News, Sentiment and Capital Flows[*]

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Abstract

Understanding the drivers of capital flows is crucial from a policy perspective. Capital inflows are desirable if they are related to a country's fundamentals, but can be problematic in the absence of surge in local productivity. Expected excess returns, which drive capital flows, are related to expected future productivity, but they can also be driven by excessive optimism about future productivity. We empirically disentangle the effect on capital flows of "news" (surges in optimism correlated with future productivity) and "sentiment" (surges in optimism unrelated to future productivity). We find that news shocks lead to a decrease in both gross capital inflows and gross capital outflows, while sentiment shocks lead to an increase in both gross inflows and outflows. This suggests that expansions in cross-border flows are typically not associated with rising productivity. These findings are consistent with the existence of asymmetric information between domestic and foreign investors about the country's fundamentals.

JEL-Classification: D82, E32, F32.
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1   Introduction

International capital flows are hard to explain. A large literature has studied the potential push (global) and pull (local) factors behind cross-country capital movements.[1] Understanding the drivers of capital flows is in fact crucial from a policy perspective. If capital inflows are related to a country's fundamentals, then they are desirable. If the country is experiencing capital inflows in the absence of surge in local productivity, then they can become problematic, and raise the question of capital controls. This has led to concerns about push factors, like the "global financial cycle" (Rey, 2015).

The aim of this paper is to assess whether domestic gross capital flows are driven by productivity shocks. In the case of capital flows, the forward-looking dimension is central, as capital flows should respond to expected excess returns. However, expected excess returns are related to expected future productivity, but they can also be driven by excessive optimism. A key contribution of the paper is to disentangle the effect of "news" (surges in optimism that are correlated with future productivity) from "sentiment" (surges in optimism that are unrelated to future productivity). We find that news shocks lead to a decrease in both gross capital inflows and gross capital outflows, while sentiment shocks lead to an increase in both gross inflows and outflows. The latter have larger quantitative impact. Overall, these results suggest that expansions in cross-border flows are typically not associated with rising productivity.

To understand our results, we present a two-country model with asymmetric information between domestic and foreign investors about the country's fundamentals. All agents share a noisy public signal that can be driven by "news" (i.e. by actual improvements in the fundamentals) or by "noise" (i.e. by excessive optimism), but home agents have additional private information. A news shock about future productivity can generate a drop in both gross inflows and gross outflows. Following a news shock, domestic investors, who are better informed about their domestic productivity, increase their demand for domestic assets relatively more than foreign investors do. The increase in demand of domestic assets raises their price, which mechanically increases the share of domestic assets in foreign investors' portfolio, and decreases their expected returns. Taken together, domestic investors sell foreign assets - decreasing capital outflows - and buy domestic assets from foreign investors - decreasing capital inflows. On the contrary, a noise shock can generate an increase in both gross inflows and outflows. A noise shock makes investors optimistic about future domestic fundamentals, but foreign investors are relatively more optimistic than domestic investors, who are better informed. Hence, foreign investors demand more domestic assets, which raises domestic assets' price. The revaluation of domestically-held domestic assets and the decrease in their expected returns make domestic investors sell domestic assets - increasing capital inflows - and buy more foreign assets - increasing capital outflows. In conclusion, our model predicts that

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[1] Calvo et al. (1993), Calvo et al. (1996), Fernandez-Arias (1996) and Chuhan et al. (1998) first referred to the "push" external forces and the "pull" domestic factors influencing the capital flows toward an economy. More recently, Fratzscher (2012), Forbes and Warnock (2012) or Adler et al. (2016) in a dynamic set-up, among others, have worked on this and underlined the importance of global factors, the VIX in particular. Broner et al. (2013) have also pointed out the cyclicality of gross capital flows.

news shocks should trigger a drop in both inflows and outflows, while noise shocks generate an increase in gross capital flows.

Empirically, we investigate the role of fundamentals for capital flows by using a recursive structural VAR approach that allows us to identify three shocks: a TFP surprise shock, a news shock about future TFP and a "sentiment" shock. Our specification includes TFP, GDP per capita, a variable of expectations and gross capital inflows or outflows in the last position. The "sentiment" shock captures any shock that affects expectations while unrelated to technology. Formally, and following Levchenko and Pandalai-Nayar (2015), who builds on Barsky and Sims (2011), we define the technology surprise shock as the technology's (TFP) own innovation. The news shock is identified as the structural shock that best explains future variations in technology not accounted for by the TFP surprise shock. The inclusion of an expectations' variable that is able to react on impact to news is key here to overcome the fundamentalness issue.[2] And finally, the sentiment shock is the shock that best explains short-run variations in expectations, not accounted for by the technology surprise shock nor by the news shock.

We start by focusing on the United States. Our time span covers the 1971-2015 periods and the data are at quarterly frequency. Our findings show that sentiment and news shocks affect significantly the U.S. capital inflows and outflows. A positive news shock triggers an immediate, short-lived and negative response of capital flows, consistent with the model's predictions. Sentiment shocks have significantly positive effects on capital flows on impact with medium-lasting effects. Interestingly, TFP surprise shocks do not induce significant responses of capital flows. This shows that expectations play a key role in driving capital flows at the country level. Our results are unchanged when extending our analysis to a panel of 18 OECD economies.

Quantitatively, we show that news and sentiment shocks are key drivers of capital flows: these shocks contribute for up to 50% of their forecast error variance decomposition (FEVD). For the United States, sentiments shocks alone can explain around 40% of the FEVD, with the remaining 10% attributable to news shocks. In our panel analysis, the shares of sentiment and news shocks are more similar in size. In all cases, the share explained by the TFP surprise shock is negligible. Two main conclusions can be drawn from these results. First, non-technology shocks are important driver of capital flows. They are at least as important as technology shocks, often even more important. Second, contemporaneous technology shocks play a negligible role but anticipated technology (i.e. news) shocks are important.

According to the model, the sentiment shock can be explained by noise shocks, i.e. shifts in expectations about future productivity. However, the sentiment shock being identified as a residual, it is important to rule out other potential explanations. First, we consider theoretically whether sentiment can reflect domestic demand shocks. The model shows that domestic demand shocks decrease capital outflows, as domestic agents save less. Assuming international assets price spillovers are small, the subsequent decrease in domestic assets prices increases foreign demand, resulting in positive capital inflows. Demand shocks thus typically generate an increase in inflows,

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[2]See for instance Leeper et al. (2013) or Forni and Gambetti (2014).

but also a decrease in outflows, which is not consistent with the effect of our identified sentiment shock. Second, we investigate empirically alternative explanations behind sentiment shocks. In the last few years, a new strand of the capital flows literature has focused on the "global financial cycles". Rey (2015) established that there were cycles in capital flows, assets prices and credit growth, which she named "global financial cycles". She also pointed out the role of the VIX or the FED funds rate. The role of global factors in driving capital flows has also been emphasized in the literature (see Forbes and Warnock (2012), Fratzscher (2012) or Passari and Rey (2015)). Hence, we assess how including global variables modifies our responses to the shocks and to which extent our identified shocks are global. Adding sequentially the VIX and the FFR (but also BBB U.S. corporate bond spread and U.S. securities broker-dealer leverage) in our VAR specification does not modify much our results, and in particular, the impact of sentiment shocks on capital flows remains similar. Then, in order to determine the extent to which our shocks and in particular sentiment shocks, are global, we undertake a principal component analysis of the countries' shocks series. This exercise shows that less than 20% of their total variance can be explained by the first principal component, suggesting that most of the country's domestic shock is not driven by some "global" component. Hence, the sentiment shock does not seem to be a "global" shock, nor reflect global factors. These findings are consistent with Cerutti et al. (2017), who argue that global financial cycles are in fact quantitatively small. We show that the fact that capital flows are not mainly driven by global shocks does not mean that there are necessarily driven by local fundamentals, as excessive local optimism is also a key driver.

Then, we also distinguish across types of capital flows: FDI, portfolio flows (bond and equity securities) and other investment (loans, trade credit/debit,...). While FDI and other flows react like total flows, equity inflows react in the opposite direction. This suggests that information asymmetries are less present in the case of equity. Indeed, equity markets are more liquid, which implies that prices better reflect fundamentals. Listed companies are also subject to disclosure, which implies that information on this type of assets is more transparent and public.

Finally, our results are robust to the addition of extra variables in the specification, such as 10-year government bonds yields, inflation, local interest rates or real effective exchange rates. Using more lags does not modify our results either; if anything they increase the contribution of our shocks to the FEVD of capital flows.

This paper is related to the literature on expectation-driven business cycles. It is a widely shared view that expectations are key drivers of macroeconomic fluctuations. Indeed, there is increasing empirical evidence that expectations do induce movements in key domestic macroeconomic aggregates.[3] Their international financial dimension has however been neglected, despite the idea that expected returns play a key role in capital flows.[4] We inform on this issue by studying the effects of news and sentiment shocks on international capital flows.

Then, little has been done to analyze the impact of expectations on capital flows. One example

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[3] See for instance Beaudry and Portier (2006) or Barsky and Sims (2011).

[4] The role of news and sentiment on international comovement is the object of Levchenko and Pandalai-Nayar (2015) and Siena (2017), but both studies do not consider capital flows.

is the paper by Milesi-Ferretti and Tille (2011) showing that countries with worse outlooks suffered larger capital retrenchments, using measures of growth and public finances' prospects. Their focus is, however, on the great recession between 2006 and 2009. In a previous paper, Cordonier (2017) shows that the forward-looking component of the consumer sentiment index is significantly related to capital flows. This paper extends on this idea by using a more structural approach and distinguishing the technology-related part of expectations (news) from their non-technology-related part (sentiment). Moreover, one particular challenge in the study of capital flows so far has been to find set-ups able to explain a significant share of capital flows' variations. To our knowledge, most specifications in the literature have little explaining power. An additional contribution of our paper is that the identified shocks explain a significant portion of domestic capital flows' variations, suggesting a key role for expectations.

Our model is related to Albuquerque et al. (2007, 2009) and Brennan (1997), who study the role of information asymmetries on capital flows. But our model is especially close to Tille and van Wincoop (2014), as it is a general equilibrium model. Unlike Tille and van Wincoop (2014), we do not consider endogenous responses of saving and investment, as savings and the stock of assets are fixed in our model. Indeed, our focus is on portfolio shifts due to changes in expected returns, so we abstract from portfolio growth effects and time-varying risk. While they also consider what we call news (a partly foreseen increase in future productivity) and noise shocks (an aggregate error in public signal), they study the effect of noise without private information, and in that context noise shocks have no effect on capital flows. We show that when there are also private signals, and especially with asymmetric information between the home and foreign country, noise shocks have non-trivial effect on capital flows.

The rest of the paper is structured as follow: Section 2 presents a two-country model with information asymmetry. Section 3 describes our methodology, Section 4 defines the data gathered for the empirical analysis, Section 5 presents the main findings of this paper, while Section 6 and 7, respectively discusses the role of the VIX and the FED funds rate and distinguishes across capital flows' types. Section 8 assesses the robustness of our results and Section 9 concludes.

2 A stylized model of gross capital flows with asymmetric information

We develop a two-country model of gross capital flows with productivity and demand shocks to understand the effects of our empirically identified shocks. Productivity shocks increase the return of domestic assets, while demand shocks are shocks that reduce savings in the domestic economy. Domestic and foreign agents have asymmetric information about domestic shocks. While domestic agents get a private signal about domestic shocks, foreign agents only observe a common noisy signal about future domestic productivity. We will be able to analyze three types of shocks: "news" shocks (shocks to future productivity), "noise" shocks (shocks to the noisy component of the signal) and demand shocks.

We consider an overlapping generations (OLG) model with agents who live two periods. In their first period, they are "investors", indexed by i, then, in their second period, they become "rentiers", indexed by r. There are two countries, home, indexed by H and foreign, indexed by F. There is a tree located in the home country, and a tree located in the foreign country. Each tree yields a dividend and can be sold every period. The dividend of the domestic tree in period t is $e^{\delta_t} - 1$ and its price Q_t, and the dividend of the foreign tree is $e^{\delta_t^*} - 1$ and its price Q_t^*. δ_t and δ_t^* are i.i.d. processes with mean zero and standard deviation σ_δ and σ_δ^*. In the home country, a generation of investors of size 1 is born every period, each endowed with $1/\beta$ units of good. They consume and buy shares in the domestic tree and in the foreign tree from rentiers. The next period, investors become rentiers and consume the endowment and value of their shares. Similarly, in the foreign country, a generation of investors of size 1 is born every period.

This OLG structure fulfils two purposes. First, it greatly simplifies the analysis by suppressing wealth effects, as assets demand and assets supply arise from different agents in the economy (investors and rentiers). Second, by limiting the time horizon of the agents, it generates a stationary wealth distribution and guarantees the existence of a steady state.

Savings and portfolio choices An investor $j \in [0, 1]$ born in t in country H maximizes the following expected utility:

$$U_{jt}^H = (1 - \beta e^{-\gamma_t^H}) \log(C_{jt}^{iH}) + \beta e^{-\gamma_t^H} E_{jt}^H \left\{ \log(C_{jt+1}^{rH}) \right\} \tag{2.1}$$

E_{jt}^H is the expectation conditional on home investor j's information. C_{jt}^{iH} is j's consumption during her investor period and C_{jt+1}^{rH} is her consumption during her rentier period. γ_t^H is a preference shock that increases the investors' demand for goods. γ_t^H is i.i.d. with mean zero and standard deviation σ_γ^H.

The agent is subject to the followings budget constraints:

$$\begin{array}{rcl} C_{jt}^{iH} + Q_t K_{jt}^H + Q_t^* K_{jt}^{H*} & = & \frac{1}{\beta} \\ (Q_{t+1} + \delta_{t+1}) K_{jt}^H + (Q_{t+1}^* + \delta_{t+1}^*) K_{jt}^{H*} & = & C_{jt+1}^{rH} \end{array} \tag{2.2}$$

K_{jt}^H is j's investment in the domestic asset and K_{jt}^{H*} is her investment in the foreign asset.

Denote by $S_{jt}^H = Q_t K_{jt}^H + Q_t^* K_{jt}^{H*}$ the total savings of home investor j and $X_{jt}^{H*} = Q_t^* K_{jt}^{H*} / S_{jt}^H$ the share of savings invested in the foreign asset. $1 - X_{jt}^{H*}$ is then the share invested at home. With log-utility, savings have a simple expression:

$$S_{jt}^H = e^{\gamma_t^H} \tag{2.3}$$

Then, following the literature, we use a second-order approximation of the optimality conditions

of the investor to obtain portfolio shares:

$$
\begin{aligned}
1 - X_{jt}^{H*} &= \frac{E_{jt}^H\{R_{t+1} - R_{t+1}^*\} + (\sigma^{H*})^2}{(\sigma^H)^2 + (\sigma^{H*})^2} \\
X_{jt}^{H*} &= \frac{E_{jt}^H\{R_{t+1}^* - R_{t+1}\} + (\sigma^H)^2}{(\sigma^H)^2 + (\sigma^{H*})^2}
\end{aligned}
\tag{2.4}
$$

where $R_{t+1} = (e^{\delta_{t+1}} - 1 + Q_{t+1})/Q_t$ is the return on the home asset, $R_{t+1}^* = (e^{\delta_{t+1}^*} - 1 + Q_{t+1}^*)/Q_t$ is the return on the foreign asset. $(\sigma^H)^2$ and $(\sigma^{H*})^2$ are the variances of home and foreign asset returns conditional on a home investor's information. As the distribution of shocks is fixed and the structure of information is fixed and homogeneous across home investors, these conditional variances are constant.

Symmetric relations hold for investor $k \in [0,1]$ in the foreign country:

$$
\begin{aligned}
S_{kt}^F &= e^{\gamma_t^F} \\
1 - X_{kt}^F &= \frac{E_{kt}^F\{R_{t+1}^* - R_{t+1}\} + (\sigma^F)^2}{(\sigma^F)^2 + (\sigma^{F*})^2} \\
X_{kt}^F &= \frac{E_{kt}^F\{R_{t+1} - R_{t+1}^*\} + (\sigma^{F*})^2}{(\sigma^F)^2 + (\sigma^{F*})^2}
\end{aligned}
\tag{2.5}
$$

where S_{kt}^F are k's savings, $X_{kt}^F = Q_t K_{kt}^F/S_{kt}^F$ is the share of savings invested in the home country's asset and $1 - X_{kt}^F$ is the share invested in the foreign country's asset. γ_t^F is the foreign demand shock, which is i.i.d. with mean zero and standard deviation σ_γ^F.

Gross capital inflows in the home country are changes in the foreign holdings of domestic assets $KI_t^H = K_t^F - K_{t-1}^F$, and gross capital outflows are changes in the domestic holdings of foreign assets $KO_t^H = K_t^{H*} - K_{t-1}^{H*}$, with $K_t^F = \int_{1/2}^1 K_{kt}^F dk$, $K_t^{H*} = \int_0^{1/2} K_{jt}^{H*} dj$. Note that $KI^F = KO^H$ and $KO^F = KI^H$. Combining savings and portfolio shares as described in (2.3)-(2.5), we can determine cross border asset holdings K_t^F and K_t^{H*} and then derive gross capital flows as changes in these holdings.

Equilibrium on the world's asset markets implies that the asset supply should be equal to the asset demand:

$$
\begin{aligned}
Q_t &= (1 - X_t^{H*})S_t^H + X_t^F S_t^F \\
Q_t^* &= X_t^{H*} S_t^H + (1 - X_t^F) S_t^F
\end{aligned}
\tag{2.6}
$$

with $X_t^{H*} = \int_0^1 X_{jt}^{H*} dj$ and $X_t^F = \int_1^1 X_{kt}^F dk$ are the average portfolio shares. We used here the fact that savings are equal across investors in a given country ($S_{jt}^H = S_t^H$ for all j and $S_{kt}^F = S_t^F$ for all k).

Asymmetric information   As assets demand, and hence capital flows, depend on expected returns, it is crucial to specify the information structure. We assume that there are public signals on home and foreign future productivity that are observed both by home and foreign investors. We denote these signals $s_t = \delta_{t+1} + e_t$ and $s_t^* = \delta_{t+1}^* + e_t^*$, where e_t and e_t^* are i.i.d. noise shocks with mean zero and standard error σ_e and σ_e^*. s_t and s_t^* summarize the publicly available information.

The asymmetry in information goes as follows. Each home investor $j \in [0,1]$ additionally observes a private signal on home productivity $x_{jt} = \delta_{t+1} + \lambda_{jt}$. Similarly, each foreign investor $k \in [0,1]$ observes a private signal on foreign productivity $x_{kt}^* = \delta_{t+1}^* + \lambda_{kt}^*$. The individual noises λ_{jt} and λ_{kt}^* are i.i.d. shocks with mean zero and standard deviation σ_λ and σ_λ^* and cancel out at the aggregate level: $\int_0^1 \lambda_{jt} dj$ and $\int_0^1 \lambda_{kt}^* dk$. Besides, home investors observe their own demand shock γ_t^H, while foreign investors observe their own demand shock γ_t^F.

Finally, investors observe assets prices q_t and q_t^*. However, we assume, for simplicity, that asset prices are not used as a source of information on the fundamental shocks. Namely, investors do not extract any information from q_t and q_t^* regarding the state of the productivity shocks δ_{t+1} and δ_{t+1}^*, i.e. they neglect the reasons why asset prices change. In other words, investors are cursed in the sense of Eyster and Rabin (2005). This assumption is without loss of generality. Indeed, in our setup, prices are imperfect signals of the fundamentals, because they are also driven by demand shocks.[5] As a consequence, allowing investors to extract information on fundamentals from prices would not dramatically change our results.

With this information structure, domestic and foreign investors form the following expectations about fundamentals:

$$
\begin{aligned}
E_{kt}^F(\delta_{t+1}) &= \alpha_0 s_t \\
E_{jt}^H(\delta_{t+1}) &= (1-\kappa)\alpha_0 s_t + \kappa x_{jt}
\end{aligned}
$$

where $\alpha_0 = \sigma_e^{-2}/(\sigma_\delta^{-2} + \sigma_e^{-2})$ and $\kappa = \sigma_\lambda^{-2}/(\sigma_\delta^{-2} + \sigma_e^{-2} + \sigma_\lambda^{-2})$ are Bayesian weights.

We denote by $\bar{E}_t^H(\delta_{t+1}) = \int_0^1 E_{jt}^H(\delta_{t+1}) dj$ and $\bar{E}_t^F(\delta_{t+1}) = \int_0^1 E_{kt}^F(\delta_{t+1}) dk$ the average expectations of home and foreign investors about home fundamentals. We obtain:

$$
\begin{aligned}
\bar{E}_t^F(\delta_{t+1}) &= \alpha_0 \delta_{t+1} + \alpha_0 e_t \\
\bar{E}_t^H(\delta_{t+1}) &= \alpha_1 \delta_{t+1} + \alpha_2 e_t
\end{aligned}
\tag{2.7}
$$

where $\alpha_1 = [\alpha_0 + \kappa(1-\alpha_0)]$ and $\alpha_2 = (1-\kappa)\alpha_0$. We can see that, when $\kappa > 0$, we have $\alpha_2 < \alpha_0 < \alpha_1$: domestic expectations about the domestic fundamentals react more to the fundamental (δ_{t+1}) and less to the aggregate noise (e_t) than foreign expectations. Domestic investors thus have more precise expectations than foreign investors. κ, which is increasing in the precision of the domestic private signal σ_λ^{-2}, is a measure of the degree of asymmetry in information between home and foreign agents.

Log-linearized equilibrium We have assumed, for simplicity, that all shocks are i.i.d. As a result, log-linearizing around the steady state yields the following equilibrium home expected return, from the point of view of a home and a foreign investors:

$$
\begin{aligned}
E_{jt}^H(r_{t+1}) &= E_{jt}^H(\delta_{t+1}) - q_t \\
E_{kt}^F(r_{t+1}) &= E_{kt}^F(\delta_{t+1}) - q_t
\end{aligned}
\tag{2.8}
$$

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[5]This is similar to the finance literature, where "noise traders" make asset prices noisy signals of the fundamentals.

where lower-case letters denote log-deviations from the steady state. Indeed, with i.i.d. shocks, future asset prices depend only on future shocks, which are not known as of date t, which implies that $E_{jt}^H(q_{t+1}) = E_{kt}^F(q_{t+1}) = 0$.

Now consider capital inflows and outflows. They are a function of changes in cross-border asset holdings:

$$
\begin{aligned}
ki_t^H &= k_t^F - k_{t-1}^F \\
ko_t^H &= k_t^{H*} - k_{t-1}^{H*}
\end{aligned}
\tag{2.9}
$$

with $ki_t^H = KI_t/KF$ and $ko_t^H = KI_t/KH^*$ and

$$
\begin{aligned}
k_t^F &= s_t^F + x_t^F - q_t \\
k_t^{H*} &= s_t^H + x_t^{H*} - q_t*
\end{aligned}
\tag{2.10}
$$

Cross-border asset holdings depend on savings, average portfolio shares $x_t^F = \int_0^1 x_{kt}^F dk$ and $x_t^{H*} = \int_0^1 x_{jt}^{H*} dj$ and valuation effects.

