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2018

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Documentos de Trabajo
N.º 1807

BANCO DE ESPAÑA
Eurosistema

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(*) I am grateful to E. Pappa and J. Dolado for their guidance and support. I would also like to thank F. Canova, M. Kulish, R. Marimon, an anonymous referee, and seminar participants at the European University Institute, the ADEMU workshop, the University of Sheffield, the Bank of England, the Bank of Spain, the Bank of Lithuania, and the SAEe 2017 in Barcelona. The views expressed in this paper are my own and do not necessarily reflect the views of the Banco de España or the European System of Central Banks.
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Documentos de Trabajo. N.º 1807

2018

ISSN: 1579-8666 (on line)

Abstract

This paper investigates the welfare and economic stabilization properties of a fiscal transfers scheme between members of a monetary union subject to sovereign spread shocks. The scheme, which consists of cross-country transfer rules triggered when sovereign spreads widen, is incorporated in a two-country model with financial frictions. In particular, banks hold government bonds in their portfolios, being exposed to sovereign risk. When this increases, a drop bank's equity value forces them to contract credit and to raise lending rates at the same time as they retain funds to build up their net worth. I show that, when domestic fiscal policy is not distortionary, fiscal transfers improve welfare and macroeconomic stability. This is because fiscal transfers can reduce banks' exposure to government debt, freeing credit supply to the private sector. On the contrary, when domestic fiscal policy is distortionary, fiscal transfers cause welfare losses, despite stabilizing the economy. This result arises because the distortions caused by funding the scheme outweigh the positive effects of fiscal transfers in smoothing the adjustment of the economy hit by the shock.

Keywords: sovereign risk, banks, monetary union, fiscal transfers.

JEL classification: E62, F41, F42, F45.

Resumen

Este documento investiga los efectos sobre el bienestar y las propiedades de estabilización económica de un esquema de transferencias fiscales entre miembros de una unión monetaria sujetos a choques de riesgo soberano. El esquema consiste en reglas de transferencia entre países que se activan cuando los diferenciales de riesgo soberano se amplían. Este esquema se incorpora en un modelo con fricciones financieras. En particular, los bancos de cada país tienen bonos del Gobierno en sus carteras y, por eso, están expuestos al riesgo soberano. Cuando este aumenta, el valor patrimonial de los bancos baja, obligándoles a contraer el crédito al sector privado y, al mismo tiempo, a elevar los tipos de interés. Este documento muestra que, cuando la política fiscal en cada país no es distorsionadora, las transferencias fiscales mejoran el bienestar y la estabilidad macroeconómica. Esto se debe a que las transferencias fiscales pueden reducir la exposición de los bancos a la deuda del Gobierno, liberando el suministro de crédito al sector privado. Por el contrario, cuando la política fiscal interna es distorsionadora, las transferencias fiscales causan pérdidas de bienestar, a pesar de estabilizar la economía. Este resultado surge porque las distorsiones causadas por el financiamiento del esquema superan los efectos positivos de las transferencias fiscales al suavizar el ajuste de la economía afectada por el choque.

Palabras clave: riesgo soberano, bancos, unión monetaria, transferencias fiscales.

Códigos JEL: E62, F41, F42, F45.

1 Introduction

The debate over the architecture of a robust monetary union attracted renewed interest during the recent sovereign debt crisis in Europe. The asymmetrical nature of sovereign interest rate shocks, coupled with the inherent constraints they pose on domestic fiscal policy, exposed an apparent gap in the design of the Euro area. This gap concerns the lack of fiscal mechanisms to facilitate the adjustments of individual member states facing idiosyncratic shocks. With the onset of the crisis, soaring sovereign spreads forced a number of countries, including Greece, Ireland, Italy, Portugal and Spain, to undertake sudden fiscal consolidations. At the same time, contractionary fiscal policy in countries belonging to the core of the Euro area failed to help boost the economies of the troubled periphery. The dramatic economic toll of the crisis and the lack of fiscal coordination within the union led commentators and policy leaders to propose the creation of a federal fiscal mechanism aimed at improving fiscal stability of individual member countries while strengthening the Euro area's response to shocks.

In this paper I construct a general equilibrium model of a two-region monetary union where sovereign spreads affect private borrowing costs due to financial frictions. The contribution to the on-going debate is twofold. First, the model provides a consistent narrative linking sovereign risk to the domestic banking sector. This link contributed to the contraction in the supply of credit to the economy seen during the sovereign debt crisis in the Euro area. Second, I assess the potential benefits of implementing fiscal transfers between national governments in response to sovereign spread shocks both in terms of welfare and economic stability. Moreover, I investigate how the conduct of national fiscal policy affects macroeconomic outcomes under such federal fiscal arrangements.

Completing the Euro area with a fiscal arrangement at the federal level is hardly a novel idea in policy and academic circles. At the time when policy makers were discussing the design of the future common currency, it appeared that a system of fiscal transfers crafted to countervail idiosyncratic shocks would be crucial for its success.[1] The arguments in support of a transfer mechanism drew directly on the literature of optimal currency areas.[2] With the creation of the Euro area, member states would no longer be able to use monetary policy or the exchange rate to buffer country-specific shocks. Moreover, to the extent that production factors are not fully mobile across countries and movements in nominal prices and wages are slow, fiscal policy would become a key instrument to fuel asymmetric adjustments. On the contrary, moral hazard considerations as well as doubts regarding the effectiveness of fiscal transfers tilted the debate towards a less ambitious outcome, with the political compromise reached in the Maastricht Treaty not contemplating the creation of an area-wide fiscal capacity. After laying dormant for decades until the sovereign debt crisis, political

[1] Refer to, for instance, the MacDougall report (Commission 1977) as well as Delors (1989).

[2] Refer to the seminal articles by Mundell (1961), McKinnon (1963) and Kenen (1969).

leaders have recently revived the discussion, having launched a road map towards a the implementation of a fiscal stabilization instrument at the Euro area level.[3]

With this paper, I contribute to this debate by examining and quantifying the effects of a federal fiscal capacity that is deployed in response to widening sovereign spread shocks. I focus on a transfers schemes that has governments engaging in non-repayable transfers, with the government making the transfers funding them through the domestic public budget. The scheme is embedded in a two-region DSGE model of a monetary union where sovereign risk affects the cost and availability of credit to firms. During the sovereign debt crisis, the fall in government bond prices severely weakened the balance sheets of banks in the periphery of the Euro area and adversely affected their ability to raise market-based funding. With the increase in borrowing costs, banks were forced to strengthen their equity ratios and, in the process, to raise lending rates and to reduce overall credit supply to firms. Credit scarcity dampened investment, which ultimately led to the recession.

To capture this mechanism, I introduce financial intermediaries who take short-term deposits from households and make long-term loans to firms and to the government. An agency problem between banks and their depositors forces the former to moderate their leverage ratios in order to attract deposits. Moreover, because banks hold government bonds in their portfolios, their net worth is exposed to sovereign risk. While generally the sovereign is able to obtain funds at the risk-free interest rate, a spread can arise to reflect an erosion of the government's credit worthiness. This deteriorates bank's equity value and forces them to contract credit and to raise lending rates at the same time as they retain funds to build up their net worth.

I find that, for a ratio of public debt to GDP of 60%, an increase in sovereign spreads of 10 percentage points leads to an increase in the interest rates charged to firms of more that 2 percentage points. The pass-through is reinforced when the share of public debt held by banks over total assets increases, with interest rates on private lending increasing twice as much for a similar increase in sovereign spreads when public debt to GDP equals 90%. Together with the increase in borrowing costs, the drop in the supply of credit to firms causes investment to drop sharply. At the trough, real GDP falls between 1% and nearly 2%, depending on the size of the public debt-to-GDP ratio. The size of the public debt-to-GDP ratio also has implications for fiscal policy, with the consolidation effort required to stabilize the fiscal stance being intensified for higher debt ratio. In addition, when distortionary fiscal instruments are used to stabilize the public debt-to-GDP ratio, they reinforce the fall in economic activity. In these cases, the fiscal adjustment required is larger.

The federal fiscal transfer scheme studied in this paper has the potential to increase welfare in the two regions of the monetary union when funded with lump-sum transfers.

[3]The 5 Presidents Report (Juncker et al. 2015) is the last high level policy contribution. It draws on and updates earlier proposals, namely Van Rompuy et al. (2012). The proposed mechanism, to be implemented before 2025, is to be deployed when domestic fiscal policy cannot, on its own, counteract large asymmetric shocks. See also IMF (2013) for discussion.

More generally, fiscal transfers are shown to increase macroeconomic stability, with GDP, consumption, labour and inflation volatility being reduced. When the public debt-to-GDP ratio is higher, sovereign spreads are responsive to movements to the fiscal stance, or when fiscal policy acts more quickly against those movements, fiscal transfers secure lower relative welfare gains.

While fiscal transfers can improve welfare when governments use lump sum transfers to target the fiscal stance, the same is not true when fiscal policy is distortionary. In this case, the negative effects of funding the scheme cause welfare to fall. It is shown, however, that fiscal transfers under distortionary domestic fiscal policy can still be used to stabilize the economy. For instance, when the domestic fiscal instrument is consumption or labour income taxes or wasteful government spending, fiscal transfers can reduce the volatility of GDP and inflation, but not the volatility of consumption. On the contrary, when the provision of a productive public good is the fiscal instrument available to member state governments, fiscal transfers have the potential to reduce the volatility of all these variables, even if reducing welfare.

The literature on international coordination using domestic fiscal instruments in countries that share a common currency has been prolific, with less attention being given to federal fiscal schemes.[4] A recent example is Blanchard et al. (2017), who propose a coordinated strategy to boost growth in the Euro area based on a fiscal expansion by the core which, with interest rates constrained at their lower bound, they show can have a significant positive impact in the periphery. Basso and Costain (2016b,a) depart from the premise of purely domestic fiscal policy and study how delegation of fiscal instruments to an independent federal authority affects public debt accumulation and economic stability. Focusing on fiscal transfers between regions in a monetary union, Werning (2017) provide a theoretical backing of fiscal transfers as a mean to improve risk sharing in a monetary union even in an environment with complete asset markets. More closely related to this paper, Kim and Kim (2017) show that fiscal transfers can improve welfare when international borrowing is restricted. Kletzer and von Hagen (2000), and Evers (2012, 2015) evaluate the potential of different federal fiscal arrangements to raise welfare and increase macroeconomic stability. I extend this literature by investigating the implications of fiscal transfers when the dynamics of the domestic fiscal stance also matter for economic stability.[5]

My analysis is also related to works studying the implications of sovereign spreads for economic stability. Schabert and van Wijnbergen (2011) and Bonam and Lukkezen (2014), for instance, focus on the interactions between fiscal, monetary, and exchange rate policies, in an environment where sovereign spreads are introduced as a pre-emptive game between the government and speculators, as I assume here. Corsetti et al. (2013) study how the sovereign risk channel exacerbates cyclical shocks when monetary policy is constrained at the

[4] Pappa and Vassilatos (2007)and Evers (2012) provide references.

[5] Evers (2015)considers different federal fiscal arrangements from those studied here (fiscal revenue sharing and a common fiscal budget) and focuses on labour and income taxation instead.

zero lower bound and analyse the effects of fiscal retrenchment in alleviating macroeconomic fluctuations. Focusing on the pass-through of sovereign shocks to private lending interest rates, the channel I explore in this paper, Bocola (2015) and Pancrazi et al. (2015) evaluate the effectiveness of asset purchases by the central bank for stabilising real activity.

The remainder of the paper is structured as follows. The next section describes the model environment and calibration. Section 3 investigates the transmission of sovereign spread shocks, while section 4 proposes a federal transfer scheme and assesses its welfare and economic stabilization properties when governments use a number of different fiscal instruments. Section 5 provides further discussion and section 6 concludes.

2 The Model

I consider a model of a monetary union composed of two symmetric regions, which are referred to as periphery and core. Each region is modelled as a small-open economy featuring habits in consumption, investment adjustment costs, and sticky wages and prices. Absent fiscal transfers between the two regional governments, the two regions are linked through trade in retail goods, through trade in non-contingent bonds, and by sharing a common central bank. I extend the standard open-economy DSGE model along two dimensions. First, I introduce a banking sector that serves as a domestic intermediary between savers and borrowers. To be specific, banks take short-term deposits from local households and sell long-term loans to firms and to the government. In order to generate a financial friction linking the fiscal stance to the supply side of the economy, I posit that banks' intermediation is constrained by their leverage ratios, which leads them to adjust lending rates and credit volumes in response to shocks affecting their net-worth. Second, I consider a rich fiscal block, with national governments having access to a comprehensive range of taxation and expenditure instruments for the conduct of fiscal policy. In particular, the government levies consumption and labour income taxes, $\tau_{c,t}$ and $\tau_{l,t}$, and issues sovereign bonds, $d_{g,t}$, to finance government expenditure G_t and lump-sum T_t transfers. In turn, G_t consists of wasteful and productive spending, $G_t = g_{e,t} + g_{x,t}$.

