac{P_t^*}{P_{T,t}^*}\pi_{F,t}^*$$

Wage equations:

$$\frac{x_{1,t}^W}{x_{2,t}^W} = \left(\frac{1-\alpha_H^W \pi_{H,t}^{W\theta_H^W-1}}{1-\alpha_H^W}\right)^{\frac{1+\theta_H^W \eta_H}{1-\theta_H^W}}$$

$$\frac{x_{1,t}^{WN}}{x_{2,t}^{WN}} = \left(\frac{1-\alpha_{HN}^W \pi_{N,t}^{W\theta_{HN}^W-1}}{1-\alpha_{HN}^W}\right)^{\frac{1+\theta_{HN}^W \eta_H}{1-\theta_{HN}^W}}$$

$$x_{1,t}^W = \frac{\theta_H^W}{(\theta_H^W-1)}\left(\frac{L_{T,t}^O}{a_T}\right)^{1+\eta_H} + \alpha_H^W \beta \pi_{H,t+1}^{W\theta_H^W(1+\eta_H)} x_{1,t+1}^W$$

$$x_{1,t}^{WN} = \frac{\theta_{HN}^W}{(\theta_{HN}^W-1)}\left(\frac{L_{N,t}^O}{1-a_T}\right)^{1+\eta_H} + \alpha_{HN}^W \beta \pi_{N,t+1}^{W\theta_{HN}^W(1+\eta_H)} x_{1,t+1}^{WN}$$

$$x_{2,t}^W = (1-\tau_H^W)C_t^{O-\sigma_H}\frac{W_{H,t}}{P_{T,t}}\frac{P_{T,t}}{P_t}\left(\frac{L_{T,t}^O}{a_T}\right) + \alpha_H^W \beta \pi_{H,t+1}^{W\theta_H^W-1} x_{2,t+1}^W$$

$$x_{2,t}^{WN} = (1-\tau_{HN}^{W})C_t^{O-\sigma_H}\frac{W_{N,t}}{P_t}\left(\frac{L_{N,t}^{O}}{1-a_T}\right) + \alpha_{HN}^{W}\beta\pi_{N,t+1}^{W\theta_{HN}^{W}-1}x_{2,t+1}^{WN}$$

$$\pi_{H,t}^{W} = \frac{W_{H,t}}{P_{T,t}}\frac{P_{T,t-1}}{W_{H,t-1}}\frac{P_{H,t-1}}{P_{T,t-1}}\frac{P_{T,t}}{P_{H,t}}\pi_{H,t}$$

$$\pi_{N,t}^{W} = \frac{W_{N,t}}{P_t}\frac{P_{t-1}}{W_{N,t-1}}\frac{P_{N,t-1}}{P_{t-1}}\frac{P_t}{P_{N,t}}\pi_{N,t}$$

$$\frac{x_{1,t}^{W*}}{x_{2,t}^{W*}} = \left(\frac{1-\alpha_F^{W}\pi_{F,t}^{W*\theta_F^{W}-1}}{1-\alpha_F^{W}}\right)^{\frac{1+\theta_F^{W}\eta_F}{1-\theta_F^{W}}}$$

$$\frac{x_{1,t}^{WN*}}{x_{2,t}^{WN*}} = \left(\frac{1-\alpha_{FN}^{W}\pi_{N,t}^{W*\theta_{FN}^{W}-1}}{1-\alpha_{FN}^{W}}\right)^{\frac{1+\theta_{FN}^{W}\eta_F}{1-\theta_{FN}^{W}}}$$

$$x_{1,t}^{W*} = \frac{\theta_F^{W}}{(\theta_F^{W}-1)}\left(\frac{L_{T,t}^{O*}}{a_T^*}\right)^{1+\eta_F} + \alpha_F^{W}\beta\pi_{F,t+1}^{W*\theta_F^{W}(1+\eta_F)}x_{1,t+1}^{W*}$$