Savings are a function of the preference shocks:

$$
\begin{aligned}
s_t^F &= -\gamma_t^F \\
s_t^H &= -\gamma_t^H
\end{aligned}
\tag{2.11}
$$

Average portfolio shares are functions of the average expected excess returns:

$$
\begin{aligned}
x_t^F &= \tfrac{\phi}{X}[\bar{E}_t^F(\delta_{t+1} - \delta_{t+1}^*) - (q_t - q_t^*)] \\
x_t^{H*} &= \tfrac{\phi}{X}[\bar{E}_t^H(\delta_{t+1}^* - \delta_{t+1}) - (q_t^* - q_t)]
\end{aligned}
\tag{2.12}
$$

where $\phi = [(\sigma^H)^2+(\sigma^{H*})^2]^{-1} = [(\sigma^F)^2+(\sigma^{F*})^2]^{-1}$ and $X = (\sigma^H)^2/[(\sigma^H)^2+(\sigma^{H*})^2] = (\sigma^{F*})^2/[(\sigma^F)^2+(\sigma^{F*})^2]$ is the steady-state share of foreign (home) assets in the home (foreign) portfolio. Note that because home (foreign) investors are relatively better informed on home (foreign) assets, $\sigma^H < \sigma^{H*}$ ($\sigma^{F*} < \sigma^F$), so there is home bias in asset holdings: $X < 1/2$. ϕ/X is the elasticity of portfolio shares to expected excess returns.

Taking asset prices as given, higher expected home productivity (higher $\bar{E}_t^H(\delta_{t+1})$ and $\bar{E}_t^F(\delta_{t+1})$) increases the portfolio shares, and should lead to more capital inflows (higher k_t^F) and less capital outflows (lower k_t^{H*}), as both home and foreign investors increase the share of home assets in their portfolio. However, the home asset is in limited supply, so an increase in the demand for the home asset leads to a price increase, which reduces the expected return of the home asset. Another effect of the asset price comes from valuation. An increase in the home asset price, by mechanically increasing the share of home assets in portfolios, reduces the need to acquire new home assets.

Asset prices are thus key to determine capital flows. Log-linearizing equations (2.6), we establish

$$
\begin{aligned}
q_t &= X(x_t^F - x_t^{H*}) + (1 - X)s_t^H + X s_t^F \\
q_t^* &= X(x_t^{H*} - x_t^F) + (1 - X)s_t^F + X s_t^H
\end{aligned}
$$

8

Using the equilibrium equations (2.6), we can also show that $q_t + q_t^* = -\gamma_t^H - \gamma_t^F$: demand shocks decrease the global demand for assets, which decrease the global asset price. We can derive the equilibrium home asset price:

$$q_t = \frac{\phi}{1+4\phi}E_t^H(\delta_{t+1} - \delta_{t+1}^*) + \frac{\phi}{1+4\phi}E_t^F(\delta_{t+1} - \delta_{t+1}^*) - \frac{(1 - X + 2\phi)\gamma_t^H + (X + 2\phi)\gamma_t^F}{1+4\phi} \quad (2.13)$$

The home asset price increases if either home or foreign investors think that the domestic asset is relatively more productive than the foreign asset, or if there is a decrease in the world demand for goods, which increases the world demand for assets. The foreign asset price q_t^* is then obtain simply as $q_t^* = -q_t - \gamma_t^H - \gamma_t^F$.

As a result, equilibrium cross-border asset holdings are:

$$\begin{aligned}
k_t^F &= \omega_1 E_t^F(\delta_{t+1} - \delta_{t+1}^*) - \omega_2 E_t^H(\delta_{t+1} - \delta_{t+1}^*) - \omega_3 \gamma_t^F + \omega_4 \gamma_t^H \\
k_t^{H*} &= \omega_1 E_t^H(\delta_{t+1}^* - \delta_{t+1}) - \omega_2 E_t^F(\delta_{t+1}^* - \delta_{t+1}) - \omega_3 \gamma_t^H + \omega_4 \gamma_t^F
\end{aligned} \quad (2.14)$$

with $\omega_1 = \frac{\phi}{X}\frac{1-X+2\phi}{1+4\phi}$, $\omega_2 = \frac{\phi}{X}\frac{(X+2\phi)}{1+4\phi}$, $\omega_3 = \frac{(1+\phi/X)(1-2X)+(X+2\phi)}{1+4\phi}$ and $\omega_4 = \frac{\phi(1-2X)+X(1-X-2\phi)}{1+4\phi}$.

Consider k_t^F, the foreign holdings of the home asset. Foreign expectations about the relative productivity of the home country have a positive effect on these foreign holdings. On the opposite, home investors' expectations about the relative productivity of the home asset have a negative effect on the foreign holdings of the home asset. This comes from the fact that a higher domestic demand for the home asset increases its price. This price increase limits the excess return of the home asset and lowers the demand of foreign investors. It also mechanically increases the share of home assets in the foreign investors' portfolios, which pushes foreign investors to sell the home asset to rebalance their portfolio.

Symmetric effects are at play for k_t^{H*}, the domestic holdings of the foreign asset.

The effect of shocks on capital flows We are now able to derive the aggregate effect of news shocks (δ_{t+1}), noise shocks (e_t) and demand shocks (γ_t^H) on capital flows.

The results are summarized in the following Proposition:

Proposition 1 (Capital inflows and outflows) *As $X < 1/2$, a positive news shock on the home asset $(\delta_{t+1} > 0)$ generates a decrease in capital outflows. It generates a decrease in inflows if $\kappa > \kappa_\delta$, with $\kappa_\delta = \frac{\alpha_0}{1-\alpha_0}\frac{1-2X}{X+2\phi}$.*

As $X < 1/2$, a positive noise shock on the home asset $(e_t > 0)$ generates an increase in capital inflows. It generates an increase in capital outflows if $\kappa > \kappa_e$, with $\kappa_e = \frac{1-2X}{(1-X+2X\phi)}$.

As $X < 1/2$, a positive demand shock at home (γ_t^H) generates a decrease in capital outflows and an increase in capital inflows.

Unambiguously, in the presence of home bias $(X < 1/2)$, a positive demand shock at home decreases capital outflows and increases capital inflows. Indeed, an increase in the demand for goods reduces savings. This means that domestic agents invest less in both home and foreign

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assets. This implies that demand shocks not only generate a decrease in capital outflows, but they also cannot drive a positive correlation between inflows and outflows.[6] A positive correlation between inflows and outflows arises only in the presence of expectation-related shocks, when the asymmetry in information is high enough ($\kappa > \max\{\kappa_\delta, \kappa_e\}$), with a retrenchment in capital flows following a news shock and an expansion following a noise shock.

First, consider the correlation of gross flows in the case of expectation-related shocks. While demand shocks correspond to a reduction in savings, expectation-related shocks do not change total savings, so larger holdings of home assets (in the case of a news shock for instance) have to come with a reduction in foreign asset holdings.[7] This mechanically generates a positive correlation of flows.

Consider now more specifically the effect of news and noise shocks on capital flows. To understand, consider a shock (either news or noise) that generates a positive public signal on home fundamentals. As both home and foreign investors receive the public signal, they become both more optimistic about those fundamentals. Holding the home asset price constant, this leads both home and foreign investors to demand more of the home asset. However, in equilibrium, home (foreign) investors can hold more home assets only if foreign (home) investors hold less home assets. Therefore, optimism about home productivity changes asset holdings only to the extent that the beliefs of home and foreign demands are affected in an asymmetric way. The adjustment then takes place through the increase in the home asset price. In equilibrium, this adjustment is large enough to keep away the agents with a relatively lower demand from the home asset.

One parameter is especially crucial to generate asymmetric demand responses: the relative precision of home investors' information about the home asset, which is reflected in $\kappa > 0$. In the case of a positive news shock, domestic agents are more confident about the fundamental nature of the shock. Hence, they are relatively more optimistic than foreign agents about domestic excess returns, and relatively more pessimistic about foreign excess returns. This tends to generate a decrease in both capital inflows and outflows, as domestic agents prefer to sell foreign assets and buy back domestic assets from foreigners. In the case of a positive noise shock, foreign agents are more easily confused by the optimistic public signal. As a result, they are relatively more optimistic than home agents about domestic excess returns, and relatively more pessimistic about foreign excess returns. This tends to generate an increase in both capital inflows and outflows, as home agents sell foreign assets and buy domestic assets from domestic agents.[8]

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[6]Note that in the absence of home bias ($X > 1/2$), a decrease in home savings would decrease the foreign asset price more than the home price. In that case, a decrease in home saving might generate more capital outflows to rebalance the home portfolio towards foreign assets. Similarly, it might generate less capital inflows to rebalance the foreign portfolio towards foreign assets as well. The presence of home bias rules out these effects.

[7]The independence of the saving rate from expected returns comes from log-utility, which is characterized by a unitary elasticity of intertemporal substitution, and might not hold with a more general utility function. However, the elasticity of intertemporal substitution is consistently estimated to be close to one in the data.

[8]Note though that, for capital outflows in the case of a news shock, the effects do not depend on κ in the presence of home bias ($X < 1/2$). This is because the initial share of foreign assets in home portfolio being smaller than in the foreign portfolio, the decrease in the value of initial foreign assets held by domestic agents is not enough to reach the portfolio share desired by domestic agents. Domestic agents therefore need to sell foreign assets. These valuation effects are more present for home assets, which constitutes a higher share of home portfolio. An increase in the value

Empirical implications On the empirical side, news shocks can be identified as they are followed by an effective increase in home productivity. Because noise shocks increase both foreign and domestic expectations about fundamentals, noise shocks can be identified as shocks that increase expectations but are orthogonal to fundamentals. We can use a measure of domestic household confidence about the future to identify such shocks, that we call "sentiment" shocks. However, in reality, we cannot exclude that household confidence is correlated to domestic demand shocks, so sentiment shocks can also potentially capture domestic demand shocks. However, the model can guide us in the interpretation of the sentiment shock, depending on the reaction of capital flows. Indeed, as implied by the model, only a noise shock can lead to a simultaneous increase in both gross capital inflows and outflows, while a demand shock tends to increase inflows and decrease outflows.

3 Empirical methodology

This section describes the identification strategy for TFP surprise, news and sentiment shocks in a structural VAR model. This recursive approach is based on Levchenko and Pandalai-Nayar (2015) and Barsky and Sims (2011) and aims at identifying the following structural shocks: a technology surprise shock, a news shock on technology and a sentiment shock. Like Barsky and Sims (2011), we identify news shocks by maximizing the forecast error of TFP at horizons greater than 1. Following **?**, we then identify sentiment shocks as the shock, uncorrelated to TFP, that maximizes the forecast error of a forward-looking variable (here consumer confidence). This methodology allows us to distinguish between shocks to expectations that are related to the country's TFP ("news") from those that are unrelated ("sentiment"), which we believe is important in terms of their impact on capital flows.[9]

Formally, assume that technology is driven both by the usual surprise technology shock, but also by a news shock. The latter has the particularity to be observable some periods in advance by the agents. The process of technology can be represented as a moving-average with the restriction that the news shock has no contemporaneous effect on the level of technology. Using A_t to denote

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of home assets held by domestic agents mechanically increase the share of home assets in the domestic portfolio. For domestic agents to actually buy back home assets, the desired portfolio share must increase sufficiently, which happens when there are strong information asymmetries (when $\kappa > \kappa_\delta$).Similarly, in the case of a noise shock, the effect on capital inflows do not depend on κ in the presence of home bias. This is because the decrease in the value of initial home assets held by foreign agents is not enough to reach the portfolio share desired by foreign agents, forcing foreign agents to buy domestic assets. On the opposite, the decline in the value of foreign assets can potentially help foreign agents reach their optimal portfolio share without needing to sell foreign assets to domestic agents. Only if the asymmetry in information is high enough ($\kappa > \kappa_e$) would the demand for foreign assets by foreign agents decrease sufficiently to require selling foreign assets to domestic agents.

[9]Beaudry and Portier (2006) were the first to provide a method to identify news. A news shock is identified in a VAR with TFP and stock prices where TFP is placed first. A news shock is then the shock that explains contemporaneous movements in stock prices that are uncorrelated to the innovation in TFP. This methodology however does not allow to distinguish between movements in stock prices that are correlated to future TFP from those that are not.

technology, one example for this particular representation is given by:

$$ln(A_t) = ln(A_{t-1}) + \lambda_1 \epsilon_t^{sur} + \lambda_2 \epsilon_{t-s}^{news}$$

where ϵ_t^{sur} is the surprise technology shock that affects contemporaneously the level of technology, and ϵ_{t-s}^{news} is the news shock, observed some period $s > 0$ in advance by the agents.

Assume then that agents' expectations about the economic situation can also be represented as a moving average process. Both the surprise technology shock and the news shock can affect the level of expectations, but also a sentiment shock. The latter captures variations in expectations not related to current or anticipated changes in technology. Denoting the expectations with F_t, a possible representation is given by:

$$F_t = F_{t-1} + \lambda_1^F \epsilon_t^{sur} + \lambda_2^F \epsilon_t^{news} + \lambda_3^F \epsilon_t^{sent} + \eta_t$$

where ϵ_t^{sent} is the sentiment shock.

Let's denote by y_t the k-dimensional state vector. In our specification, we have $y_t = [TFP_t, GDP_t, E12m_t, KF_t]'$ where TFP is the log of TFP, GDP is the log of real GDP, $E12m$ is the sentiment measure and KF are capital inflows or outflows. Consider the case where y_t follows a VAR whose MA representation is:

$$y_t = B(L)u_t,$$

with $B(0)$ an identity matrix. We assume that the linear mapping between the residuals (or innovations) and structural shocks is given by:

$$u_t = A_0 \epsilon_t.$$

where $Var(\epsilon_t) = I$. The vector of innovations of the VAR corresponds to $A_0 \epsilon_t$. Its variance-covariance matrix of innovations is given by $A_0 A_0' = \Sigma$. The VAR estimation provides us with a consistent estimate of Σ. This is however not sufficient to get an estimate of A_0. Indeed, there is an infinity of A_0 matrices satisfying $A_0 A_0' = \Sigma$. They are all of the form $\tilde{A}_0 D$, where D is a $M \times M$ orthonormal matrix ($DD' = I$) and $\tilde{A}_0$ results from the Cholesky decomposition of Σ. The h step ahead forecast error is given by:

$$y_{t+h} - E_{t-1}y_{t+h} = \sum_{\tau=0}^{h} B_\tau \tilde{A}_0 D \epsilon_{t+h-\tau}$$

Define the share of the forecast error variance of variable i attributable to shock j at horizon h by $\Omega_{i,j}(h)$. The first structural shock, ϵ^{sur} is identified as the reduced form innovation of the VAR with the technology measure ordered first. This implies that the first row of D is of the form $[1, 0, .., 0]$.[10] Hence, the share of the forecast error variance of the first variable, the technology measure, attributable to the surprise technology shock is now determined. Formally, it means that $\Omega_{1,1}(h)\ \forall h$ is fixed.

Given that only the surprise technology shock and the news shock are moving the level of technology, they have to account for all the forecast error variance of technology. Formally, it means that the sum of the shares of the forecast error variance of technology attributable to the first and second structural shocks - the surprise technology shock and the news shock - should be as close as possible to 1 at all horizons:

$$\Omega_{1,1}(h) + \Omega_{1,2}(h) \approx 1\ \forall h$$

where $\Omega_{i,j}(h)$ is given by:

$$\Omega_{i,j}(h) = \frac{e_i'(\sum_{\tau=0}^h B_\tau \tilde{A}_0 D e_j e_j' D' \tilde{A}_0' B_\tau')e_i}{e_i'(\sum_{\tau=0}^h B_\tau \Sigma B_\tau')e_i} = \frac{\sum_{\tau=0}^h B_{i,\tau}\tilde{A}_0 \gamma_j \gamma_j' \tilde{A}_0' B_{i,\tau}'}{(\sum_{\tau=0}^h B_{i,\tau}\Sigma B_{i,\tau}')} = \frac{\gamma_j' Z \gamma_j}{(\sum_{\tau=0}^h B_{i,\tau}\Sigma B_{i,\tau}')}$$

with $Z = \sum_{\tau=0}^h \tilde{A}_0' B_{i,\tau}' B_{i,\tau} \tilde{A}_0$ and $\gamma_j = De_j$ selecting the jth column of the D matrix. e_j is the selection vector and contains zero everywhere except at the jth position and $B_{i,\tau} = e_i' B_\tau$ denotes the ith row of the matrix of moving average coefficients. As stated earlier, all the forecast error variance of technology must be attributed to the surprise technology and the news shocks only. As $\Omega_{1,1}(h)$ is fixed, the strategy to identify the second structural shock consists in maximizing its contribution to the forecast error variance of technology, not attributable to the first structural shock.

Let's denote by γ^{news} the second column of D. The impact of the second structural shock on the variables is $\tilde{A}_0 \gamma^{news}$. Since D is orthonormal, we must have $\gamma^{news}(1) = 0$ an $\gamma^{news'}\gamma^{news} = 1$. As a result, γ^{news} is obtained by solving the following problem:[11]

$$\gamma^{news} = argmax_\gamma \sum_{h=0}^H (H-h)\Omega_{1,2}(h) = \sum_{h=0}^H (H-h)\frac{\sum_{\tau=0}^h B_{1,\tau}\tilde{A}_0 \gamma\gamma \tilde{A}_0' B_{1,\tau}'}{(\sum_{\tau=0}^h B_{1,\tau}\Sigma B_{1,\tau}')}$$

$$= \sum_{h=0}^H (H-h)\frac{\gamma' N \gamma}{(\sum_{\tau=0}^h B_{1,\tau}\Sigma B_{1,\tau}')}$$

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[10]This also implies that the first column is $[1, 0, ..., 0]'$ because D is orthonormal.

[11]Notice that in Barsky and Sims (2011) they do not explicitly include the time-weights, i.e. denoted by $(H-h)$, in their presentation of the optimisation problem, although they write about them.

s.t

$$\gamma(1) = 0$$
$$\gamma'\gamma = 1$$

with, $N = \sum_{\tau=0}^{h} \tilde{A}_0' B_{1,\tau}' B_{1,\tau} \tilde{A}_0$ The restrictions ensure that the news shock has no contemporane-ous effect on technology. As pointed out by Barsky and Sims (2011) and based on the paper by Uhlig (2003), this strategy is equivalent to the identification of news shock as the first principal component of the technology orthogonalized with respect to its own innovation. Formally, γ^{news} is the eigenvector associated with the maximum eigenvalue of a weighted sum, using time-weights, of the lower $(M-1) \times (M-1)$ sub-matrices of $(B_{1,\tau}\tilde{A}_0)'(B_{1,\tau}\tilde{A}_0)$ over τ. To summarize, we identify the news shock as the linear combination of the $M-1$ reduced form innovations - excepting the first one - that best explain TFP at long horizons.

The last structural shock to be identified is the sentiment shock. As seen earlier, this third structural shock is not related to technology, but rather to changes in expectations not explained by any of the technology shocks. We assume it is a short-run shock, i.e. its impacts on the expecta-tions' variable only last for few quarters. Hence, following **?**, the sentiment shock is identified such as to maximise its contribution to the remaining short-run forecast error variance of the expecta-tion variables. Assume the expectations' variable, F_t, is ordered third in the VAR. The two first structural shocks have been identified, meaning that $\Omega_{3,1}(h)$ and $\Omega_{3,2}(h)$ are fixed at all horizons h. Using the same strategy as for the news shocks, identifying the third structural shock is equivalent to choosing γ^{sent} (the third column of D), such that the sentiment shock is orthogonal to the other two shocks and contributes the most to the remaining forecast error variance of F_t. Formally,

$$\gamma^{sent} = argmax_\gamma \sum_{h=0}^{H^{sent}} \Omega_{3,3}(h) = \sum_{h=0}^{H^{sent}} (H^{sent} - h) \frac{\sum_{\tau=0}^{h} B_{3,\tau} \tilde{A}_0 \gamma\gamma' \tilde{A}_0' B_{3,\tau}'}{(\sum_{\tau=0}^{h} B_{3,\tau} \Sigma B_{3,\tau}')}$$
$$= \sum_{h=0}^{H^{sent}} (H^{sent} - h) \frac{\gamma' S \gamma}{(\sum_{\tau=0}^{h} B_{3,\tau} \Sigma B_{3,\tau}')}$$

s.t

$$\gamma(1) = 0$$
$$\gamma'\gamma = 1$$
$$\gamma'\gamma^{news} = 0$$

with $S = \sum_{\tau=0}^{h} \tilde{A}_0' B_{3,\tau}' B_{3,\tau} \tilde{A}_0$. Note that as the sentiment shock is assumed to be a short-run shock, the horizon H^{sent} is set to two quarters.

To sum up, the technology surprise shock is identified as the technology's own innovation. The news shock is identified as the structural shock that best explains future variations in technology not accounted for by the TFP surprise shock. And finally, the sentiment shock is the shock that best explains short-run variations in expectations, not accounted for by neither the technology surprise shock, nor the news shock.

4   Data

For this analysis, we gather data on TFP, GDP, an expectations' variable and capital flows for the U.S. We also collect data for 17 other economies, mostly selected based on data availability.

4.1   United States

The baseline vector y_{USt} used to estimate U.S. shocks includes four variables: TFP - as a measure of technology, the log of real GDP per capita, an expectations' variable and capital flows. For TFP, we use the utilization-adjusted TFP series from Fernald (2014), where the adjustments for variable utilization are based on the methodology by Basu et al. (2006). This measure has been frequently used in the empirical literature identifying news shocks in the United States.[12] Then, we use the chain-weighted real GDP variable from the BEA as measure of output (NIPA table 1.1.6). To obtain per capita terms, we divide by the civilian non-institutionalized population aged 16 and over (BLS).

The main measure of expectations is from the survey of consumers produced by the University of Michigan. We use in particular the standardized forward-looking component asking about expected change in business conditions in a year, which is part of the main consumer sentiment index. More specifically, they ask "Now turning to the business conditions in the country as a whole: do you think that during the next twelve months we will have good times financially, or bad times, or what?". They have 6 possibilities of answers: Good times, good with qualifications, pro-con, bad with qualifications, bad times or do not know. From these answers, they compute the relative scores, i.e. the percent giving favorable replies minus the percent giving unfavorable replies, plus 100. Similarly to Barsky and Sims (2012), we label the variable "E12M". There are three main reasons, why our baseline uses consumer sentiment rather than the expectations obtained from the Survey of Professional Forecasters (SPF). First, such a survey does not exist for the panel of countries considered in this paper. Second, it allows us to link this paper to the literature on news and sentiment shocks using the same variable. Last, Cordonier (2017) has found that this specific "E12M" variable relates significantly to capital flows (while controlling for other key factors).

The data on capital flows are obtained from the Balance of Payment Statistics Database (IFS/IMF), based on the BPM6 methodology. This study considers both gross capital inflows and outflows.[13] Gross inflows are the country's net incurrence of liabilities, while gross outflows

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[12]See for instance, Barsky and Sims (2011) or **?**

[13]Our theoretical model shows domestic and foreign investors should react differently to shocks if asymmetry of information exists. Thus, our focus is on gross capital flows.

represent the net acquisitions of foreign assets by domestic agents. As in Forbes and Warnock (2012), official reserves are excluded from the gross capital outflows. Following the literature (see Broner et al. (2013) or Adler et al. (2016)), we express capital flows in terms of GDP trend (trend extracted using a Hodrick-Prescott filter).[14] Notice that this study also considers different types of capital flows: foreign direct investment flows (FDI), portfolio flows (equity and debt securities) and other investment flows (currency & deposits, trade advances/credit, loans, other). They will be described further in this paper.

4.2 Other countries

We also collect TFP, GDP and sentiment data for 17 OECD economies. Unfortunately, to our knowledge, no TFP measure similar to the U.S. series exists for any of the other countries considered in our analysis. We therefore build our own measure of TFP based on the methodology of Imbs (1999). This approach adjusts the Solow residuals for capital and labor utilization, using aggregated measures of investment, hours worked, wages and consumption. In order to assess the quality of our approach, we compute a TFP series for the United States and compare it with the Fernald (2014)'s series. The methodology seems to do a fairly good job: a Kernel analysis of the differences between the two series does not show the presence of a systematic bias. These graphs and further details on the methodology can be found in Appendix D. Moreover, as argued by Sims (2016), the less precise the TFP measure, the smaller are the measured effects of news shocks. So if anything, bad measures of TFP imply less important effects of news shocks.