The remainder of the model can be summarised as follows. On the demand side, households consume a composite bundle consisting of domestic and foreign produced goods and supply labour to monopolistic labour agencies. Households can allocate their savings in domestic banks, as well as trade non-contingent bonds with foreign households. On the supply side, there are four types of firms: (i) competitive wholesalers that use a composite labour input and capital to produce a non-tradable intermediate good, (ii) monopolistic retailers that transform the intermediate good into tradable retail varieties, (iii) competitive final good producers that use domestic and foreign produced retail goods to produce a final good, and (iv) capital producers that invest in new capital. Finally, the union-wide central bank sets the nominal interest rate according to a feed-back rule targeting aggregate inflation and output growth.

The following subsections describe the economy of the periphery in more detail. The description of the core is omitted for brevity since its structure is analogous to the periphery. All variables are in *per capita* terms, and the conventional $\star$ denotes foreign variables or parameters (i.e., those of the core).

2.1 Households

The infinitely lived household is composed of a continuum of measure 1 of household members, among whom a fraction $1 - f$ are workers and a fraction f are bankers. The former supply labour $l_{h,t}$ to wholesale firms, while the latter manage a financial intermediary for profits. Household members switch between the two occupations but keep the relative proportion of each type constant.

Household members are assumed to pool consumption risk perfectly. Their life-time utility is given by:

$$\mathcal{L}_t^{welfare} = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \psi_t U\left(c_t, l_{h,t}\right) \tag{1}$$

with instantaneous utility of the form:

$$\mathcal{U}\left(C_t, l_{h,t}\right) = \frac{\left(c_t - \varrho c_{t-1}\right)^{1-\sigma} - 1}{1-\sigma} - \zeta_t \frac{\left(l_{h,t}\right)^{1+\eta}}{1+\eta}$$

where E_0 denotes the expectations operator conditional on the information available up to $t = 0$ and $\beta \in (0,1)$ is the household's discount factor. Households derive utility from consumption c_t, which is subject to external habit formation $\varrho \in (0,1)$, and where $\sigma > 0$ is the elasticity of intertemporal substitution, and disutility from labour, where $\eta > 0$ is the inverse elasticity of labour supply. The terms ψ_t and ζ_t represent intertemporal and intratemporal preference shocks and are assumed to follow independent AR(1) processes.

The budget constraint of the household, in real terms[6], is given by:

$$\begin{array}{c} \left(1+\tau_{c,t}\right) c_t + b_{b,t} + e_t \frac{i_{t-1}}{\pi_t} b_{f,t-1} \\ \leq \\ \left(1-\tau_{l,t}\right) w_{h,t} l_{h,t} + r_{h,t-1} b_{b,t-1} + e_t b_{f,t} - \Psi\left(e_t b_{f,t}\right) + \Pi_t + T_t \end{array} \tag{2}$$

where b_b denotes deposits with domestic banks, which pay the real interest rate $r_{h,t-1}$, and b_f denotes non-contingent bonds traded with households abroad and which pay the real interest rate $r_{f,t-1}$.[7] The term $\Psi(\cdot)$ denotes convex costs incurred on holdings of bonds traded with

[6] The price of the consumption good, P_t, is used as the *numeraire* price in each region.

[7] For ease of exposition, the budget constraint is written such that $b_b > 0$ implies positive savings from the households, while $b_f > 0$ implies that the household is a net borrower in international markets. Moreover, I assume that non-contingent bonds traded between the two regions are denominated in units of consumption in the core.

foreign households. The nominal rate on international bonds, i_t, is the set by the central bank, while π_t denotes domestic consumer price inflation. As a consequence of being in a monetary union, the nominal exchange rate between the two countries is fixed and therefore the real exchange rate, e_t, is simply equal to the ratio of consumer prices in each region.[8] Workers receive the real wage $w_{h,t}$, real profits from firms, Π_t, pay consumption and labour income taxes, $\tau_{c,t}$ and $\tau_{l,t}$, and receive lump sum transfers T_t from the government.

The first-order conditions with respect to consumption, labour, and financial asset holdings are:

$$(1+\tau_{c,t})\varsigma_t = \frac{1}{c_t - \varrho c_{t-1}} \tag{3}$$

$$\psi_t \zeta_t (l_{h,t})^{\eta} = \varsigma_t (1-\tau_{l,t}) w_{h,t} \tag{4}$$

$$1 = \beta \Lambda_{t,t+1} r_{h,t} \tag{5}$$

$$1 = \beta \Lambda_{t,t+1} \frac{e_{t+1}}{e_t} \frac{i_t/\pi_{t+1}}{1-\Psi'} \tag{6}$$

where ς_t is the multiplier on the budget constraint and $\Lambda_{t,t+1} = \varsigma_{t+1}/\varsigma_t$ is the stochastic discount factor.

I introduce nominal wage rigidities as follows. On the supply side, workers are assumed to supply differentiated labour services to labour agencies. The latter are assumed to have market power to negotiate wages with intermediate good producers. In turn, intermediate good producers use a composite labour input in production, l_t, which they obtain by aggregating the differentiated labour services according to:

$$l_t = \left(\int_0^1 (l_{i,t})^{\frac{\mu_w - 1}{\mu_w}} \, di \right)^{\frac{\mu_w}{\mu_w - 1}}$$

where $l_{i,t}$ is the labour service provided by member i and $\mu_w > 1$ is the constant elasticity of substitution between labour services. The demand curve for labour service i is therefore given by:

$$l_{i,t} = \left(\frac{W_{i,t}}{W_t} \right)^{-\mu_w} l_t \tag{7}$$

where $W_{i,t}$ is the nominal wage agency i charges in order to supply $l_{i,t}$, whereas the wage index of the composite labour input is given by $W_t = \left(\int_0^1 (W_{i,t})^{1-\mu_w} \, di \right)^{1/(1-\mu_w)}$.

[8]More specifically, $e_t = P_t^{\star}/P_t$.

In each period, only a fraction $1-\lambda_w$ of agencies can adjust their posted nominal wage. When able to so, it chooses the nominal wage $W_{i,t}$ that maximizes the stream of real discounted profits, $\Pi^W(i)$, given by:

$$\underset{W_{i,t}}{\text{Max}}\text{E}_t \sum_{s=0}^{\infty} (\beta\lambda_w)^s \Lambda_{t,t+s} \left\{ \left[\frac{W_{i,t}}{P_{t+s}} - w_{h,t+s} \right] l_{i,t} \right\} \tag{8}$$

subject to (7) and where $w_{h,t}$ is the real wage paid to workers.

2.2 Banks

I extend the banking sector described in Gertler and Karadi (2011) by allowing banks not only to provide credit to wholesale firms but also to fund the domestic government. However, I make two simplifying assumptions: first, I assume that the domestic banking sector holds the total amount of public debt issued by the domestic government; second, banks do not engage in cross-border deposits or investment activities. These two assumptions can be motivated with the following stylized facts. In 2011, at the height of the sovereign debt crisis, around 80% of sovereign debt claims on countries in the periphery of the Euro area were held by domestic banks. Moreover, domestic government bond holdings in the periphery accounted for 93% of banks' equity. This home bias in sovereign bond holdings, although not as high, was also present in the core. These figures had been markedly rising since 2009. On the other hand, national banks represented roughly 75% of external financing to domestic private firms. Consistent with the theory proposed in this paper, when sovereign spreads started to widen in the periphery, from 2008 to 2013, the volume of newly issued loans fell by more than 50%.[9]

Every period a fraction f of household members are bankers who run a domestic financial intermediary. They obtain deposits $b_{b,t}$ from other household members and lend funds to wholesale producers and to the government, $a_{x,t}$ and $a_{b,t}$ respectively. With probability λ_f, a banker remains active in the following period, whereas a fraction $(1-\lambda_f)f$ of bankers retire and become workers.[10]

Denoting by n_t the net worth of the financial intermediary and by $\mathcal{W}_t$ the total value of its assets, the bank's balance sheet is then given by:

$$\mathcal{W}_t \equiv q_{x,t}a_{x,t} + q_{b,t}a_{b,t} \quad = \quad n_t + b_{b,t} \tag{9}$$

[9]The figures are taken from Uhlig (2013), Acharya et al. (2014), and Bocola (2015). Assuming government debt is only held by domestic households is in line with the empirical pattern for the "repatriation of public debt" after 2009 in the periphery of the Euro area (See Figure 1 in Brutti and Sauré (2016)), supported by the secondary market theory of Broner et al. (2010). A report by the Bank for International Settlements, BIS (2011), provides a comprehensive discussion on the links between sovereign credit risk and banks funding conditions. Dedola et al. (2013) extend the framework of Gertler and Karadi (2011) to allow banks to take deposits from foreign households and to lend to foreign firms, generating an incentive for credit policy coordination between different regions.

[10]Conversely, each period the same number of workers randomly become bankers.

where $q_{j,t}$ is the relative price of claim $a_{j,t}$. Depositors charge the real interest rate $r_{h,t}$, whereas banks require a return of $r_{x,t}$ on the loans they make to firms. The interest rate on government bonds, $r_{b,t}$, is assumed to equal the risk-free rate adjusted by a sovereign credit risk premium δ_{t+1}:

$$r_{h,t} = \mathrm{E}_t r_{b,t}\left(1-\delta_{t+1}\right) \tag{10}$$

where δ_t is defined below. The evolution of the intermediary's net worth depends on the difference between earnings on assets and interest payments on liabilities:

$$\begin{aligned} n_t &= \left(r_{x,t-1}-r_{h,t-1}\right) q_{x,t-1}a_{x,t-1} + \left(\left(1-\delta_t\right) r_{b,t-1}-r_{h,t-1}\right) q_{b,t-1}a_{b,t-1} \\ &\quad + r_{h,t-1}n_{t-1} \end{aligned} \tag{11}$$

The objective of bankers is to maximize their expected terminal net worth:

$$\mathcal{N}_t = \mathrm{E}_0 \sum_{s=0}^{\infty} \left(1-\lambda_f\right) \lambda_f^s \beta^{s+1} \Lambda_{t,t+1+s} n_{t+1+s} \tag{12}$$

To the extent that the expected discounted returns on their assets are higher than the risk-free rate, bankers will want to raise deposits and build their net worth indefinitely. However, a moral hazard problem between depositors and bankers limits banks leverage. This occurs because, at any given period, bankers can divert a fraction ι of available assets. Having knowledge of this, depositors can force the bank into bankruptcy, but can only recover the remaining $1-\iota$ of funds. Hence, depositors will only supply funds to the bank if the following incentive-compatibility constraint is satisfied:

$$\mathcal{N}_t \geq \iota \mathcal{W}_t \tag{13}$$

that is, the value of carrying on doing business must be higher than the value of diverting funds. Due to this constraint on the ability of banks to raise external funds, the risk premium on loans may be positive.

To solve the banker's problem, I define first the leverage ratio of the financial intermediary, ϕ_t, as:

$$\phi_t = \frac{\mathcal{W}_t}{n_t} \tag{14}$$

I then proceed by guessing and verifying that $\mathcal{N}_t = \nu_t \mathcal{W}_t + \eta_t n_t$, where ν_t is the marginal value of expanding assets, holding n_t constant, and η_t is the marginal value of the bank's net worth, holding its portfolio $\mathcal{W}_t$ constant. After some algebra, it can be shown that the expressions for ν_t and η_t are given by:

$$\eta_t = \mathrm{E}_0 \Omega_{t,t+1} r_{h,t} \tag{15}$$

$$\nu_t = \Omega_{t,t+1}\left((r_{x,t} - r_{h,t}) - (r_{x,t} - r_{b,t}(1-\delta_{t+1}))\,\alpha_t^{\mathcal{W}}\right) \quad (16)$$

where $\alpha_t^{\mathcal{W}} = q_{b,t}a_{b,t}/\mathcal{W}_t$ is the share of government debt in the bank's portfolio and $\Omega_{t,t+1}$ is the banker's effective discount factor, which is given by:[11]

$$\Omega_{t,t+1} = \beta\Lambda_{t,t+1}\left\{1 + \lambda_f\left[\eta_{t+1} + \nu_{t+1}\phi_{t+1} - 1\right]\right\} \quad (17)$$

When (13) is binding, the leverage ratio can be written as:

$$\phi_t = \frac{\eta_t}{\iota - \nu_t} \quad (18)$$

For positive values of net worth, the constraint binds only if $0 < \nu_t < \iota$. With $\nu_t > 0$, it is profitable to expand $\mathcal{W}_t$. However, if $\nu_t > \iota$, the incentive constraint does not bind since the value from intermediation exceeds the gain from diverting funds. In equilibrium, I assume (and verify) that the incentive-compatibility constraint always binds within a neighbourhood of the non-stochastic steady state. That is, the amount of funds banks can intermediate is limited by their net worth due to the borrowing constraint.

