CESifo WORKING PAPERS

8541
2020

September 2020

Nontradable Goods and Fiscal Multipliers

Jesús Crespo Cuaresma, Christian Glocker

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 8541*

Nontradable Goods and Fiscal Multipliers

Abstract

We assess the role that nontradable goods play as a determinant of fiscal spending multipliers, making use of a two-sector model. While fiscal multipliers increase with the share of nontradable goods, an inverted U-shaped relationship exists between multiplier size and the import share. Employing an interacted panel VAR model for EU countries, we estimate the effect of the share of nontradable goods on fiscal spending multipliers. Our empirical results provide strong evidence for the predictions of the theoretical model. They imply that the drag of fiscal consolidations is on average smaller in countries with a low share of nontradable goods.

JEL-Codes: E62, F41, C23.

Keywords: fiscal spending multiplier, nontradable goods, openness, DSGE model, interacted panel VAR model.

Jesús Crespo Cuaresma
Vienna University of Economics and Business
jcrespo@wu.ac.at

Christian Glocker
Austrian Institute of Economic Research
christian.glocker@wifo.ac.at

Version of August, 2020.
Acknowledgments: We are very grateful to Astrid Czaloun for research assistance

1. Introduction

Understanding the effects of fiscal spending shocks in an open economy setting has been an important research agenda over the last decades. Lane and Perotti (1998) document that an expansionary fiscal spending shock causes a contraction in exports and a deterioration of the trade balance for a group of OECD countries, especially under flexible exchange rates. Monacelli and Perotti (2010) and Ravn et al. (2012) conclude that an increase in government purchases produces output and consumption increases and a trade balance deterioration and that, in contrast to what would be expected, the fiscal shock also produces a real exchange rate depreciation. Beetsma et al. (2008), Corsetti et al. (2012) and Bénétrix and Lane (2013) document that for European countries a positive shock to government purchases produces an appreciation of the domestic currency.

The potential importance of the interactions between fiscal policy and trade openness motivates an assessment of the role of cross-country production chains as a determinant of the size of fiscal spending multipliers, as well as of possible international spillovers of fiscal shocks. In this context, Corsetti and Müller (2007) show that the degree of openness does not alter the effects of government spending on output, but affects its impact on private demand. Ilzetzki et al. (2013) analyse the determinants of differences in the size of fiscal multipliers across countries and show that, among others, the openness to trade is an important factor explaining the variation observed in fiscal multipliers across economies. More recently, Wierzbowska and Shibamoto (2018) identify net capital inflows and openness to trade as two of the most important determinants of fiscal policy effectiveness, while Cacciatore and Traum (2018) highlight that the domestic effectiveness of fiscal policy can be larger in economies more open to trade, irrespective of the trade balance dynamics. Devereux et al. (2019) show that network structures may play a central role in the international propagation of fiscal shocks, particularly when wages are slow to adjust. The majority of contributions studying the impact of government spending on economic activity limits the scope to the analysis of the effect on aggregate demand and its various sub-components. Even when open-economy specific aspects are taken into account, the focus remains limited to demand-side variables such as imports and exports and balance of payments variables.

In this paper we contribute to the existing body of literature that investigates the role of fiscal policy for business cycle fluctuations within an open economy perspective by assessing the role of production structure in this context. To the extent that the composition of production of an economy matters for a country's degree of openness, it is also likely to play a role for the size of fiscal spending multipliers. We thus focus on structural factors related to the composition of tradable and nontradable goods and services (as opposed to cyclical ones, which tend to be at the centre of the discussion in the existing literature) as determinants of the response of output to fiscal shocks in open economies. The basic intuition behind the fact that the production structure may be an important factor to explain differences in fiscal multipliers over time and across countries is simple. If a country produces mostly nontradables, a fiscal contraction gives rise to a large drop in domestic demand and hence in domestic production. On the other hand, if a country produces mostly tradables, then a fiscal contraction implies a drop in domestic demand but is likely to exert only a small negative effect on domestic production. In this case, domestic producers can react to the fall in domestic demand simply by switching to exports and the drop in domestic production can be curbed as foreign demand stabilises the total demand for domestic goods. As a result, fiscal spending multipliers are likely to be higher in countries whose production structure is characterised by a high share of nontradable goods in total production, *ceteris paribus*. This effect is based on the notion that, for the case of nontradable goods, the potential of a compensatory effect by means of international trade is absent. The production of tradables, in turn, can be very different to domestic demand: if tradable goods production exceeds its domestic demand, the rest can simply be exported – while when tradable goods production falls short of its domestic demand imports cover the gap. The crucial structural element in this context is given by the ease with which producers can choose between domestic and foreign markets.

In order to address the question of how the composition of production affects the size of the fiscal multiplier, we develop a simple dynamic stochastic general equilibrium (DSGE) model with a small open economy set-up, which includes a home country consisting of households, firms and a government, as well as a foreign country. The results of this theoretical model imply that openness is determined by two structural parameters: it depends negatively on the share of nontradables and positively on the import share. Subsequently, two key conclusions in the context of fiscal spending can be drawn from the model results: (i) if a higher degree of openness is due to a lower share of nontradables, then fiscal spending multipliers decrease with the degree of openness; and (ii) if a higher degree of openness is due to a higher import share, then the effect of the degree of openness on the size of fiscal spending multipliers is given by an inverted U-shaped relationship.

We evaluate empirically the predictions of our theoretical model using data for EU member states. We employ a block-exogenous Bayesian panel vector autoregressive (VAR) model, where we identify the effects of changes in government spending for different levels of the share of nontradables by means of interaction terms, as proposed by Towbin and Weber (2013). Our empirical findings confirm the implications of our theoretical setting. We find that fiscal spending shocks trigger a negligibly small response in output at low values of the share of nontradables, while the response for a high share of nontradables is significantly different from zero, large and persistent. For environments with a high values of the share of nontradables, fiscal spending shocks explain more than 17 percent in the variation of output, while that figure is below 4 percent for low values of the nontradable share. Furthermore, we find that the response of the trade balance decreases with the share of nontradables. The response is low and insignificant at high values of the share of nontradables, while at low levels the response is negative and highly significant. In addition, we find that the relative price of nontradable goods and services rises in response to an expansionary fiscal spending shock. The size of this response increases with the share of nontradables. All these results are in line with those derived from the theoretical model presented. We also find that fiscal spending multipliers decrease with the import share. The difference in the output response across low and high values of the import share is sizeable and supports theories of increased import leakage in response to a rise in fiscal spending, with negative fiscal spending multipliers for high values of the import share.

The key policy implication from our study is that the drag of fiscal consolidations is mitigated when the share of nontradable goods and services in total production is low. Conversely, if the intention behind the use of fiscal policy is to stabilize an economy in the wake of a recession, then the policy is likely to be most effective when the share of nontradables is large.

The paper is organized as follows. Section 2 describes the data used and discusses the relation between the share of nontradables, the degree of openness and the relative price of nontradables. Section 3 presents the theoretical model and derives the implications of variation in the sizes of the share of nontradables for macroeconomic responses to fiscal shocks. The empirical analysis is carried out in Section 4, which also contains a discussion on the robustness of the results. Finally, Section 5 concludes.

2. Nontradable goods, openness and relative prices – a look at the data

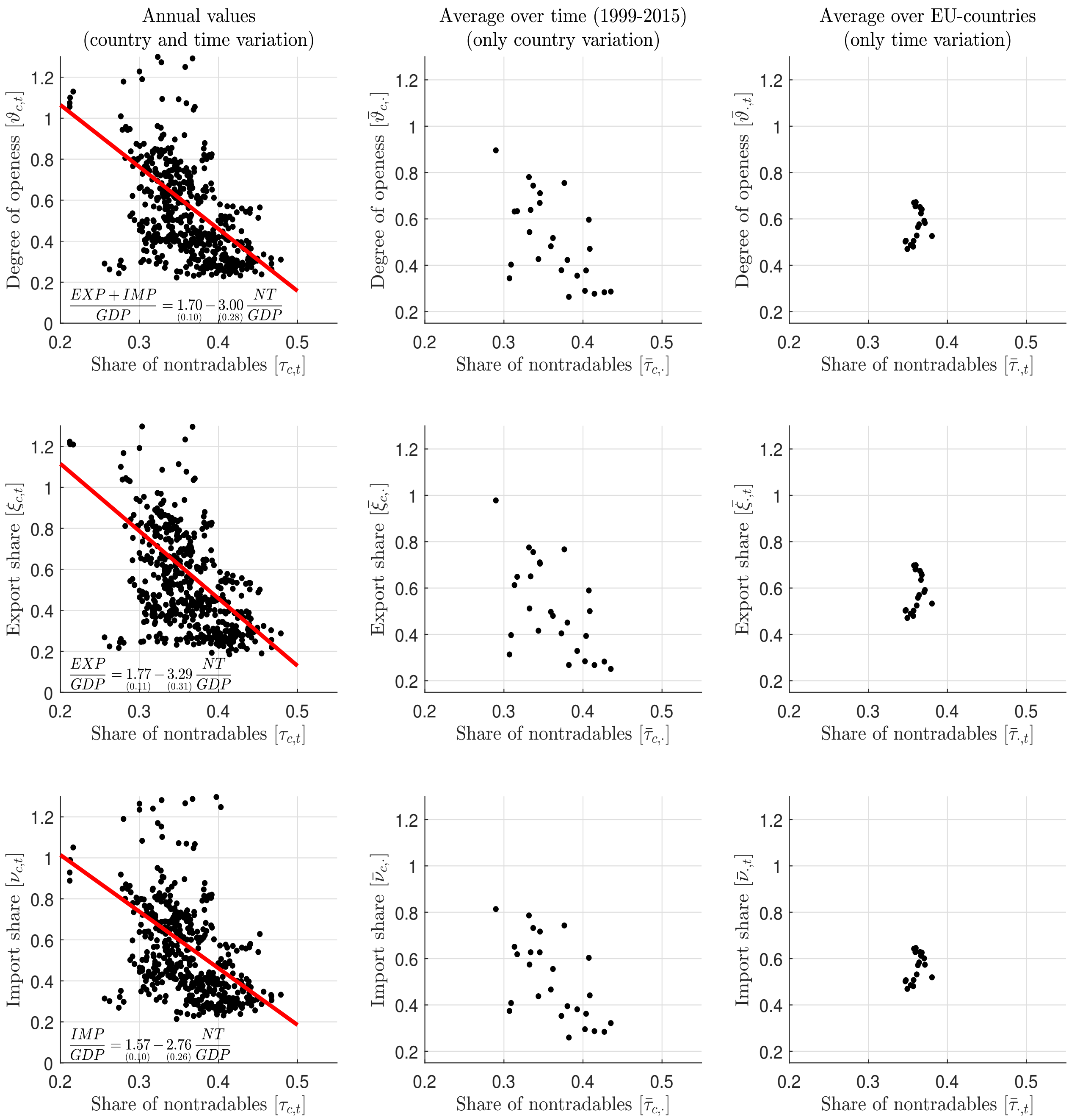
The theoretical literature on the composition of production relies on a neat division of goods and services into *tradables* and *nontradables*. Unfortunately, few real world goods and services fall easily into any of these two categories. Hence, empirical work requires an operationalisation of this concept.