For output, we use the chain-weighted real GDP variable from the OECD database. Labor force - active population aged 15 or over, is obtained from the ILO. As expectations' variable, we use the forward-looking component of the consumer confidence index. The survey question considered is the following: "How do you expect the general economic situation in this country to develop over the next 12 months?".[15] There are six possibilities of answers: it will get a lot better (+2)/ a little better(+1)/ stay the same (0)/ a little worse (-1)/ a lot worse (-2)/ I do not know (0), from which they compute the net balance. The countries in our sample are selected based on data availability and are listed in Appendix B Table 1. The time-series of our baseline variables - log TFP, log GDP per capita, E12M and capital inflows/outflows - are presented in Appendix C Figures C.1 to C.18.

5 Empirical results

In this section, we estimate the effects of TFP surprise, news and sentiment shocks on capital flows both for the U.S. and a panel of 18 individual countries. We show that news shocks typically

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[14]Indeed, GDP trend reacts much less to shocks than current GDP. Using current GDP would make it much harder to attribute the impact of the shock mostly on capital flows as GDP would react as well.

[15]The question described here is the one asked to most countries that are part of the joint harmonized EU program of business and consumer surveys, but other countries' survey questions are very close. Each country's details are available on the OECD website (link).

generate a decrease in both gross capital inflows and outflows, while sentiment shocks generate an increase in both gross capital inflows and outflows. These findings are consistent with the model and point to the existence of asymmetric information between domestic and foreign investors. It also suggests that our identified sentiment shock is closer to a "noise" shock than a local demand shock. Sentiment shocks seem to result from excessive optimism rather than a change in domestic demand.

5.1 The effects of news and sentiment in the U.S.

In this section, we start by presenting the orthogonalized response functions obtained from the SVAR analysis for the United States. The identification of the shocks follows the methodology described earlier. We set the baseline number of lags to $p = 2$[16] and we use bias-corrected confidence intervals from 2000 bootstraps based on Kilian (1998). We start with a SVAR containing TFP, GDP, E12M and gross inflows as described in the data section. First, Figure 1 shows the responses of all variables to the three shocks: TFP surprise, news and sentiment shocks. We then replace gross inflows with gross outflows and represent in Figure 2 the responses of gross capital outflows only. The figures show responses over a 20-quarter horizon as most of the capital flows' reaction to the shocks occurs in the first 20 quarters.

The first point to stress is that news and sentiment shocks are well-identified. The news shock has a slow-building persistent impact on TFP, while TPF does not react significantly to a sentiment shock at any horizon. Thus, the sentiment shock does not relate to technology. The responses of GDP are as expected: TFP generates an immediate positive response and the news shock has a persistent positive impact.

Regarding the impact of the shocks on gross capital inflows, the focus of this paper, we see in Figure 1 that the news shock has an immediate negative impact, which then becomes positive and persistent. Figure 2 shows that the response of gross capital outflows is similar. Therefore, a news shock leads to a retrenchment in capital flows. On the opposite, the sentiment shock triggers an immediate positive response of gross capital inflows and outflows, which lasts for about 8 to 10 quarters.[17] Hence, optimism that is unrelated to fundamentals (here measured by TFP) generates an expansion in cross-border holdings.

The negative response of capital flows following a news shock and their positive response to a sentiment shock is consistent with the effects of news and noise shocks in the model. Domestic investors have an informational advantage over foreigners on their countries' future performances. As they can observe the news shock better than foreigners, their demand for domestic assets increases more than foreigners'. Similarly, their demand for foreign assets decreases more than foreigners'. As domestic agents buy back the domestic assets and sell foreign assets, we observe a

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[16]In the robustness part, specification with more lags, e.g. $p = 4$ will be presented. Results are robust to the lag specification.

[17]Our results remain similar when we use the same variable as ? in our specification, i.e. including consumption and hours in third and fourth position. Responses of capital inflows to TFP surprise shock becomes however positive, and the response of GDP to sentiment shock as well. The impulse responses functions are presented in Appendix B Figure B.1.

Figure 1: IRFs to TFP surprise, news and sentiment shocks
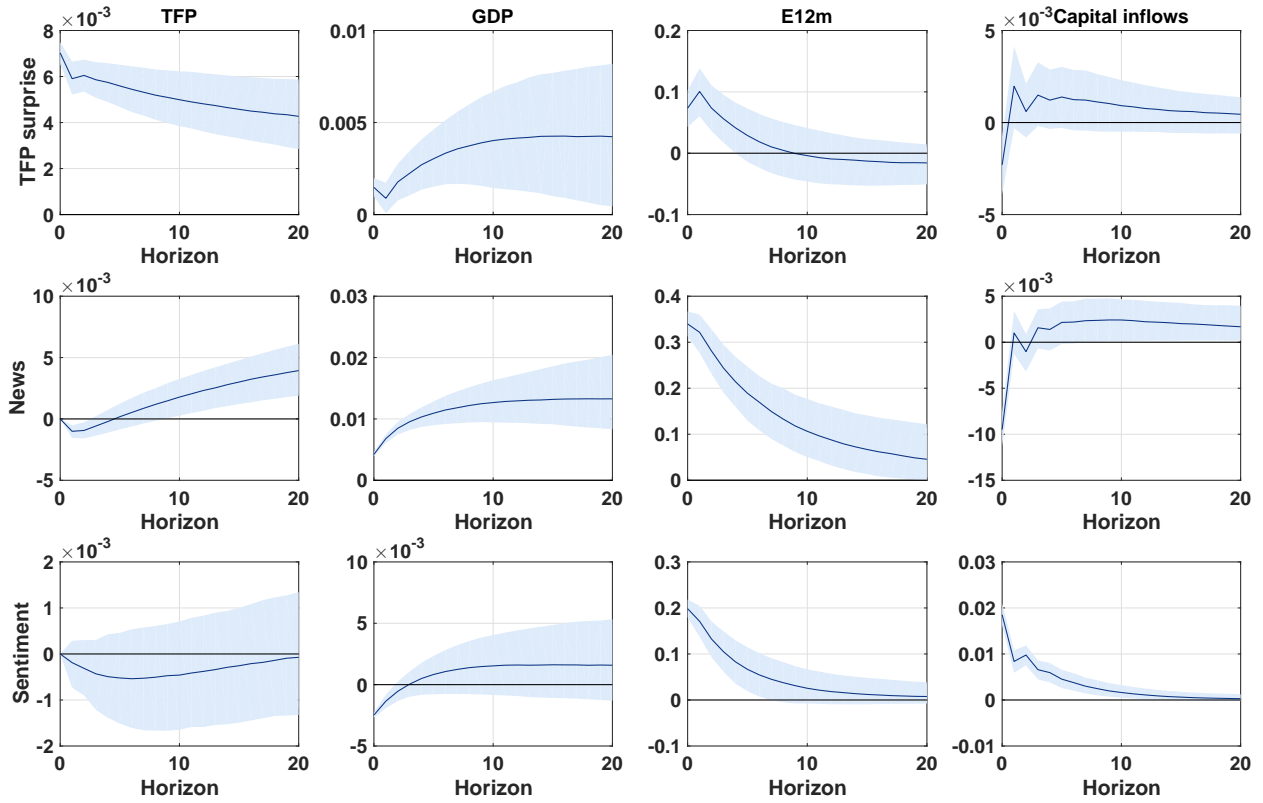
Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors

Figure 2: IRFs of capital outflows to TFP surprise, news and sentiment shocks
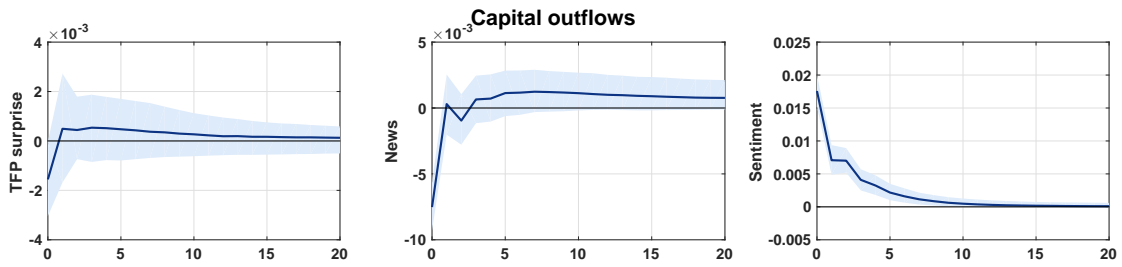

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors

decrease in gross inflows and outflows. Following a noise shocks, agents are excessively optimistic but foreigners are even more optimistic than domestic investors, who are better informed. Hence, foreign agents buy domestic assets and sell foreign assets, and we observe an increase in gross inflows and outflows. Note that, given that inflows and outflows both respond positively to a sentiment shock, we can rule out demand shocks as the main drivers of sentiment shocks. Indeed, according to the model, while demand shocks can lead to an increase in inflows, they typically lead to a decrease in outflows.

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Finally, the responses of capital flows to a surprise TFP shock are positive, although non-significant. Overall, capital flows are found to react not to current changes in fundamentals, but to expectations about the country's future performance. In terms of magnitude, the response of capital flows to sentiment is the strongest. This suggests that the expansionary effect of a country's optimism on capital flows, as documented by Cordonier (2017), is not related to the country's technology, but to sentiment. This is confirmed by the forecast error variance decomposition of both inflows and outflows, presented in Figure 3. The sentiment shock alone can explain up to 45% of the FEVD of gross capital flows. News shocks explain about 10% of capital flows, while TFP surprise shocks have a negligible contribution. All in all, this evidence suggests an important role for sentiment, and to a lesser extent, for news shocks, in driving domestic U.S. capital flows.

Figure 3: Forecast Error Variance Decomposition of gross capital flows
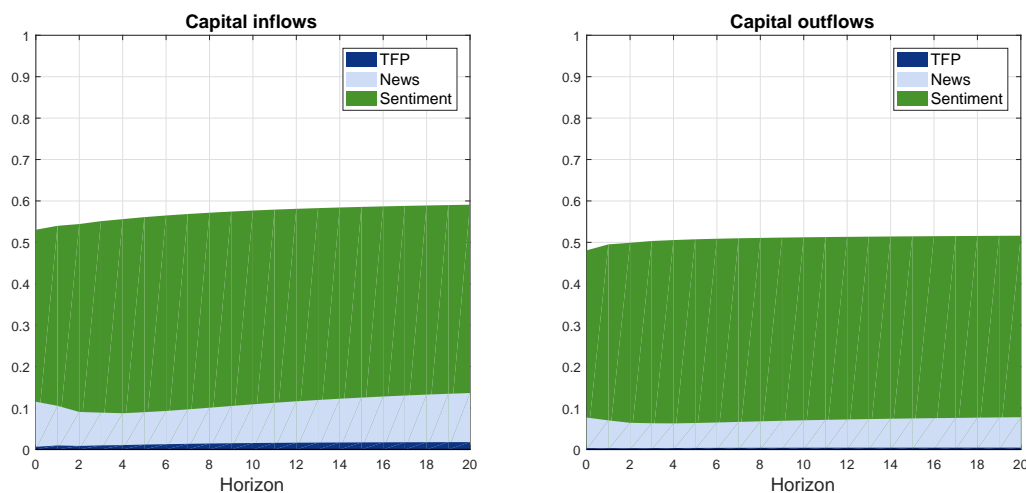
5.2   The effects of news and sentiment - Panel results

This part aims at extending the above analysis to a panel of countries, therefore assessing our findings' external validity. Hence, we use the same identification strategy but include 17 additional OECD economies. The selected countries are those for which data are available, both to build a measure of TFP and to conduct the SVAR exercise. Our methodology for the panel is as follow: First, we run a SVAR identification including TFP, GDP, E12M and capital flows at the country level and compute the individual impulse response functions.[18]   Then, the aggregate response function is obtained as the median across individual responses at all horizons.

The median responses of both capital inflows and outflows to all three shocks are presented in Figure 4. Both inflows and outflows react immediately and negatively to news shocks and positively to sentiment shocks. In other words, the panel findings are similar to those for the United States alone, confirming the importance of sentiment shocks in driving capital flows. Computing the aggregate responses as a median rather than a mean gives less weight to extreme values. Nevertheless, mean responses, presented in Figure B.2 in Appendix B, lead to similar conclusions

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[18]Notice that we use demeaned data to account for country-specific effects.

regarding the role of sentiment, although the effect of news shock is less pronounced. Regarding the panel forecast error variance decomposition, we see in Figure 5 that both news and sentiment shocks can explain close to 50% of the FEVD, with an equal contribution of the two shocks. On the contrary, TFP surprise shock plays no role in driving capital flows as pointed out by the impulse response functions and the FEVD. This suggests that if technology plays a role in explaining international capital movements, then only "anticipated" technology shocks matter.[19]

Figure 4: Panel median IRFs to TFP surprise, news and sentiment shocks
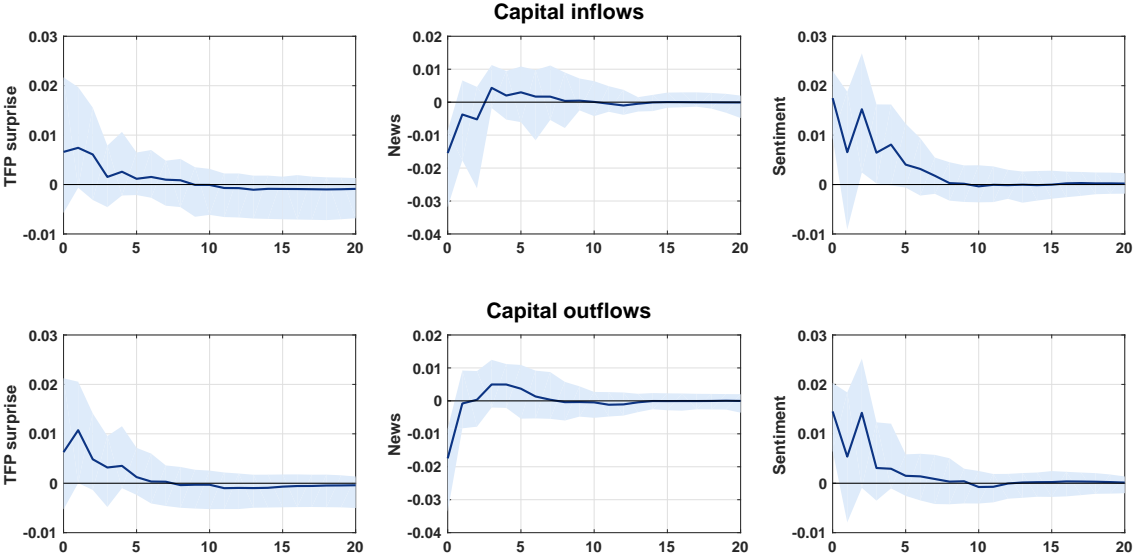
Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors

Figure 5: Forecast Error Variance Decomposition of gross capital flows for the panel

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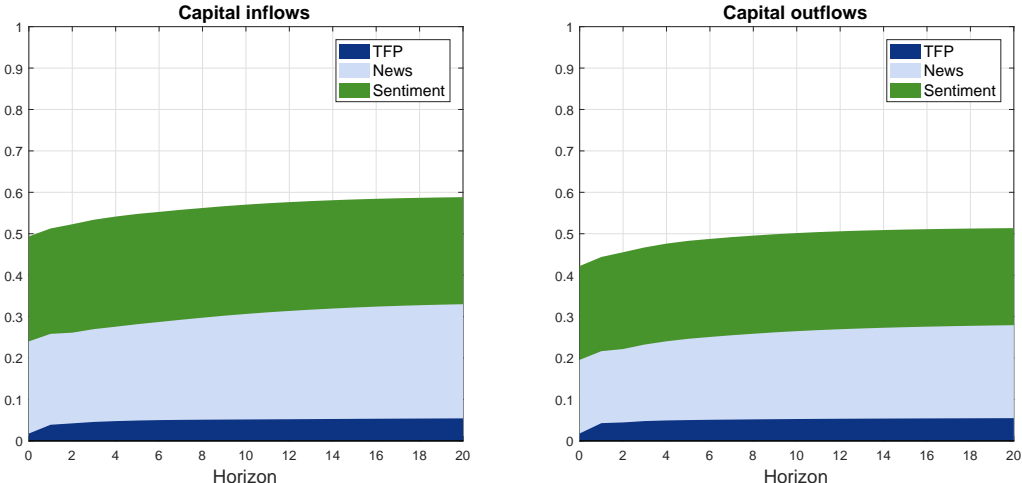
[19]Note that, since TFP is less precisely measured for the panel of countries than for the U.S., we cannot exclude that part of the sentiment shock is wrongly attributed to news.

6   Are the shocks global or local?

This section is related to the debate on the existence and importance of global financial cycles. In the last few years, a new strand of the capital flows literature has debated on the existence of "global financial cycles". Rey (2015) first established that there are cycles in capital flows, assets prices and credit growth, which she referred to as "global financial cycles". Taking into account these cycles is especially important in the case of sentiment shocks. Indeed, sentiment shock is identified as a residual, so it is important to rule out other shocks. In particular, as sentiment shocks are shocks unrelated to the country's fundamentals, they may capture global "push" factors.

We assess the global dimension of our shocks in two parts. First, we analyze the role of the global factors, including the VIX and the FED funds rate, on capital flows and whether they modify our findings. In the second part, we assess the extent to which our shocks are global using a principal component analysis on shocks identified at the country-level.

6.1   The role of global factors

So far, we have not included any of the global factors that have been emphasized as important drivers of capital flows. In particular, we have not taken into account the VIX or the FED funds rate (FFR), which have received strong support from the literature.[20] Moreover, one could argue that our sentiment shocks merely reflect variations in overall markets' uncertainty, proxied by the VIX. Thus, we start by repeating the empirical exercise but including sequentially the VIX and the FFR in our specifications. Then, we will also use the U.S. corporate BBB option-adjusted spread and the U.S. security brokers and dealers leverage instead. To give the maximum weight to this additional shock, we identify it before the sentiment shock. Formally, we add the global variable in third position, $y_t = [TFP_t, GDP_t, G_t, E12m_t, KF_t]$, where G_t stands for the global variable. Then, we identify the global variable shock after the TFP surprise and news shocks, in a similar way as for our sentiment shock. The global shock is the structural shock that best explains short-run future variations (2 quarters) of the global variable, unexplained by the first two shocks.

We start by analyzing responses of the panel capital flows to the shocks, including a VIX shock.[21] Figure 6 shows responses of inflows and outflows when identifying a VIX shock as well. Consistently with the literature's findings, an increase in the VIX triggers an immediate short-lived negative responses of capital flows. The responses to the news and sentiment shocks remain qualitatively similar. The significance of the sentiment shock is however less pronounced, although we should keep in mind that the weight given to the VIX shock was maximized. In other words, the impact of the sentiment shocks could be interpreted as a lower band. Nevertheless, this can be taken as evidence that some kind of investors "animal spirit" is indeed included in the sentiment shock. On the other hand, the share of capital flows' FEV attributable to the global VIX shock is

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[20]See for instance Rey (2015) or Forbes and Warnock (2012)

[21]Notice that the inclusion of this VIX shock shortens our sample, as this variable is only available from 1990. In order to assess only the effect of the VIX inclusion and not the change in the timespan, we re-estimate the three main shocks starting from 1990 onward. This is shown in Figure B.11 in Appendix B. Responses of inflows and outflows to the three shocks are almost identical to the longer sample's IRFs.

Figure 6: Panel median IRFs to TFP surprise, news, VIX and sentiment shocks
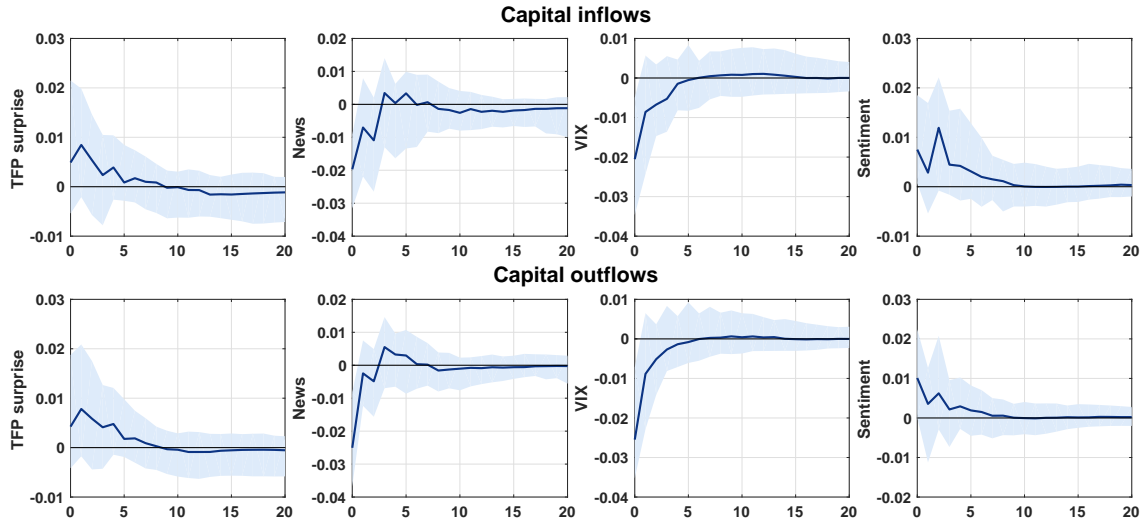
Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors

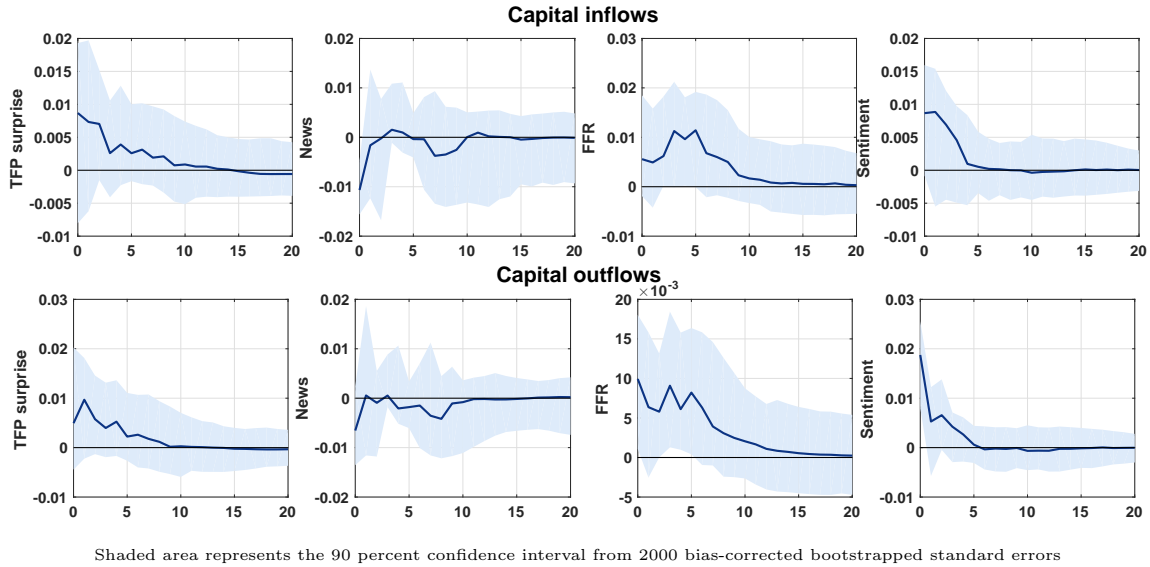**Figure 7:** FEVD of the panel's capital flows - Including VIX shock
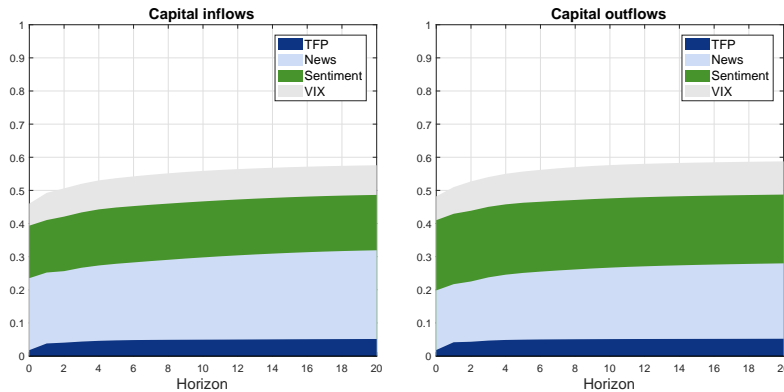
relatively small, as presented in Figure 7. As previously, mostly sentiment and news shocks matter in driving capital flows.
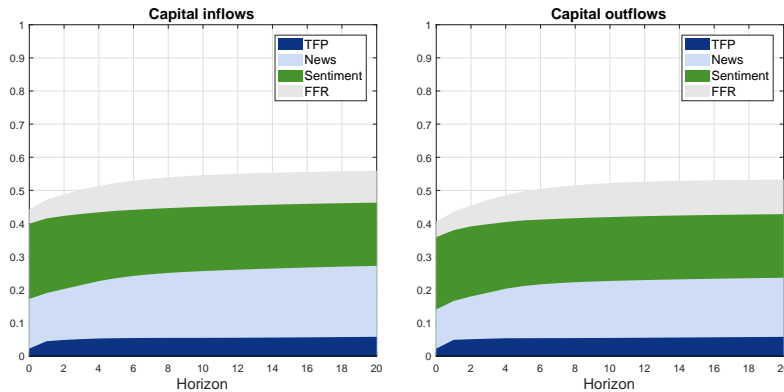
We now include the FED funds rate (FFR) as a global shock. Figures 8 and 9 present the panel median IRFs and the FEVD including the FFR shock. A positive FFR shock increases inflows and outflows. As before, although the confidence bands are broader, the news and sentiment shocks are qualitatively similar as in the baseline. Overall, the contribution of FFR shocks to the FEVD is small relatively to news and sentiment shocks.