Finally, aggregate net worth is the sum of the net worth of existing bankers plus the start-up funds of entering ones. Surviving bankers carry their total net-worth into the next period, whereas new bankers receive a fraction $\epsilon/(1-\lambda_f)$ of the assets of exiting ones in order to start business. Hence, in aggregate:

$$\begin{aligned} n_t = {} & \lambda_f\left\{\left[(r_{x,t-1} - r_{h,t-1}) - (r_{x,t-1} - r_{b,t-1}(1-\delta_t))\,\alpha_{t-1}^{\mathcal{W}}\right]\phi_{t-1} + r_{h,t-1}\right\} n_{t-1} \\ & + \epsilon\left\{q_{x,t}a_{x,i,t-1} + q_{b,t}\delta_t a_{b,i,t-1}\right\} \end{aligned} \quad (19)$$

2.3 Production

2.3.1 Capital Producers

Perfectly competitive capital producers buy and repair undepreciated capital from wholesale firms and invest in new capital by purchasing and transforming domestic final goods. The repaired and newly created capital is then sold to wholesalers as an input to production. The discounted real profit of capital producers, Π^{CP}, is given by:

$$\underset{z_t}{\text{Max}}\;\; \mathrm{E}_t \sum_{s=0}^{\infty} \beta^{t+s}\Lambda_{t,t+s}\left\{q_{x,t+s}\left(k_{t+s} - (1-\sigma)\,k_{t-1+s}\right) - z_{t+s}\right\}$$

where $q_{x,t}$ is the value of one unit of new capital and z_t denotes the amount of final goods invested to generate new capital. Capital producers are assumed to incur adjustment costs when investing in new capital. The law of motion of capital is thus given by:

[11] The effective discount rate of bankers differs from that of the households due to the financial friction.

$$k_t = \xi_t^z \left[1 - \frac{\Delta}{2}\left(\frac{z_t}{z_{t-1}} - 1\right)^2\right] z_t + (1-\sigma) k_{t-1} \tag{20}$$

where Δ governs investment adjustment costs and ξ_t^z represents investment-specific technology shocks. Substituting (20) in the objective function of capital producers, the optimal level of investment is given by:

$$\begin{aligned} 1 &= q_{x,t}\xi_t^z \left(1 - \frac{\Delta}{2}\left(\frac{z_t}{z_{t-1}} - 1\right)^2 - \Delta\left(\frac{z_t}{z_{t-1}} - 1\right)\frac{z_t}{z_{t-1}}\right) \\ &\quad + \beta\Lambda_{t,t+1} q_{x,t+1}\xi_{t+1}^z \Delta \left(\frac{z_{t+1}}{z_t} - 1\right)\frac{z_{t+1}^2}{z_t^2} \end{aligned} \tag{21}$$

2.3.2 Wholesale Firms

Perfectly competitive wholesale firms use the composite labour input and capital in order to produce a homogeneous good. They purchase capital from capital producers at the real price $q_{x,t}$, and finance their capital acquisition by borrowing from the domestic intermediary. To be specific, the intermediary issues claims $a_{x,t}$ equal to the number of units of capital acquired, k_t, pricing each claim at the price of a unit of capital. After production, wholesalers sell their capital to capital producers and pay the return $r_{x,t}$ over their loans.

The production function of wholesale firms is given by:

$$x_t = \xi_t^s (k_{t-1})^\alpha (l_t)^{1-\alpha-\nu} (g_{x,t})^\nu \tag{22}$$

where ξ_t^s is a shook to total factor productivity and α is the share of capital in production. Wholesalers' marginal productivity can also be enhanced through the provision of a productive public-good. As in Barro (1990), I retain the assumption of constant returns to scale in all factors of production. Similarly to the utility-enhancing public good formulation, I allow the flow of productive spending to increase private productivity, rather than the stock.[12]

The homogeneous good is sold to domestic retailers at the real price $p_{x,t}$. The demand curve for composite labour services is given by:

$$w_t = p_{x,t}(1-\alpha-\nu)\frac{x_t}{l_t} \tag{23}$$

Perfect competition imposes zero profits and therefore the ex-post real return paid to banks is given by:

$$r_{x,t-1} = \frac{p_{x,t}\alpha x_t / k_{t-1} + q_{x,t}(1-\sigma)}{q_{x,t-1}} \tag{24}$$

[12] This formulation is widely used in the literature for its increased tractability. See also Turnovsky (1999).

2.3.3 Retail Firms

A continuum of retail firms purchase the homogeneous good produced by wholesalers at the real price $p_{x,t}$ and differentiate it into a continuum of retail goods that are sold to final good firms at home and abroad. Retailer i faces the following demand curve:

$$y_{i,r,t} = \left(\frac{P_{i,r,t}}{P_{r,t}}\right)^{-\mu_p} \left(y_{l,t} + y^{\star}_{m,t}\right) \tag{25}$$

where $\mu_p > 1$ is the constant elasticity of substitution between retail varieties, and $y_{l,t}$ and $y^{\star}_{m,t}$ denote aggregate demand for domestic retail goods by local final goods producers and aggregate imports from the core, respectively. Retailer i sets the price of the retail variety it produces, $P_{i,r,t}$, independently of where it is sold to since the law of one price is assumed to hold. Finally, the price index of the composite retail good is given by $P_{r,t} = \left(\int_0^1 \left(P_{i,r,t}\right)^{1-\mu_p} di\right)^{1/(1-\mu_p)}$.

Retail firms are subject to Calvo price rigidities such that each period only a fraction $1-\lambda_p$ of retailers is able to adjust prices. When a retail firm does not re-optimize its price, it updates it to lagged inflation. Retail prices follow:

$$P_{i,r,t+s} = \begin{cases} P^{*}_{i,r,t+s} & \text{with prob. } 1-\lambda_p \\ P^{*}_{i,h,t}\left(\Pi^{s}_{k=1}\pi_{r,t+k-1}\right)^{\vartheta_p} & \text{with prob. } \lambda_p \end{cases} \tag{26}$$

where indexation is governed by $\vartheta_p \in [0,1]$, a measure of the extent to which prices adjust to past inflation, and $\pi_{r,t} = P_{r,t}/P_{r,t-1}$. When allowed to adjust prices, retailer i maximizes the stream of real discounted profits, $\Pi^{\mathrm{R}}(i)$, given by:

$$\underset{p_{i,h,t}}{\mathrm{Max}} \mathrm{E}_t \sum_{s=0}^{\infty} \left(\beta\lambda_p\right)^s \Lambda_{t,t+s} \left\{\left[\frac{P_{i,r,t}}{P_{t+s}} - p_{x,t+s}\right] y_{i,r,t}\right\}$$

subject to (25) and (26). The numeraire P_t is the consumer price index.

2.3.4 Final Good Producers

Perfectly competitive firms produce a non-tradeable final good by aggregating a continuum of domestic and foreign intermediate goods. The aggregation technology for the final good is given by:

$$y_t = \left[(\varpi)^{\frac{1}{\gamma}} \left(y_{l,t}\right)^{\frac{\gamma-1}{\gamma}} + (1-\varpi)^{\frac{1}{\gamma}} \left(y_{m,t}\right)^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} \tag{27}$$

In the above CES aggregator, the home-bias parameter ϖ denotes the fraction of goods produced at home that is used in the production of the final good. The elasticity of substitution between home-produced and imported intermediate goods is given by γ.

Final good producers maximize profits $P_t y_t - P_{r,t} y_{l,t} - P^{\star}_{r,t} y_{m,t}$ each period, subject to (27). The resulting optimal demand functions are given by:

$$y_{h,t} = \varpi \left(\frac{P_{r,t}}{P_t} \right)^{-\gamma} y_t \quad (28)$$

$$y_{f,t} = (1 - \varpi) \left(\frac{P^{\star}_{r,t}}{P_t} \right)^{-\gamma} y_t \quad (29)$$

The consumer price index, P_t, is obtained by plugging in (28) and (29) into (27):

$$P_t = \left[\varpi \left(P_{r,t} \right)^{1-\gamma} + (1 - \varpi) \left(P^{\star}_{r,t} \right)^{1-\gamma} \right]^{\frac{1}{1-\gamma}} \quad (30)$$

2.4 Government

Similarly to Chatterjee and Eyigungor (2012) and Bocola (2015), the government issues long-term securities which pay the coupon μ_b every quarter and the principal when bonds reach maturity. Government bonds mature with probability λ_b, implying an average duration of bonds of $1/\lambda_b$ periods. Government debt is held by domestic financial intermediaries.[13] Hence, in the aggregate, the number of claims held by the financial intermediary must equal the total amount borrowed by the government, $a_{b,t} = d_{g,t}$. The government's *ex post* budget constraint is given by:

$$(\lambda_b + (1 - \lambda_b) \mu_b) d_{g,t-1} + G_t + T_t = \tau_{c,t} c_t + q_{b,t} (d_{g,t} - (1 - \lambda_b) d_{g,t-1}) \quad (31)$$

where $q_{b,t}$ is the price of loans to the government. Conversely, the return on government bonds is given by:

$$r_{b,t-1} = \frac{\lambda_b + (1 - \lambda_b)(\mu_b + q_{b,t})}{q_{b,t-1}} \quad (32)$$

I model sovereign credit risk in a parsimonious way similar to Schabert and van Wijnbergen (2014) and Corsetti et al. (2013). In particular, I assume that the government's decision not to honour its debts depends on a *fiscal limit* above which the fiscal burden is deemed to be politically unacceptable.[14] Exogenous investors speculate about the actual value of the fiscal limit, with the resulting expected probability of default being a determining factor for the dynamics of sovereign bond prices and, consequently, of the net worth of banks. To be specific, actual default is neutral ex post in the sense that it does not reduce actual govern-

[13] Banks do not price sovereign bonds and supply the government with the amount of funds it demands. Devereux and Sutherland (2007) describe how to implement optimal portfolio choice (and pricing) in an open economy setting, while Dedola et al. (2013) apply their method to a model of banks with cross-border linkages. Kollmann et al. (2013) assume instead that banks bear portfolio adjustment costs on government and private bond holdings in order to pin down bank's portfolio composition.

[14] Refer to Davig and Leeper (2011).

ment debt. However, ex ante, the probability of default is crucial for the pricing of sovereign bonds and, through its effects on the net worth of banks, for the economy.[15] The expectation over the probability of default is given by:

$$\delta_t = \overline{\delta} \left(s_t/\overline{s}\right)^{\Theta} exp\left(\varepsilon_t^d\right) \tag{33}$$

where ε_t^d is an exogenous shock that captures the market's perception regarding sovereign credit risk and and $s_t \equiv d_{g,t}/gdp_t$ is the fiscal stance. The parameter Θ denotes the elasticity of the probability of default with respect to changes in the fiscal stance.

In the exercises below, I consider four fiscal instruments but assume that only one is active at a time. Denoting by ψ_t the active fiscal instrument, the simple fiscal rule takes the following form:

$$\psi_t = \overline{\psi} \left(s_t/\overline{s}\right)^{\kappa_\psi} \tag{34}$$

where κ_ψ characterises the strength to which the government stabilizes the fiscal stance. In other words, the lower the (absolute) value of κ_ψ the more willing is the government to let the fiscal stance deviate from its steady state ratio in response to shocks. Absent lump-sum transfers, actual consolidation measures put forward during the sovereign debt crisis involved raising distortionary taxation and cutting government spending. In this paper, I focus on consumption and labour income taxation, and wasteful and productive public expenditure. When active, each fiscal instrument is assumed to follow the simple rule (34), with $\kappa_{\tau_c}, \kappa_{\tau_l} > 0$ and $\kappa_T, \kappa_{g_e}, \kappa_{g_x} < 0$, such that an increase of the fiscal stance s_t leads to an increase in taxation or to cuts in expenditure. Finally, the reason behind the focus on simple rules of the form (34), where only the fiscal stance is targetted, is meant to ensure the comparability across the different instruments.