We classify sectors according to their level of tradability making use of the work of Friesenbichler and Glocker (2019). Utilising input-output (IO) data within an approach that allows for a change in the classification for sectors over time, Friesenbichler and Glocker (2019) construct quarterly data for the share of nontradable goods (τ, the value added of nontradable goods producing sectors relative to total value added) for the period ranging from 1999 to 2019.[1] Figure 1 shows the share of nontradable goods for EU28 countries in relation to different measures of openness: (i) the sum of exports and imports relative to GDP multiplied by one half (ϑ), (ii) the export share (ξ), and (iii) the import share (ν). The subplots in the first column display the variation of the share of nontradables relative to different measures of openness for all EU countries and each year in the period 1999 - 2019. The share of nontradables ranges between 0.20 and 0.50 and presents thus far less variation than the degree of openness, which takes values that can be as low as 0.20 but also above unity. A clear negative relation between the share of nontradables and all measures of openness considered can be observed, pointing towards a statistically strong co-movement of these variables and implying that a decrease in the share of nontradables by one percentage point is associated with an increase in the degree of openness of around 3 percentage points.

Assuming that openness is a function of the share of nontradables, the negative co-movement depicted in Figure 1 allows to establish $\vartheta(\tau)$ with $\vartheta'(\tau) < 0$. Intuitively, the degree of openness is restricted by the composition of production: if the production structure of a country is confined exclusively to nontradable goods, its export ability is zero, which in turn naturally limits its degree of openness. However, a high share of tradables $(1 - \tau)$ does not necessarily imply a high export intensity. If a significant amount of tradable goods produced is consumed domestically, then the export intensity can be low despite a high share of tradables. If, however, domestic demand for tradable goods falls short of supply, the excess supply could then be easily provided to foreign markets. This simple assessment highlights the extent to which the share of nontradable goods – and equivalently the share of tradable goods – characterise a country's export

[1] Further details on the data can be found in Section 4.2

FIGURE 1. Nontradable goods share and degree of openness: EU28

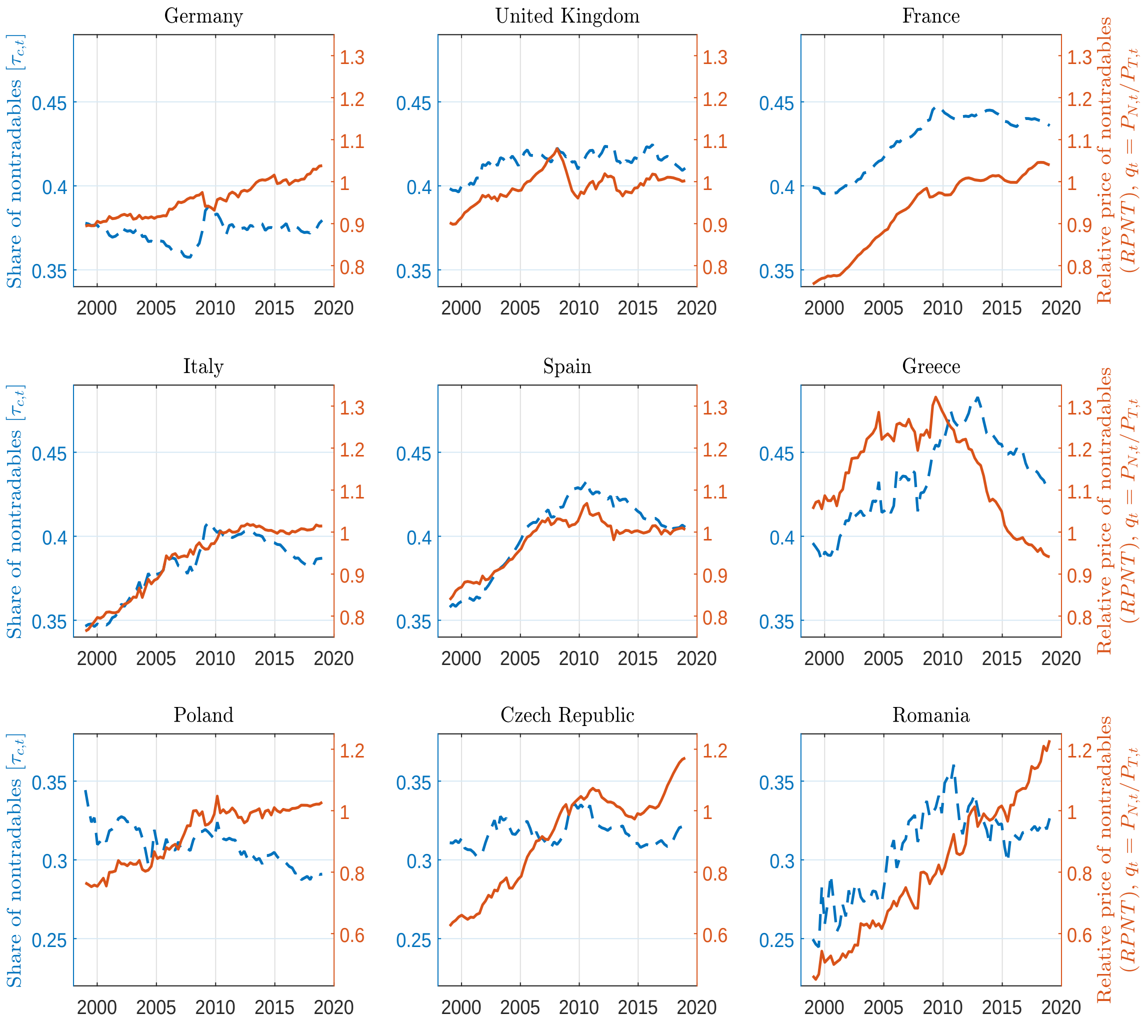


Note: The subplots show the share of nontradable goods and services (sum of value added of all sectors producing nontradable goods and services relative to total value added) relative to different measures of openness across the rows. The subplots in the first column are accompanied by estimated regression lines and equations, where the values in parenthesis are the standard deviations of the estimated parameters.

potential. The subplots in the second column show the cross-country variation in the data, and those of the third column their time variation. The variation over countries is sizeable and mimics the pattern observed in the full sample including variation across countries and over time. However, the variation over time is comparably small.

In order to study differential price dynamics across the two classifications of goods and services, we aggregate the sectoral price deflators to obtain aggregate price indices

FIGURE 2. The share of nontradables and their relative price: selected EU countries



Note: The blue dashed line shows the share of nontradable goods and services (left scale) and the orange solid line the relative price (right scale).

for tradables ($P_{T,t}$) and nontradables ($P_{N,t}$), from which we establish a measure of the relative price of nontradables goods[2] (q_t, $RPNT$) as $q_t = P_{N,t}/P_{T,t}$. We display the relative price of nontradables jointly with the share of nontradables (τ_t) in Figure 2 for (i) Germany, United Kingdom and France, the three largest EU countries (first row), (ii) Italy, Spain and Greece, the three countries most affected by the European debt crisis of 2010-2013 (second row), and (iii) Poland, Czech Republic and Romania, the three largest Central and Eastern European (CEE) countries (third row).

Figure 2 highlights that the relative price of nontradables has increased almost uniformly across the countries depicted over the 1999 to 2019 period. The countries that

[2]Throughout the paper, we use the expression *relative price of nontradables*. It is useful to bear in mind that an increase in this relative price corresponds to a real appreciation.

depart from this pattern are those most affected by the European debt crisis.[3] In particular, Greece experienced a strong decline in the relative price of nontradable goods. Secondly, most countries experienced both an increase in the relative price of nontradables and an increase in the relative size of the nontradables sector. Both findings are in line with the results put forward in De Gregorio et al. (1994a), where empirical evidence is presented concerning the fact that in the long run, most of the increase in the relative price of nontradables can be explained by the faster increase of total factor productivity in the tradable goods sector, which in turn conforms with the Balassa-Samuelson hypothesis.

This descriptive analysis of the data uncovers significant variation in the share of nontradable goods across EU countries, as well as in the relative price of nontradable goods. Our theoretical model and the empirical exercise concern the extent to which these structural differences shape the effectiveness of fiscal policy. In what follows, we tackle this issue theoretically in Section 3 and provide empirical evidence in Section 4.

3. The theoretical model

In order to gain an understanding of the linkages between production structure and fiscal multipliers, we employ a dynamic stochastic general equilibrium (DSGE) model for a small open economy. The model is comprised by a home economy, consisting of households, firms, a government, and a foreign economy. We follow Sachs and Larrain (1993); Wickens (2012); Uribe and Schmitt-Grohé (2017); Schmitt-Grohé et al. (2019) and assume that production takes place along two stages: intermediate goods and final goods. Intermediate goods production involves tradable and nontradable goods producers. Final goods producers merge tradable and domestic nontradable goods to a final good which is supplied to domestic households and the government. Households supply labour to firms in the tradable and nontradable sectors. We assume that international asset markets are incomplete, such that only a risk-free bond is traded. Hence, the wealth effect is borne by the home economy, which in turn implies that in response to an expansionary fiscal spending shock, labour input rises by more and the fall in the real wage will be larger than under the case of complete markets (see Corsetti and Müller, 2007; Beetsma and Giuliodori, 2010, for further details). Labour is assumed to be the only factor of production and is immobile across the two economies, however, it is mobile across the tradable and nontradable sectors.

[3]Estrada et al. (2013); Ederer and Reschenhofer (2018) present further details concerning the recent dynamics of structural variables in Europe.

3.1. **The production sectors.** There are four types of goods in the economy: (i) tradable (ii) nontradable, (iii) composite-tradable, and (iv) final goods. Final goods are obtained by combining domestic nontradable goods and composite-tradable goods. They are used only for serving domestic final goods demand, which is given by private and public consumption. Final goods are not traded across countries. Nontradable goods enter in the production process for the final goods directly and domestic tradable goods, in turn, enter final goods production only in the form of composite-tradable goods, which consist of domestic and foreign tradable goods. All the trade between the two economies is exclusively in tradable goods.