As a way to further exclude that sentiment shocks contain mostly global "push" factors, we sequentially add two other global factors also reflecting global financial markets' activity. First, we include the U.S. corporate BBB option-adjusted spread (from the Bank of America Merill Lynch). This variable has an even shorter timespan than the VIX and starts only in 1997. Unsurprisingly, impulse responses and FEVD of capital flows to all shocks look very alike to those when identifying

Figure 8: Panel median IRFs to TFP surprise, news, FFR and sentiment shocks

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors

Figure 9: FEVD of the panel's capital flows - Including FFR shock

a VIX shock, as shown in Appendix B Figures B.3 and B.4. Then, we use the U.S. security brokers dealers leverage variable. Adrian and Shin (2010) show that global market liquidity is related to the leverage of security brokers dealers. We define leverage as they do, i.e. the ratio of total assets over equities, which is the difference between total assets and liabilities. Figures B.5 and B.6 in Appendix present the IRFs and the FEVD of capital flows. The impact of the U.S. brokers dealers leverage shock is non significant and flat at any horizon. The conclusions for the other shocks remain similar.

To conclude, some global factors, namely the VIX, FED funds rate and the U.S. corporate BBB spread shocks are found to affect significantly capital flows. However and although we give additional global shocks more weight by identifying them before the sentiment shock, their contributions to the capital flows' forecast error variances are relatively small. Our findings regarding the three shocks, including the sentiment shock, remain robust, although the confidence interval

broaden.

6.2 How global are the identified shocks?

Recently, Cerutti et al. (2017) have tried to quantify the importance of global financial cycles. They assess the role of some global variables from center countries, but also extract common factors directly from actual capital flows. They find little evidence in favor of global factors as drivers of capital flows and argue that these cycles are quantitatively small: they cannot explain more than a quarter of capital flows' variations.

In this section, we aim at assessing whether our shocks identified at the country-level have a strong global component. Formally, we use a principal component analysis for each type of shock identified for the 18 countries in our sample. The first principal component spans the largest variability of our country-specific shocks' series. Intuitively, if the first principal component can explain a large share of the total variance, it can be interpreted as evidence of "global" shocks.

Our findings show that the first principal component for TFP surprise shocks accounts for about 20.64% of the variance of gross inflows and and 21.3% of the variance of gross outflows. For the news shocks, the shares of variance explained by the first principal component are 20.95% and 21.57% respectively, while they are about 21.05% and 18.89% for the sentiment shocks. When considering the shock driving the remaining capital flows' variations, the first principal component can account for 22.99% and 23.43% of the total variance. Overall, these findings indicate that no more than a quarter of the total variance of all shocks series can be accounted for by the first principal component. This points toward a limited global component in the shocks identified at the country-level.

One could argue that some shocks may not be global, i.e. relate to all 18 countries, but specific to some groups of economies. In order to rule this out, we plot the factor loadings of each country's shock associated with the two first principal components (using inflows). If the factor loadings of the first principal component, PC1, would be larger for similar countries, while the ones of the second principal component, PC2, larger for some other group of countries with close characteristics, this would suggest that the shocks are common to some countries' groups. Graphs for each of the four shocks are shown in Appendix B Figures B.7 to B.10. Factor loadings do not appear to exhibit patterns across countries. We can therefore exclude that our shocks reflect some "regional" factors.

Up to this point, we have found little evidence supporting the importance of global shocks: Shocks identified using country-specific data seems to be mostly domestic shock with only a small global component, even across country groups. Moreover, the importance of the global component of sentiment shocks is comparable to the other shocks. All in all, our results go in the direction of Cerutti et al. (2017). Our findings suggest a limited quantitative importance of global financial cycle and a greater importance of domestic factors, in particular sentiment and news shocks. Our analysis complement theirs, which does not have intrinsic dynamics.

7 Distinction across types of capital flows

Some types of capital flows may react differently to specific shocks than others. For instance, Avd-jiev et al. (2017) have underlined the importance of distinguishing across capital flows' types and regions. More importantly, within-country gross total inflows and outflows are partially correlated by construction. Unless the counterpart of an international transaction is related to the Current Account (or Capital Account), both sides of a financial transaction are recorded in the Financial Account. In other words, a purely financial transaction is automatically recorded as an increase in inflows and an increase in outflows. This, however, does not hold true when considering different types of asset classes. An increase in portfolio inflows may be "compensated" by an increase in other investment outflows or reserves.

In this section, we classify the gross capital flows according to the IMF BPM6 methodology into three main categories: foreign direct investment (FDI), portfolio and other investment flows. FDI are defined as investments in companies that give foreign investors control or a significant degree of influence on the management of the firm.[22] Portfolio flows include financial transactions related to equity or bond securities. Other investments include many categories such as loans, currency and deposits or trade credit/advances.[23]

The impulse responses of each type of capital flows to TFP surprise, news and sentiment shocks are presented in Appendix Figures B.12 to B.16. Responses of other investment flows, even when looking only at the sub-category debt, essentially track those of total capital flows: News shocks trigger negative inflows and outflows, while sentiment shocks generate positive responses. This is true to a certain extent for FDI flows as well.

Portfolio equity inflows, interestingly, increase following a news shock. This suggests that the informational advantage of domestic agents is not present in the case of equity, as compared to other assets, so that the increase in demand for domestic assets by foreigners is strong enough to generate capital inflows. Indeed, equity markets are more liquid, which implies that prices better reflect fundamentals. Listed companies are also subject to disclosure, which implies that information on this type of assets is more transparent and public. Finally, portfolio equity inflows decrease following a sentiment shock. This might suggest that equity investors are in fact more sophisticated than domestic equity investors, and recognize the noisy nature of the sentiment shock.

8 Robustness checks and additional results

8.1 Lags

Our baseline specification uses two lags. Here, we repeat the analysis and plot the response functions using different lag lengths ($p = 1, 3, 4$). We present the IRFs and FEVD for the panel of 18 OECD economies in Appendix Figures B.17 and B.18. Impulse responses computed using

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[22]The full and exact definitions can be found in page 101 of the Balance of Payments BPM6 manual. A significant degree of control is defined as a share of 10 percent or more of the voting power.

[23]See page 111 of the BMP6 manual for all details.

different lag specifications are very close to the ones of the baseline using two lags. The FEVD confirms the robustness of our results: adding more lags increase the contribution of our news and sentiment shocks to the variance of capital flows.

8.2 Additional variables

In order to ensure our findings are not sensitive to the inclusion of additional variables in our SVAR specification, we include an extra variable before the capital flows variable. We include sequentially, the 10-year government bonds yields, the inflation rate, the nominal exchange rate volatility, local stock prices, local interest rates and the real effective exchange rate. Figures B.19 and B.20 in Appendix present the IRFs: Compared to the baseline, there are no real differences in terms of capital flows' responses to the three shocks.

Then, responses of the additional variable to the three shocks are shown in Figure B.21. All variables increase following news and sentiment shocks. It is interesting to note that all these positive responses (except the exchange rate volatility) look like the response to a demand shock. This is consistent with the fact that both news and sentiment are associated with a rise in domestic optimism while not affecting TFP contemporaneously. Notably, while domestic variables react similarly to both shocks, capital flows react differently to news and sentiment, which reflects the relative optimism of domestic and foreign agents.

8.3 Both inflows and outflows

Then, instead of including either inflows or outflows in the VAR specification, we add both inflows and outflows in our variables' vector y_t. Figure B.22 in Appendix B shows the panel responses of capital inflows and outflows when added together in the VAR. The responses are almost unchanged compared to a case where we identify the impact of TFP surprise, news and sentiment shocks including only inflows or outflows in the identification procedure.

8.4 First-difference

As described in the methodology, following the literature we have estimated our SVAR in levels. Here, we show that using first-differences leave our findings mostly unchanged, as shown in Figures B.23 and B.24 in Appendix. Only capital outflows react less to news shock, which is confirmed by the larger share of the FEV of capital flows attributed to the sentiment shock.

9 Conclusion

Overall, our findings show that domestic surges in optimism either related to future productivity - news shocks - or not - sentiment shocks - are important drivers of gross capital flows at the country level. Together they can explain up to 50% of the FEVD of capital flows for a panel of 18 OECD economies. While sentiment shocks trigger positive inflows and outflows, news shocks have

a negative impact on gross capital flows. This suggests that the increase in cross-border capital positions in not related to better fundamentals, but rather driven by surges in optimism unrelated to future productivity. These sentiment shocks are also found to be distinct from global factors, such as the VIX or the FFR and do not include a large "global" component. The fact that capital inflows rise following optimism shocks disconnected from fundamentals can raise concerns from a policy perspective, even though forces driving these flows are not necessarily global.

Our empirical exercise is restricted, due to data limitations, to a panel of OECD economies. These countries are likely to have similar characteristics and conclusions could differ when considering a group of emerging economies.

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A   Model appendix

A.1   Proof of proposition 1

Using the expression for cross-border holdings (2.14) and the expression for expectations (2.7), we can show that

$$k_t^F = -(\omega_2\alpha_1 - \omega_1\alpha_0)\delta_{t+1} + (\omega_1\alpha_0 - \omega_2\alpha_2)e_t + ...$$
$$k_t^{H*} = -(\omega_1\alpha_1 - \omega_2\alpha_0)\delta_{t+1} + (\omega_2\alpha_0 - \omega_1\alpha_2)e_t + ...$$

where we consider only terms that affect the expectations of δ_{t+1}.

Since $\kappa > 0$ in the presence of asymmetric information, we have $\alpha_1 = [\alpha_0 + \kappa(1 - \alpha_0)] > \alpha_0 > \alpha_2 = (1-\kappa)\alpha_0$. Besides, in the presence of home bias $(X < 1/2)$, $\omega_1 = \frac{\phi}{X}\frac{1-X+2\phi}{1+4\phi} > \omega_2 = \frac{\phi}{X}\frac{(X+2\phi)}{1+4\phi}$. Therefore, $\omega_1\alpha_0 > \omega_2\alpha_2$ and $\omega_1\alpha_1 > \omega_2\alpha_0$: a noise shock e_t generates an increase in capital inflows k_t^F and a news shock δ_{t+1} generates a reduction in capital outflows k_t^{H*} whatever the level of information asymmetry, as long as there is home bias in asset holding.

Now consider the effect of news δ_{t+1} on capital inflows k_t^F. There is a reduction in capital inflows if $\omega_2\alpha_1 - \omega_1\alpha_0 > 0$, which amounts to

$$(X + 2\phi)[\alpha_0 + \kappa(1 - \alpha_0)] > (1 - X + 2\phi)\alpha_0$$
$$\Leftrightarrow \quad \kappa > \frac{1-2X}{X+2\phi}\frac{\alpha_0}{1-\alpha_0}$$

Similarly, consider the effect of noise e_t on capital outflows k_t^{H*}. There is an increase in capital outflows if $\omega_2\alpha_0 - \omega_1\alpha_2 > 0$, which amounts to

$$(X + 2\phi)\alpha_0 > (1 - X + 2\phi)(1 - \kappa)\alpha_0$$
$$\Leftrightarrow \quad \kappa > \frac{1-2X}{1-X+2\phi}$$

B Additional results

Table 1: Time coverage including baseline data

Panel - OECD economies		
Australia	1995Q1	2015Q4
Austria	2005Q2	2015Q4
Belgium	2005Q2	2015Q4
Czech Republic	1996Q3	2015Q4
Denmark	1995Q3	2015Q4
Estonia	2000Q3	2015Q2
Finland	1990Q3	2015Q4
France	1985Q1	2015Q4
Germany	1992Q1	2015Q4
Ireland	2005Q1	2015Q4
Italy	1996Q3	2015Q4
Netherlands	1996Q3	2015Q4
Portugal	1995Q3	2015Q4
Spain	1995Q3	2015Q4
Sweden	1995Q4	2015Q4
Switzerland	1999Q1	2015Q4
United Kingdom	1995Q3	2015Q4
United States	1973Q1	2015Q4

Figure B.1: U.S. IRFs to TFP surprise, news and sentiment shocks – with consumption and hours
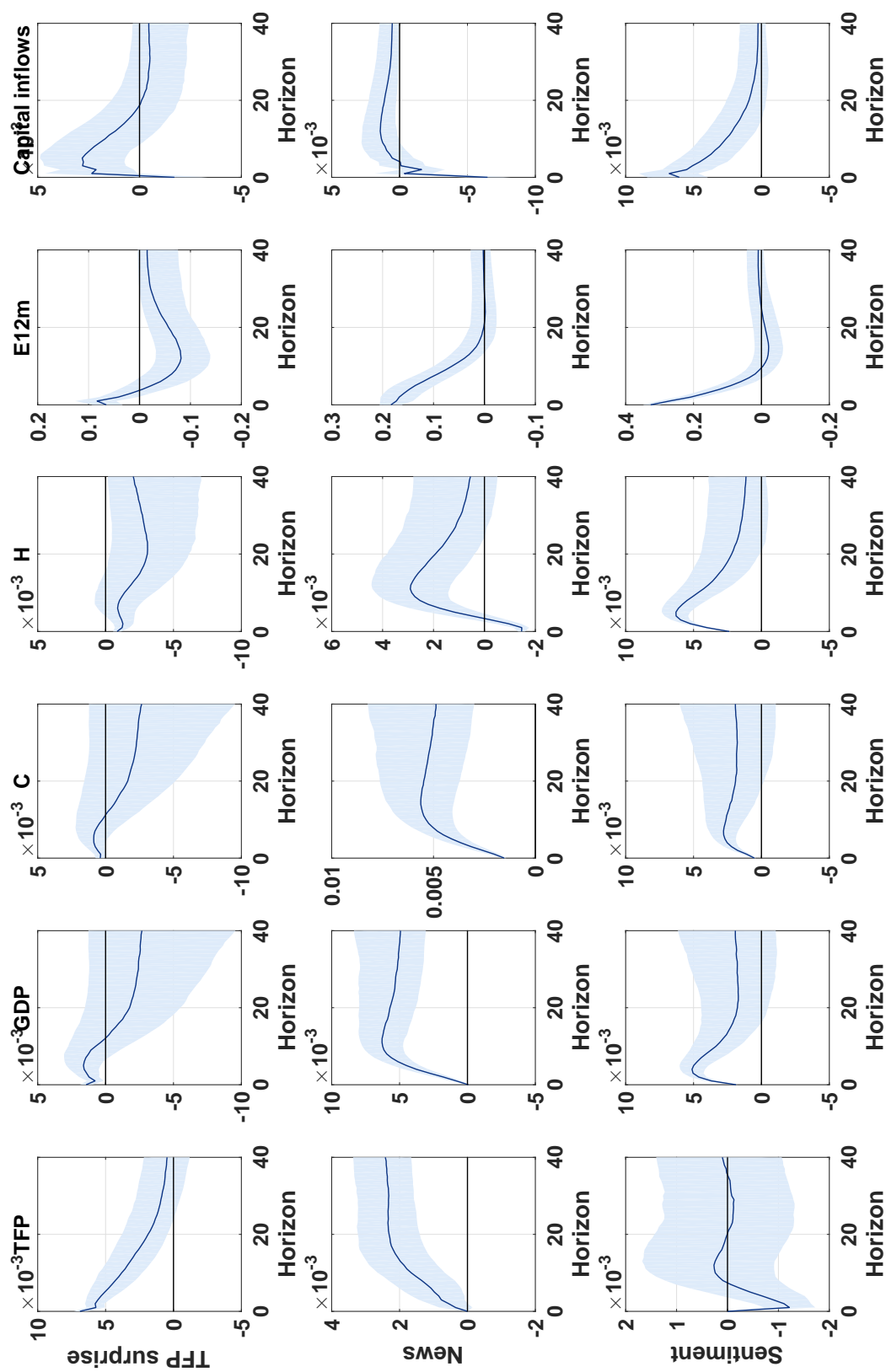
Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors

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Figure B.2: Panel mean IRFs to TFP surprise, news and sentiment shocks

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
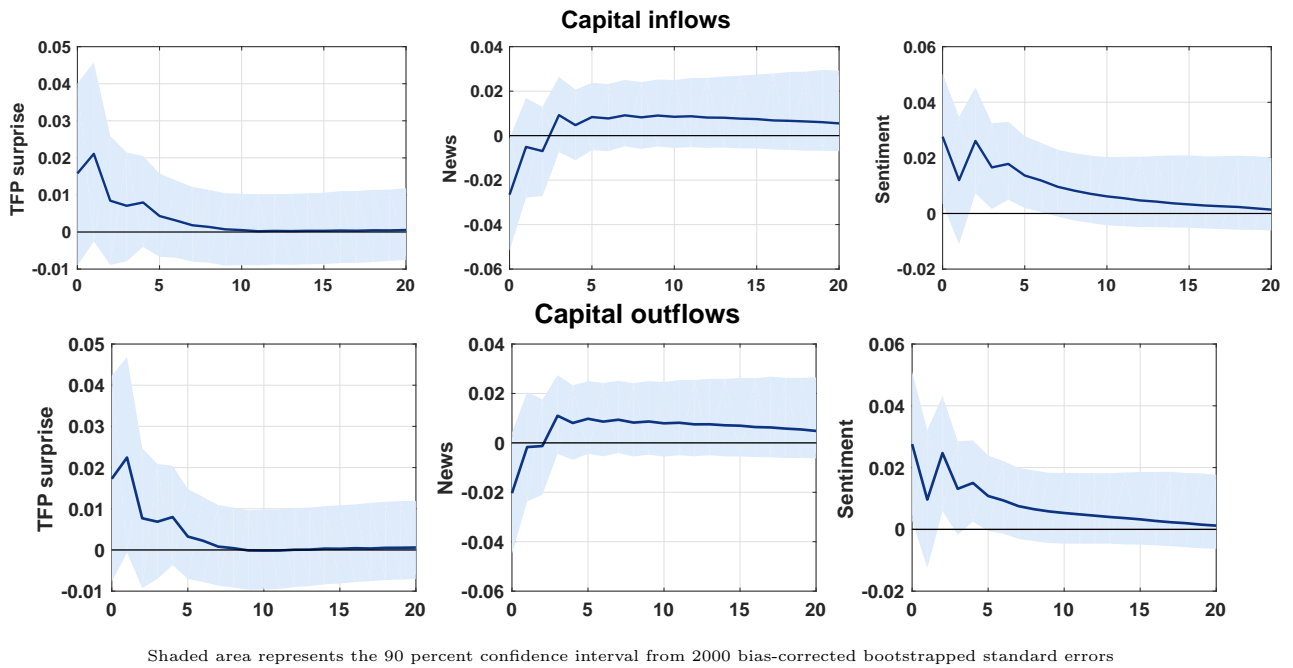
Figure B.3: Panel median IRFs to TFP surprise, news, BBB spread and sentiment shocks

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
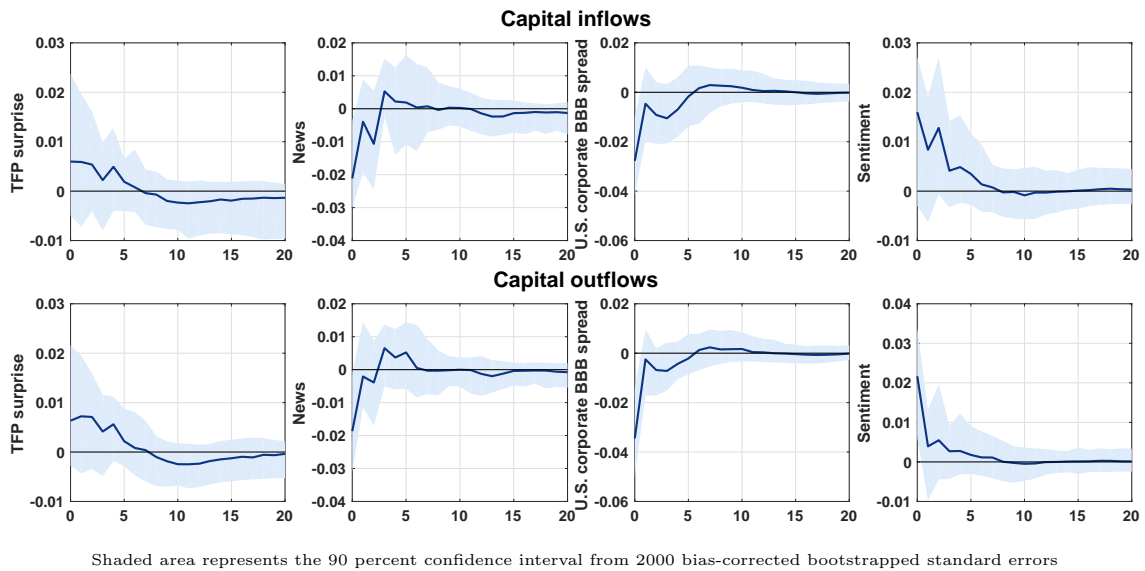
Figure B.4: FEVD of the panel's capital flows - Including BBB corporate spread shock
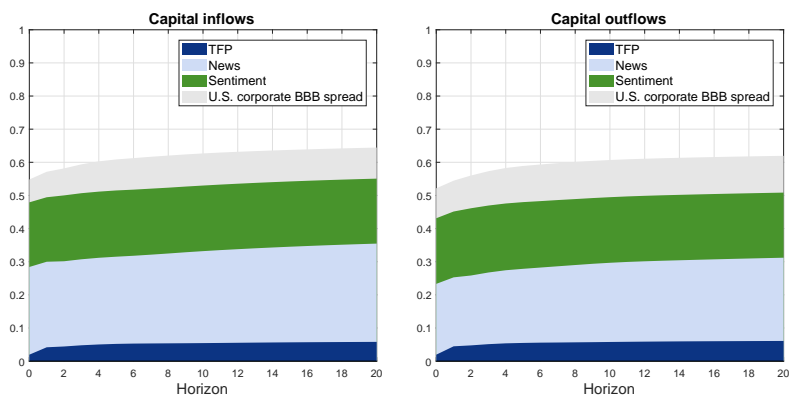
Figure B.5: Panel median IRFs to TFP surprise, news, brokers dealers leverage and sentiment shocks
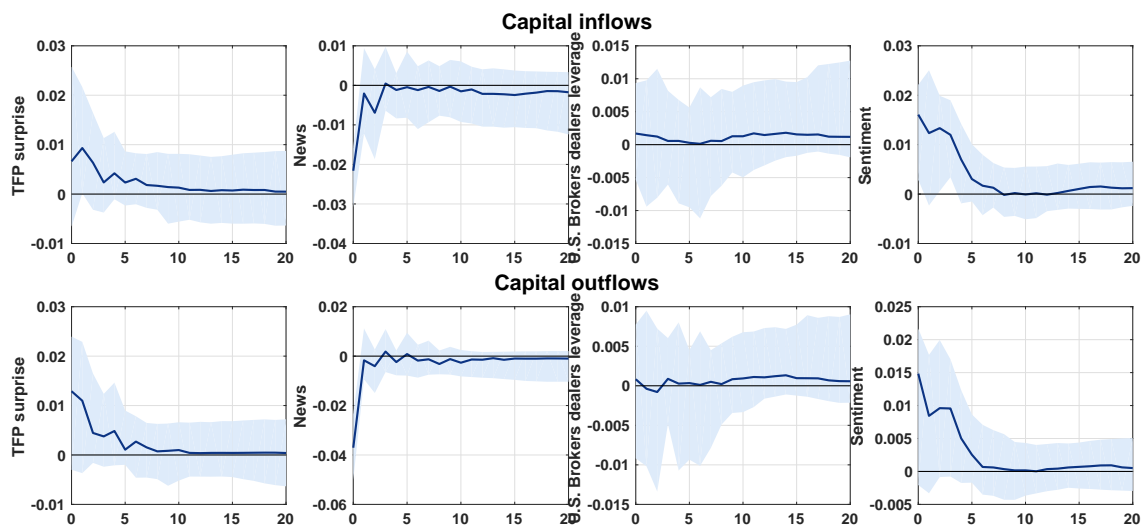
Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors

Figure B.6: FEVD of the panel's capital flows - Including brokers dealers leverage shock
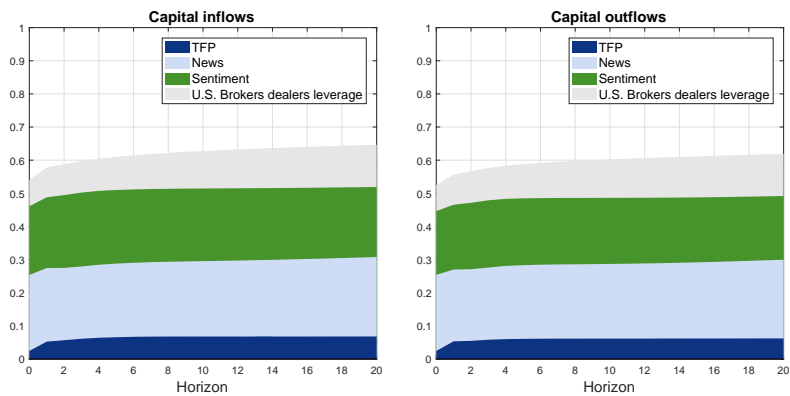
Figure B.7: Factor loadings of first two principal components - TFP surprise shocks
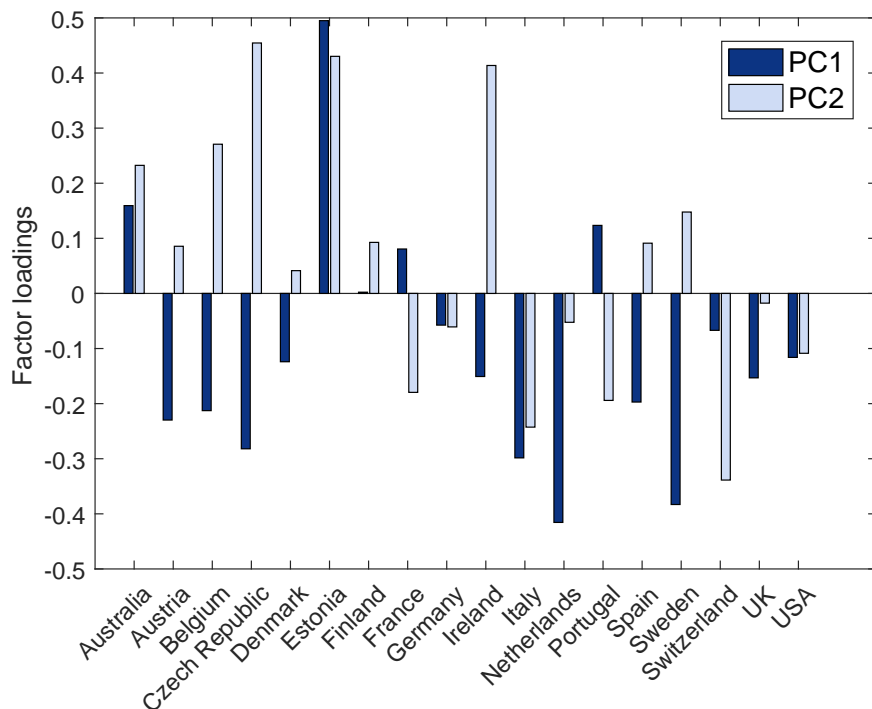
Figure B.8: Factor loadings of first two principal components - News shocks
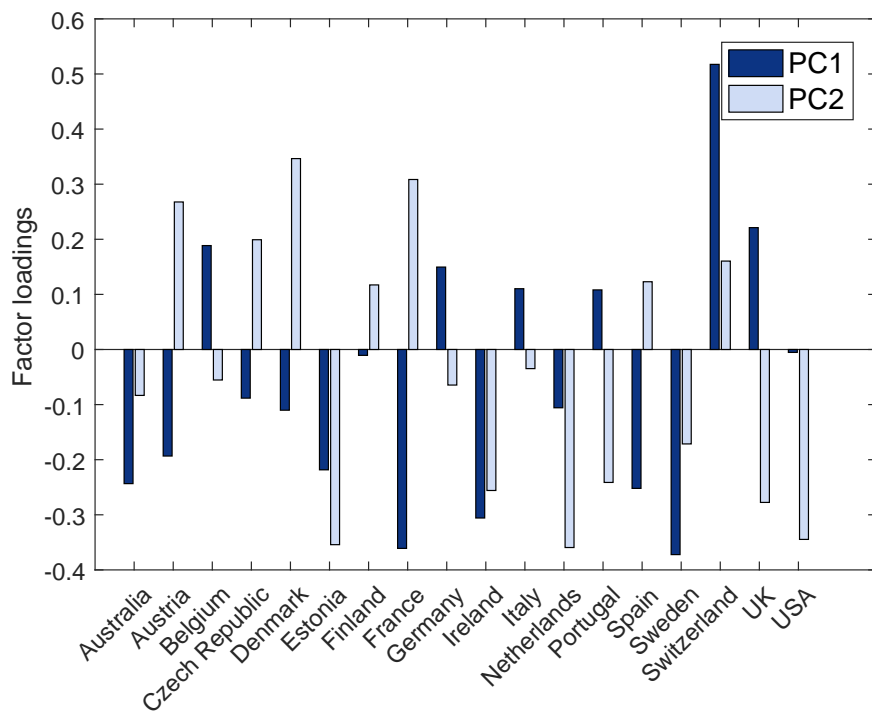
Figure B.9: Factor loadings of first two principal components - Sentiment shocks
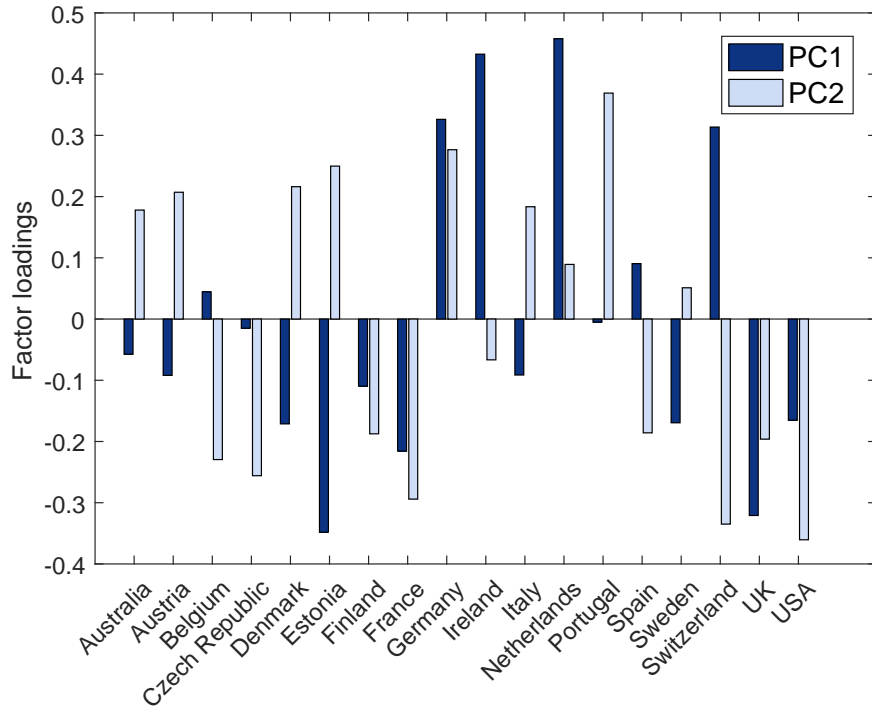
Figure B.10: Factor loadings of first two principal components - Capital flows shocks
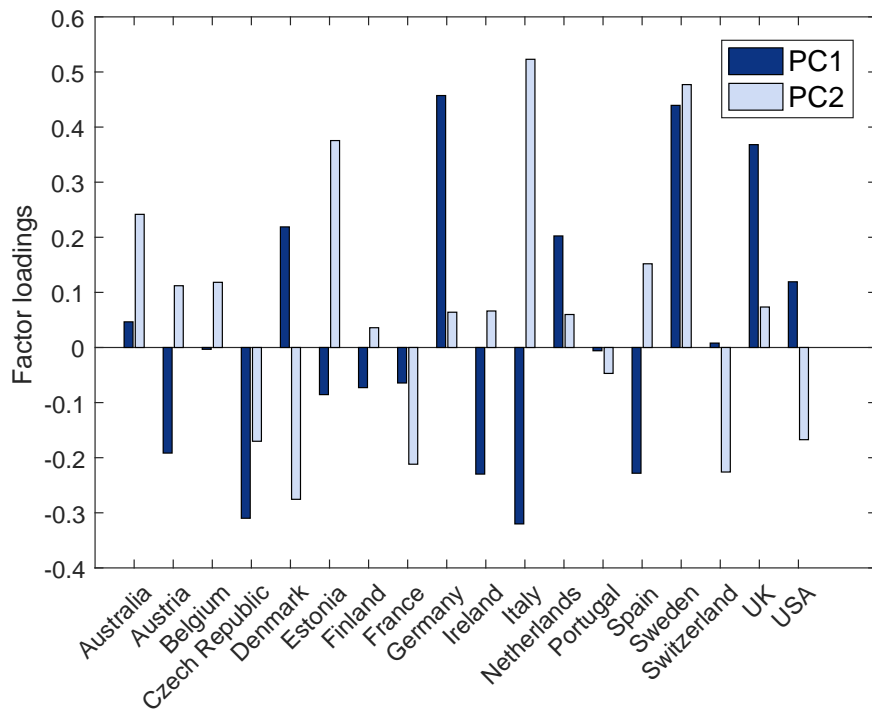
Figure B.11: Panel median IRFs to TFP surprise, news and sentiment shocks - From 1990 onward

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
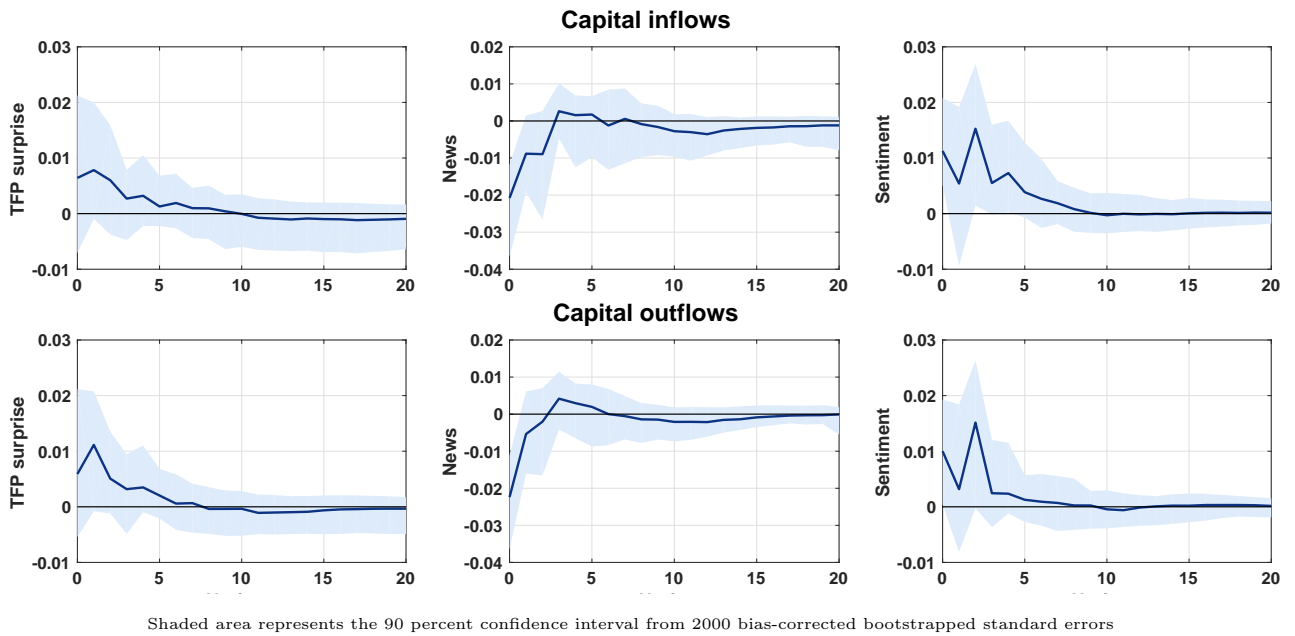
Figure B.12: Panel median IRFs to TFP surprise, news and sentiment shocks - FDI flows

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
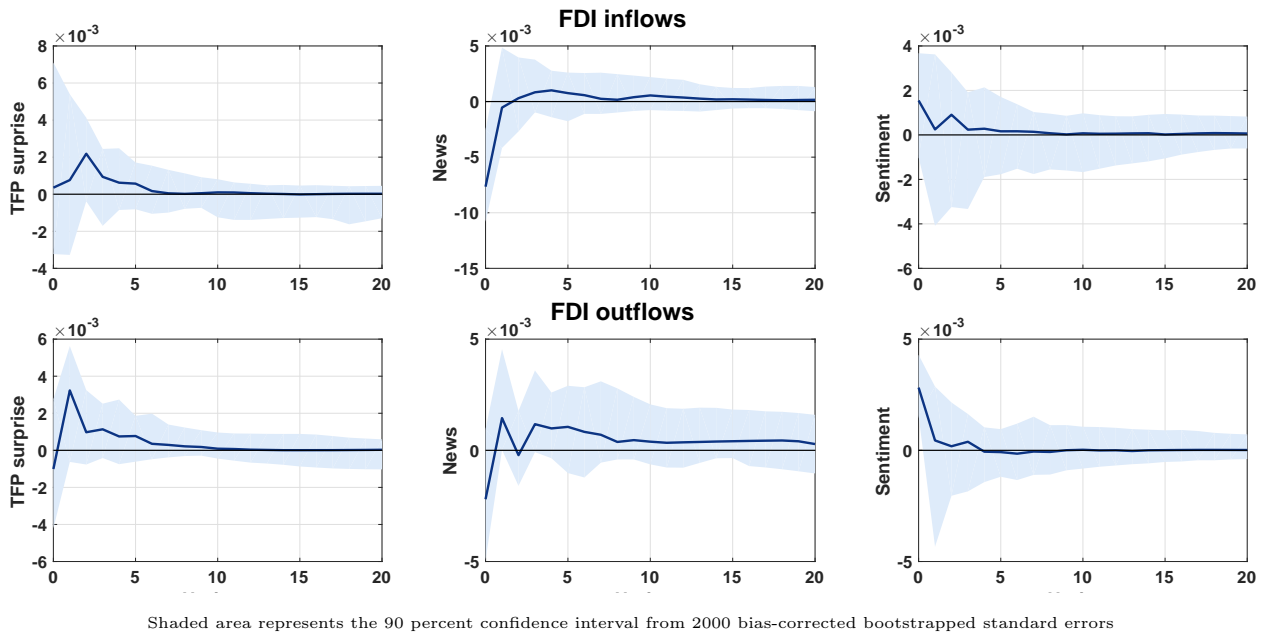
Figure B.13: Panel median IRFs to TFP surprise, news and sentiment shocks - Portfolio equity flows

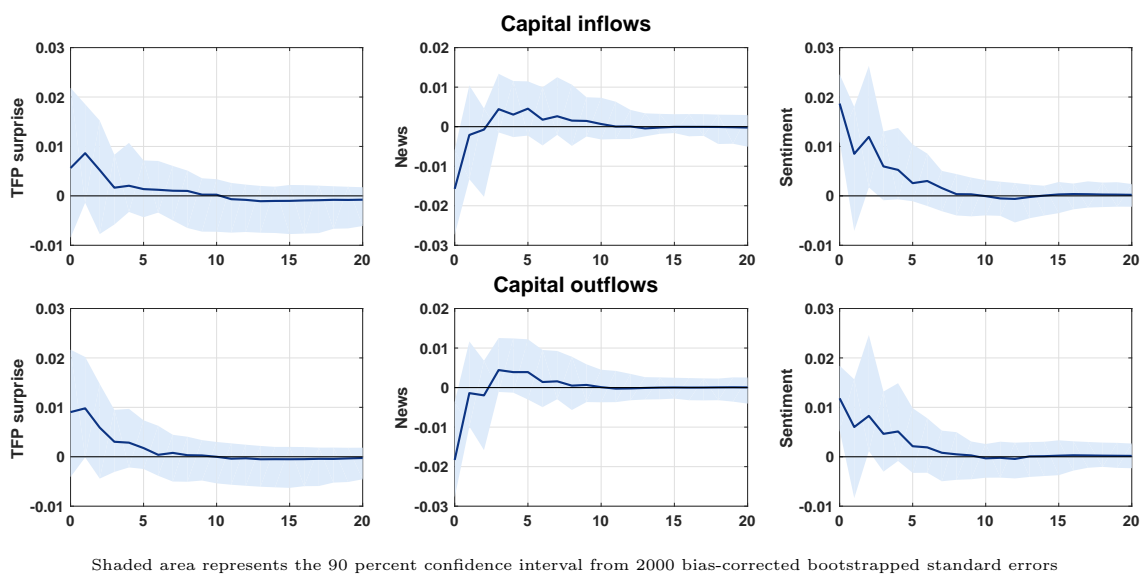Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
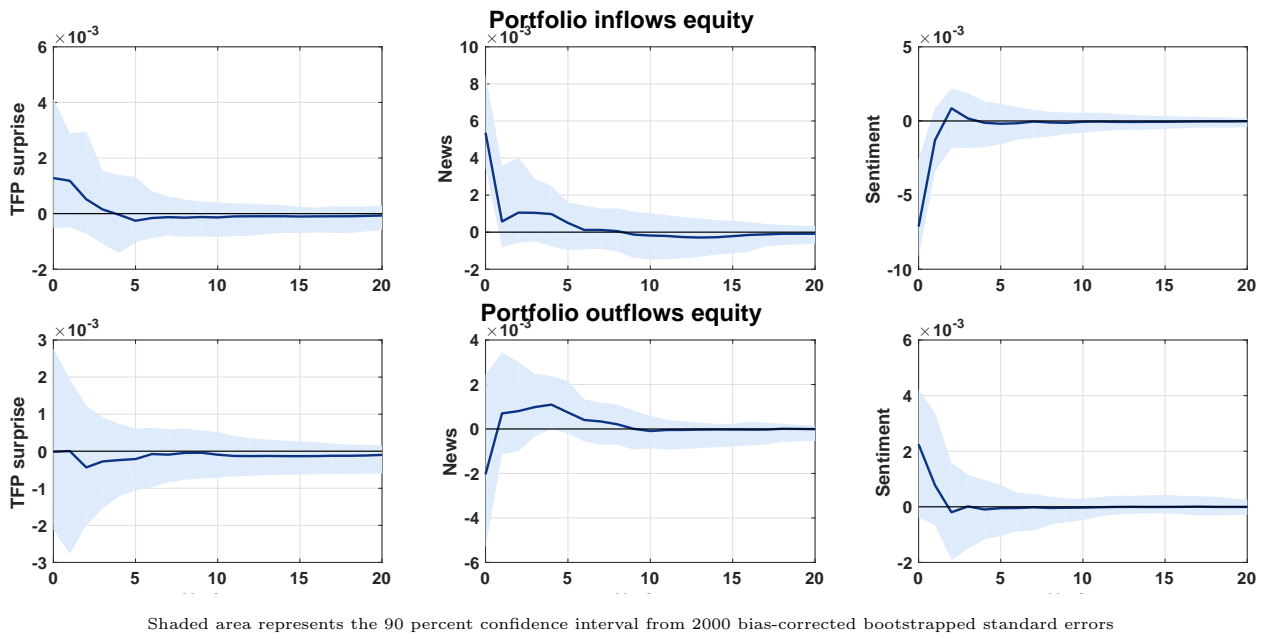
Figure B.14: Panel median IRFs to TFP surprise, news and sentiment shocks - Portfolio bond flows


Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
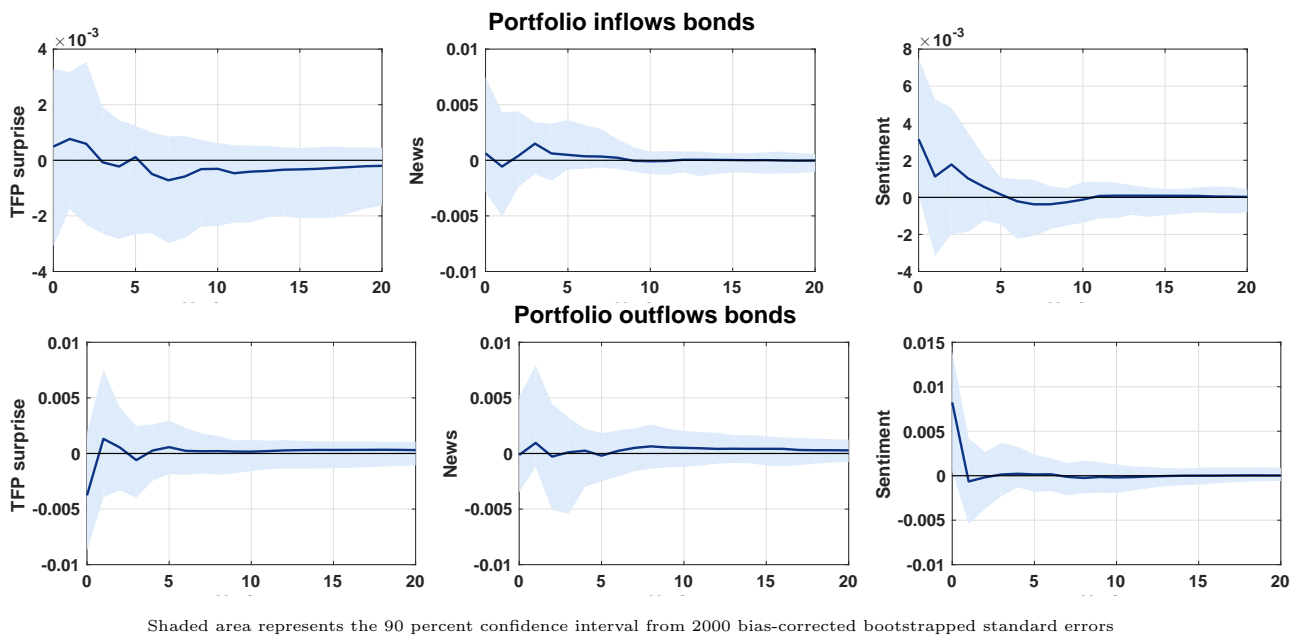
Figure B.15: Panel median IRFs to TFP surprise, news and sentiment shocks - Other investment flows

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
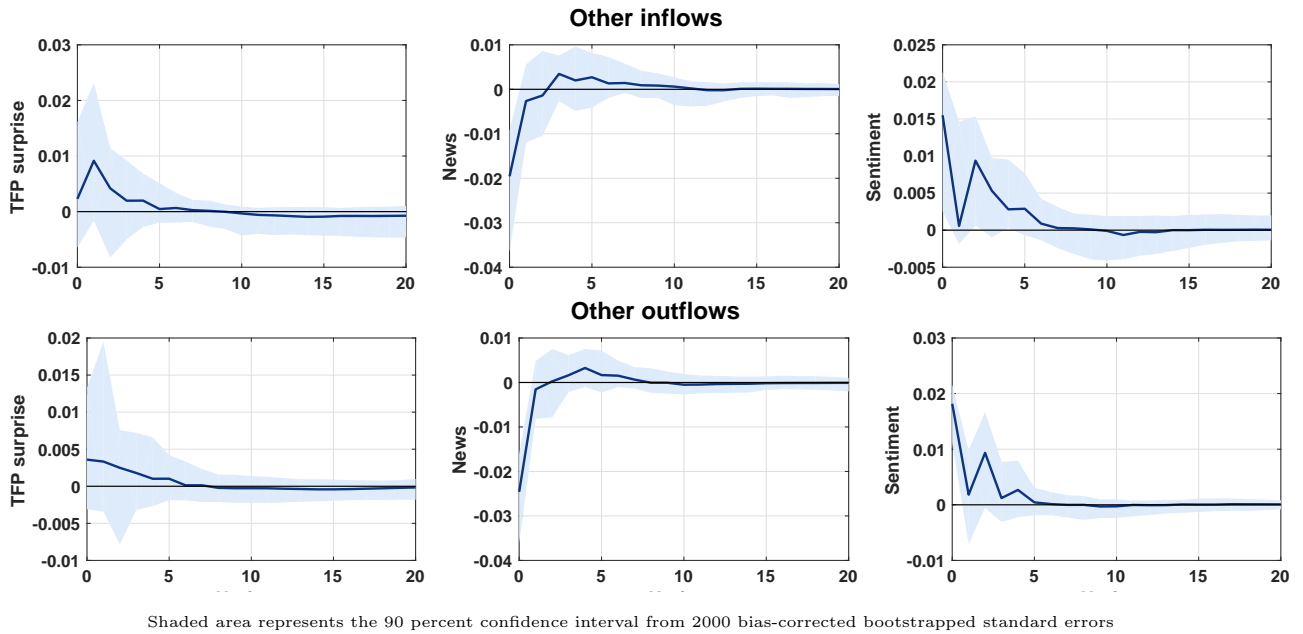
Figure B.16: Panel median IRFs to TFP surprise, news and sentiment shocks - Other investment debt flows

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
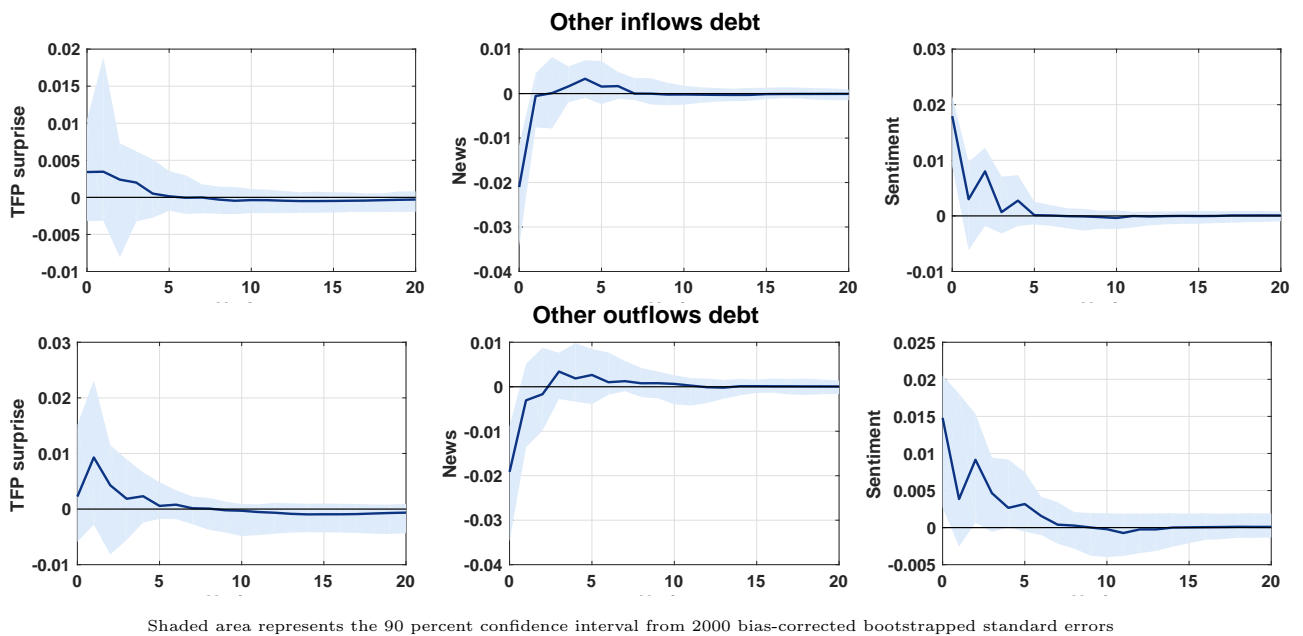
Figure B.17: Panel median IRFs to TFP surprise, news and sentiment shocks – Various lag specifications

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
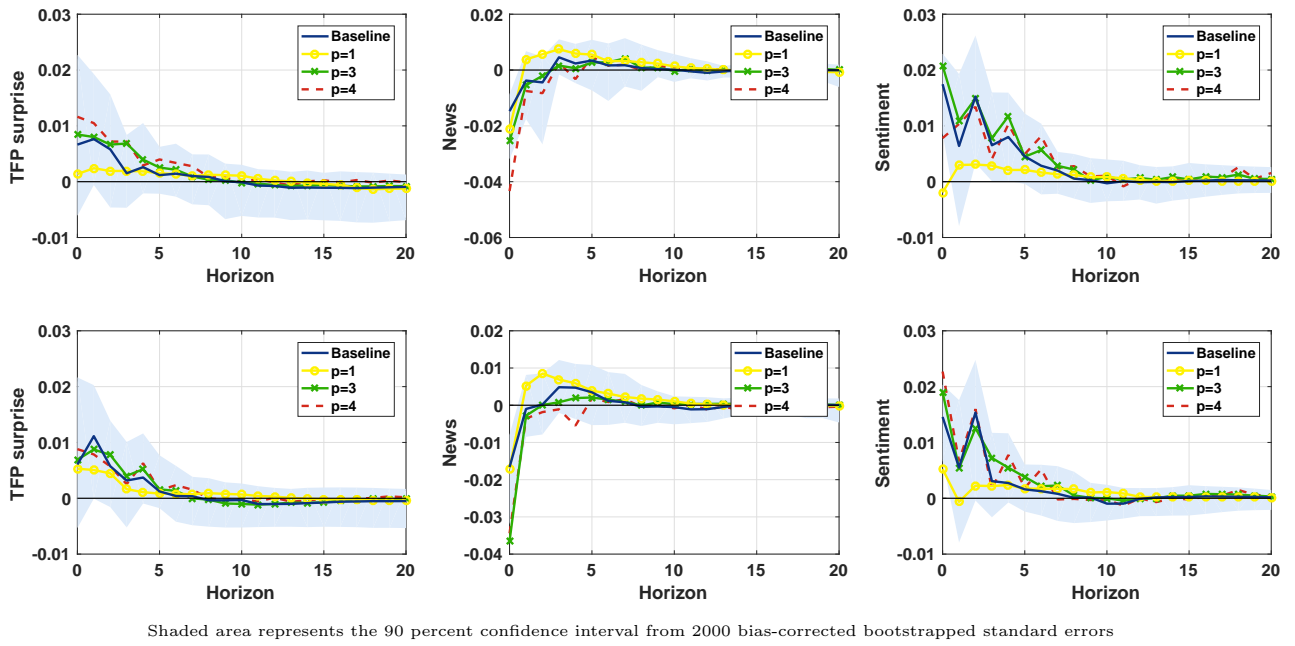
Figure B.18: FEVD of the panel's capital flows attributable to all three shocks – with 4 lags
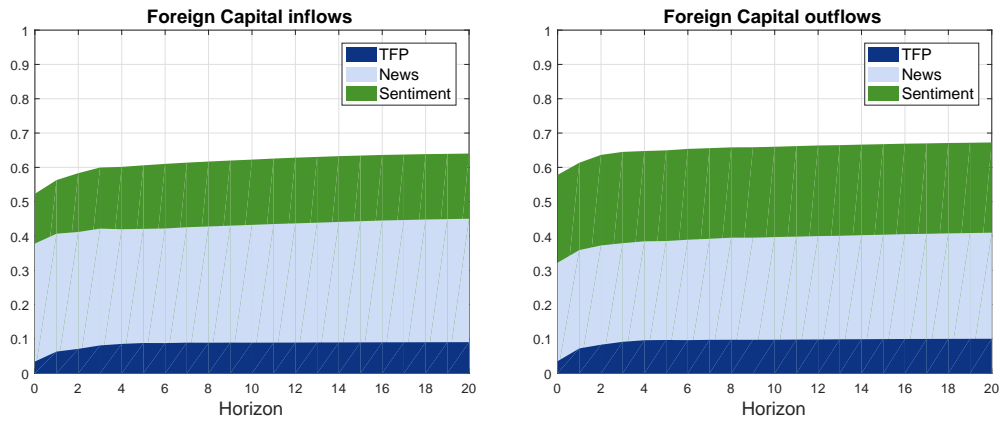
Figure B.19: Panel median IRFs to TFP surprise, news and sentiment shocks – Impact on capital flows with additional variables

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
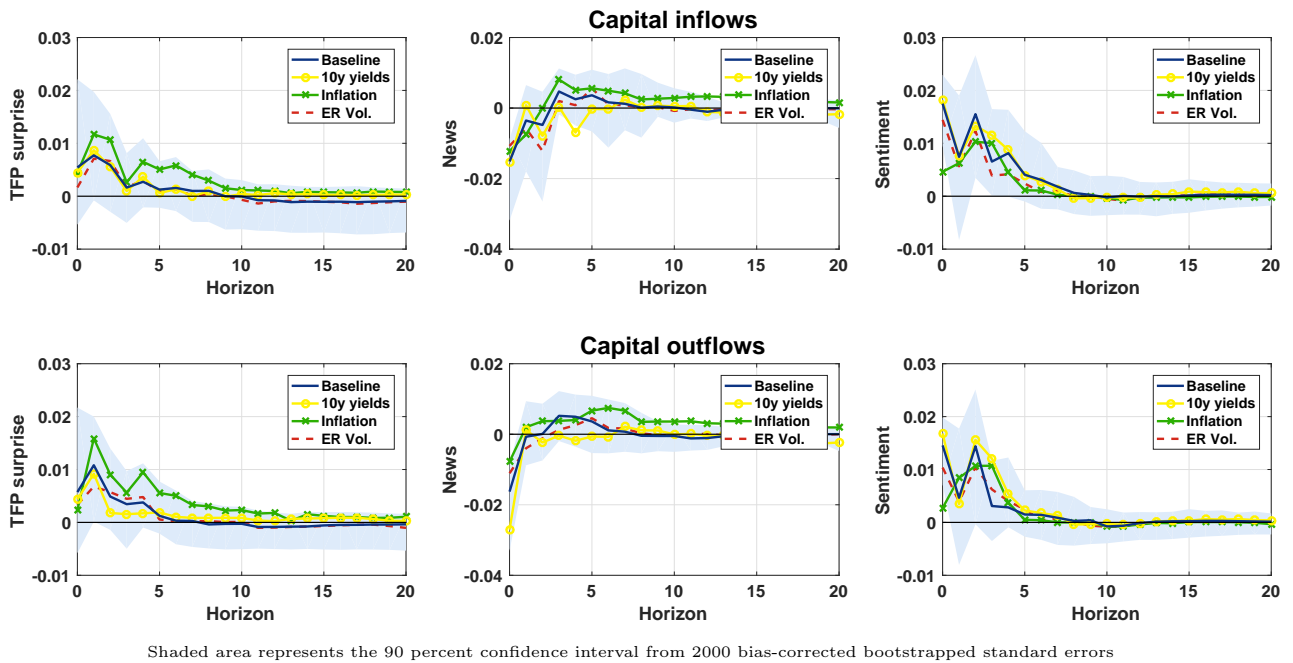
Figure B.20: Panel median IRFs to TFP surprise, news and sentiment shocks – Impact on capital flows with additional variables

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
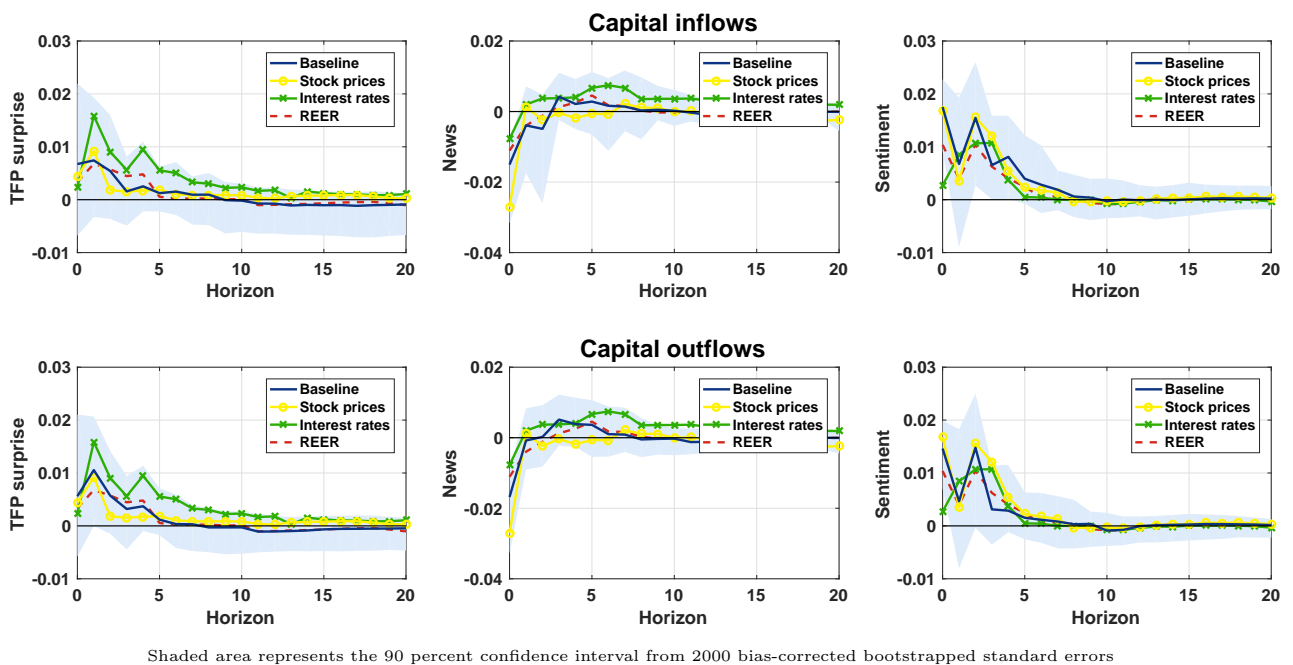
Figure B.21: Panel median IRFs to TFP surprise, news and sentiment shocks – Impact on additional variables
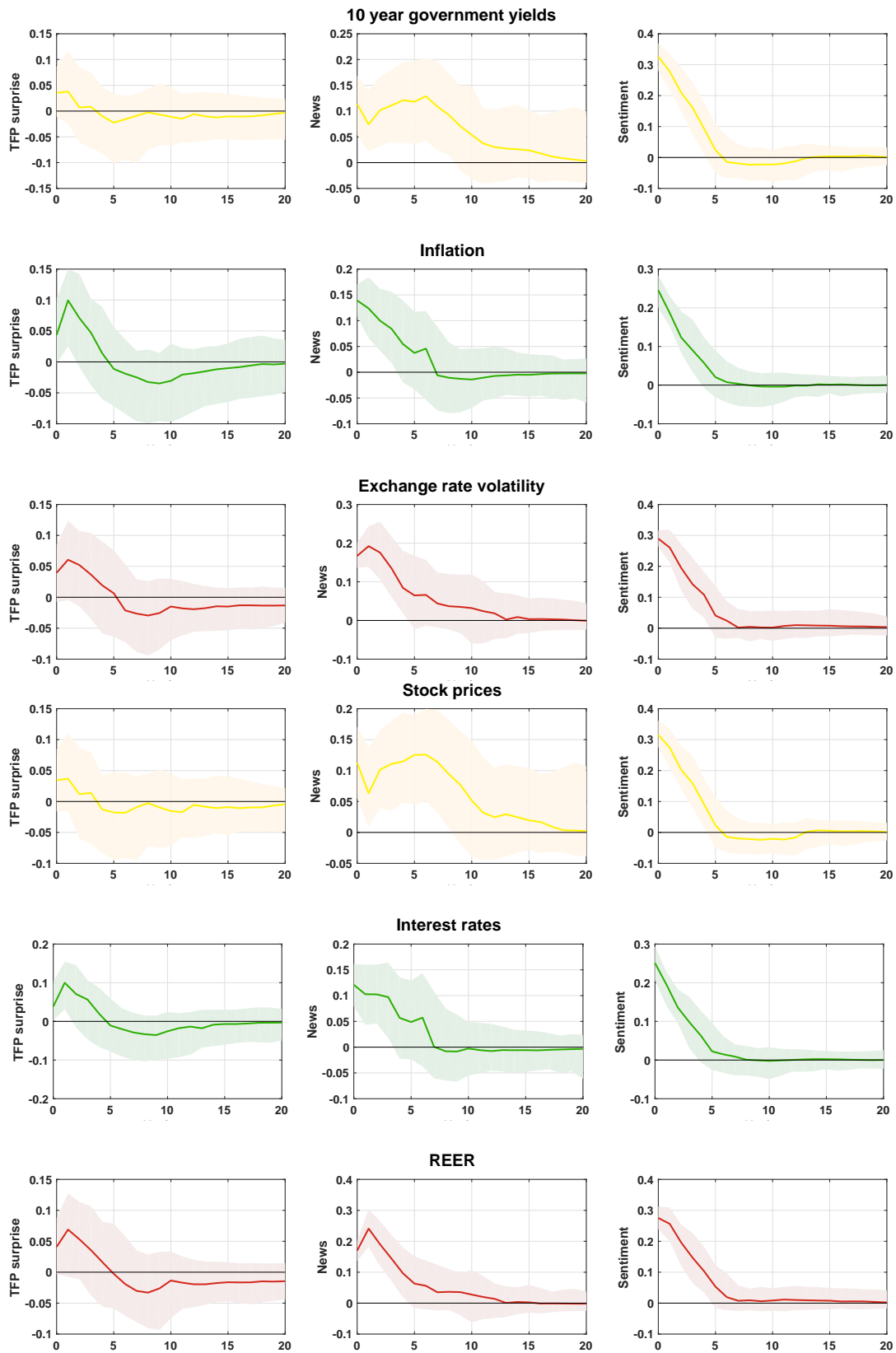
Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors

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Figure B.22: Panel median IRFs to TFP surprise, news, sentiment shocks - Inflows and outflows together

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors

Figure B.23: Panel median IRFs to TFP surprise, news, sentiment shocks – First differences

Shaded area represents the 90 percent confidence interval from 2000 bias-corrected bootstrapped standard errors
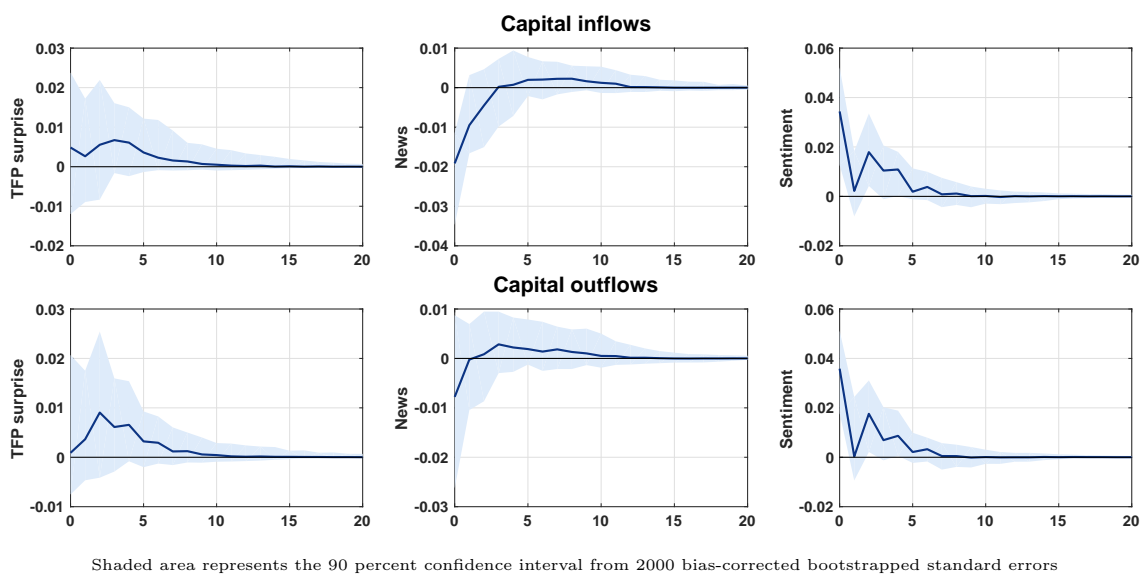
Figure B.24: FEVD of the panel's capital flows attributable to all three shocks – First differences
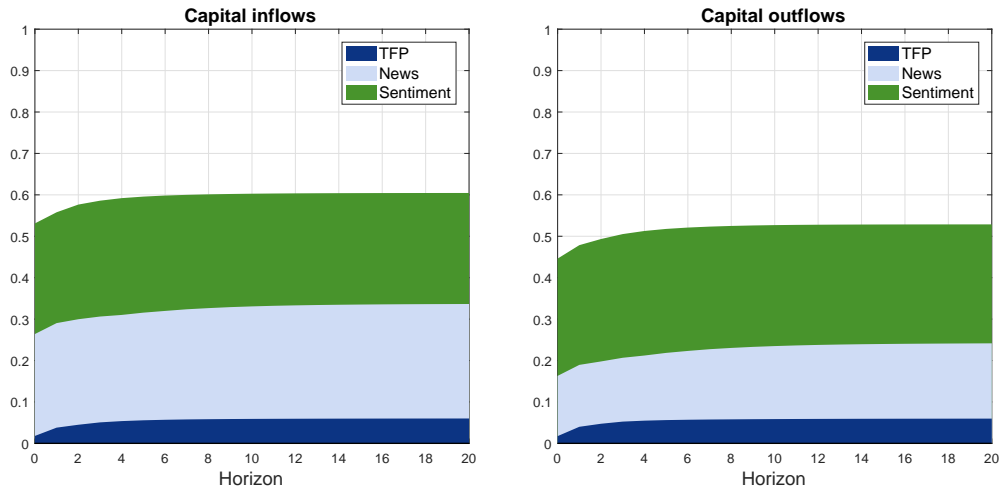
C Additional graphs