2.5 Closing the model

2.5.1 Market Clearing

Two markets for goods in each region must clear in equilibrium. The supply of intermediate goods by wholesalers must equal aggregate demand by retailer firms:

$$x_t = \Upsilon_{r,t}\left(y_{l,t} + y^{\star}_{m,t}\right) \tag{35}$$

[15] The strategic default literature is growing rapidly after the seminal work by Eaton and Gersovitz (1981). Gennaioli et al. (2014), Bocola (2015) and Sosa-Padilla (2014) expand this literature by including a banking sector. Because default can actually occur in these models, they are suited to characterize strategic default and its distributional consequences to economic agents.

Note that, due to price dispersion, retailers incur real losses during price setting, which are denoted by $\Upsilon_{r,t}$.[16] On the other hand, the non-tradeable domestic final good is sold to households, to capital producers, and to the government:

$$y_t = c_t + z_t + G_t + \Psi\left(e_t b_{f,t}\right) \tag{36}$$

Labour market clearing implies:

$$l_{h,t} = \Upsilon_{w,t} l_t \tag{37}$$

where $l_{h,t} = \int_0^1 l_{i,t} di$ and $\Upsilon_{w,t}$ denotes the dead-weight loss due to wage dispersion.

Holdings of internationally traded financial assets must also clear, $b_{f,t} + b^{\star}_{f,t} = 0$. Real GDP is defined as:

$$gdp_t = y_t + nx_t \tag{38}$$

with net exports being given by:

$$nx_t = p_{r,t} y^{\star}_{m,t} - e_t p^{\star}_{r,t} y_{m,t} \tag{39}$$

where $y^{\star}_{m,t}$ are exports of locally-produced retail goods, sold at the real price $p_{r,t}$, and $y_{m,t}$ are imports of the foreign-produced goods, bought at the real price $p^{\star}_{r,t}$, which is expressed in consumption units of the core and, therefore, is converted to domestic consumption units using the real exchange rate $e_t = P^{\star}_t / P_t$.

2.5.2 Monetary policy

Monetary policy is conducted through a simple targeting rule by which the nominal interest rate responds to aggregate inflation and aggregate GDP growth in the monetary union:

$$i_t = \left(\bar{i}\right)^{1-\rho_i} \left(i_{t-1}\right)^{\rho_i} \left(\left(\pi_{mu,t}\right)^{\rho_\pi} \left(\tilde{gdp}_{mu,t}\right)^{\rho_y}\right)^{(1-\rho_i)} \tag{40}$$

where $\rho_i \in (0,1)$ is the smoothing parameter, and ρ_π and ρ_g are the usual response coefficients. Aggregate variables are denoted with an a superscript and are the sum of the respective regional variables weighted by their population size. Headline inflation in the periphery is defined as $\pi_t = P_t / P_{t-1}$, whereas GDP growth is given by $\tilde{gdp}_t = gdp_t / gdp_{t-1}$. Finally, the Fisher condition holds in each region: $r_t = i_t / \pi_{t+1}$.

[16] Expression (35), and the definition of $\Upsilon_{h,t}$, are obtained from the aggregation of retail production $x_t = \int_0^1 y_{i,r,t} di$.

2.6 Calibration

One period in the model corresponds to one quarter. The model is solved numerically around a deterministic, zero-inflation steady state. Table 1 reports the calibrated values used in the analysis below. Except when specifically stated, corresponding parameter in both regions share the same values.

I set the discount factor, β, to 0.99, implying a steady state annual interest rate of 4%. The immediate utility function with respect to consumption takes the standard logarithmic form, implying a unitary intertemporal elasticity of substitution ($\sigma = 1$), whereas a quadratic disutility from labour is assumed by setting η to 1. External habits in consumption are set to 0.70. I calibrate the home bias to 0.70, which implies a steady state trade share over GDP of 30% and is in line with the data for the Euro area countries. The price elasticity between home produced and imported goods is set to 1.2. To preserve symmetry between the two regions, I impose zero net foreign assets in steady state.

The capital share in production takes the standard value of 0.30, while productive public spending accounts for 0.05 of total production. I assume a value of 2.5% for the steady state quarterly depreciation rate of capital. The parameter governing the costs of adjusting investment is set to 4, also in accordance with the literature. For the parameters pertaining to the banking sector, I use the same values as Gertler and Karadi (2011). To be specific, I set the steady state leverage ratio of banks, ϕ, to 4 and the probability a banker remains active through the next period, λ_f, to 0.972. The premium between the interest rate on loans to private firms and the risk-free rate is set to 1% in annualized terms. The implied values for ι, the share of divertable assets, and ϵ, the fraction of startup assets new bankers receive, are 0.34 and 0.003, respectively.

Also based on the standard calibration in the DSGE literature, I set the elasticity of substitution across types of labour and intermediate goods such that wage and price markups are equal to 14 and 10%, respectively. I calibrate the Calvo parameters such that, on average, the average duration of nominal wage and price contracts last 4 quarters, while ϑ_p, the price indexation parameter, is set to 0.10 following Lamma and Rabanal (2014). The parameters of the monetary rule are well within the standard values found in the literature. In particular, I set the weight on lagged nominal interest rates to 0.80, the response to inflation, ρ_π, to 1.75, and the weight on output targering, ρ_y, to 0.25.

Table 1: Parameter values

Utility		
β	0.99	discount rate
σ	1	coefficient of risk aversion
ϱ	0.70	habits in consumption
η	1	inverse elasticity labour supply

Table 1: Parameter values (continued)

Trade		
γ	1.20	price elasticity of traded goods
ω	0.70	home bias
b_f	0	net foreign assets
υ	0.01	adjustment costs international bonds
Production		
α	0.30	capital share
ν	0.05	share of productive public good
δ	0.025	capital depreciation rate
Δ	4	investment adjustment costs
Banks		
$r_x - r$	0.0025	premium on private lending
ϕ	4	leverage ratio
λ_f	0.972	survival probability
Nominal rigidities		
ϵ_w	8	substitution elasticity of labour
λ_w	0.75	Calvo lottery wages
ϵ_p	11	substitution elasticity of goods
λ_p	0.75	Calvo lottery prices
ϑ_p	0.10	inflation indexation
Monetary policy		
ρ_i	0.80	innertia
ρ_π	1.75	response to inflation
ρ_y	0.25	response to output
Government		
λ_b	0.025	inverse average debt maturity
χ	0.002	sovereign spread
Θ	0	sovereign spread response to fiscal stance
d_g	0.60	annual public debt over GDP
τ_c	0.20	consumption tax rate
τ_l	0.25	labour income tax rate
g_e	0.12	wasteul expenditure over GDP
g_x	0.08	productive expeniture over GDP
κ_L	-3.75	lump sum response to fiscal stance
κ_{g_e}	-1.75	wasteful spending response to fiscal stance
κ_{g_x}	-2.15	productive spending response to fiscal stance
κ_{τ_c}	0.95	consumption tax response to fiscal stance
κ_{τ_l}	1.175	labour income tax response to fiscal stance

I calibrate λ_b such that the average maturity of government debt equals 10 years, as 10 year bond yields are the indicative statistic used to assess government's borrowing costs. Also for illustrative purposes, I consider a steady state annual spread on sovereign debt of 80 basis points. For the benchmark calibration, I assume that sovereign spreads are purely exogenous and do not depend on the fiscal stance. I therefore set Θ to 0. The ratio of public debt to annual GDP is set equal to the upper limit imposed by the Maastricht Treaty of 60%. The effective tax rates on consumption and labour income are based on calculations for the periphery of the Euro area using annual data from the Eurostat. Wasteful government expenditure, $g_{e,t}$, accounts for 12% of GDP, whereas productive spending, $g_{x,t}$, represents 8%. These values are such that total government spending amounts to 20% of GDP in the steady state. I calibrate the parameters in the fiscal rule, κ_ψ, for each of the five fiscal instruments by imposing that, for a sovereign risk shock that adds 10 percentage points to the sovereign interest rate, the increase in the public debt-to-GDP ratio is capped at 2%. This cap is purely illustrative and is only meant to standardize, and make comparable, the general equilibrium effects of using different fiscal instruments to stabilize the fiscal stance. Below I run sensitivity analysis to changes in the values of κ_ψ.

3 Sovereign Spreads: the transmission mechanism

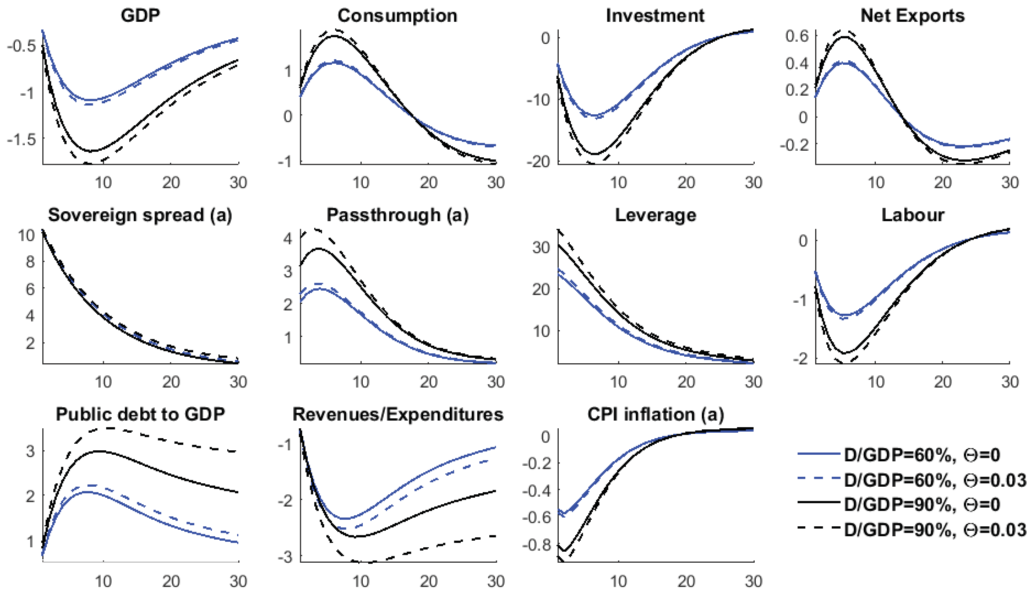
In this section I inspect the transmission of sovereign spread shocks in the model. I start with the case when the government uses lump sum transfers to stabilize the fiscal stance. I do so in order to abstract from the distortions caused by the other fiscal instruments. I then assess the impact different fiscal distortions have on the transmission of these shocks.

3.1 Lump sum transfers

Figure 1 reports the impulse responses to a shock that adds 10 percentage points to the sovereign spread in the periphery, in annual terms. The solid blue line shows the baseline specification, where government debt-to-GDP ratio equals 60% in the steady state and sovereign spreads do not respond to the fiscal stance, $\Theta = 0$. The increase in the probability that the government will not service its debt lowers the value of government bonds and, conversely, raises the premium investors require to hold these assets. As interest payments become heavier, the government incurs a budget deficit, which raises the stock of public debt.

As the price of government bonds plunges, banks, who hold these securities in their portfolios, see their total net worth contract. This triggers a persistent increase in banks' leverage ratio. Due to leverage constraints, banks are forced to reduce lending and to raise the premium on lending rates to private firms in order to rebuild the value of their equity. In the baseline scenario, the pass-through of sovereign spreads to firm's borrowing costs is more than 1/5, with the increase in 10 percentage points in the former leading to an increase of more than 2 percentage points in the latter. The drop in credit supplied by banks and the

Figure 1: Absent fiscal distortions



Responses to a sovereign spread increase of 10 percentage points. Spreads and inflation responses are in annualised basis points; net-exports are in levels; remaining responses are expressed in terms of percent deviations from steady state. Θ governs the feedback effect from the fiscal stance to sovereign spreads.