3.1.1. *Tradable and nontradable goods producing firms.* Representative firms producing tradable and nontradable goods operate in perfectly competitive markets. They use labour and a sector-specific technology in form of a Cobb-Douglas production function. Firms in the nontradable sector produce $y_{N,t}$, which is supplied only to domestic producers of final goods. Firms producing tradable goods serve both domestic and foreign composite-tradable goods producers. They supply $y_{H,t}$ for domestic and $y^*_{H,t}$ to foreign composite-tradable goods producers. Hence, the total supply of tradable goods is given by $y_{H,t} + y^*_{H,t}$.

The maximization problems of firms producing nontradable and tradable goods are given by

$$\max_{h_{N,t}} P_{N,t} y_{N,t} - w_t h_{N,t}, \qquad \max_{h_{H,t}} P_{H,t}\left(y_{H,t} + y^*_{H,t}\right) - w_t h_{H,t}, \tag{1}$$

subject to $\qquad\qquad$ subject to

$$y_{N,t} = A_N h^{\alpha}_{N,t}, \qquad y_{H,t} + y^*_{H,t} = A_H h^{\alpha}_{H,t}, \tag{2}$$

where w_t is the nominal wage rate per hour worked in both the nontradable and tradable sectors, $h_{N,t}$ and $h_{H,t}$ are the overall hours worked in the two sectors and $P_{N,t}$ and $P_{H,t}$ are the prices of domestic nontradable and tradable goods. A_N and A_H are sector specific technology parameters. Since labour is assumed mobile across the two sectors, nominal (w_t) and real (w_t/P_t, where P_t is the price of final goods defined below) wages equalize in both sectors of production. Taking prices of all goods and factor inputs as given, the solution to this maximisation problem is given by the following first-order conditions

$$\frac{w_t}{P_{N,t}} = \alpha \frac{y_{N,t}}{h_{N,t}}, \qquad \frac{w_t}{P_{H,t}} = \alpha \frac{y_{H,t} + y^*_{H,t}}{h_{H,t}}. \tag{3}$$

3.1.2. *Composite-tradable and final goods producing firms.* The final good Y_t is produced using composite-tradable goods ($y_{T,t}$) and nontradable goods ($y_{N,t}$) according to the following technology

$$Y_t = \left((1-\tau)^{\frac{1}{\kappa}} y_{T,t}^{\frac{\kappa-1}{\kappa}} + \tau^{\frac{1}{\kappa}} y_{N,t}^{\frac{\kappa-1}{\kappa}}\right)^{\frac{\kappa}{\kappa-1}}, \tag{4}$$

where κ is the elasticity of substitution between composite-tradable and nontradable goods and τ determines the share of nontradable goods used in the production of final goods. Composite-tradable goods are produced using both domestic ($y_{H,t}$) and foreign ($y_{F,t}$) tradable goods according to

$$y_{T,t} = \left((1-\nu)^{\frac{1}{\theta}} y_{H,t}^{\frac{\theta-1}{\theta}} + \nu^{\frac{1}{\theta}} y_{F,t}^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}, \tag{5}$$

where θ is the elasticity of substitution between domestic and foreign tradable goods and ν is the share of foreign tradable goods used in the production of composite-tradable goods. Final goods producers and producers of the composite-tradable goods operate in perfectly competitive markets and maximise their profits according to

$$\max_{y_{T,t}, y_{N,t}} P_t Y_t - P_{T,t} y_{T,t} - P_{N,t} y_{N,t}, \qquad \max_{y_{H,t}, y_{F,t}} P_{T,t} y_{T,t} - P_{H,t} y_{H,t} - P_{F,t} y_{F,t}, \tag{6}$$

subject to equations (4) and (5). P_t and $P_{T,t}$ are the prices of final and composite-tradable goods and $P_{F,t}$ is the price of foreign tradable goods in terms of domestic currency units. We assume that the law of one price holds, so that $P_{F,t}$ depends on the price of foreign tradable goods expressed in foreign currency terms (P_F^*) and the nominal exchange rate (S_t): $P_{F,t} = S_t P_F^*$, assuming P_F^* exogenous. The solution to the maximisation problem in equation (6) yields the following first order conditions, which characterise the demand functions for the input factors for production

$$y_{N,t} = \tau \left(\frac{P_{N,t}}{P_t}\right)^{-\kappa} Y_t, \tag{7}$$

$$y_{H,t} = (1-\tau)(1-\nu) \left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\theta} \left(\frac{P_{T,t}}{P_t}\right)^{-\kappa} Y_t, \tag{8}$$

$$y_{F,t} = (1-\tau)\nu \left(\frac{P_{F,t}}{P_{T,t}}\right)^{-\theta} \left(\frac{P_{T,t}}{P_t}\right)^{-\kappa} Y_t. \tag{9}$$

The price indices for composite-tradable goods ($P_{T,t}$) and final goods (P_t) in line with the demand system of equations (7) - (9) are given by

$$P_{T,t} = \left((1-\nu) P_{H,t}^{1-\theta} + \nu P_{F,t}^{1-\theta}\right)^{\frac{1}{1-\theta}}, \qquad P_t = \left((1-\tau) P_{T,t}^{1-\kappa} + \tau P_{N,t}^{1-\kappa}\right)^{\frac{1}{1-\kappa}}. \tag{10}$$

3.2. **The household sector.** We consider a household sector that is comprised by a continuum of infinitely lived households. In a given period, households derive utility from consumption C_t and disutility from working by supplying h_t hours. They receive labour income $w_t h_t$ (expressed in nominal terms). Their instant utility function is $u(C_t, h_t) = \log(C_t) - \frac{h_t^{1+\phi}}{1+\phi}$. Households can invest their savings in domestic nominal bonds B_t and foreign nominal bonds B_t^* evaluated at the exchange rate S_t. To ensure stationarity, we assume that acquiring foreign bonds entails a holding cost equal to $\frac{\psi_B^*}{2}\left(\frac{S_t}{P_t}B_t^*\right)^2$. In addition to labour income, households receive gross interest payments on their holdings on domestic bonds $i_{t-1}B_t$ and foreign bonds $\bar{\imath}^* B_t^*$, dividends D_t from goods producing firms, and pay lump-sum taxes T_t to the government. The budget constraint is given by

$$P_t C_t + B_t + S_t B_t^* = i_{t-1}B_{t-1} + \bar{\imath}^* S_t B_{t-1}^* + P_t(D_t - T_t) + +w_t h_t - \frac{\psi_B^*}{2} P_t \left(\frac{S_t}{P_t}B_t^*\right)^2 . \tag{11}$$

Households discount instant utility with a factor of β. They maximise their expected lifetime utility function $E_0 \sum_{t\geq 0} \beta^t u(C_t, h_t)$, subject to the budget constraint above, which leads to the following optimality conditions

$$1 = \beta E_t \left[\frac{C_t}{C_{t+1}} \frac{i_t}{P_{t+1}/P_t}\right], \tag{12}$$

$$1 + \psi_B^* \frac{S_t}{P_t} B_t^* = \bar{\imath}^* \beta E_t \left[\frac{C_t}{C_{t+1}} \frac{S_{t+1}/P_{t+1}}{S_t/P_t}\right], \tag{13}$$

$$\frac{w_t}{P_t} = h_t^{\phi} C_t, \tag{14}$$

where P_{t+1}/P_t is the gross inflation rate. Note that i_t and $\bar{\imath}^*$ denote gross interest rates on the domestic and foreign one-period bonds, respectively.

3.3. **The foreign economy.** We specify the demand of the foreign economy for tradable goods from the home economy in the form of the following (exogenously given) demand function

$$y_{H,t}^* = \nu^* \left(\frac{P_{H,t}}{S_t P_T^*}\right)^{-\theta^*} Y^*, \tag{15}$$

where θ^* is the elasticity of substitution between the home economy's and the foreign economy's tradable goods within the production occurring in the *foreign* economy. Y^* is total final goods demand in the foreign economy and ν^* is the share of tradable goods from the home economy used in production in the foreign economy. Finally, P_T^* is the price index of the equivalent composite-tradable goods in the foreign economy. P_T^* and

Y^* are assumed to be constant. From the point of view of the home economy, equation (15) is the export demand function and hence determines $y^*_{H,t}$.

3.4. **Equilibrium.** Labour market clearing gives rise to the condition

$$h_t = h_{N,t} + h_{H,t}. \tag{16}$$

Equilibrium in the goods market implies that the supply of final goods (Y_t) equals final goods demand. The latter arises from demand by households (C_t) and the government (G_t). Using the households' budget constraint, we find the following equilibrium condition for the final goods market

$$Y_t = C_t + G_t + \left[\frac{S_t}{P_t}\left(B^*_t - \bar{\imath}^* B^*_{t-1} - \frac{\psi^*_B}{2} P_t \left(\frac{S_t}{P_t} B^*_t\right)^2\right)\right], \tag{17}$$

where the government budget constraint implies that $T_t = G_t$, that is, tax revenues are equal to government spending on final goods and domestic bonds are in zero net supply. The term in parentheses in equation (17) captures the current account.

Finally, the model is closed by defining the balance of payments. The exports of the home economy are given by $P_{H,t} y^*_{H,t}$, and imports are equal to $P_{F,t} y_{F,t}$. Hence, the trade balance is equal to $P_{H,t} y^*_{H,t} - P_{F,t} y_{F,t}$ and the balance of payments identity is then given by

$$S_t B^*_t - \frac{\psi^*_B}{2} P_t \left(\frac{S_t}{P_t} B^*_t\right)^2 = \bar{\imath}^* S_t B^*_{t-1} + P_{H,t} y^*_{H,t} - P_{F,t} y_{F,t}, \tag{18}$$

where, as before, $P_{F,t} = S_t P^*_F$.

3.5. **Solving the model.** We solve and simulate the model assuming rational expectations for all forward looking variables. To this purpose, we consider a log-linear approximation around the symmetric steady state. We assume that in the steady state the trade balance is in equilibrium ($P_H y^*_H = P_F y_F$) and that foreign and domestic bonds are in zero net supply. We normalise P^*_F, P^*_T to unity and express all prices relative to P_t, which is used as the numéraire.