$$x_{1,t}^{WN*} = \frac{\theta_{FN}^{W}}{(\theta_{FN}^{W}-1)}\left(\frac{L_{N,t}^{O*}}{1-a_T^*}\right)^{1+\eta_F} + \alpha_{FN}^{W}\beta\pi_{N,t+1}^{W*\theta_{FN}^{W}(1+\eta_F)}x_{1,t+1}^{WN*}$$

$$x_{2,t}^{W*} = (1-\tau_F^{W})C_t^{O*-\sigma_H}\frac{W_{F,t}^*}{P_{T,t}^*}\frac{P_{T,t}^*}{P_t^*}\left(\frac{L_{T,t}^{O*}}{a_T^*}\right) + \alpha_H^{W}\beta\pi_{H,t+1}^{W\theta_H^{W}-1}x_{2,t+1}^{W*}$$

$$x_{2,t}^{WN*} = (1-\tau_{FN}^{W})C_t^{O*-\sigma_F}\frac{W_{N,t}^*}{P_t^*}\left(\frac{L_{N,t}^{O*}}{1-a_T^*}\right) + \alpha_{FN}^{W}\beta\pi_{N,t+1}^{W*\theta_{FN}^{W}-1}x_{2,t+1}^{WN*}$$

$$\pi_{F,t}^{W*} = \frac{W_{F,t}^*}{P_{T,t}^*}\frac{P_{T,t-1}^*}{W_{F,t-1}^*}\frac{P_{F,t-1}^*}{P_{T,t-1}^*}\frac{P_{T,t}^*}{P_{F,t}^*}\pi_{F,t}^*$$

$$\pi_{N,t}^{W*} = \frac{W_{N,t}^*}{P_t^*}\frac{P_{t-1}^*}{W_{N,t-1}^*}\frac{P_{N,t-1}^*}{P_{t-1}^*}\frac{P_t^*}{P_{N,t}^*}\pi_{N,t}^*$$

Ricardian households:

$$\beta E_t\frac{C_{t+1}^{O-\sigma_H}}{C_t^{O-\sigma_H}}\frac{(1+i_t)}{\pi_{t+1}} = 1$$

$$\beta E_t \frac{C_{t+1}^{O-\sigma_H}}{C_t^{O-\sigma_H}} \frac{(1+i_t^*)}{\pi_{t+1}} \frac{Q_{t+1}}{Q_t} = \frac{1}{\Phi\left(\frac{s_t B_{F,t}}{P_t}\right)}$$

$$\beta E_t \frac{C_{t+1}^{O*-\sigma_F}}{C_t^{O*-\sigma_F}} \frac{(1+i_t^*)}{\pi_{t+1}^*} = 1$$

Rule-of-thumb households:

$$C_t^R = a_T \left(\frac{W_{T,t}}{P_t}\right)^{\frac{1+\eta_H}{\eta_H}} + (1-a_T)\left(\frac{W_{N,t}}{P_t}\right)^{\frac{1+\eta_H}{\eta_H}}$$

$$\frac{\left(\frac{L_{k,t}^R}{a_k}\right)^{\eta_H}}{C_t^{R-\sigma}} = \frac{W_{k,t}}{P_t}, \qquad k = T, N$$

$$C_t^{R*} = a_T^* \left(\frac{W_{T,t}^*}{P_t^*}\right)^{\frac{1+\eta_F}{\eta_F}} + (1-a_T^*)\left(\frac{W_{N,t}^*}{P_t^*}\right)^{\frac{1+\eta_F}{\eta_F}}$$

$$\frac{\left(\frac{L_{k,t}^{R*}}{a_k^*}\right)^{\eta_F}}{C_t^{R*-\sigma}} = \frac{W_{k,t}^*}{P_t^*}, \qquad k = T, N$$