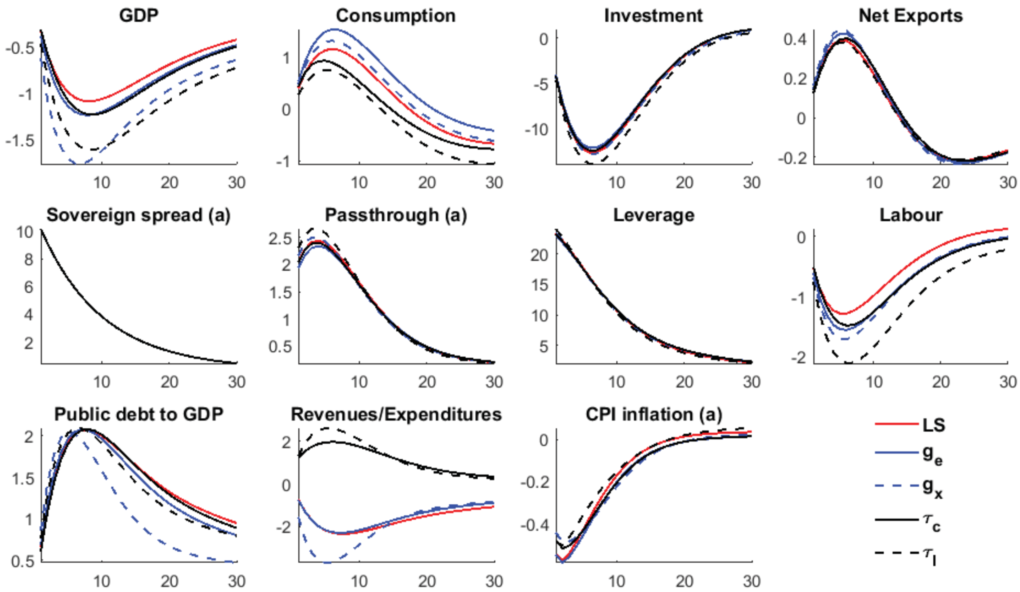
increase in borrowing costs induce a collapse in investment of more than 10% at the trough. As firms face higher costs of capital, labour demand also contracts and total employment falls. Consequently, real output falls.

The marked contraction in domestic demand due to the fall in investment induces prices to fall. Moreover, the fall in inflation and in output leads the central bank to cut nominal interest rates. Although the real interest rate initially increases, it subsequently falls below its steady state. Because households are net savers domestically, they make their intertemporal consumption decisions in response to the risk-free rate. Hence, and despite the fall in employment, the fall in prices and in the real interest rate leads households to increase consumption.

Figure 1 shows three alternative scenarios to the baseline. The dashed dark-grey lines report the responses to the same shock when sovereign spreads respond to the evolution of the fiscal stance, i.e. for $\Theta = 0.03$.[17] Compared to the baseline, the responses under this scenario do not change significantly. However, this is not the case for higher ratios of public debt to GDP. The solid light-grey lines show instead the case when spreads do not respond to the fiscal stance, but the steady state debt-to-GDP ratio equals 90%. A higher public debt-to-GDP ratio intensifies the magnitude of the recession. This is because banks now hold a larger share of government bonds relative to total assets in their balance sheets. As a

[17] Refer to Corsetti et al. 2013 for a discussion on the quantification of the impact of the fiscal stance on sovereign spreads and, consequently, on credit spreads to private firms.

Figure 2: With fiscal distortions



Responses to a sovereign spread increase of 10 percentage points. Spreads and inflation responses are in annualised basis points; net-exports are in levels; remaining responses are expressed in terms of percent deviations from steady state. *LS*: lump sum transfers; g_e: wasteful expenditures; g_x: productive expenditure; τ_c: consumption taxation; τ_l: labour income taxation.

result, a fall in the price of sovereign bonds produces a relatively higher loss in their portfolio. Accordingly, the pass-through to private lending rates increases significantly by more. The resulting collapse in investment and the drop in labour are sizeable too.

The final scenario in Figure 1, the dashed light-grey lines, reports the worst case scenario. Besides assuming a public debt-to-GDP ratio equal to 90%, sovereign spreads also respond to the fiscal stance, $\Theta = 0.03$. Unlike in the previous case when the public debt represents 60% of GDP, having sovereign spreads responding to the fiscal stance under the worst case scenario generates a significantly bigger recession. Hence, a high public debt-to-GDP ratio is not only a potential source of economic instability *per se*, it can also generate sizeable feed-back effects when sovereign spreads respond to the weakening of the fiscal stance. Moreover, this exercise assumes that the response of sovereign spreads to the fiscal stance is constant. However, it is possible that the elasticity of spreads is increasing with the debt-to-GDP ratio. If that is the case, the size of the feed-back effects reported in Figure 1 would appear rather conservative.

3.2 Distortionary fiscal policy

Figure 2 shows the responses to a sovereign spread shock when the government uses distortionary fiscal instruments. The values of the parameters governing fiscal policy, κ_ψ, are calibrated such that the increase in the fiscal stance is capped at 2% under each of the four distortionary instruments as well as under lump sum transfers. By doing so, the consolidation effort is normalized and the feed-back effects of fiscal policy to the economy are comparable. For comparison purposes, the solid red lines in Figure 2 report the scenario where the government uses lump sum transfers to stabilize the fiscal stance.

The solid blue lines depict the case when fiscal stance stabilization is achieved through adjustments to wasteful public expenditure, $g_{e,t}$. To curb the increase in the fiscal stance, public spending has to be reduced. This leads GDP to fall by more than in the baseline. Nevertheless, because the reduction in wasteful spending crowds in private consumption, the fall in GDP is mitigated. The fall in aggregate demand lead firms to further reduce the demand for labour, while the fall in investment is not affected significantly.

The same can be seen from the dashed-blue lines, which report the scenario when the government cuts productive public spending to stabilize the fiscal stance. To cap the rise of the fiscal stance at 2%, the government has to reduce public expenditure by more than 3%, and significantly by more than if it were to cut wasteful spending. The direct reason is that cutting productive spending further subtracts nearly 0.70% more to GDP at the trough relative to the previous scenario, requiring an extra effort to stabilize the debt-to-GDP ratio. Although the behaviour of investment is similar, labour falls by more, but only marginally: as productive public spending falls, the marginal productivity of labour falls as well, and labour demand is reduced. The larger fall in GDP is explained by both the larger cut in public spending, but also by the lower crowding in of private consumption. This is due to the behaviour of employment and the real wage, which are adversely affected by the reduction in the marginal productivity of labour.

The solid black lines in Figure 2 correspond to the case when the government uses consumption taxation to keep the fiscal stance to target. In this scenario, the government is led to collect more revenues in order to reduce the public debt. The increase in consumption taxes generates a contraction in consumption, with households substituting consumption today for consumption in the future, when taxes are cut back. With the contraction in consumption adding to the contraction in investment, GDP falls further than in the baseline, pushing up on the public debt-to-GDP ratio. When the government instead uses labour income taxation, as reported by the dashed-black lines, public revenues need to be raised by more. This again is explained by the behavior of GDP, which falls by more than in the case when consumption taxes where increased. Labour income taxes reduce the incentive to work, lowering labour supply. In equilibrium, employment falls significantly by more than in all previous scenarios. Hoseholds retrench spending compared to the previous secnarios, and investment falls by more. These effects combined explain the larger fall in GDP.

As reported in Figure 2, distortionary fiscal policy aggravates the recession caused by sovereign spread shocks. If the budgetary strain on the government is alleviated and, therefore, if the consolidation effort that is required is reduced, the distortionary effects of domestic fiscal policy can also be mitigated. The next subsection proposes a transfer schemes that can achieve an alleviation of the government budget during sovereign spread shocks. Again to facilitate the discussion, I first assume that the active domestic fiscal instrument consists of lump sum transfers. Subsequently, I reintroduce distortionary fiscal policy in the analysis and compare the effects of implementing the transfer scheme across the different domestic fiscal instruments.

4 Fiscal Transfers

Governments in countries that were more severely hit during the sovereign debt crisis eventually requested external financial assistance in order to mitigate the budgetary strain caused by widening sovereign spreads. The various assistance programmes implemented in countries like Ireland, Greece and Portugal entailed credit lines to the government under more favourable financial conditions than those offered by the market at that time. In return, creditors were granted the power to monitor the duly implementation of consolidation measures and structural reforms aimed at guaranteeing the sustainability of interventioned countries' public finances.

In this paper, I consider a simple fiscal transfers scheme between national governments. The scheme has governments making transfers across the border when sovereign spreads widen abroad. Transfers are determined by the following rule:

$$S_t = \left(\delta_t - \overline{\delta}\right)^{\kappa_s} \tag{41}$$

where δ_t is the sovereign credit risk premium defined above. An equivalent expression defines the transfers to be made the opposite direction. S_t, together its foreign counterpart $S_t^\star$, denote aggregate transfers made between governments. For instance, when sovereign spreads arise in the core, the government in periphery is called upon to transfer a given amount of funds, determined by κ_s, to the government in the core. By definition, transfers are only temporary, being equal to zero in the long-run. Importantly, the parameter governing the magnitude of the transfers, κ_s, is equal for both countries. The proposed scheme addresses directly the problem of fiscal strain due to sovereign spreads. As there is no direct transfers to households or firms, the feedback to the real economy will run through the government budget.[18]

I conduct the analysis in the remainder of the paper using two alternative measures of welfare, both widely used in the literature. First, I use the utility-based criterion (1). In particular, I express the welfare gains in terms of certainty-equivalent consumption: the permanent change in consumption that would make households equally well off as under

[18] I assume δ_t is observable and, therefore, can be used to guide policy. In reality, however, sovereign spread shocks might be difficult to measure. Importantly, it might also be the case that optimal transfers should not respond to all swings in sovereign spreads as measured, for instance, by the differentials in government bond yields in the secondary market. I leave these questions for future research.

the non-stochastic steady state. Denote by $\lambda_{ce,s}$ the welfare gain associated with a federal transfer scheme defined by κ_s. Then $\lambda_{ce,s}$ must solve:

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t U\left(\left(1+\lambda_{ce}\right)\bar{c}, \overline{l_h}\right) \quad = \quad \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t U\left(c_t^{\kappa}, l_t^{\kappa}\right) \qquad (42)$$

where $\bar{c}$ and $\overline{l_h}$ are the deterministic steady state values of consumption and labour, and $\{c_{\kappa_s,t}, l_{h,\kappa_s,t}\}_{t=0}^{\infty}$ are the consumption and labour allocations corresponding to the fiscal trasfer scheme defined by $\kappa_s \in \mathbb{R}_0^+$. I follow Evers (2012, 2015) and further decompose the welfare compensation into its mean and variance components, λ_m and λ_v, respectively, which reflect the changes in the mean and varaince of consumption and labour and satisfy $(1+\lambda_{ce}) = (1+\lambda_m)(1+\lambda_v)$.

Second, I consider an *ad hoc* loss function in which the relevant satistics are the squared gaps of inflation and output growth:

$$\mathcal{L}_t^{ad\,hoc} \quad = \quad \mathrm{E}_t \sum_{t=0}^{\infty} \beta^t \left\{\lambda_\pi \left(\pi_{mu,t} - \pi\right)^2 + \left(1-\lambda_\pi\right)\left(\tilde{gdp}_{mu,t} - 1\right)^2\right\} \qquad (43)$$

The objective of the policy maker is to minimize this loss function by reducing the volatility of inflation and output. I follow Blanchard et al. (2017) and set $\lambda_\pi = 3/4$.[19]

The calibrated volatility of sovreign spread shocks determines the quantitative magnitudes of both welfare gains and volatilities. However, as the qualitative results rest on the comparison between different schemes, the policy message should be robust to a different calibration. I what follows, I set the standard deviation of sovereign spreads to 0.001, with an autoregression coefficient set to 0.90.[20]

4.1 Lump sum transfers

The first column of Table 2 reports the impact of sovereign spread shocks on welfare and the volatility of inflation, output, consumption, labour, and investment. Because the calibration of the model is perfectly symmetric, the values reported in the Table refer to both countries alike. The second row in Table 2 reports the welfare gain compared to the deterministic steady state as measured by the utility criterion. A negative value of $-0.60‰$ implies a loss in consumption equivalent terms derived from sovereign spread shocks. Although these shocks affect negatively on the mean and volatility of welfare, it is the volatility component that has the largest negative impact. Turning to the volatilities, sovereign spread shocks have the greatest impact on investment, as could already be seen in Figures 1. The volatility of consumption and output is of similar magnitude, while inflation is only mildly affected.

[19] The welfare analysis is done on a second-order log-linear approximation to the model's equilibrium conditions. Details can be found in the appendix.

[20] The volatility of spreads on 10 year government bond yields in the Euro area, over the 10 year German bund, vary wildely across country. Using quarterly data from 1990 to 2016, the figures run from 0.0004 and 0.0009 for the Netherlands and France, and 0.0178 and 0.0068 for Greece and Portugal, respectively.