Since we are characterising a nominal model, we need to specify a monetary policy rule. We assume that the monetary authority follows the strategy of setting final goods' price inflation to zero, so that $E_t P_{t+1}/P_t = 0$. We define $\epsilon_t = S_t P^*/P_t$ as the real exchange rate and the terms of trade (tot_t) as the relative price of imported goods, $\text{tot}_t = P_{F,t}/P_{H,t}$. In line with Section 2, we define the relative price of nontradables to tradables by $q_t = P_{N,t}/P_{T,t}$ and, since $P_{T,t}/P_{H,t} = (1 - \nu + \nu(P_{F,t}/P_{H,t})^{1-\theta})^{1/(1-\theta)} =$

$g(\text{tot}_t)$ with $g'(\cdot) > 0$, we have

$$q_t = \frac{q_{N,t}}{g(\text{tot}_t)} \tag{19}$$

where $q_{N,t} = P_{N,t}/P_{H,t}$ is the sectoral relative price of domestic goods, that is, a price measure of domestic nontradable goods relative to their tradable counterparts (see Sachs and Larrain, 1993; Monacelli and Perotti, 2010; Schmitt-Grohé and Uribe, 2016). We define $P_t/P_{T,t} = (1 - \tau + \tau q_t^{1-\kappa})^{1/(1-\kappa)} = h(q_t)$ with $h'(\cdot) > 0$. Given the definition of the real exchange rate, we obtain

$$\epsilon_t \propto \frac{1}{h(q_t)}, \tag{20}$$

where the law of one price has been used and the foreign counterpart of $h(q_t)$ is constant. Hence, equations (19) and (20) identify a direct link between the relative price of nontradables (q_t), the terms of trade (tot_t) and the real exchange rate (ϵ_t). In other words, under the law of one price, movements in the terms of trade and the real exchange rate are proportional to those of the relative price of nontradables.

Finally, government consumption G_t is assumed to satisfy $\log(G_t) \sim N\left(\log\left(\bar{G}\right), \sigma_G^2\right)$ and we assume that the government balances its budget in each period by adjusting lump-sum taxes accordingly.

The log-linearised equations employed to solve for equilibrium are presented in Appendix A. Henceforth, variables with a hat denote the percent deviation from the steady state and those with a tilde denote level deviations.[4]

3.6. **Nontradable goods and the degree of openness.** As Figure 1 shows, a negative relation between the degree of openness and the share of nontradable goods is observable in European data. We assess, to which extent the model is able to replicate this stylized fact by identifying the theoretical link between the degree of openness (ϑ) and the structural parameters of the model, with a particular focus on the behaviour in the steady state. The definition of the degree of openness considered in Section 2 can be reproduced in the model by means of

$$\vartheta_t = \frac{P_{H,t} y_{H,t}^* + P_{F,t} y_{F,t}}{2 \cdot P_t Y_t}. \tag{21}$$

The steady state version of the balance of payments identity given by equation (18) and the demand functions for the input factors for production in equations (7)–(9) give

[4]Let $\bar{x}$ be the steady state value of some variable x_t, then the two notations are linked as follows: $\tilde{x}_t = \bar{x} \cdot \hat{x}_t$ with $\hat{x}_t = dx_t/\bar{x}$.

rise to the following equilibrium condition for the degree of openness

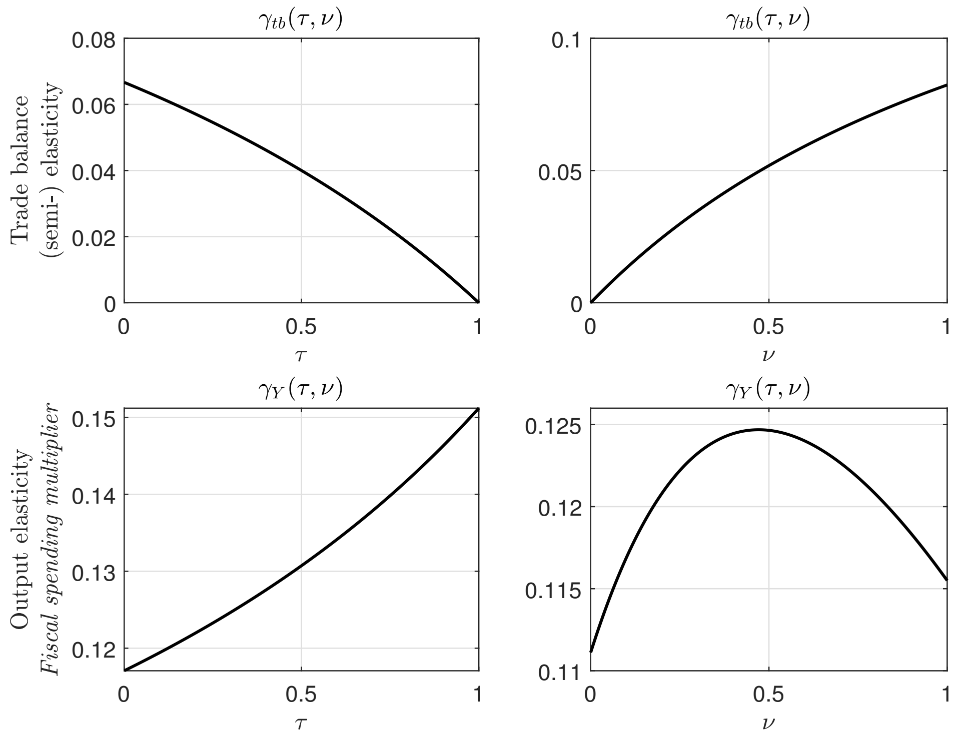
$$\vartheta = \nu(1 - \tau). \tag{22}$$

Equation (22) identifies the structural parameters that determine the degree of openness: the degree of openness (ϑ) increases with the import share (ν) and decreases with the share of nontradable goods (τ). Since $1 - \tau$ captures the share of tradable goods, equation (22) equivalently states that the degree of openness increases with the share of tradable goods. Hence, the model gives clear predictions about the particular way in which the degree of openness is restricted by the composition of production.

The share of foreign goods used in domestic goods production (ν) characterises an economy's import intensity. An increase therein implies a higher degree of openness as implied by equation (22). This parameter has traditionally been considered when studying the role of openness for fiscal spending multipliers (see for instance Corsetti and Müller, 2006, 2007, 2008; Monacelli and Perotti, 2010). Cacciatore and Traum (2018), for instance, use the trade share (the ratio of total trade to GDP) and show that this measure increases monotonically with the import share as implied also by equation (22). A rather different measure for openness is considered in Alcalá and Ciccone (2004), where a real measure of openness is introduced with the purpose of eliminating distortions due to cross-country differences in the relative price of nontradable goods within a context where the effects of trade are analysed on aggregate productivity.

Since the degree of openness is determined by both the import share and the share of nontradables, we assess the role of both parameters in shaping fiscal spending multipliers. From a theoretical point of view, the import share has been considered as an important determinant for the size of fiscal multipliers. However, the direction of its effect is not clear. On the one hand, trade integration theory predicts a downward trend in the size of government spending multipliers as higher trade integration should increase the share of the government spending impulse that leaks abroad through higher imports. On the other hand, the appreciation of the terms of trade in response to an expansionary fiscal spending shock causes a positive wealth effect, which increases with the share of imported goods (see Corsetti and Müller, 2006). These opposing effects might explain, why empirical studies have failed to identify a statistically significant role for the import share as a determinant of fiscal multipliers (see for instance Glocker et al., 2019).

Figure 3. Influence of τ and ν on the trade balance and output



Note: The subplots show the sensitivity of $\gamma_{tb}(\tau,\nu)$ and $\gamma_Y(\tau,\nu)$ for different values of the share of nontradable goods (τ) and the import share (ν). The remaining parameters are fixed at the following values: $c_y = 0.7$, $\kappa = 0.5$, $\lambda = 0.5$; the two subplots in the first column consider variation over τ holding ν fixed at 0.5 while the two in the second column show the variation over ν holding τ fixed at 0.3.

3.7. **An analytic solution.** The solution of the log-linearised rational expectations DSGE model is given by

$$A_0(\tau,\nu)x_t = A_1(\tau,\nu)x_{t-1} + \Psi_0(\tau,\nu)z_t, \tag{23}$$

where the vector x_t contains the endogenous variables and $z_t = Pz_{t-1}+u_t$ the exogenous variables, with $z_t = \hat{G}_t$ in our particular case. Matrices labelled $A_k\ \forall\ k \in \{0,1\}$ govern the dynamics among the dependent variables and the matrix Ψ_0 governs the impact of the fiscal spending shock on the endogenous variables. The derivation of a tractable, analytical solution requires that we restrict ourselves to the special case of $\phi = \alpha = \theta^* = 1$, $\theta = \kappa$ and $\psi_B^* \to 0$. In this case,[5] we find that the equilibrium law of motion reduces to $x_t = \Gamma_0(\tau,\nu)\hat{G}_t$ with $\Gamma_0(\tau,\nu) = A_0(\tau,\nu)^{-1}\Psi_0(\tau,\nu)$. The matrix $\Gamma_0(\tau,\nu)$ gives rise to the following equilibrium law of motion for the trade balance ($\widetilde{tb}_t$)

[5]See the details in Section B of the Appendix

and output ($\hat{Y}_t$)[6]

$$\widetilde{tb}_t = -\gamma_{tb}(\tau,\nu)\hat{G}_t, \qquad \hat{Y}_t = \gamma_Y(\tau,\nu)\hat{G}_t, \tag{24}$$

with $\gamma_{tb}(\tau,\nu) > 0$ and $\gamma_Y(\tau,\nu) > 0$. An intuitive understanding of the working of this model can be gained by concentrating on the negative wealth effect caused by government spending, and in particular the negative Hicksian wealth effect on labour supply. The rise in government consumption raises expected future taxes, which induces a fall in private consumption. In turn, for any given level of the foreign interest rate ($\bar{\imath}^*$), the households' intertemporal first order conditions in equations (12) and (13) require an appreciation of the real exchange rate.[7] Since the Marshall-Lerner condition holds, the exchange rate appreciation brings about a deterioration of the trade balance, which is reinforced by higher import demand arising from the increase in domestic final goods demand.[8] This is captured by $d\widetilde{tb}_t/d\hat{G}_t = -\gamma_{tb}(\tau,\nu) < 0$, which is the (semi-)elasticity of the trade balance to fiscal spending.

In principle, the effect of an increase in fiscal spending on total output is ambiguous. Higher government spending raises output, but the decline in private consumption and the real appreciation (that causes a switch to foreign goods) both reduce output. Still, it is easy to see why output would tend to increase: private consumption and leisure are both normal goods, hence they both fall as a result of the negative wealth effect from higher expected taxation. As a consequence, the associated increase in employment raises output and leads to a positive fiscal multiplier.[9]

In our model, both reduced form parameters $\gamma_{tb}(\tau,\nu)$ and $\gamma_Y(\tau,\nu)$ are functions of the underlying structural parameters, and in particular of τ and ν. This allows us to assess the sensitivity of the trade balance and output to fiscal spending shocks with respect to different values of τ and ν. As shown in Appendix B, the two reduced form

[6] In case of $\psi_B^* > 0$, equation (24) characterises the impact response of the trade balance and output to the fiscal spending shock $\hat{G}_t$.