Aggregation across households:

$$L_{k,t} = (1-\lambda_H^R)L_{k,t}^O + \lambda_H^R L_{k,t}^R, \qquad k = T, N$$

$$C_t = (1-\lambda_H^R)C_t^O + \lambda_H^R C_t^R$$

$$L_{k,t}^* = (1-\lambda_F^R)L_{k,t}^{O*} + \lambda_F^R L_{k,t}^{R*}, \qquad k = T, N$$

$$C_t^* = (1-\lambda_F^R)C_t^{O*} + \lambda_F^R C_t^{R*}$$

Price indices:

$$P_t = \left[a_T P_{T,t}^{1-\varphi_H^N} + (1-a_T)P_{N,t}^{1-\varphi_H^N}\right]^{\frac{1}{1-\varphi_H^N}}$$

$$P_t^* = \left[a_T^* P_{T,t}^{*1-\varphi_F^N} + (1-a_T^*)P_{N,t}^{*1-\varphi_F^N}\right]^{\frac{1}{1-\varphi_F^N}}$$

$$P_{T,t} = \left[a_H P_{H,t}^{1-\varphi_H} + (1-a_H)P_{F,t}^{1-\varphi_H}\right]^{\frac{1}{1-\varphi_H}}$$

$$P^*_{T,t} = \left[a_F P^{*1-\varphi_F}_{F,t} + (1-a_F) P^{*1-\varphi_F}_{H,t}\right]^{\frac{1}{1-\varphi_F}}$$

Exchange rate definition:

$$Q_t = \left(\frac{s_t P^*_{T,t}}{P_{T,t}}\right)\left(\frac{P_{T,t}}{P_t}\right) \left(\frac{P^*_{T,t}}{P^*_t}\right)^{-1}$$

Production functions:

$$Disp_{T,t} Y_{T,t} = L_{T,t}$$
$$Disp^*_{T,t} Y^*_{T,t} = L^*_{T,t},$$
$$Disp_{N,t} C_{N,t} = L_{N,t}$$
$$Disp^*_{N,t} C^*_{N,t} = L^*_{N,t}$$

Resource constraint:

$$C_t + \frac{s_t B_{F,t}}{P_t (1+i^*_t) \Phi\left(\frac{s_t B_{F,t}}{P_t}\right)} = Y_t + \frac{s_t B_{F,t-1}}{P_t}$$

Monetary policy rules:

$$\log\left(\frac{i_t}{\bar{\imath}}\right) = (1-\alpha^{FIX}_H)\left[\alpha^R_H \log\left(\frac{i_{t-1}}{\bar{\imath}}\right) + \alpha^\pi_H \log\left(\frac{\pi_t}{\bar{\pi}}\right)\right] + \alpha^{FIX}_H \log\left(\frac{i^*_t \Phi\left(\frac{s_t B_{F,t}}{P_t}\right)}{\bar{\imath}}\right) + \psi^I_t$$

$$\log\left(\frac{i^*_t}{\bar{\imath}}\right) = (1-\alpha^{FIX}_F)\left[\alpha^R_F \log\left(\frac{i^*_{t-1}}{\bar{\imath}}\right) + \alpha^\pi_F \log\left(\frac{\pi^*_t}{\bar{\pi}}\right)\right] + \alpha^{FIX}_F \log\left(\frac{i_t}{\bar{\imath} \Phi\left(\frac{s_t B_{F,t}}{P_t}\right)}\right) + \psi^{I*}_t$$

References

Abbritti, M and Weber, S (2010). 'Labor market institutions and the business cycle Unemployment rigidities vs. real wage rigidities', *Working Paper Series 1183*, ECB.

Abiad, A, Detragiache, E and Tressel T (2010). 'A New Database of Financial Reform', IMF Working Paper 08/266

Assenmacher-Wesche K. and S. Gerlach (2010). 'Financial Structure and the Impact of Monetary Policy on Property Prices'. Swiss National Bank Working Paper.

Bandiera, O, Caprio, R, Honohan, P and Schiantarelli, F (2000). 'Does financial reform raise or reduce saving?', *Review of Economic and Statistics*, Vol. 82(2), pages 239-63.

Barnett, A and Straub, R (2008). "What drives U.S. current account fluctuations?," *ECB Working Paper Series 959*, European Central Bank.

Barrell, R and Davis, E P (2007). 'Financial Liberalisation, Consumption and Wealth Effects in Seven OECD Countries', *Scottish Journal of Political Economy*, Vol. 54, pages. 254-267.