Table 2: Welfare and Stability: absent fiscal distortions

	No Transfers	Maximizing Welfare	Stabilizing Ad Hoc	π	gdp	c	l
κ_s	0,00	1,10	1,82	1,83	1,82	2,14	1,92
λ_{ce}	-0,60	-0,36	-0,45	-0,45	-0,45	-0,55	-0,48
$\Delta\lambda_{ce}$	-	-39,42	-24,69	-24,28	-24,69	-8,55	-20,28
λ_m	-0,07	0,08	-0,03	-0,03	-0,03	-0,12	-0,05
$\Delta\lambda_m$	-	-217,80	-62,09	-58,36	-62,09	78,41	-22,84
λ_v	-0,53	-0,44	-0,43	-0,43	-0,43	-0,43	-0,43
$\Delta\lambda_v$	-	-16,33	-19,85	-19,87	-19,85	-19,81	-19,95
$\Delta\sigma_\pi$	*	-1,44	-1,73	-1,73	-1,73	-1,68	-1,73
$\Delta\sigma_{gdp}$	0,03	-9,06	-10,63	-10,63	-10,63	-10,30	-10,60
$\Delta\sigma_c$	0,04	-15,75	-19,42	-19,44	-19,42	-19,78	-19,61
$\Delta\sigma_l$	0,02	-16,24	-19,59	-19,60	-19,59	-19,39	-19,64
$\Delta\sigma_z$	2,19	-32,45	-37,54	-37,51	-37,54	-35,41	-37,18

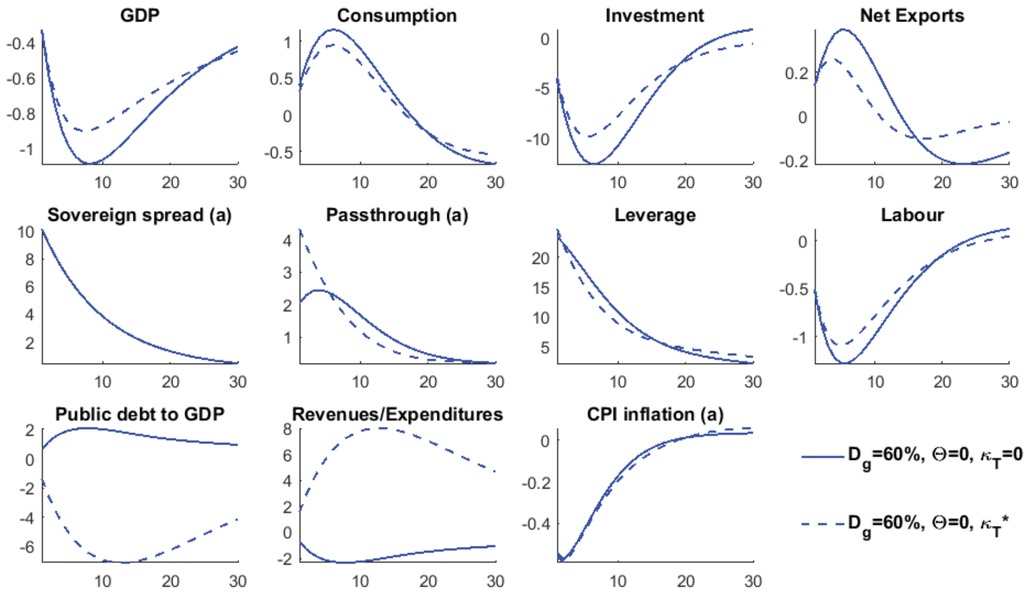
* 4.1025e-04. λ_{ce}, λ_m and λ_v are stated in per mill. Δ are stated in percentage changes relative to the scenario without transfers.

The second and third column of Table 2 report the gains from implementing the fiscal transfer scheme in a scenario where national governments use lump sum transfers to fund the scheme and to stabilize the respective fiscal stances. The value of κ_s that maximizes welfare is found to be 1.10. Under a fiscal transfer scheme, the welfare loss generated by sovereign spread shocks is reduced to $-0.36‰$, a fall of nearly 40%. The main contribution for this fall comes from the steady state component of welfare, which reverses sign and now becomes positive, with both the stochastic mean of consumption increasing and the mean of labour falling. The volatility component is reduced by 16.33%. Looking at the volatilities, the largest reduction is found to be with respect to investment, while percentage changes in consumption and labour volatilities are of similar magnitude.

Turning to the *ad hoc* measure, the value of κ_s that minimizes the loss function (43) equals 1.82. Larger transfers between governments result in a welfare improvement as measured by the utility criterion of 25%, with a smaller improvement coming from the stochastic means component and a larger fall from the volatility component. In fact, minimizing (43) yields larger reductions in volatility for all variables shown in Table 2. Although the reduction in the volatility of inflation is almost negligible, the forth and fifth columns show that changing the weight λ_π in the loss function would not affect significantly the optimal value of κ_s under the *ad hoc* function.

The last two columns of Table 2 show the welfare gains and volatility reductions of fiscal transfers schemes that target the reduction in the volatility of consumption and labour,

Figure 3: Fiscal Transfers absent domestic fiscal distortions



Responses to a sovereign spread increase of 10 percentage points. Spreads and inflation responses are in annualised basis points; net-exports are in levels; remaining responses are expressed in terms of percent deviations from steady state. Θ governs the feedback effect from the fiscal stance to sovereign spreads. $\kappa_T^* = 1.104$.

respectively. Interestingly, the scheme aiming at reducing the volatility of consumption yields the lowest improvements in welfare as measure by the utility criterion. In fact, the stochastic mean component of the consumption equivalent gain falls by more than 78% compared to the scenario with no transfers. Instead, the value of κ_s that minimizes the volatility of labour yields results closer to those obtained when the objective is to minimize the *ad hoc* loss function.[21]

Figure (3) shows the responses of the periphery to a sovereign spread shock under the fiscal transfer scheme calibrated to maximize welfare as measured by the utility criterion, i.e. with $\kappa_s = 1.10$. For comparison, I plot the responses to the same shock in the absence of fiscal transfers. Domestic fiscal policy is conducted using lump sum transfers and the parameter governing the domestic fiscal rule is kept constant under the two scenarios. This exercise is illustrative of the effects of fiscal transfers on the banking system, since it abstracts from the distortionary effects of fiscal policy. An increase in spreads leads the foreign government to make a transfer to the government in the periphery of a magnitude large enough to bring the public debt-to-GDP ratio more than 6% below its steady state value. The fall in public debt reduces the amount of assets financial intermediaries hold in their portfolios. This causes banks to further increase the pass-through of sovereign spreads to the interest rate on private lending. However, after an initial jump in the interest rate on private lending, banks quickly

[21]Companion tables in the appendix report sensitivity analysis over different values of the parameters governing domestic fiscal policy, under symmetric and asymmetric calibrations.

reduce it, bringing it below the path under the scenario with no fiscal transfers. On the other hand, as banks reduce their exposure to government debt, their leverage ratios fall more quickly and they become relatively better positioned to supply credit to private firms. As a result, the drop in investment is mitigated substantially. With less scarce access to credit, firms reduce their capital purchases and labour demand by less, mitigating the fall in output.

4.2 Distortionary fiscal policy

The analysis so far has assumed that regional governments conduct domestic fiscal policy using lump sum taxation. It has shown that fiscal transfers can be welfare improving in a number of different scenarios under this crucial assumption. In reality, however, governments typically use distortionary taxation and spending as fiscal instruments. Unlike lump sum taxation, these instruments can significantly affect intertemporal substitution as well as resource allocation. Importantly, as the analysis that follows shows, distortionary fiscal policy changes the incentives to the implementation of fiscal transfers as well.

In an environment with distortionary fiscal policy, it turns out that no positive value of κ_s is associated with an improvement in welfare in the monetary union. As shown below, fiscal transfers between member states, by acting directly on the fiscal stance, reduce the consolidation effort required by the recipient government. However, transfers also affect the fiscal stance of the country they originate from, requiring fiscal policy to adjust there as well. On balance, it appears that these effects overturn the welfare gains from the transfer schemes discussed above.

The impact fiscal transfers have on welfare comprises a non-trivial combination of effects on the volatilities and stochastic means of consumption and labour. In other words, transfers can prove to lower the volatility of some variables despite affecting negatively on welfare. This is illustrated in Table 3. The first four columns shows the impact on welfare and volatility of implementing a fiscal transfer scheme characterized by a value of κ_s equal to 1.10, the value that maximizes the utility criterion when domestic fiscal policy is non-distortionary. Again, all outcomes reported in the table are comparing against a scenario without transfers. For all instruments except productive public spending, $g_{x,t}$, the increase in the volatility component of the consumption equivalent measure nearly doubles, accentuating the welfare losses generated by sovereign spread shocks. The same is true for the stochastic mean component. For the case of productive public spending, this term is behind the increase in welfare costs. Adjusting productive spending in response to shocks not only reduces the stochastic mean of private consumption, but it increases the stochastic mean of labour. In other words, it affects the mean allocation of resources in an inefficient fashion as measured by the welfare criterion.

Turning to the volatilities, fiscal transfers increase significantly the volatility of consumption when the government uses wasteful spending and consumption taxation to stabilize the fiscal stance. These two instruments, together with labour income taxation, also push up

Table 3: Welfare and Stability: with fiscal distortions

	Welfare				Ad Hoc			
	g_e	g_x	τ_c	τ_l	g_e	g_x	τ_c	τ_l
κ_s	1,10	1,10	1,10	1,10	0,83	0,42	0,79	0,45
λ_{ce}	-13,26	-9,98	-8,82	-13,90	-11,90	-7,48	-7,29	-11,82
$\Delta\lambda_{ce}$	58,40	53,21	84,26	33,37	42,16	14,81	52,21	13,40
λ_m	-11,69	-9,07	-7,43	-11,27	-10,79	-6,72	-6,30	-10,28
$\Delta\lambda_m$	53,53	61,57	82,10	26,55	41,68	19,65	54,23	15,42
λ_v	-1,59	-0,92	-1,40	-2,66	-1,13	-0,77	-1,00	-1,55
$\Delta\lambda_v$	108,25	1,40	97,41	73,87	47,39	-15,30	40,82	1,71
$\Delta\sigma_\pi$	-0,65	15,50	-0,47	11,59	-1,00	-0,96	-1,02	-2,23
$\Delta\sigma_{gdp}$	-13,44	-3,27	-12,46	-6,59	-14,39	-11,35	-13,63	-10,91
$\Delta\sigma_c$	300,38	17,64	180,63	42,68	158,42	-12,77	107,66	15,72
$\Delta\sigma_l$	79,07	-0,37	82,05	78,45	30,81	-15,27	28,55	-0,50
$\Delta\sigma_z$	-1,79	3,86	-13,24	-28,80	-3,31	-1,19	-12,47	-18,99

g_e: wasteful expenditures; g_x: productive expenditure; τ_c: consumption taxation; τ_l: labour income taxation. λ_{ce}, λ_m and λ_v are stated in per mill. Δ are stated in percentage changes relative to the scenario without transfers.

on labour volatility. These insights were already apparent from the analysis of the impact of fiscal transfers on welfare. When the domestic fiscal instrument at hand is productive government spending, the increase in volatilities is predominant for consumption and inflation. However, this increase is relatively small when compared to the remaining distortionary instruments.

The last four columns in Table 3 report the scenarios where κ_s is chosen to minimize the *ad hoc* loss function. As reported, there are positive, albeit small, values of κ_s that sustain a reduction in the volatility of inflation and GDP. In particular, when domestic fiscal policy uses productive government spending, all volatilities are reduced. Despite this fact, the welfare costs still increase due to the negative impact on the stochastic mean component. For the remaining three instruments, consumption volatility is never reduced, with wasteful spending and consumption taxation also increasing the volatility of labour.

The usefulness of starting the analysis assuming that domestic fiscal policy is carried out with lump sum taxation is now evident. Under such scenario, fiscal transfers have the ability to reduce the fiscal adjustment caused by sovereign spread shocks, with both regions sharing the fiscal burden. Insofar as stabilising the fiscal stance does not involve distorting the allocation of resources in production nor the intertemporal allocation of consumption, welfare and economic stability were shown to improve. However, the inefficiencies induced when fiscal policy is distortionary wipe out the welfare benefits of fiscal transfers. Nevertheless, it is important to note that fiscal transfers do have an important effect in reducing macroeconomic fluctuations.