[7] This is shown analytically in equation (34) of Appendix B.

[8] The linearised/log-linearised trade balance is given by $\widetilde{tb}_t = \vartheta(\kappa\hat{\epsilon}_t - \hat{Y}_t)$. An exchange rate appreciation (i.e. a fall in $\hat{\epsilon}_t$) and the increase in domestic demand for final goods induce a decline in the trade balance.

[9] Horvath et al. (2020) show that the size of fiscal spending multipliers also depends on the slope of the Phillips curve. In the context of nominal rigidities, an increase in government spending can raise output owing to a rise in expected inflation, which, at the zero lower bound, decreases the real interest rate, stimulating consumption and output. This element is absent in our model, hence diminishing the size of fiscal spending multipliers.

parameters satisfy

$$\frac{\partial \gamma_{tb}(\tau,\nu)}{\partial \tau} < 0, \qquad \frac{\partial \gamma_{Y}(\tau,\nu)}{\partial \tau} > 0, \tag{25}$$

$$\frac{\partial \gamma_{tb}(\tau,\nu)}{\partial \nu} > 0, \qquad \frac{\partial \gamma_{Y}(\tau,\nu)}{\partial \nu} \lesseqgtr 0. \tag{26}$$

The partial derivatives in equation (25) imply that a higher share of nontradables (τ) gives rise to a lower sensitivity of the trade balance and a higher sensitivity of output to fiscal spending shocks. Hence fiscal spending multipliers increase with the share of nontradables. The subplots in the first column in Figure 3 display the dependency of the reduced form parameters $\gamma_{tb}(\tau,\nu)$ and $\gamma_Y(\tau,\nu)$ on the share of nontradables. The relationship between $\gamma_Y(\tau,\nu)$ and τ is convex, implying that small increases in the share of nontradables have a comparably large effect on fiscal spending multipliers. Conversely, in case of $\gamma_{tb}(\tau,\nu)$ and τ we observe a negative concave relationship.

The effects change when we consider the sensitivity to the import share (ν). The sign of the partial derivative of the trade balance in equation (26) implies that the sensitivity of the trade balance to fiscal spending shocks increases with the import share. This results are in line with a key finding of Corsetti and Müller (2006), Corsetti and Müller (2007) and Corsetti and Müller (2008), who argue that the effect of spending shocks on the trade balance is smaller if an economy is not very open to trade. The effect on output is, however, ambiguous. The subplots in the second column of Figure 3 highlight that there is an inverted U-shaped relationship between $\gamma_Y(\tau,\nu)$ and ν. Hence, a higher import share can either increase or decrease fiscal spending multipliers depending on the level of the import share itself.

The results presented rely on fairly strong assumptions concerning the calibration of key structural parameters. We thus also consider a more flexible calibration in the following subsection. As this does not allow for a tractable analytic solution any more, we use numerical tools for solving and simulating the model.

3.8. **A quantitative assessment based on simulations.** As an extension to the analysis hitherto, we assess the sensitivity of the coefficient matrices $A_k(\tau,\nu)$ $\forall$ $k \in \{0,1\}$ and $\Psi_0(\tau,\nu)$ within a more general calibration of the structural parameters of the model. We distinguish two scenarios where we set the share of nontradable goods (τ) equal to 0.3 and 0.5, respectively. In each scenario, the import share ν is fixed at 0.5; hence the degree of openness (ϑ) in the steady state equals 0.35 and 0.25 respectively.

Given that our focus is on the role of openness in the international transmission of fiscal spending shocks, we do not calibrate our model to a particular economy. Instead,

Table 1. Calibration

Ident.	Value	Description	Range
α	1.0	Labour share in production	$[0.5 - 1.0]$
κ	0.1	Substitution between tradable and nontradable goods	$(0.0 - 2.0]$
θ, θ^*	0.9	Substitution between domestic and foreign goods in the home (θ) and foreign (θ^*) economy	$(0.0 - 2.0]$
λ	0.5	Share of total hours worked in the nontradable sector	$[0.2 - 0.8]$
β	0.985	Discount factor	$[0.950 - 0.995]$
ϕ	3.0	Inverse of the Frish labour supply elasticity	$(0.0 - 5.0]$
ψ_{B^*}	0.02	Adjustment costs for net foreign assets	$[0.001 - 0.1]$
c_y	0.70	Private household consumption share in output	$[0.50 - 0.90]$

we consider a continuum of values for the degree of openness. Table 1 lists the details of the calibration exercise. The specific values chosen are standard in the literature (Benigno and Thoenissen, 2008; Dotsey and Duarte, 2008; Glocker and Towbin, 2012; Schmitt-Grohé and Uribe, 2016).

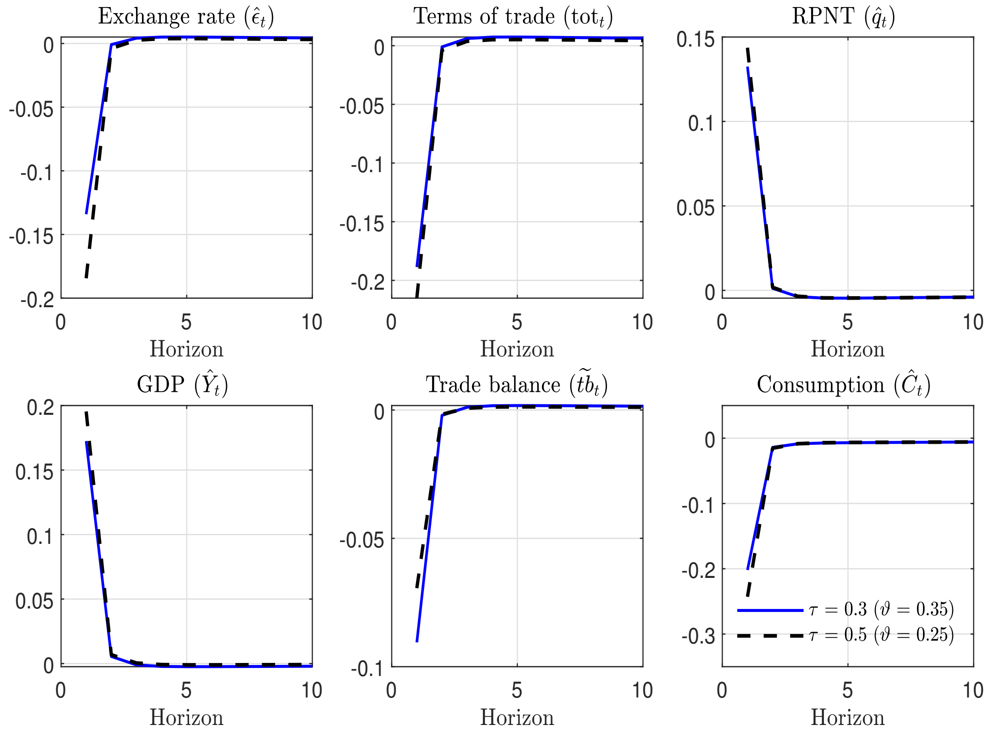
Figure 4 displays the responses of output and several other variables to an expansionary fiscal spending shock. Output increases, private consumption declines, the relative price of nontradable goods increases, the terms of trade and the real exchange rate appreciate[10] and the trade balance deteriorates. The responses vary with the size of the share of nontradable goods (τ). Our results show that the impact response is representative for the direction of the change in the adjustment mechanism induced by different sizes of the share of nontradables.[11]

As implied by equation (22), the degree of openness is determined by two structural parameters: the share of nontradable goods (τ) and the import share (ν). We now turn to consider the role of both parameters in shaping the effects of fiscal spending shocks. We simulate the model over a wide range of different values for the structural parameters. To this purpose we attach a uniform distribution to each parameter and define upper and lower bounds as indicated in the fourth column (*Range*) in Table 1. We simulate the model 2000 times and show the difference of the impact responses for

[10]The Mundell-Fleming model also predicts an appreciation of the (real) exchange rate, as long as the increase in fiscal spending is debt financed. If it is financed through lump-sum taxes, the (real) exchange rate could also depreciate (see Frenkel and Razin, 1985). This follows from assuming an exogenous money supply. With lump-sum taxes increasing, disposable income and hence demand for domestic money falls and the (real) exchange rate depreciates. Similarly, in Obstfeld and Rogoff (1995) the nominal exchange rate depreciates in response to an increase in domestic fiscal spending because of a fall in money demand (assuming that purchasing power parity holds).

[11]Alternatively, computing cumulative responses gives similar results.

FIGURE 4. Impulse response functions to an expansionary fiscal spending shock



Note: The figure shows the impulse response functions to a one percent rise in government spending. A decline in the real exchange rate (ϵ_t) and the terms of trade (tot_t) refers to an appreciation in each case. *RPNT* refers to the *relative price of nontradable goods* ($q_t = P_{N,t}/P_{T,t}$).

the following two scenarios (i) $\tau = 0.3$ and $\tau = 0.5$ with ν fixed at 0.5 and (ii) $\nu = 0.5$ and $\nu = 0.3$ with τ fixed at 0.3. The first scenario is depicted in the upper subplot in Figure 5, and the second in the lower one.[12] The boxplots show the difference in the impact response. Considering the output response ($\hat{Y}_t$) in the upper subplot as an example, we notice that it is negative throughout due to the fact that the impact response of output with a low share of nontradable goods ($\tau = 0.3$) is systematically smaller than that with a high share ($\tau = 0.5$) The negative range of values in this particular plot replicates the difference in the impact responses shown in Figure 4 and described in the analytic discussion in Section 3.7 for a more flexible set of calibrations.

The upper subplot in Figure 5 highlights that the impact response of output varies considerably with τ. This is crucially driven by the effects of τ on the trade balance, consumption and labour supply. We discuss them in what follows. In response to an increase in fiscal spending, the trade balance deteriorates. The size of the drop depends

[12]We draw values for the structural parameters shown in Table 1. For a particular draw, we solve the model for $\tau = 0.3$ and compute impulse response functions. For the same draw we also solve the model using $\tau = 0.5$ – in both cases holding ν fixed at 0.5. The difference in the impact values of the impulse response functions is depicted in Figure 5. By this procedure we can uniquely attach the difference in the impact response to changes in τ, while at the same time allowing for flexibility in the model calibration. We carry out the same exercise for the import share (ν), keeping τ fixed.