Figure C.1: Australia
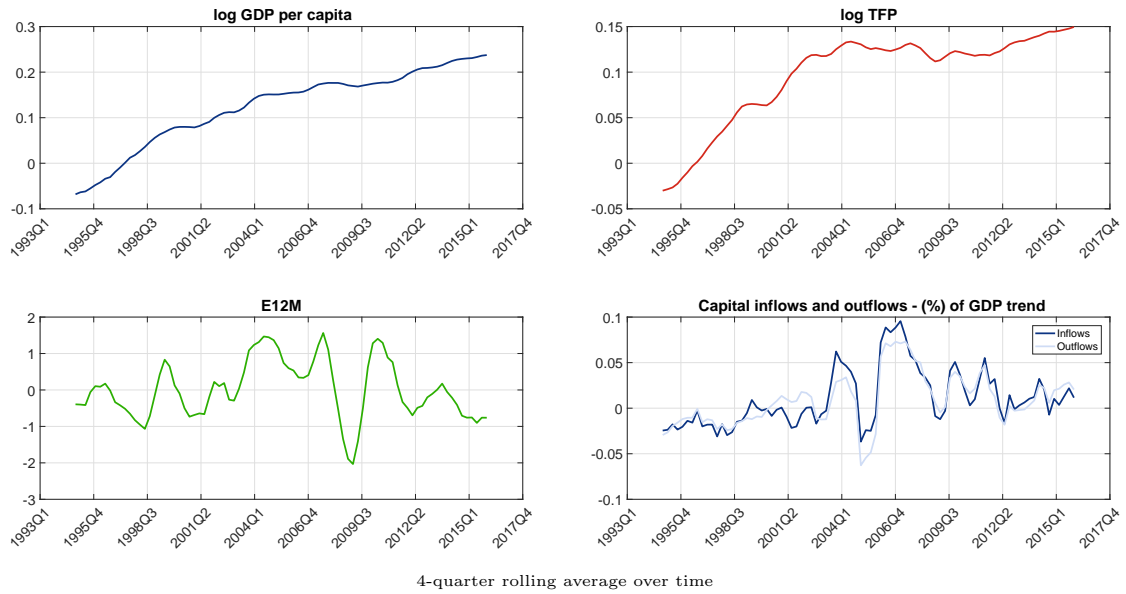
4-quarter rolling average over time

Figure C.2: Austria
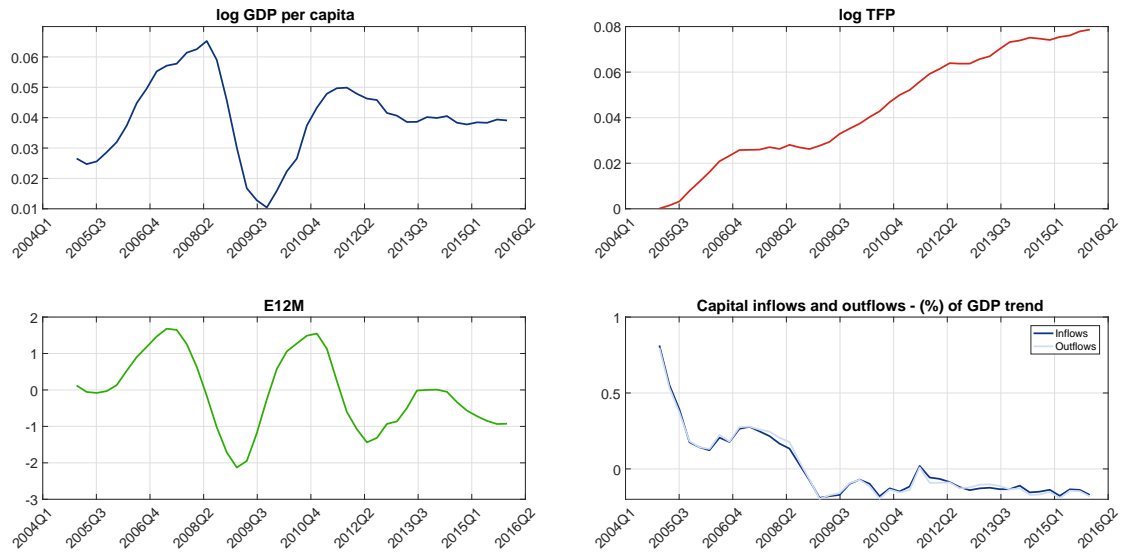
4-quarter rolling average over time

Figure C.3: Belgium

4-quarter rolling average over time

45
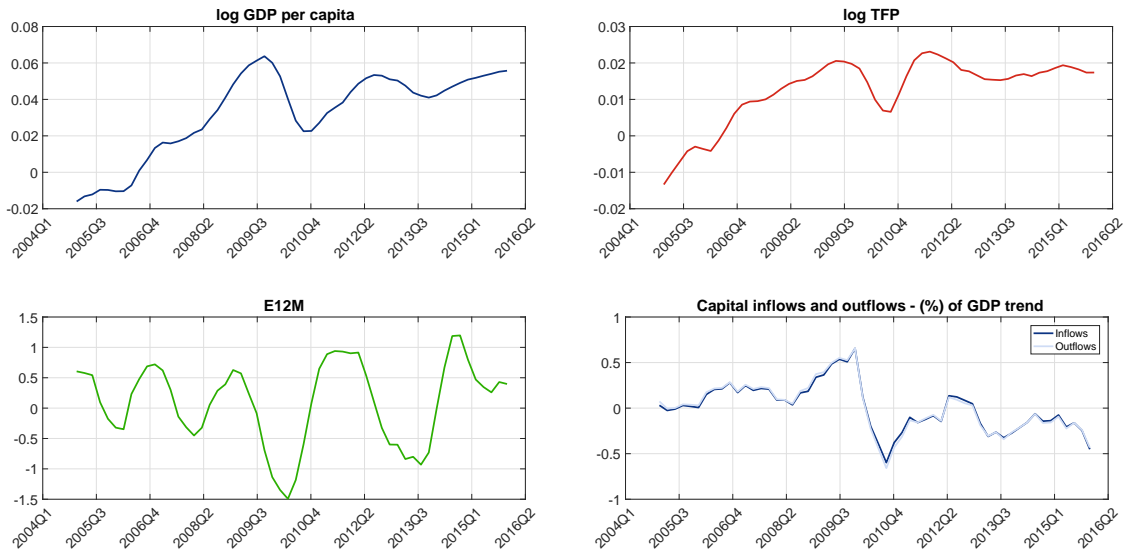
Figure C.4: Czech Republic

log GDP per capita

log TFP

E12M

Capital inflows and outflows - (%) of GDP trend
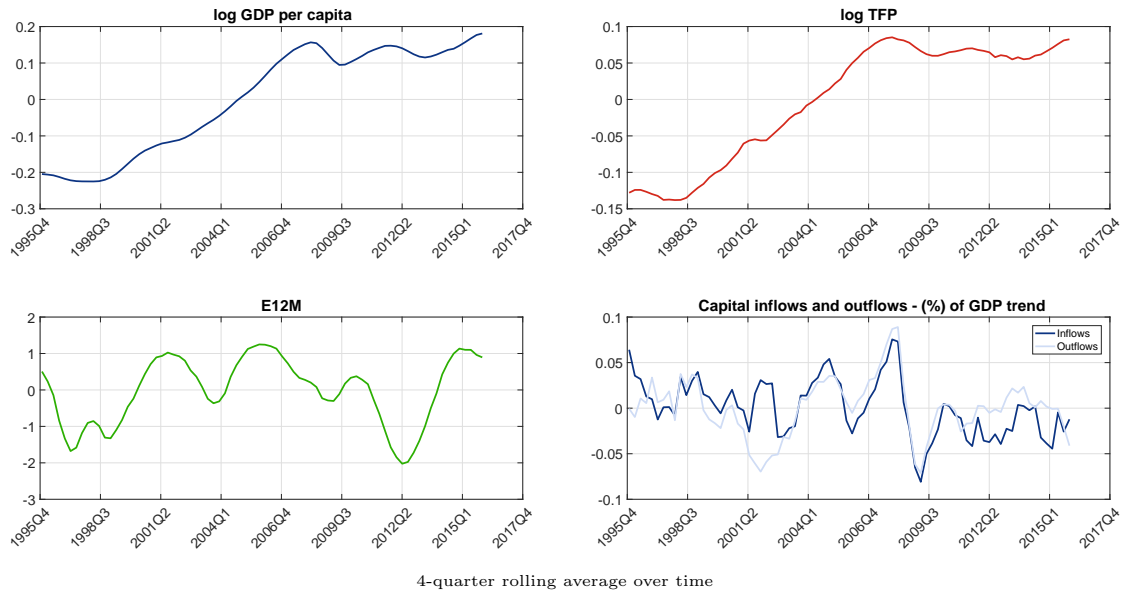
4-quarter rolling average over time

Figure C.5: Denmark

log GDP per capita

log TFP

E12M

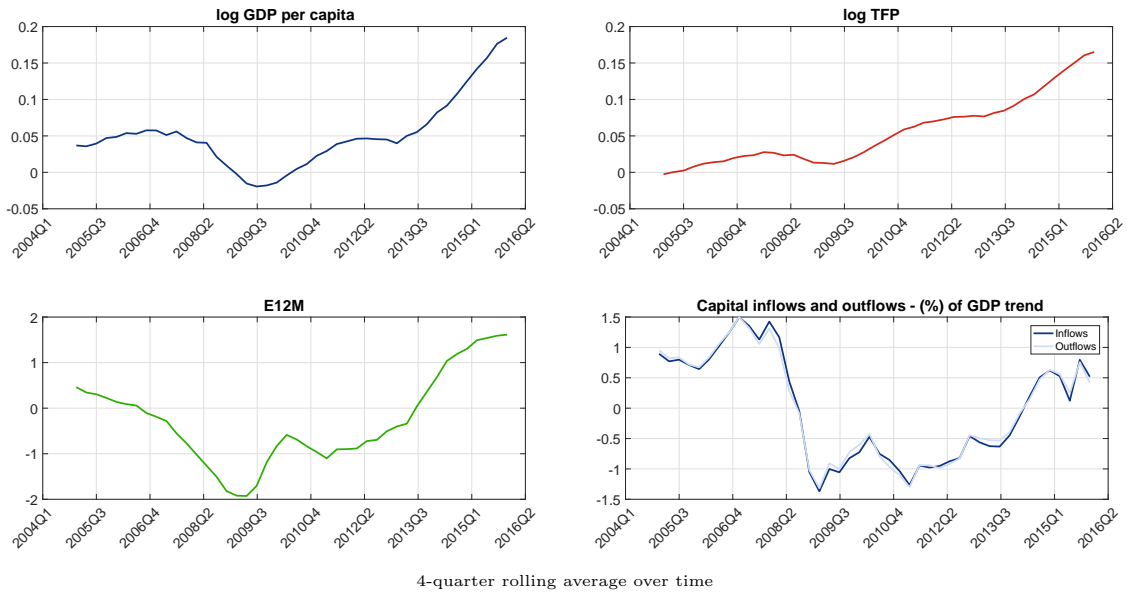Capital inflows and outflows - (%) of GDP trend
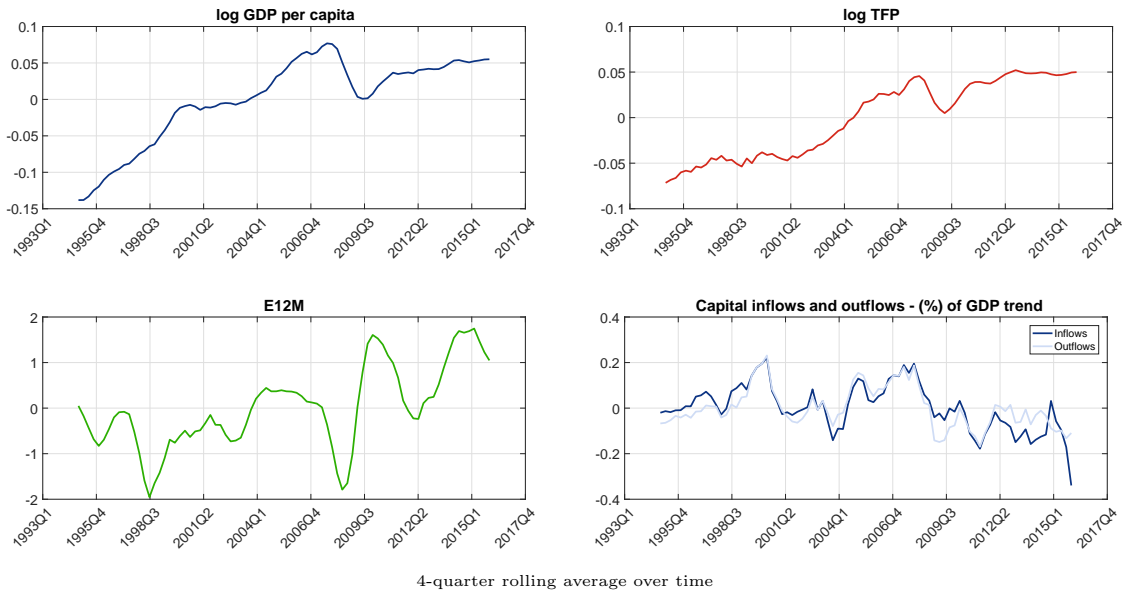
4-quarter rolling average over time

Figure C.6: Estonia

4-quarter rolling average over time

Figure C.7: Finland

4-quarter rolling average over time

47

Figure C.8: France

log GDP per capita

log TFP

E12M

Capital inflows and outflows - (%) of GDP trend
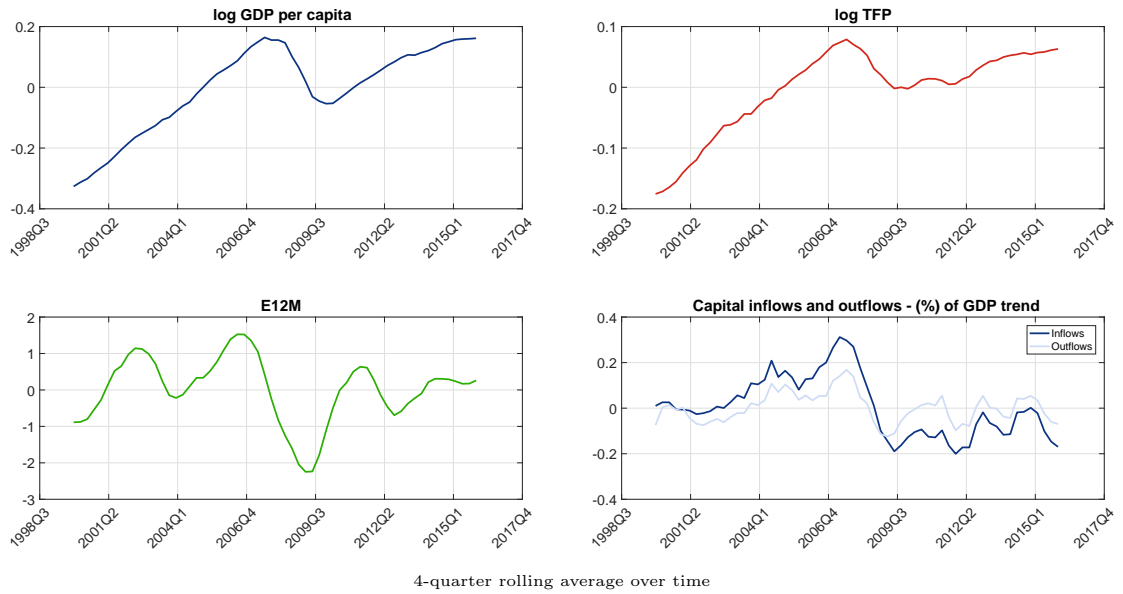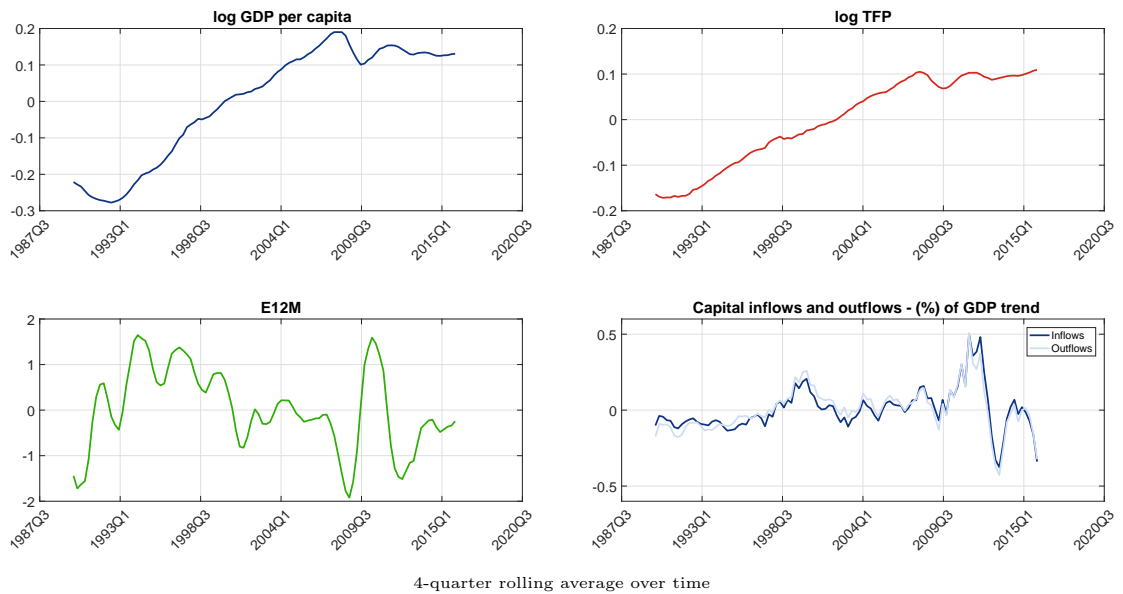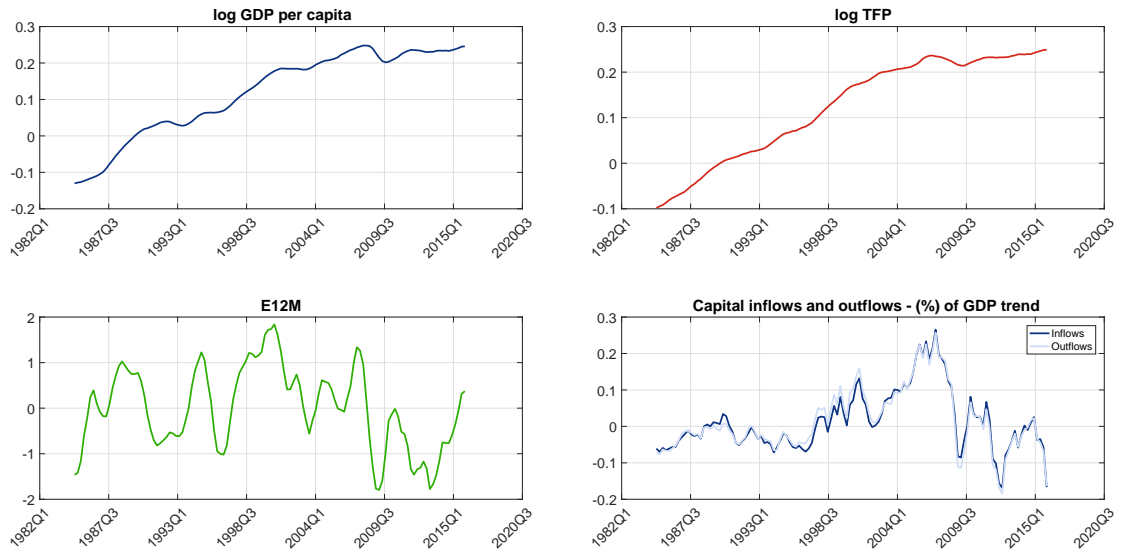
4-quarter rolling average over time