Figure 4: Fiscal Transfers with domestic expenditure policy

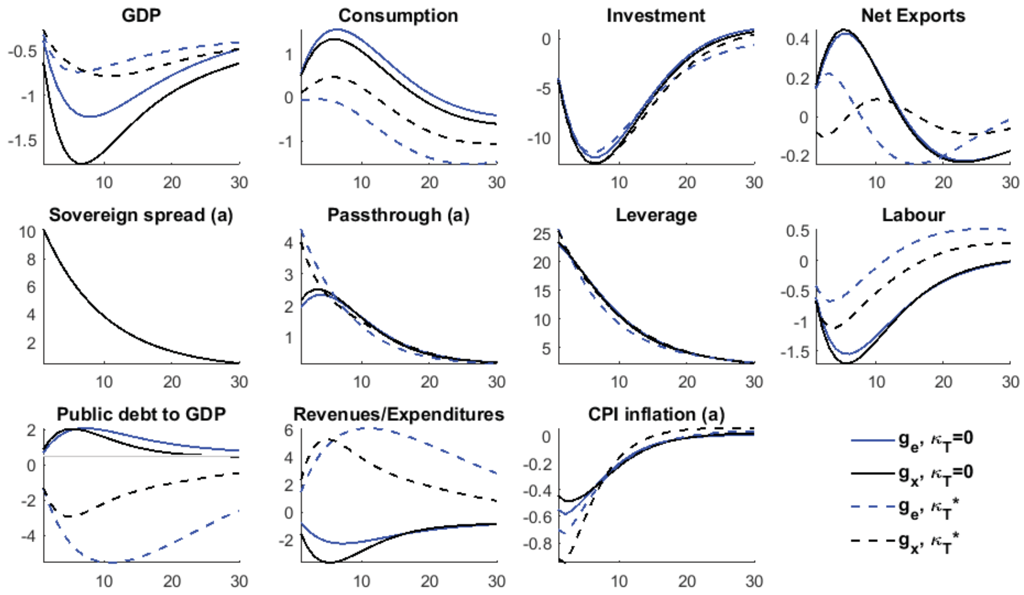
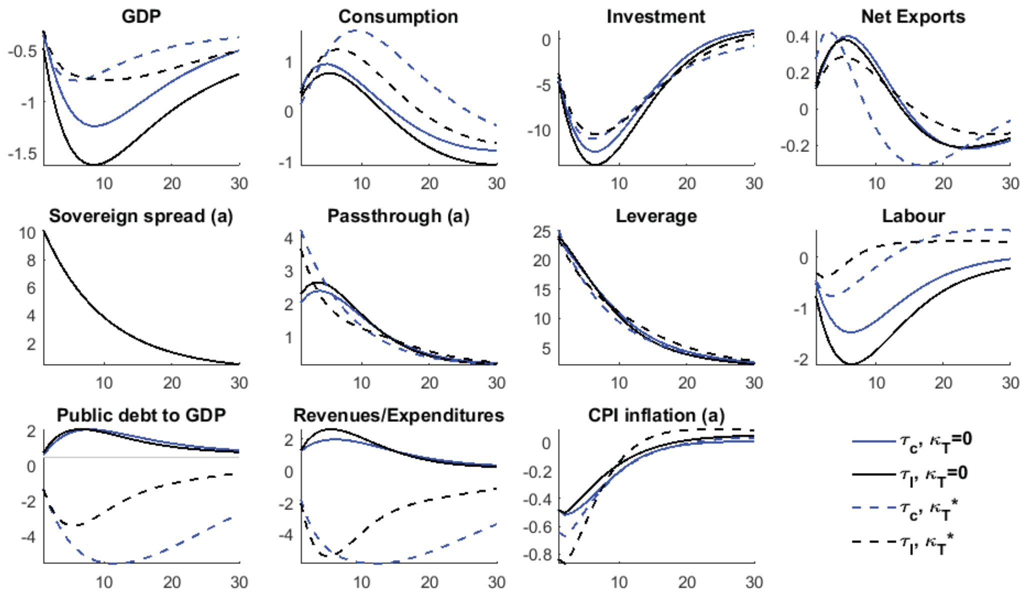


Figure 5: Fiscal Transfers with domestic taxation policy



Responses to a sovereign spread increase of 10 percentage points. Spreads and inflation responses are in annualised basis points; net-exports are in levels; remaining responses are expressed in terms of percent deviations from steady state. g_e: wasteful expenditures; g_x: productive expenditure; τ_c: consumption taxation; τ_l: labour income taxation. $\kappa_T^* = 1.104$.

This can be seen in Figures 4 and 5, which show the impact of fiscal transfers in the periphery when domestic fiscal policy is distortionary. Figure 4 reports the cases when national governments use expenditure instruments, whereas Figure 5 focuses on consumption and labour income taxation. The solid lines in both figures report again the responses of the periphery to a sovereign spread shock in the absence of fiscal transfers. The dashed lines instead report a scenario where fiscal transfers are implemented for a value of κ_s equal to 1.10. As before, the parameters governing domestic fiscal policy, κ_ψ, are kept constant across the two scenarios and were calibrated such that, absent fiscal transfers, the increase in the public debt-to-GDP ratio is curbed at 2%.

Turning first to Figure 4, the inflow of transfers from abroad leaves the domestic government with enough space to increase spending. Under both expenditure instruments, fiscal transfers reduce the debt-to-GDP ratio in the periphery, therefore reducing bank's exposure to government bonds. As with the case with lump sum transfers analysed above, initially banks increase the interest rates on private lending by more. However, their subsequent path back to steady state does not occur significantly faster compared to the scenario without fiscal transfers, as it did in Figure (3). As a result, the fall in investment is not mitigated significantly. Despite this fact, the increase in aggregate demand generated by the increase public expenditure leads firms to cut demand for labour by less. Interestingly, because the increase in wasteful expenditure is higher, demand for labour falls by less than when the government increases productive spending. This is so despite the fact that productive spending increases the marginal productivity of labour. Output therefore falls by less while private consumption is crowded out by government spending significantly.

Looking at Figure 5, the effects on consumption run exactly the opposite way. The reduction in the public debt-to-GDP ratio caused by fiscal transfers allows the government in the periphery to cut taxes. Hence, the effects on GDP, although comparable to the previous cases, are caused instead by the increase in private consumption and, to a lesser extent, in investment. Regarding the latter, the explanation rests on the same mechanism described for the case of lump sum transfers in Figure (3): the fall in the pass-through occurs at a faster pace, allowing firms to reduce capital purchases by less. The reduction in taxation explains the increase in private consumption. Note that cuts in consumption taxation expand private consumption by more, while cuts in labour income taxes affect labour by relatively more. In fact, the increase in aggregate demand makes firms reduce labour demand by less, a plan that is helped when labour income taxes are cut.

Cross-checking the insights from Figures 4 and 5 with Table 3 highlights important messages. The impulse responses of consumption when the government uses wasteful spending or consumption taxation to stabilize the fiscal stance shows that fiscal transfers seem incapable of reducing the volatility of consumption in the periphery. In the core, using these same instruments (in the opposite direction as the foreign government need to cut spending/raise revenue to fund the transfer to the periphery) also increases the volatility of consumption there. This is reported in the Table. Turning to productive government spending, although consumption in the periphery appears less volatile, in the core it necessarily falls by more compared to the scenario without transfers, therefore raising consumption volatility as well. Finally, using labour income taxation to stabilize the fiscal stance under a fiscal transfer scheme increases the response of consumption in the periphery while reducing the movements in labour. In the core, a higher tax on labour income reduces employment and consumption there. On net, as reported in the Table, both volatilities increase, rather than decrease, with fiscal transfers.

Figures 4 and 5 illustrate the potentially positive effects fiscal transfers between countries in the monetary union have in lessening the impact sovereign spread shocks have on economic aggregates. However, they also show the impact fiscal policy has in distorting the allocation of consumption and labour. Despite the fact that fiscal transfers can reduce economic volatility, this analysis has shown that welfare can actually fall when fiscal transfers are implemented. All in all, in the absence of lump sum taxation, it appears that, to reduce volatility and improve welfare, a scheme of fiscal transfers needs not only to buffer effectively the economy from sovereign spread shocks, but also to minimize the distortions its funding causes.

5 Further discussion

In the previous section, I found that sharing the burden of fiscal tightening imposed on one country across all members of the monetary union is not welfare improving. However, one could argue this result is dependent on the way domestic fiscal policy is carried or on the complex effects domestic fiscal policy has on the banking sector. I therefore run the following experiment, shown in Table 4. I assume that domestic fiscal policy is conducted such that public debt (and not the public debt-to-GDP ratio) remains constant at all times.[22] This requires the domestic fiscal instrument to act decisively to curb any fall in tax revenues, which depend on the evolution of the economy (public spending, including lump sum transfers, depend solely on government policy), or any movement in the sovereign interest rate, in order to keep the public debt constant. On the other hand, keeping government debt constant insulates the banking sector from any effects steaming from the quantity of government debt they hold in their portfolios. As a result, sovereign spread shocks, with or without fiscal transfers, affect the banking sector solely through their impact on asset prices.

Under this setup, Table 4 shows that there are small positive values for κ_s that can sustain the implementation of a fiscal transfer scheme that improves welfare as measured by the utility criterion. However, the benefits a patently small. My conjecture is that, even for a scenario where domestic fiscal policy is relatively harsh and where it does not mitigate the impacts of sovereign spreads on the banking sector, the fact that in this paper the conduct of fiscal policy is symmetric across the two regions at all time, fails to allow fiscal transfers

[22] In the appendix I show that reducing or increasing κ_ψ, i.e. having domestic fiscal policy stabilizing less or more quickly the fiscal stance, does not affect the qualitative results discussed in the previous section.

Table 4: Holding government debt fixed

	Welfare				Ad Hoc			
	g_e	g_x	τ_c	τ_l	g_e	g_x	τ_c	τ_l
κ_s	0,07	0,09	0,07	0,32	0,33	0,35	0,89	0,51
λ_{ce}	-8,36	-6,50	-4,67	-10,03	-8,67	-6,96	-6,82	-10,09
$\Delta\lambda_{ce}$	-0,26	-1,30	-0,40	-3,16	3,49	5,69	45,62	-2,62
λ_m	-7,59	-5,71	-3,99	-8,87	-7,97	-6,23	-5,33	-8,71
$\Delta\lambda_m$	0,72	-0,25	0,56	-1,51	5,79	8,77	34,40	-3,24
λ_v	-0,78	-0,79	-0,68	-1,18	-0,71	-0,73	-1,50	-1,39
$\Delta\lambda_v$	-8,92	-8,29	-5,67	-14,15	-16,87	-14,92	108,03	1,45
$\Delta\sigma_\pi$	-0,17	-1,49	-0,16	-0,56	-0,55	1,86	-0,71	3,45
$\Delta\sigma_{gdp}$	-1,75	-4,79	-2,05	-10,31	-4,70	-9,39	-12,64	-11,21
$\Delta\sigma_c$	-13,83	-9,10	11,47	11,90	-11,66	-13,91	430,15	20,16
$\Delta\sigma_l$	-8,08	-8,03	-8,56	-18,71	-17,11	-14,68	40,41	-1,95
$\Delta\sigma_z$	5,76	3,19	4,26	-9,81	29,83	11,89	65,12	-13,28

g_e: wasteful expenditures; g_x: productive expenditure; τ_c: consumption taxation; τ_l: labour income taxation. λ_{ce}, λ_m and λ_v are stated in per mill. Δ are stated in percentage changes relative to the scenario without transfers.

Table 5: Share government debt held domestically

	Welfare				Ad Hoc			
	baseline	$s_b =$ 0.90	$s_b =$ 0.75	$s_b =$ 0.55	*baseline*	$s_b =$ 0.90	$s_b =$ 0.75	$s_b =$ 0.55
κ_s	1,10	1,05	0,91	0,46	1,82	1,90	1,92	1,94
λ_{ce}	-0,36	-0,53	-0,58	-0,60	-0,45	-0,56	-0,60	-0,62
$\Delta\lambda_{ce}$	-39,42	-15,94	-6,36	-0,84	-24,69	-11,47	-3,23	1,78
λ_m	0,08	-0,08	-0,14	-0,17	-0,03	-0,12	-0,16	-0,19
$\Delta\lambda_m$	-217,80	-26,71	-8,47	-2,51	-62,09	9,84	8,50	6,88
λ_v	-0,44	-0,46	-0,44	-0,43	-0,43	-0,45	-0,44	-0,43
$\Delta\lambda_v$	-16,33	-13,82	-5,69	-0,16	-19,85	-15,68	-6,91	-0,30
$\Delta\sigma_\pi$	-1,44	-1,13	-0,43	-0,01	-1,73	-1,26	-0,52	-0,02
$\Delta\sigma_{gdp}$	-9,06	-8,04	-3,14	-0,09	-10,63	-9,00	-3,75	-0,16
$\Delta\sigma_c$	-15,75	-12,69	-5,07	-0,14	-19,42	-14,51	-6,19	-0,26
$\Delta\sigma_l$	-16,24	-13,88	-5,75	-0,17	-19,59	-15,68	-6,94	-0,30
$\Delta\sigma_z$	-32,45	-29,30	-14,21	-0,48	-37,54	-31,95	-16,50	-0,85

s_b: share of government debt held by domestic banks. λ_{ce}, λ_m and λ_v are stated in per mill. Δ are stated in percentage changes relative to the scenario without transfers.

to show significant welfare gains. Instead, if funding fiscal transfers could subject countries to less harsher fiscal tightening than when they are hit by sovereign spread shocks, perhaps then a fiscal transfer scheme could have better chances to impact positively on welfare.