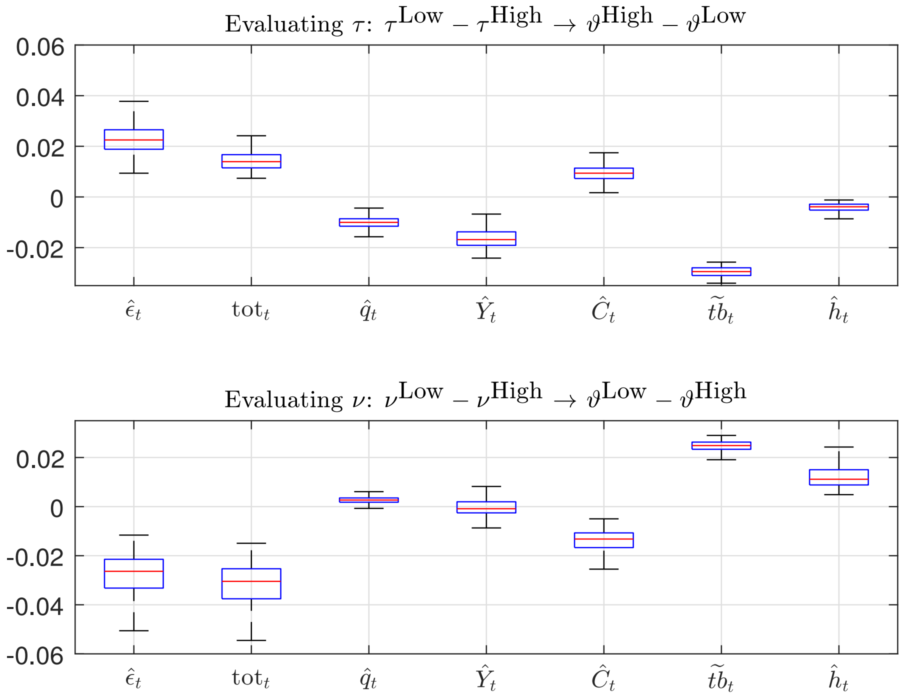
on the degree of openness (ϑ) and hence on τ. A higher value of τ implies a lower degree of openness, which mitigates the drop in the trade balance. This is indicated by the negative box of the trade balance in the upper subplot in Figure 5 and shown formally by $\partial\gamma_{tb}(\tau,\nu)/\partial\tau < 0$ in equation (25). While the drop in the trade balance decreases with τ, the rise in output in response to the expansionary fiscal spending shock increases with τ. The reaction of consumption is determined by the wealth effects arising from (i) the expected higher future taxation, (ii) the terms of trade appreciation and (iii) the increase in the relative price of nontradables. As shown formally in Appendix C, the effects of the latter two depend on τ: the terms of trade appreciation attenuates the decline in consumption as imports become relatively cheaper and this effect decreases with τ. The rise in the relative price of nontradables reinforces the decline in consumption and this effect increases with τ. Hence, the sensitivity of consumption with respect to τ is unambiguous: a higher share of nontradables attenuates the positive wealth effect from the terms of trade appreciation and reinforces the negative wealth effect of higher nontradable goods prices. This implies that the drop in consumption increases with τ, as captured in the upper subplot of Figure 5. This, in turn, implies that the rise in output in response to the expansionary fiscal spending shock is likely to decrease with τ, a result that stands in contrast to the effects arising for the trade balance. This apparent puzzle can be solved easily. First of all, the effect of τ on the trade balance outweighs the one on consumption, as indicated in the upper subplot of Figure 5. In addition, since consumption and leisure are normal goods, the intratemporal first order condition given by equation (14) gives rise to an increase in labour supply when consumption declines. Since the drop in consumption increases with τ, we equivalently have that the increase in labour supply rises with τ. This finally motivates an unambiguous effect on output and confirms the sign of $\partial\gamma_{Y}(\tau,\nu)/\partial\tau > 0$ in equation (25).

The implications are different when we consider the role of the import share (ν) in shaping the response of output, as indicated in the lower subplot of Figure 5. As indicated by equation (39) in the Appendix, the wealth effect due to the terms of trade appreciation increases with ν. Moreover, the wealth effect arising from the increase of the relative price of nontradables does not depend on ν. Hence, a higher ν implies a weaker drop in consumption,[13] which is depicted in the effects of consumption in the lower subplot in Figure 5.[14] The deterioration of the trade balance increases with the

[13]Corsetti and Müller (2008) and Monacelli and Perotti (2010) show that this result also applies within a New Keynesian framework, i.e. when allowing for nominal rigidities.

[14]Note that the intertemporal first order conditions for households imply that a drop in consumption is accompanied with an exchange rate appreciation. To the extent that the drop in consumption in response to an increase in fiscal spending declines with ν, the appreciation of the real exchange rate

Figure 5. Differences of impact responses to an expansionary fiscal spending shock



Note: The figure shows the difference of the impact responses to a fiscal spending increase for different degrees of openness (ϑ). In the upper subplot the degree of openness changes with the share of nontradable goods (τ). In the lower subplot, changes in the degree of openness stem from changes in the import share (ν). The boxes refer to the variation of the difference in the impact response for different calibrations of the remaining structural parameters.

degree of openness and consequently with ν. Hence, output increases by less, when ν is large. These two opposing effects on output explain the inverted U-shaped pattern between ν and $\gamma_Y(\tau, \nu)$ depicted in Figure 3 and the ambiguous sign of $\partial\gamma_Y(\tau, \nu)/\partial\nu$ in equation (26). The results of Section 3.7 are thus also present within a more flexible calibration environment.

Summing up, our model predicts that (i) if a higher degree of openness is due to a lower share of nontradable goods, then fiscal spending multipliers decrease with the degree of openness and (ii) if a higher degree of openness is due to a higher import share, then the effect of the degree of openness on the size of fiscal spending multipliers is ambiguous.

and the terms of trade is weaker the higher ν is, a result which is in line with the conclusions of Corsetti and Müller (2007).

4. The econometric model

We validate our theoretical model empirically by examining the conditional response to fiscal spending shocks in a panel of EU economies using an interacted panel vector-autoregressive (IPVAR) specification. The IPVAR model is employed to estimate how the matrices $A_0(\tau,\nu)$, $A_1(\tau,\nu)$, and $\Psi_0(\tau,\nu)$ of the system given by equation (23) depend on the two structural parameters of interest. We consider a first-order approximation of these matrix functions around the sample average of τ and ν, $\bar{\tau}$ and $\bar{\nu}$,

$$(27) \qquad A_k(\tau,\nu) \approx A_k(\bar{\tau},\bar{\nu}) + \frac{\partial A_k}{\partial \tau}(\bar{\tau},\bar{\nu})(\tau-\bar{\tau}) + \frac{\partial A_k}{\partial \nu}(\bar{\tau},\bar{\nu})(\nu-\bar{\nu}) \quad \text{for } k \in \{0,1\}$$

and similarly for Ψ_0.

In contrast to the standard panel VAR (PVAR) model, in the IPVAR specification the regressand is not only regressed on covariates at various lags but also on the interaction between these and the share of nontradable goods, as well as the import share. The response coefficients are thus allowed to change deterministically with the characteristics of the economy, in particular, the impulse responses functions can be evaluated for varying constellations of τ and ν in order to validate empirically the theoretical results presented in Section 3.8.

There are two potential limitations to the empirical approach adopted here. First of all, both the share of nontradable goods and the import share may be endogenous to the shocks hitting the economy. De Gregorio et al. (1994a), De Gregorio et al. (1994b) and Micossi and Milesi-Ferretti (1994), however, provide empirical evidence showing that demand shocks (to which fiscal spending contributes a small part) trigger negligibly small changes in the share of nontradables in the short run. This evidence supports the assumption of the share of nontradables being exogenous to changes in government spending. We therefore ignore the possible endogeneity of the share of nontradables in our main specification, but provide an evaluation of its potential importance in the robustness analysis presented in Section D of the Appendix. A second potential limitation is the linearity assumption embedded in our IPVAR model, which mimics the approximation in equation (27). The literature has stressed the role of non-linearities between government spending and output volatility (Crespo Cuaresma et al., 2011a), as well as economic growth (Barro, 1990). As highlighted in Section 3.7 (see the analytical derivation in Appendix B), the import share enters quadratically in the reduced form coefficients of the matrices $A_0(\tau,\nu)$, $A_1(\tau,\nu)$ and $\Psi_0(\tau,\nu)$. In principle, the assumption of linearity could be relaxed by considering various non-linear combinations of ν and τ. However, depending on the number of observations and parameters of interest in the estimation, overfitting of the model becomes a problem in our setting, so we stick to linear specifications with interactions in this piece instead of assessing more complex nonlinear parametrizations of the model. Such an analysis could be an interesting avenue of further research, eventually making use of shrinkage estimators in the framework of Bayesian VAR models.

4.1. **Estimation and identification.** We consider an IPVAR model with a block-exogenous structure given by

$$\begin{bmatrix} I_G & 0 \\ \Psi_{0,t} & A_{0,t} \end{bmatrix} \begin{bmatrix} y_t^G \\ y_t^C \end{bmatrix} = \sum_{k=1}^{K} \begin{bmatrix} P_k & 0 \\ \Psi_{k,t} & A_{k,t} \end{bmatrix} \begin{bmatrix} y_{t-k}^G \\ y_{t-k}^C \end{bmatrix} + \begin{bmatrix} \Xi_G \\ \Xi_C \end{bmatrix} \zeta_t + \begin{bmatrix} e_t^G \\ e_t^C \end{bmatrix}, \tag{28}$$

where y_t^G is a vector of global macroeconomic variables, y_t^C is a vector of domestic (country-specific) variables and ζ_t is a vector of exogenous variables, with Ξ_C capturing the country fixed effects. K is the number of lags in the model and I_G is a suitable identity matrix. e_t^C is assumed to be a Gaussian random vector of reduced form disturbances for the domestic economy with mean zero and covariance matrix Σ_C, and the vector e_t^G is its global (foreign) counterpart, with covariance matrix Σ_G. Due to the block exogenous structure of the model, e_t^C and e_t^G are mutually uncorrelated by construction and the joint error vector $e_t = [\ (e_t^G)' \quad (e_t^C)'\ ]'$ has a block-diagonal covariance matrix Σ with blocks given by Σ_G and Σ_C.