Figure C.9: Germany

log GDP per capita

log TFP

E12M

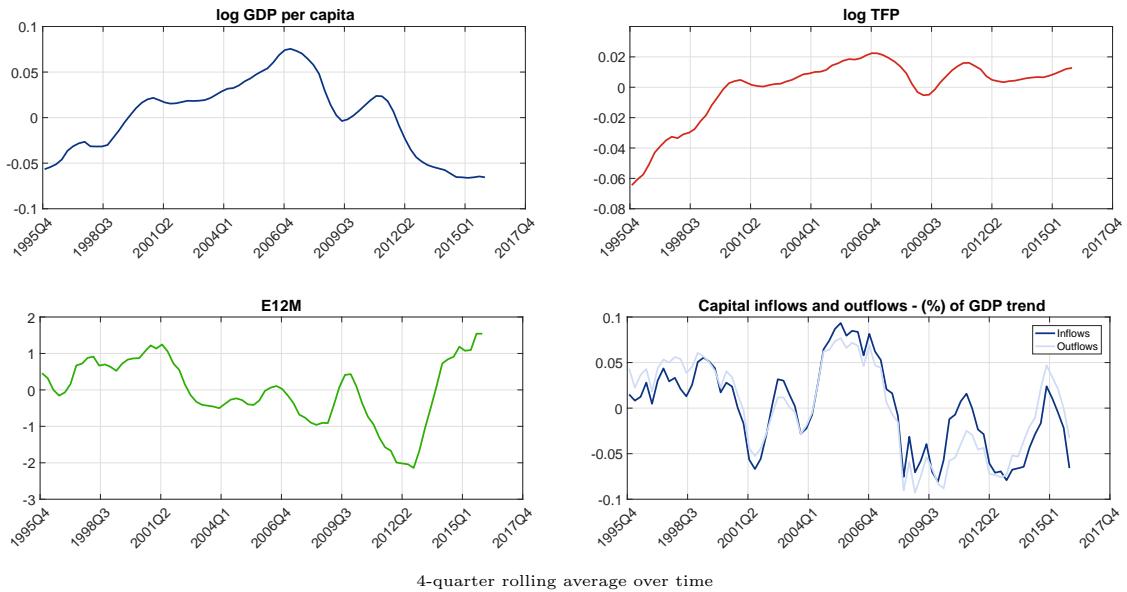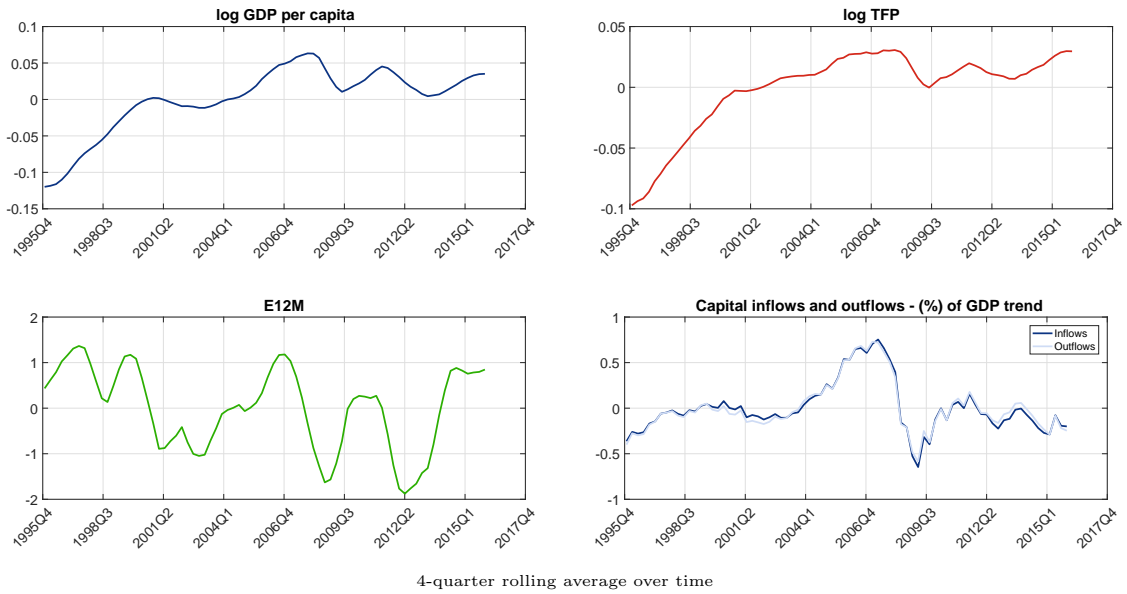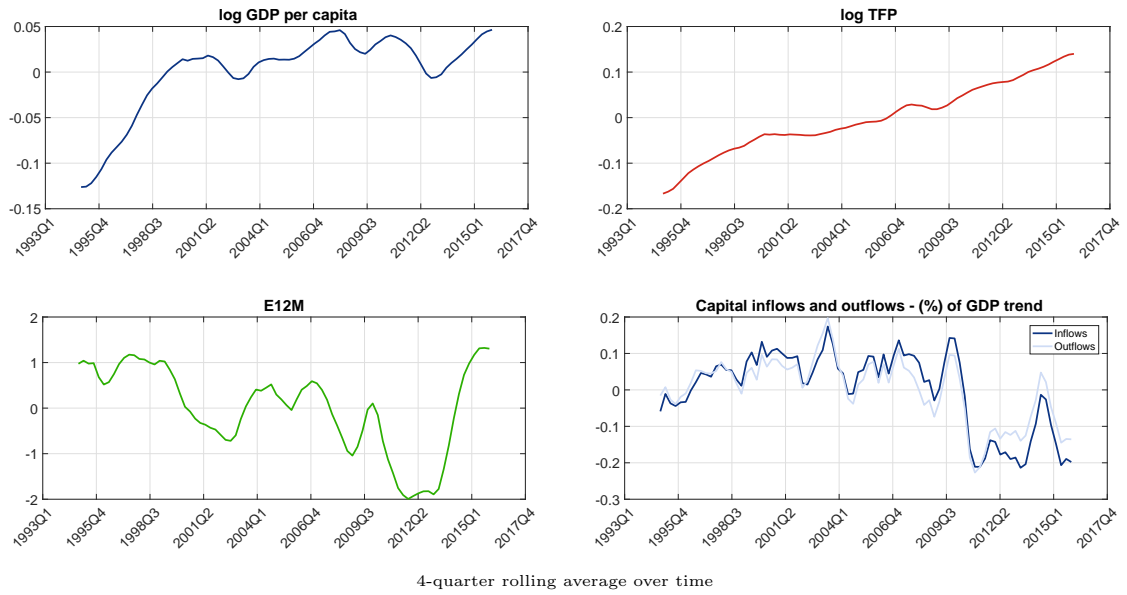Capital inflows and outflows - (%) of GDP trend

4-quarter rolling average over time

48
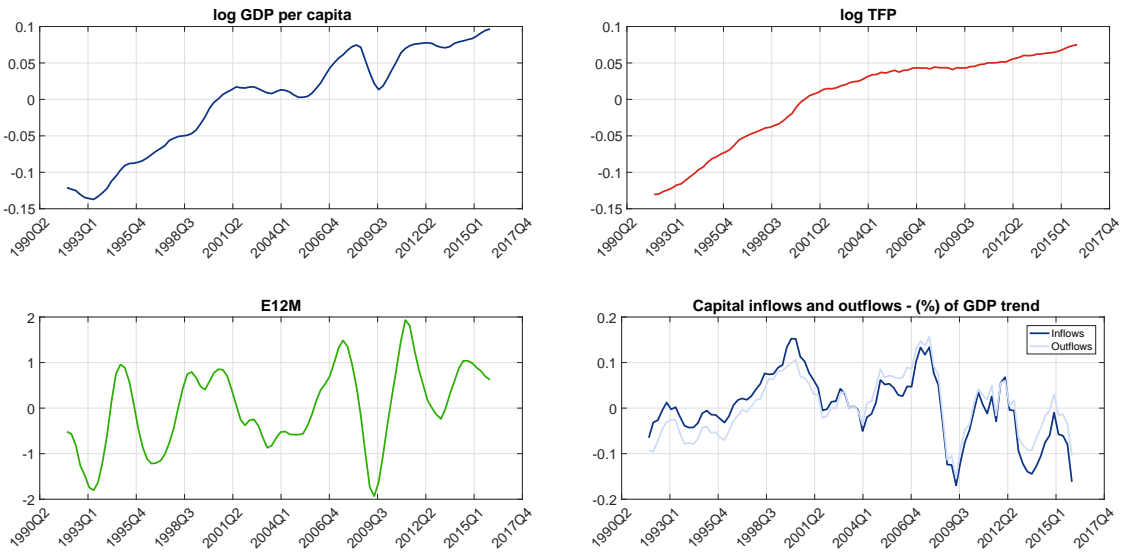
Figure C.10: Ireland

4-quarter rolling average over time

Figure C.11: Italy

4-quarter rolling average over time

49

Figure C.12: Netherlands
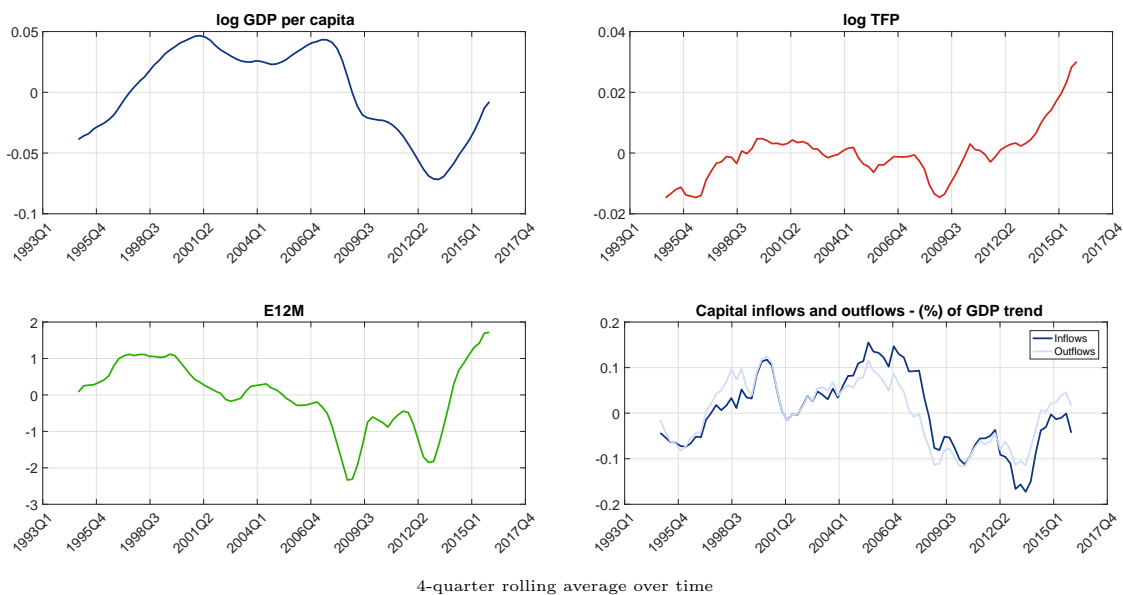

log GDP per capita

log TFP

E12M

Capital inflows and outflows - (%) of GDP trend

4-quarter rolling average over time

Figure C.13: Portugal

log GDP per capita

log TFP

E12M

Capital inflows and outflows - (%) of GDP trend

4-quarter rolling average over time

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Figure C.14: Spain

log GDP per capita

log TFP

E12M

Capital inflows and outflows - (%) of GDP trend

4-quarter rolling average over time

Figure C.15: Sweden

log GDP per capita

log TFP

E12M

Capital inflows and outflows - (%) of GDP trend

4-quarter rolling average over time

51
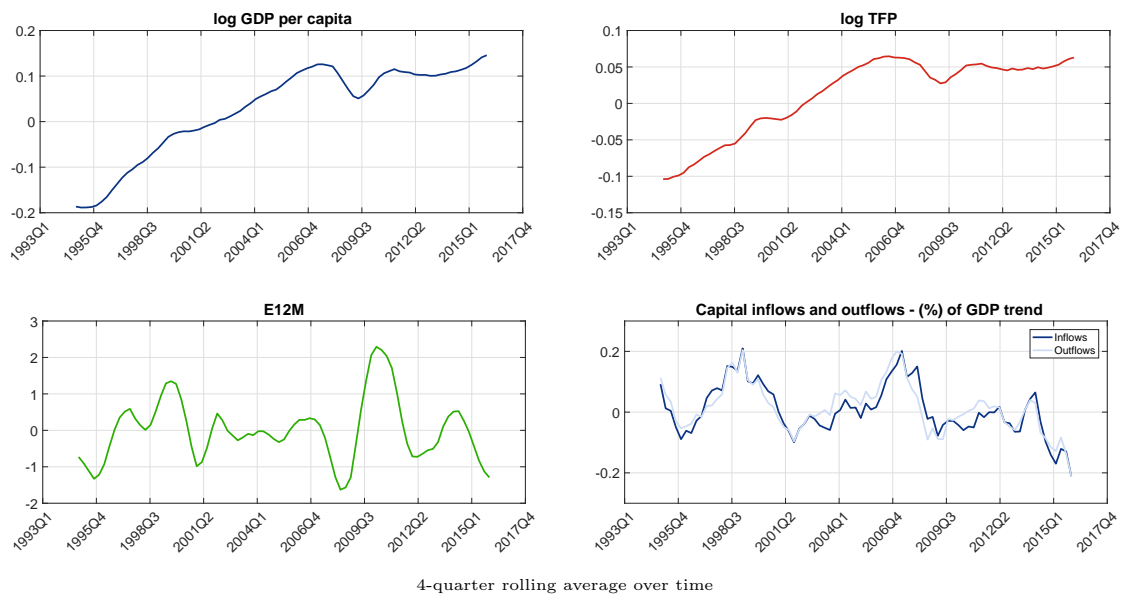
Figure C.16: Switzerland

4-quarter rolling average over time
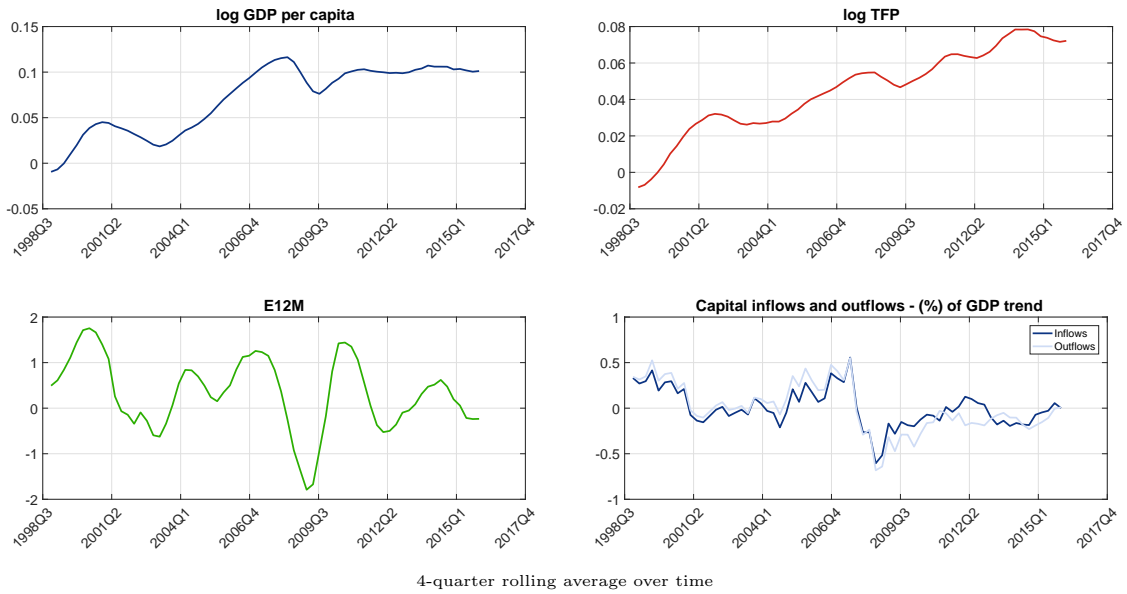
Figure C.17: United Kingdom

4-quarter rolling average over time

52

Figure C.18: United States

log GDP per capita

log TFP

E12M

Capital inflows and outflows - (%) of GDP trend
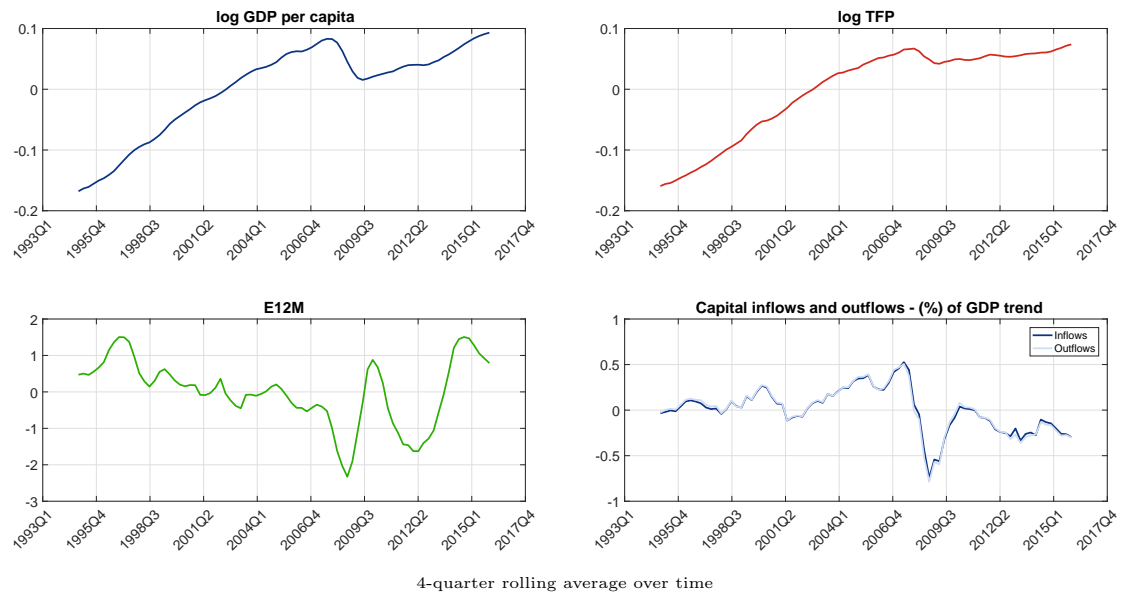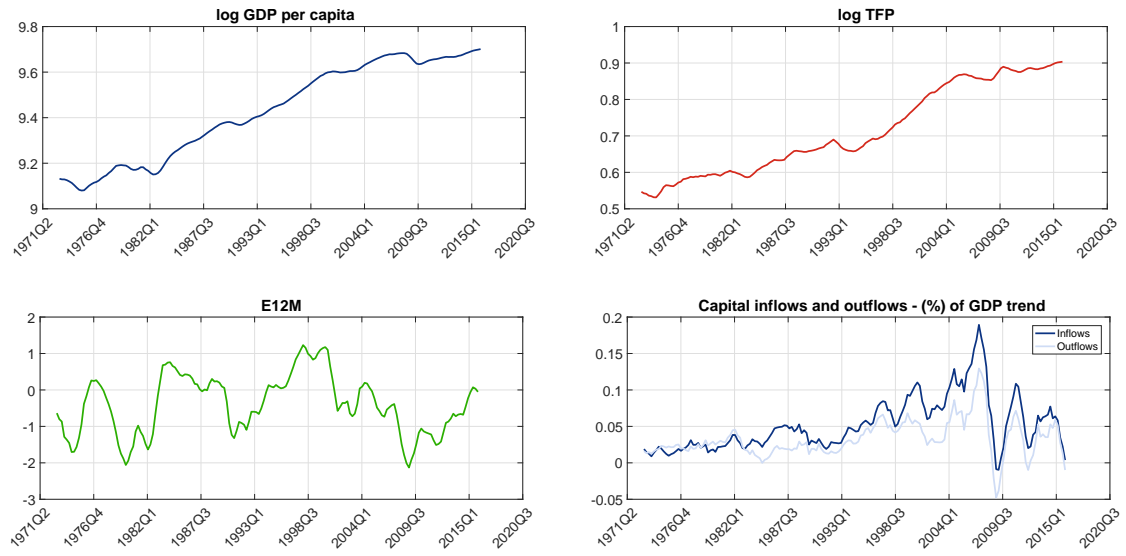
4-quarter rolling average over time

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D   TFP construction

Methodology

An ideal measure of utilisation-adjusted TFP would be similar to the US series by Fernald (2014). To our knowledge, such series cannot be constructed for the 17 countries considered in this paper. Therefore, we compute a measure of TFP using the methodology proposed by Imbs (1999) and close to the one used in Basu et al. (2006). The main idea is to adjust Solow residuals for capital and labour utilisation, using aggregated measures of investment, hours worked, wages and consumption. Hence, this approach does not use industry-level data nor control for sectors and non-constant returns to scale. The remaining of the Appendix aims at providing the equations of the iterative algorithm used to construct TFP series for each country. For more details on the derivations, the reader should refer to Imbs (1999).

Output

The output is assumed to be given by the following production function:

$$Y_t = X_t(K_t u_t)^{1-\alpha}(N_t e_t)^{\alpha}$$

where Y_t is aggregate output, K_t is the capital stock, N_t represents hours worked over the period, e_t is the labour effort and u_t the capital utilisation rate. Thus, $(K_t u_t)$ gives us the effective capital services and $(N_t e_t)$ the effective labour input.

Capital stock series

First, the capital stock series is constructed using the perpetual inventory method, with a time-varying depreciation rate:

$$K_{t+1} = (1 - \delta_t)K_t + I_t. \tag{A.1.}$$

The initial level of capital K_0 is constructed following Berlemann and Wesselhöft (2014):

$$K_0 \approx \frac{I_1}{g_I + \delta}$$

The initial investment value I_1 is obtained by regressing the logarithm of investment series on a constant and time t. The first observation of investment is excluded and the OLS regression therefore goes from $t = 2$ to T.

$$ln(I_t) = \alpha + \beta t + \epsilon_t$$

The initial investment value is then given by the fitted value for period $t = 1$:

$$\widehat{ln(I_t)} = \widehat{\alpha} + \widehat{\beta}t$$

After taking the exponential, this fitted value of investment is used to compute the initial stock of capital. The growth rate of investment g_I is obtained using the $\hat{\beta}$ estimated in the OLS regression. We slightly depart from their methodology by taking a fixed rather than time-varying depreciation rate to estimate the initial stock of capital. In other words, we use $\delta = 2.5\%$ and do not re-estimate K_0 after having determined a vector of time-varying depreciation rates.

Having estimated the initial stock of capital, K_0, the capital stock series can therefore be constructed using the perpetual inventory method as described in equation (A.1.).

Utilisation and depreciation rates

The second step is to determine the utilisation rate of capital, using the following equation:

$$u_t = \left(\frac{Y_t/K_t}{Y/K}\right)^{\delta/(r+\delta)} \tag{A.2.}$$

where Y/K is the average output-capital ratio. r is set to 4% and $\delta = I/K - g_I$, with I/K the average investment-capital ratio and g_I the growth rate of investments.

Then, the series for the depreciation rate is updated according to the following rule:

$$\delta_t = \delta u_t^\phi \tag{A.3.}$$

with $\phi = 1 + (r/\delta)$ and $\phi > 1$ such that depreciation is a convex function of utilisation.

This algorithm departs from Imbs (1999) paper regarding δ. In the original version, δ is defined as the average of the depreciation rate series. However, with this specification, the expectation of $\delta_t = \delta u_t^\phi$ would be equal to one.

Our definition of δ comes from the steady-state of the capital accumulation equation (A.1.);

$$K(1 + g_K) = (1 - \delta)K + I$$
$$\Leftrightarrow (1 + g_K) = (1 - \delta) + I/K$$
$$\Leftrightarrow \delta = I/K - g_K$$

As data on capital stock is constructed, the growth rate of capital g_K is approximated by the growth rate of investment, g_I.

Once the depreciation rate series is constructed, the process restarts at equation (A.1.), generating a new capital stock series, until (A.3.). As soon as the average depreciation rate δ converges

- i.e. two consecutive identical δ, the iteration process stops and the final utilisation and capital stocks series are constructed. From these series for K_t and u_t, one can construct the series for the effective capital service, $K_t u_t$.

Labour effort series

The series for labour effort can then be constructed using the following equation:

$$e_t = \left(\alpha \frac{Y_t}{C_t} \right)^{1/(1+\psi)}$$

with C_t the data on consumption, α given by

$$\alpha = 1 - (K/Y)(r + \delta)$$

and ψ being such that

$$\psi = \frac{\alpha}{w(e_t)N_t/Y_t} - 1$$

with $w(e_t)$ the data on wages. These steps allow the computation of the effective labour input series, $N_t e_t$.

TFP series

Finally, using the utilisation adjusted series of capital and labour, the TFP series can be computed using the production function:

$$X_t = Y_t * ((u_t K_t)^\alpha (e_t N_t)^{(1-\alpha)})^{-1}$$

Data

The present section aims at describing the data series used in the TFP construction.

- Y_t: Real GDP - Gross domestic product using the expenditures approach, chained volume estimates at quarterly frequency, seasonally adjusted and in domestic currency. Source: OECD.

- I_t: Real investment - Gross fixed capital formation using the expenditures approach, chained volume estimates at quarterly frequency, seasonally adjusted and in domestic currency. Source: OECD.

- C_t: Real private consumption - Private final consumption expenditures (households and non-profit organisations), using expenditures approach, chained volume estimates at quarterly

frequency, seasonally adjusted and in domestic currency. Source: OECD.

○ N_t: Total hours worked - Hours per worker times the total number of persons employed. Sources: OECD Economic Outlook/ILO.

○ w_t: Real wages - Total wages in value, denominated in domestic currency (earning per employee times number of persons employed for Portugal), deflated by private final consumption expenditures deflator. Sources: OECD/Oxford economics.

Comparing U.S. TFP series

The two graphs presented here assess differences between the U.S. TFP series from Fernald (2014) and the one obtained using the methodology described above. The first graph on the left compares the one-year average of the Fernald's series with the constructed one: except for few spikes in the 90s it seems to do a fairly good job. This impression is confirmed by the plot of the estimated Kernel density based on differences between the two.