Finally, the assumption that domestic government debt is held solely within the domestic banking system might be considered rather strong in the context of the Euro area. In Table 5 I relax this assumption by setting the steady state share of government debt held domestically to 90, 75 and 55%. To investigate the welfare consequences of fiscal transfers, I assume again that domestic fiscal policy stabilizes the fiscal using lump sum transfers. Intuitively, the more diversified the asset allocation in banks' portfolios, the less are the welfare gains from implementing fiscal transfers. In the extreme case of banks in the monetary union holding equal shares of national governments debt, sovereign spread shocks in one regions would equally affect both banking systems and both countries. Hence, both governments would be in need to consolidate, since tax revenues would be falling in both countries. As a result, with a diversified banking sector, a federal fiscal transfers scheme would not serve to improve welfare nor stabilize the economy in response to idiosyncratic sovereign spread shocks.

6 Conclusion

The recent sovereign debt crisis in Europe has tested the resilience of the most ambitious supra-national endeavour seen in the old continent. It has also reopened the discussion over the design of a federal mechanism that can facilitate the adjustment of individual member states facing large idiosyncratic shocks. The answers so far have been in the direction of more integration and discipline, with the Banking Union and the Fiscal Compact being notable examples. Looking ahead, however, the completion of a robust monetary union requires some form of fiscal arrangement as well. After all, it was the inability of domestic fiscal policy to tackle sovereign spread shocks in the countries most affected by the crisis that sparked the severe tensions seen within the EMU.

The paper illustrates the mechanisms at work during a sovereign spread shock. The model features financial frictions due to leverage constraints on banks, linking the availability of credit to productive firms to the value of bank's net worth. Because domestic banks are exposed to sovereign credit risk, an exogenous unexpected increase in sovereign spreads impairs credit provision to firms. The consequent recession is intensified due to fiscal consolidation, which is shown be more aggressive when sovereign spreads react to a deterioration in public finances or for higher debt burdens,

I contribute to the debate about a future fiscal capacity at the EMU level by investigating the welfare and stability implications of a simple fiscal transfer schemes between members of a monetary union. Under the scheme, transfers are triggered when sovereign spreads widen, therefore alleviating the budgetary strain on the government. Transfers can also provide a stimulus to real activity by reducing the negative impacts of distortionary fiscal policy. When the domestic fiscal instrument is lump sum taxation, the proposed fiscal arrangements can improve welfare. However, when domestic fiscal instruments are distortionary, fiscal transfers still reduce economic volatility but are unable to improve welfare.

Further research should investigate the mechanisms by which these fragilities can be reduced. Two extensions seem particularly relevant. First, one could consider asymmetric domestic fiscal policy in the sense that the fiscal instrument used to stabilize the fiscal stance could differ from the instrument used to fund the transfers. This has the potential to lessen the distortionary costs of the transfer scheme and therefore to make transfers welfare improving even in an environment where governments use distortionary taxation to stabilize the fiscal stance. Second, one could assume that transfers, instead of going to the government, are channelled to the banking sector. Credit provision to banks can reduce the contraction of private lending to firms and mitigate the recession. It could also increase the welfare and stability gains induced by a transfer scheme.

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Appendix

Table 6: Sensitivity: symmetric

	Welfare					
	baseline	$\Theta =$ 0.03	$D_g =$ 100%	$0.5\times$ κ_T	$0.75\times$ κ_T	$1.25\times$ κ_T
κ_s	1,10	1,09	0,47	0,91	1,03	1,14
λ_{ce}	-0,36	-0,49	-1,95	-0,35	-0,35	-0,37
$\Delta\lambda_{ce}$	-39,42	-24,48	-13,71	-44,50	-42,71	-35,76
λ_m	0,08	-0,03	-0,60	0,09	0,09	0,07
$\Delta\lambda_m$	-217,80	-63,64	-23,53	-205,08	-208,32	-229,85
λ_v	-0,44	-0,47	-1,35	-0,44	-0,44	-0,45
$\Delta\lambda_v$	-16,33	-19,91	-8,51	-18,71	-17,89	-14,66
$\Delta\sigma_\pi$	-1,44	-1,74	-0,42	-1,30	-1,44	-1,39
$\Delta\sigma_{gdp}$	-9,06	-12,07	-5,42	-10,94	-10,15	-8,00
$\Delta\sigma_c$	-15,75	-18,62	-9,87	-19,85	-18,05	-13,57
$\Delta\sigma_l$	-16,24	-19,95	-8,14	-18,23	-17,63	-14,69
$\Delta\sigma_z$	-32,45	-38,16	-10,27	-29,76	-32,68	-30,82
	Ad Hoc					
	baseline	$\Theta =$ 0.03	$D_g =$ 100%	$0.5\times$ κ_T	$0.75\times$ κ_T	$1.25\times$ κ_T
κ_s	1,82	1,89	2,07	1,48	1,67	1,95
λ_{ce}	-0,45	-0,53	-4,12	-0,44	-0,44	-0,47
$\Delta\lambda_{ce}$	-24,69	-18,81	81,95	-30,50	-28,93	-19,66
λ_m	-0,03	-0,08	-2,93	-0,01	-0,02	-0,04
$\Delta\lambda_m$	-62,09	10,24	273,38	-84,45	-80,66	-31,03
λ_v	-0,43	-0,45	-1,19	-0,43	-0,42	-0,43
$\Delta\lambda_v$	-19,85	-22,20	-19,61	-21,83	-21,18	-18,42
$\Delta\sigma_\pi$	-1,73	-1,90	-0,98	-1,52	-1,69	-1,72
$\Delta\sigma_{gdp}$	-10,63	-13,29	-11,79	-12,60	-11,74	-9,58
$\Delta\sigma_c$	-19,42	-20,92	-23,49	-23,46	-21,62	-17,36
$\Delta\sigma_l$	-19,59	-22,15	-18,34	-21,10	-20,72	-18,30
$\Delta\sigma_z$	-37,54	-40,92	-22,44	-33,39	-37,04	-36,66

* 4.1025e-04. λ_{ce}, λ_m and λ_v are stated in per mill. Δ are stated in percentage changes relative to the scenario without transfers.

Table 7: Sensitivity: asymmetric (welfare)

	baseline	$\Theta =$ 0.03	$D_g =$ 100%	$0.5\times$ κ_T	$\sigma\sigma =$ -0.5	$\sigma\sigma =$ 0.5
κ_s	1,10	1,01	0,54	0,93	1,10	1,10
$\lambda_{ce,H}$	-0,36	-0,10	-3,46	-0,36	-0,01	-0,72
$\Delta\lambda_{ce,H}$	-39,42	-87,57	-10,21	-43,38	-97,85	-14,12
$\lambda_{m,H}$	0,08	0,33	-2,19	0,10	0,27	-0,11
$\Delta\lambda_{m,H}$	-217,80	-235,84	-10,87	-217,50	489,89	-40,83
$\lambda_{v,H}$	-0,44	-0,43	-1,28	-0,45	-0,28	-0,61
$\Delta\lambda_{v,H}$	-16,33	-24,50	-9,08	-16,87	-31,86	-6,64
$\lambda_{ce,F}$	-0,36	-0,78	1,06	-0,39	-0,01	-0,72
$\Delta\lambda_{ce,F}$	-39,42	82,65	7,49	-35,71	-97,85	-14,12
$\lambda_{m,F}$	0,08	-0,30	1,63	0,06	0,27	-0,11
$\Delta\lambda_{m,F}$	-217,80	-377,37	2,14	-184,36	489,89	-40,83
$\lambda_{v,F}$	-0,44	-0,48	-0,57	-0,45	-0,28	-0,61
$\Delta\lambda_{v,F}$	-16,33	-10,05	-6,46	-15,20	-31,86	-6,64
$\Delta\sigma_{\pi_H}$	-1,44	0,89	3,89	0,15	-4,15	-0,49
$\Delta\sigma_{gdp_H}$	-9,06	-17,91	-10,63	-11,77	-20,19	-3,42
$\Delta\sigma_{c_H}$	-15,75	-21,38	-14,04	-20,43	-31,16	-6,34
$\Delta\sigma_{l_H}$	-16,24	-24,99	-7,97	-15,81	-31,70	-6,60
$\Delta\sigma_{z_H}$	-32,45	-42,16	-12,68	-29,67	-49,94	-15,83
$\Delta\sigma_{\pi_F}$	-1,44	-3,28	2,46	0,27	-4,15	-0,49
$\Delta\sigma_{gdp_F}$	-15,75	-10,93	-5,02	-11,69	-31,16	-6,34
$\Delta\sigma_{c_F}$	-9,06	-1,25	-1,30	-5,34	-20,19	-3,42
$\Delta\sigma_{l_F}$	-16,24	-9,60	-6,70	-15,83	-31,70	-6,60
$\Delta\sigma_{z_F}$	-32,45	-26,74	-18,28	-29,38	-49,94	-15,83

λ_{ce}, λ_m and λ_v are stated in per mill. Δ are stated in percentage changes relative to the scenario without transfers.

Table 8: Sensitivity: asymmetric (*ad hoc*)

	baseline	$\Theta =$ 0.03	$D_g =$ 100%	$0.5\times$ κ_T	$\sigma\sigma =$ -0.5	$\sigma\sigma =$ 0.5
κ_s	1,82	1,32	1,61	1,23	1,82	1,82
$\lambda_{ce,H}$	-0,45	-0,09	-1,59	-0,32	-0,14	-0,76
$\Delta\lambda_{ce,H}$	-24,69	-89,40	-58,74	-48,93	-61,25	-8,85
$\lambda_{m,H}$	-0,03	0,34	-0,43	0,12	0,11	-0,16
$\Delta\lambda_{m,H}$	-62,09	-237,90	-82,42	-249,37	139,40	-11,66
$\lambda_{v,H}$	-0,43	-0,42	-1,16	-0,44	-0,25	-0,60
$\Delta\lambda_{v,H}$	-19,85	-26,23	-17,42	-18,42	-38,72	-8,06
$\lambda_{ce,F}$	-0,45	-0,82	-2,09	-0,47	-0,14	-0,76
$\Delta\lambda_{ce,F}$	-24,69	91,53	-312,31	-22,37	-61,25	-8,85
$\lambda_{m,F}$	-0,03	-0,35	-1,51	-0,03	0,11	-0,16
$\Delta\lambda_{m,F}$	-62,09	-419,04	-194,47	-58,79	139,40	-11,66
$\lambda_{v,F}$	-0,43	-0,48	-0,58	-0,44	-0,25	-0,60
$\Delta\lambda_{v,F}$	-19,85	-11,37	-5,24	-17,35	-38,72	-8,06
$\Delta\sigma_{\pi_H}$	-1,73	1,47	15,58	0,99	-4,98	-0,59
$\Delta\sigma_{gdp_H}$	-10,63	-19,26	-21,15	-12,78	-23,68	-4,01
$\Delta\sigma_{c_H}$	-19,42	-22,71	-26,42	-21,87	-38,42	-7,82
$\Delta\sigma_{l_H}$	-19,59	-26,75	-15,29	-17,29	-38,24	-7,96
$\Delta\sigma_{z_H}$	-37,54	-45,78	-27,34	-33,48	-57,76	-18,31
$\Delta\sigma_{\pi_F}$	-1,73	-3,06	9,85	1,32	-4,98	-0,59
$\Delta\sigma_{gdp_F}$	-10,63	-0,63	4,53	-5,33	-23,68	-4,01
$\Delta\sigma_{c_F}$	-19,42	-12,11	-6,87	-13,69	-38,42	-7,82
$\Delta\sigma_{l_F}$	-19,59	-10,88	-4,24	-17,94	-38,24	-7,96
$\Delta\sigma_{z_F}$	-37,54	-29,80	-29,71	-33,58	-57,76	-18,31

λ_{ce}, λ_m and λ_v are stated in per mill. Δ are stated in percentage changes relative to the scenario without transfers.

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