We analyse the role of the share of nontradable goods and the import share as mediators of the effect of (fiscal) shocks by allowing the coefficients of the A and Ψ matrices to vary as follows

$$\begin{bmatrix} A_{k,t} \\ \Psi_{k,t} \end{bmatrix} = \begin{bmatrix} \bar{A}_k \\ \bar{\Psi}_k \end{bmatrix} + \begin{bmatrix} \delta_{A,k}^{\tau} & \delta_{A,k}^{\nu} \\ \delta_{\Psi,k}^{\tau} & \delta_{\Psi,k}^{\nu} \end{bmatrix} \begin{bmatrix} \tau_t \\ \nu_t \end{bmatrix} \tag{29}$$

where $k = 0, 1, ...K$ refers to the lag order. The representation corresponding to equation (27) is given by $A_k(\tau,\nu) = A_{k,t}$, $A_k(\bar{\tau},\bar{\nu}) = \bar{A}_k - \partial A_k(\tau,\nu)/\partial\tau \cdot \bar{\tau} - \partial A_k(\tau,\nu)/\partial\nu \cdot \bar{\nu}$, $\delta_{A,k}^{\tau} = \partial A_k(\tau,\nu)/\partial\tau$, and $\delta_{A,k}^{\nu} = \partial A_k(\tau,\nu)/\partial\nu$. A parallel parametrization is assumed for $\Psi_0(\tau,\nu)$.

The IPVAR model is characterised by equations (28) and (29). The representation of the IPVAR model corresponding to the solution of the DSGE model depicted in equation (23), ignoring the truly exogenous variables ζ_t, is given by $z_t = [\ y_t^G \quad y_{t-1}^G \quad e_t^G\ ]'$, $A_k(\tau,\nu) = A_{k,t}$ for $k \in \{0,1\}$, $\Psi_0(\tau,\nu) = [\ -\Psi_{0,t} \quad \Psi_{1,t} \quad I_G\ ]$ and the matrix P contains P_1 and the identity matrix in the first column-block. In our empirical model, the interaction term $[\ \tau_t \quad \nu_t\ ]'$ in equation (29) captures time variation in the share of nontradables and the import share. The interaction term influences the dynamic relationship between the endogenous variables via the $\delta^{(\tau,\nu)}_{(A,\Psi),k}$ coefficients. It can also affect the level of the variables via $\bar{A}_k$ and $\bar{\Psi}_k$. In order to preserve degrees of freedom, we assume that the effect of the interaction term $[\ \tau_t \quad \nu_t\ ]'$ on the intercept and slope coefficients ($\delta^{(\tau,\nu)}_{(A,\Psi),k}$ and $\bar{A}_k$ and $\bar{\Psi}_k$) is homogeneous across countries. Moreover, in order to avoid problems of endogeneity and identification, we set the matrices $\delta^{\tau}_{\Psi,k}$ and $\delta^{\nu}_{\Psi,k}$ equal to zero (Abbritti and Weber, 2018).

We estimate the IPVAR model using quarterly data from 1999Q1 to 2018Q4 for all EU countries (EU28). The vector of country variables y_t^C includes the log of GDP (Y_t) and of government consumption spending (G_t), both in real terms, the trade balance (tb_t), captured by the ratio of exports to imports, and the relative price of nontradable goods (q_t, $RPNT$). The vector of global variables y_t^G includes a measure for global real GDP. We specifically focus on the effects of fiscal spending shocks on GDP, the trade balance and the relative price of nontradables.

All estimations are performed using a constant term and a lag length of one, as suggested by the BIC. The model is estimated with Bayesian techniques. We use a natural-conjugate prior and draw all parameters jointly from the posterior. The prior densities are calibrated such that they are uninformative. We refer to Towbin and Weber (2013); Sa et al. (2014); Abbritti and Weber (2018) for further details on the estimation of the Bayesian IPVAR model. We report the average responses across all of the countries in our sample. We abstract from variation in $[\ \tau_t \quad \nu_t\ ]'$ over time, and instead concentrate on variability across countries in the regression coefficients. The average coefficient estimates are thus given by $A_{k,t} = \sum_{c=1}^{N} A^c_{k,t}/N$ for $k = 0, ..., K$ and $\Psi_{k,t} = \sum_{c=1}^{N} \Psi^c_{k,t}/N$ for $k = 0, 1$ and $N = 28$. We compute impulse response functions using these average estimates and interpret them as responses in a typical EU country. This procedure yields the same regression coefficients as averaging country-by-country estimates, as proposed by Pesaran and Smith (1995).

We identify fiscal spending shocks by imposing a recursive identification based on the Cholesky decomposition of the variance-covariance matrix Σ_C of the reduced-form

IPVAR shocks. We follow Beetsma et al. (2006), Crespo Cuaresma et al. (2011b) or Capek and Crespo Cuaresma (2020) and assume that fiscal spending does not react contemporaneously to shocks arising from GDP or the trade balance in the system. GDP and the trade balance are assumed to respond within the same quarter to the fiscal spending shock. The relative price of nontradables is ordered last, which implies that shocks in government spending do not affect relative prices contemporaneously. This assumption is motivated by the idea of inertia in the adjustment of prices. This recursive structure is the most conventional strategy used to identify fiscal spending shocks in the established structural VAR literature.[15] We assess the sensitivity of the results with respect to this particular identification approach in Appendix D.

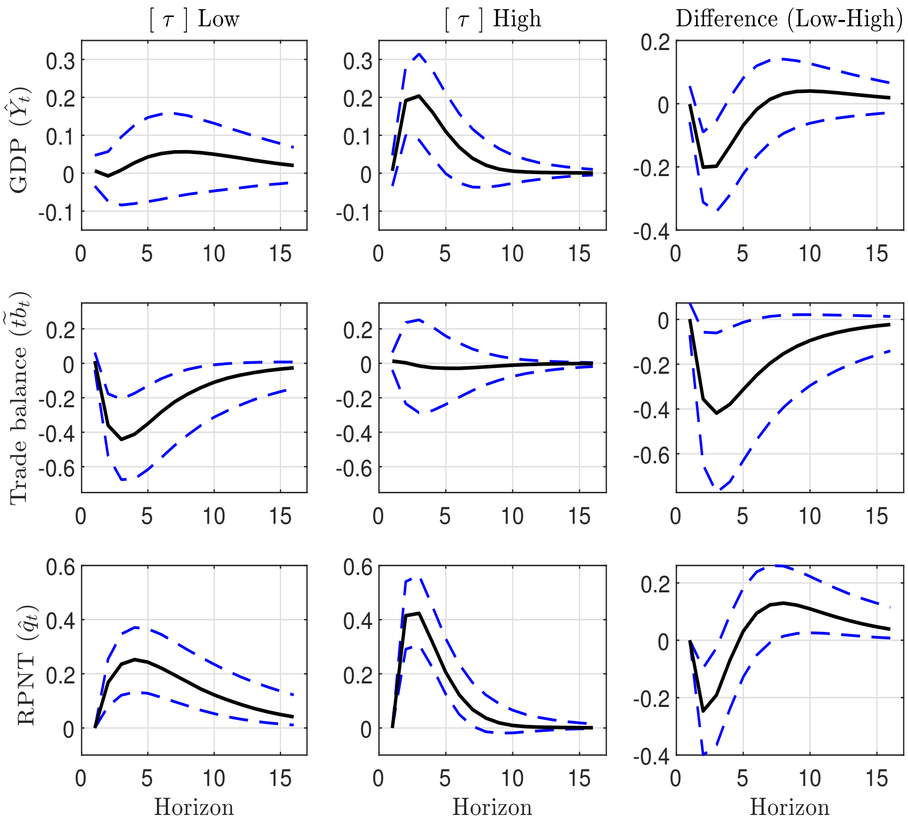
4.2. **Data.** The data used to construct the quarterly measures for tradable and non-tradable goods production, as well as for sectoral price deflators, are from the EURO-STAT database (further details are provided by Friesenbichler and Glocker, 2019). The variable used to identify the fiscal spending shocks at the country level is *Total final consumption expenditure of the general government* at constant prices (ESA 2010-code: P.3), where prices of total final consumption of the general government are used as deflator ESA 2010-code: P.3. Our key variable of interest is output measured by means of *Gross domestic product at constant market prices* (ESA 2010-code: B.1*g), where the GDP deflator is used as price measure. The trade balance is defined as the ratio between exports (*Exports of goods and services at constant prices* (ESA 2010-code: P.6)) to imports (*Imports of goods and services at constant prices* (ESA 2010-code: P.7)). Additionally, we take into account a measure for the terms of trade, which is defined as the ratio of export to import prices and is constructed using the import and export price deflators for goods and services (*Price deflator exports of goods and services*, and *Price deflator imports of goods and services at constant prices*). The definition of the terms of trade implies that an increase is a depreciation of the terms of trade.

The measure of world GDP (at constant prices and seasonally adjusted) for our global demand measure is sourced from the World Bank (Global Economic Monitor). Additional global variables used in our model are (i) global industrial production and (ii) the VIX index, aimed at capturing global uncertainty.[16]

[15]See for instance the discussion in Capek and Crespo Cuaresma (2020).

[16]Both series are retrieved from Macrobond. The series for global industrial production is from the CPB World Trade Monitor (Industrial Production excluding Construction, Monthly World, Import Weights, Calendar Adjusted, Seasonal Adjusted, Index).