Bayoumi, T (1993a). 'Financial deregulation and consumption in the United Kingdom', *The Review of Economics and Statistics*, Vol. 75(3), pages 536-39.

Bayoumi, T (1993b). 'Financial deregulation and household saving', *Economic Journal*, Vol. 103(421), pages 1997-202.

Bayoumi, T and Koujianou, P (1989). 'The Effects of Financial Deregulation on Consumption', *IMF Working Papers*, No. 89/88.

Benito, A and Mumtaz, H (2006). 'Consumption excess sensitivity, liquidity constraints and the collateral role of housing', *Bank of England Working Paper* No. 306

Blanchard, O and Giavazzi, F (2003). 'Macroeconomic effects of regulation and deregulation in goods and labour markets' *Quarterly Journal of Economics*, Vol. 118, pages 1369-1413.

Born, B, Pfeiffer, J and Mueller, G (2015). 'Does Austerity Pay off?' *CEPR DP 10425.*

Canova, F (2007). 'Methods for Applied Macroeconomic Research', Princeton University Press.

Canova, F and De Nicolo, G (2002). 'Monetary disturbances matter for business fluctuations in the G-7', *Journal of Monetary Economics*, Vol. 49(6), pages 1131-59.

Calza, A, Monacelli, T and Stracca, L (2013). 'Housing Finance And Monetary Policy', *Journal of the European Economic Association*, vol. 11, pages 101-122.

Campbell, J and Mankiw, G (1989). 'Consumption, Income, and Interest Rates: Reinterpreting the Time Series Evidence', *NBER Macroeconomics Annual* 1989, Vol. 4

Canova, F and Paustian, M (2011). "Business Cycle Measurement with some Theory," *Journal of Monetary Economics*, vol. 58, no. 4, pages 345-361.

Chinn, M and Ito, H (2008). "A New Measure of Financial Openness", *Journal of Comparative Policy Analysis*, Volume 10, Issue 3, pages 309 - 322.

Christiano, L, Eichenbaum, M and Evans, C (1999). 'Monetary policy shocks: what have we learned and to what end?' in: J. B. Taylor and M. Woodford (ed.), Handbook of Macroeconomics, edition 1, volume 1, chapter 2, pages 65-148 Elsevier

Cogley, T and Sargent, T (2005). 'Drift and Volatilities: Monetary Policies and Outcomes in the Post WWII U.S', *Review of Economic Dynamics,* Vol. 8(2), pages 262-302.

Conway, P. and de Rosa D. and Nicoletti G. and Steiner, F. (2006). "Product market regulation and productivity convergence," *OECD Economic Studies*, Vol. 2, pages 39-76.

Corsetti, G, Dedola, L and Leduc, S (2008). 'International Risk Sharing and the Transmission of Productivity Shocks', *The Review of Economic Studies*, 75, pages 443-473

Corsetti, G, Dedola, L and Leduc, S (2010). 'Optimal Monetary Policy in Open Economies', in *Handbook of Monetary Economics*, Benjamin M. Friedman & Michael Woodford (ed.), Vol 3, Chapter 16, pages 861-933.

Diaz-Alejandro, C (1985). 'Good-bye Financial Repression, Hello Financial Crash', *Journal of Development Economics,* Vol. 19(1–2): pages 1–24.

Eggertson, G, Ferrero, A and Raffo, A (2014). 'Can structural reforms help Europe?', *Journal of Monetary Economics*, Vol 61 pages 2-22

Erceg, C, Guerrieri, L and Gust, C (2006). 'SIGMA: a new open economy model for policy analysis', *International Journal of Central Banking Vol. 2, No. 1*

Faust, J and Rogers, J H (2003). 'Monetary policy's role in exchange rate behavior', *Journal of Monetary Economics, Vol. 50(7),* pages 1403-1424.

Fraser Institute (2013). *Economic freedom of the world: 2013 Annual report*, Vancouver.

Fry, R and Pagan, A (2011). 'Sign Restrictions in Structural Vector Autoregressions: A Critical Review' *Journal of Economic Literature*, American Economic Association, vol. 49(4), pages 938-60.

Gali, J, Lopez-Salido, D and Valles, J (2004). 'Rule of thumb consumers and the design of interest rate rules', *Journal of Money, Credit and Banking, Vol. 36, No. 4.*

Gali, J, Lopez-Salido, D and Valles, J (2007). 'Understanding the effects of government spending on consumption', *Journal of the European Economic Association, Vol. 5, No. 1,* pages 227-270.

Gilhooly, R, Weale, M and Wieladek, T (2012). 'Estimation of short dynamic panels in the presence of cross-sectional dependence and dynamic heterogeneity', *Bank of England External MPC Unit Discussion Paper No. 38*.

Godley, W and Cripps, F (I974). 'Budget deficit and demand management', *London and Cambridge Economic Bulletin*, January.

Goldsmith, R W (1969). 'Financial structure and development', Yale University Press.

Gordon, R J (1977). 'Can the inflation of the 1970s be explained?', *Brookings Papers on Economic Activity, Vol.* ***8*** *(1),* 765–78.

Griffith, R, Harrison, R and Macartney, G (2007). 'Product Market Refors, Labour Market Institutions and Unemployment', *Economic Journal*, Vol. 117, pages C142-C146.

Haefke, C, Sonntag, M and van Rens, T (2013). 'Wage Rigidity and Job creation', mimeo.

Heathcote, J and Perri, F (2002). 'Financial autarky and international business cycles', *Journal of Monetary Economics*, vol. 49(3), pages 601-627.

Hooper, P, Johnson, K and Marquez, J (2000). 'Trade elasticities for the G-7 countries', *Princeton Studies in International Economics*, No. 87.

Iacoviello, M and Minetti, R (2003). 'Financial Liberalization and the Sensitivity of House Prices to Monetary Policy: Theory and Evidence', *Manchester School*, University of Manchester, Vol. 71(1), pages 20-34, January.

Ilzetzki, E, Reinhart, C and Rogoff, K (2010). 'Exchange Rate Arrangements Entering the 21st Century: Which Anchor Will Hold?'

Jappelli, T and Pagano, M (1994). 'Saving, growth, and liquidity constraints', *Quarterly Journal of Economics*, Vol. 109(1), pages 83-109.

Jappelli, T, Pischke, J and Souleles, N (1998). 'Testing for liquidity constraints in Euler equations with complementary data sources', *The Review of Economics and Statistics*, pages 251-262.

Jarocinski, M (2010). 'Responses to Monetary Policy Shocks in the East and the West of Europe', *Journal of Applied Econometrics*, Vol. 25(5), pages 838-68.

Jayaratne, J and Strahan, P (1996). 'The Finance-Growth Nexus: Evidence from Bank Branch Deregulation', *Quarterly Journal of Economics*, Vol. 111(3), pages 639-670.

Jorda, O (2005). 'Estimation and Inference of Impulse Responses by Local Projections', *American Economic Review*, Vol. 95(1), pages 161-182.

Jorda, O, Schularick, M and Taylor, A (2014). 'When Credit Bites Back', *Journal of Money, Credit and Banking*, Vol. 45(s2), pages 3-28.

Kim, S (2001a). 'International transmission of US monetary policy shocks: Evidence from VARs', *Journal of Monetary Economics,* No. 48, pages 339-372.

Kim, S (2001b). 'Effects of monetary policy shocks on the trade balance in small open European countries', *Economics Letters*, No. 71, pages 197-203.

King, M (2009). Speech at the CBI dinner, Nottingham, 20th January.

Koop, G, Pesaran, H and Potter, S (1996). 'Impulse response analysis in nonlinear multivariate analysis', vol. 74, pages 119-147.

Lee, J and Chinn, M (2006). 'Current account and real exchange rate dynamics in the G7 countries', *Journal of International Money and Finance,* No. 25, pages 257-274.

Lewis, K (1997). 'Are countries with official international restrictions liquidity constrained?', *European Economic Review*, Vol. 46(6), pages 1079-109.

Litterman, R (1986). 'Forecasting with Bayesian Vector Autoregressions-Five Years of Experience', *Journal of Business and Economic Statistics*, Vol. 4, pages 25-38.

Mendoza, E (1992). 'The effects of macroeconomic shocks in a basic equilibrium framework', *IMF staff papers*, Vol. 39, No.5, p. 855-889.

Mertens, K (2008). 'Deposit rate ceilings and monetary transmission in the US', *Journal of Monetary Economics*, Vol. 55(7), pages 1290-1302.

Muellbauer, J and Murphy, A (1989). 'Why has Personal Saving Collapsed', Credit Suisse First Boston Research.

Nickell, S, Nunziata, L, and Ochel, W (2005). 'Unemployment in the OECD since the 1960s. What do we know?', *Economic Journal,* Vol. 115 (1), pages 1–27.

Olivei, G and Tenreyro, S (2007). 'The Timing of Monetary Policy Shocks', *American Economic Review*, Vol. 97(3), pages 636-663.

Olivei, G and Tenreyro, S (2010). 'Wage-setting patterns and monetary policy: International evidence', *Journal of Monetary Economics*, Vol. 57(7), pages 785-802.

Pesaran, M H and Smith, R (1995). 'Estimating long-run relationships from dynamic heterogeneous panels', *Journal of Econometrics*, Vol. 68(1), pages 79-113.

Pissarides, C (2009). 'The unemployment volatility puzzle: is wage stickiness the answer?', *Econometrica*, Vol. 77, No. 5, pp 1339-1369

Rebucci, A (2003). 'On the heterogeneity bias of pooled estimators in stationary VAR specifications', *IMF Working Papers 03/73*.

Romer C and Romer, D (2004). 'A new measure of monetary shocks: derivation and implications', *American Economic Review*, Vol. 94, No. 4, pages 1055-1084.

Rubio-Ramirez, J, Waggoner, D F and Zha, T (2010). 'Structural Vector Autoregressions: Theory of Identification and Algorithms for Inference', *Review of Economic Studies*, Vol. 77(2), pages 665-96.

S**chmitt-Grohe, S and Uribe, M (2003).** 'Closing small open economy models', *Journal of International Economics*, Vol. 61, pages 163-185

Sims, C. (1980). 'Macroeconomics and Reality'. *Econometrica*. Vol 48. Pp. 1-48.

Sims, C. (1992). 'Interpreting the macroeconomic time series facts: The effects of monetary policy', *European Economic Review*. Vol 36(5). Pp. 975-1000.

Sims, C and Zha, T. (2006). 'Does Monetary Policy Generate Recessions?', *Macroeconomic Dynamics*. Vol 10. Pp. 231-272.

Sa, F, Towbin, P and Wieladek, T (2014). 'Capital Inflows, Financial Structure and Housing Booms', *Journal of the European Economic Association*, vol. 12(2), pages 522-546.

Sarno, L and Taylor, M P (1998). 'Real Interest Rates, Liquidity Constraints and Financial Deregulation: Private Consumption Behaviour in the U.K', *Journal of Macroeconomics*, Vol. 20(2), pages 221-42.

Shaw, E (1973). 'Financial deepening in economic development', New York, Oxford University Press.

Stockman, A and Tesar, L (1995). 'Tastes and technology in a two-country model of the business cycle: explaining international comovements', *American Economic Review*, Col. 85, No.1, pp. 168-185.

Stone, J R N and Rowe, D A (1962). 'A Post-war Expenditure Function', *Manchester School*, Vol. 30, pages 187-201.

Thwaites, G and Tenreyro, S (2016). 'Pushing on a String: US Monetary Policy is less Powerful in Recessions', *American Economic Journal: Macroeconomics*, forthcoming.

Towbin, P and Weber, S (2013). 'Limits of floating Exchange Rates: the role of Foreign Currency Debt and Import Structure', *Journal of Development Economics, forthcoming.*

Uhlig, H (2005). 'What are the effects of monetary policy on output? Results from an agnostic identification procedure', *Journal of Monetary Economics*, Vol. 52(2), pages 381-419.

Wieladek, T (**2016**). 'The Varying Coefficient Bayesian Panel VARs', *Bank of England Staff Working Paper* No. 578.