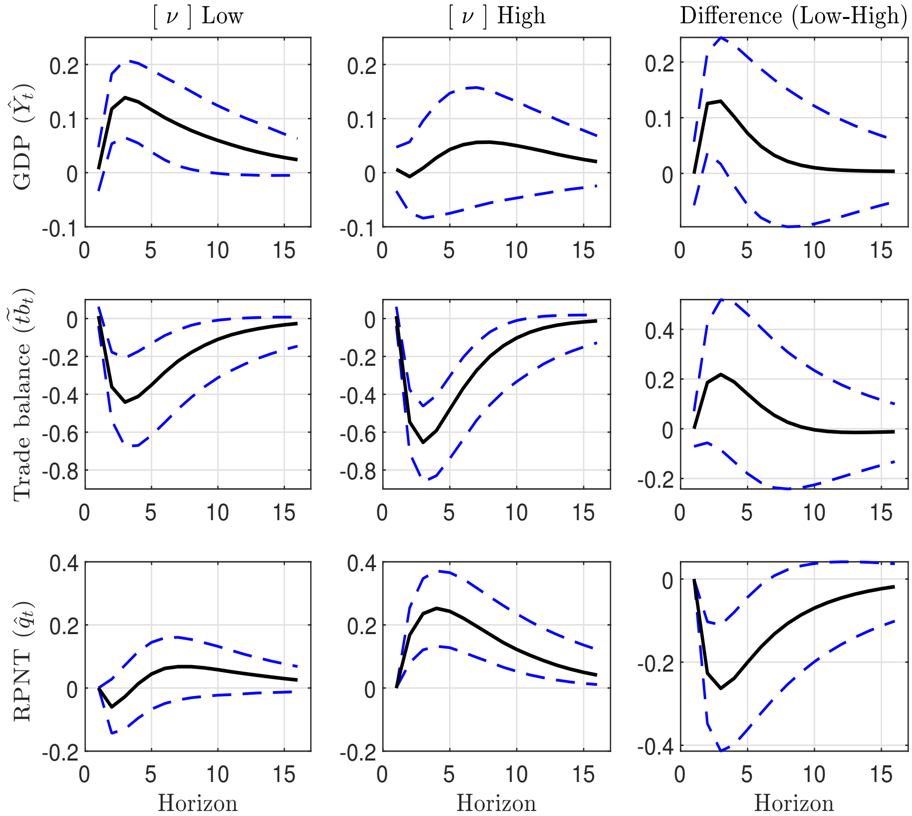
FIGURE 6. Effects of a fiscal spending shock by share of nontradables



Note: The subplots in the first column depict IRFs and corresponding 95 percent posterior credible intervals, when the share of nontradable goods has a low level (20th percentile). The subplots in the second column depict IRFs and 95 percent posterior credible intervals, when the share of nontradable goods has a high level (80th percentile). The third column shows the difference of the two IRFs and the 95 percent credible interval.

4.3. **Results.** To address whether interactions with the share of nontradables and the import share affect the dynamics of the endogenous variables in the IPVAR model, we assess the posterior distribution of the impulse response functions (IRFs) and compute forecast error variance decompositions (FEVD). The impulse response functions are computed after fixing one of the interacting variables at its median value and varying the other one between the 20th and 80th percentile of the sample distribution. Specifically, the coefficient matrices for a typical country with a high share of nontradables are $A_{k,t}|_{\tau^{\text{High}}} = \sum_{c=1}^{N} A^c_{k,t}/N + \delta^{\tau}_{A,k} \cdot \tau^{\text{High}} + \delta^{\nu}_{A,k} \cdot \bar{\nu}$ for $k = 0, ..., K$ where $\bar{\nu}$ refers to the median of the import share observed across all EU28 countries. Analogously, the coefficient matrices for a typical country with a low share of nontradables is $A_{k,t}|_{\tau^{\text{Low}}} = \sum_{c=1}^{N} A^c_{k,t}/N + \delta^{\tau}_{A,k} \cdot \tau^{\text{Low}} + \delta^{\nu}_{A,k} \cdot \bar{\nu}$ for $k = 0, ..., K$. We proceed in the same fashion when evaluating the role of the import share in shaping the impulse response functions with the share of nontradables in this case held fixed at its median value.

FIGURE 7. Effects of a fiscal spending shock by import share



Note: The subplots in the first column depict IRFs and corresponding 95 percent posterior credible intervals, when the import share has a low level (20th percentile). The subplots in the second column depict IRFs and corresponding 95 percent posterior credible intervals, when the import share has a high level (80th percentile). The third column shows the difference of the two IRFs and the corresponding 95 percent confidence bands.

4.3.1. *Impulse response analysis.* Figures 6 and 7 present the impulse responses of GDP, the trade balance, and the relative price of nontradables to the fiscal spending shock for varying degrees of the share of nontradable goods and the import share. Each figure contains three columns: the first depicts IRFs and 95 percent credible intervals from the posterior when the relevant interaction term has a low level; the second column shows the IRFs when the interaction term has a high level; and the third column shows the difference of the two previous IRFs.[17] This allows us to assess whether the specific interaction term has a significant impact on the dynamic adjustment to the shock.

The figures show the effects after a one percent increase in government spending. In line with the implications of the theoretical model in Section 3, the expansionary shock

[17]The IRFs for low and high values of the interaction variable are correlated. We follow Abbritti and Weber (2018) and compute a test statistic using the impulse responses from draws of the posterior parameters. For each of the 2,000 draws we compute the differences between the response of each variable to a fiscal spending shock under different values for the interaction term of interest, respectively. This yields a distribution of the difference between the responses, which can then be used to compute credible intervals. The IRFs for low and high values of a specific interaction variable can be considered statistically different to each other, if the credible interval of their difference (shown in the third column) lies above or below zero.

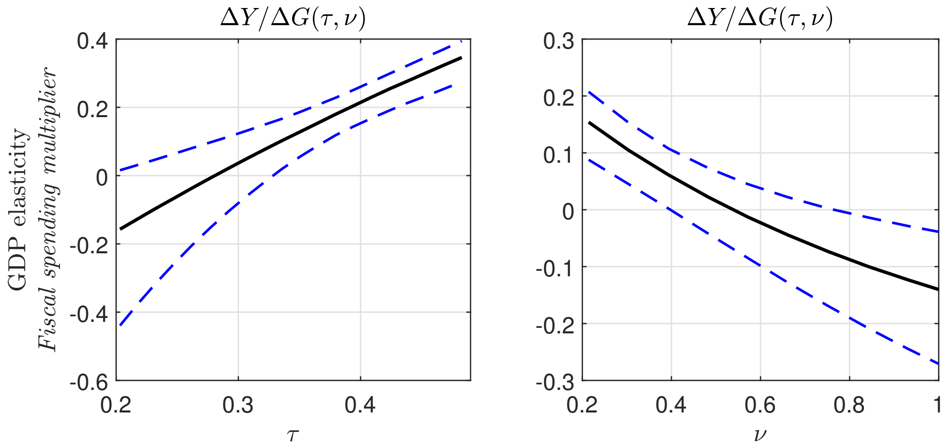
causes a rise in GDP, an increase in the relative price of nontradables and a deterioration of the trade balance. The latter squares well with conventional wisdom and earlier empirical studies, supporting the notion of twin deficits, defined as a conditional positive correlation between budget and trade balance deficits (see for instance Monacelli and Perotti, 2010; Corsetti et al., 2012; Cacciatore and Traum, 2018). The increase in the relative price of nontradables gives rise to an appreciation. When using the terms of trade or the real effective exchange rate[18] instead, we also find evidence in favour of an appreciation. This is in line with the results documented in studies focusing on European countries such as Beetsma et al. (2008), Corsetti et al. (2012) or Bénétrix and Lane (2013), all of which document a real appreciation in response to positive spending shocks for several countries of the European Union.

The size and persistence of the responses, however, differ markedly across different constellations of the share of nontradables and the import share. Considering Figure 6, which shows the role of the share of nontradables, we observe that a low value implies a modest positive reaction in GDP in response to the fiscal expansion. In contrast, the reaction in GDP is large and significant once the share of nontradables is high. Hence, as indicated by the third column in Figure 6 the difference between these two IRFs is negative and significantly different from zero. As for the trade balances responses, deteriorating in both cases, the reaction is larger once the share of nontradables is low. Finally, the relative price of nontradables rises, with a larger reaction the higher the share of nontradables is. These findings are in line with the predictions of the DSGE model outlined in Sections 3.7 and 3.8. Although the theoretical implications merely give rise to a small, though unambiguous effect of the share of nontradables on the IRFs, the IPVAR model indicates sizeable differences.

Figure 7 shows the role of the import share in shaping the effects of fiscal spending shocks. As can be seen in the subplots of the first row, the reaction in GDP is strongly dependent on the import share. The larger the share of imported goods, the smaller the rise in GDP. This is in line with the theoretical implications stated previously and implies that the government spending impulse that leaks abroad through higher imports dominates the positive wealth effect arising from the appreciation of the terms of trade. The difference of the IRFs for low and high values of the import share is sizeable and amounts to nearly 0.15 percentage points. Considering the effects on trade, we observe a deterioration in the trade balance for both low and high values of the import share. The

[18]Data for the real effective exchange rate are taken from the database of the Bank for International Settlements (BIS).

Figure 8. Influence of τ and ν on the output multiplier



Note: The subplots show the sensitivity of the output (GDP) ($\Delta Y/\Delta G(\tau,\nu)$) multiplier for different values of the share of nontradable goods (τ) and the import share (ν) as identified by the IPVAR model. The subplots show the median jointly with a 95 percent credible interval.

IRFs are significantly different from zero and display a high degree of inertia. While the point estimates indicate a statistically significant reaction in the trade balance for both high and low values of the import share, the third column in Figure 7 highlights that the difference may not be different from zero. Finally, we find that the reaction of the relative price of nontradables rises with the size of the import share. In particular, when the import share is high, the increase in the relative price of nontradables is significantly different from zero for a comparably long time span. In contrast to that, at low levels of the import share, the relative price does not show any significant reaction. The difference in the IRFs for low and high values of the import share is correspondingly negative. This again conforms with the theoretical predictions and emphasizes the important role of the import share in shaping the responses to fiscal spending shocks.

The impulse response functions of the IPVAR model are functions of τ and ν. We can thus display the fiscal spending multiplier for output over the whole distribution of the share of nontradables and the import share. We do so by considering the following definition of the fiscal spending multiplier

$$\frac{\Delta Y}{\Delta G}(\tau,\nu) = \frac{\sum_{i=1}^{\mathcal{P}} \text{IRF}_i^Y(\tau,\nu)}{\sum_{j=1}^{\mathcal{P}} \text{IRF}_j^G(\tau,\nu)}, \tag{30}$$

where $\text{IRF}_t^Y(\tau,\nu)$ and $\text{IRF}_t^G(\tau,\nu)$ denote the impulse response functions of output (Y) and government spending (G) to a fiscal spending shock over the horizon $\mathcal{P}$. We concentrate on short run multipliers only and use $\mathcal{P} = 1$. The results are shown in Figure 8 and can be compared with the fiscal spending multiplier for output of the DSGE model as depicted in Figure 3 and formally given by $d\hat{Y}_t/d\hat{G}_t = \gamma_Y(\tau,\nu)$ as implied by equation (24). Figure 8 shows that the output multiplier increases with the

Table 2. Forecast error variance decomposition

Horizon	*GDP* Low	*GDP* High	*Trade balance* Low	*Trade balance* High	*RPNT* Low	*RPNT* High
Share of nontradable goods (τ)						
2	0.3	7.7	4.0	1.0	4.8	20.5
4	1.1	16.6	11.7	2.4	17.8	42.3
8	3.4	17.2	17.9	3.5	29.9	44.6
Share of imported goods (ν)						
2	4.8	0.3	3.7	9.9	0.6	4.9
4	12.4	1.0	11.4	22.8	1.3	18.1
8	18.1	3.2	16.6	27.9	3.6	29.8

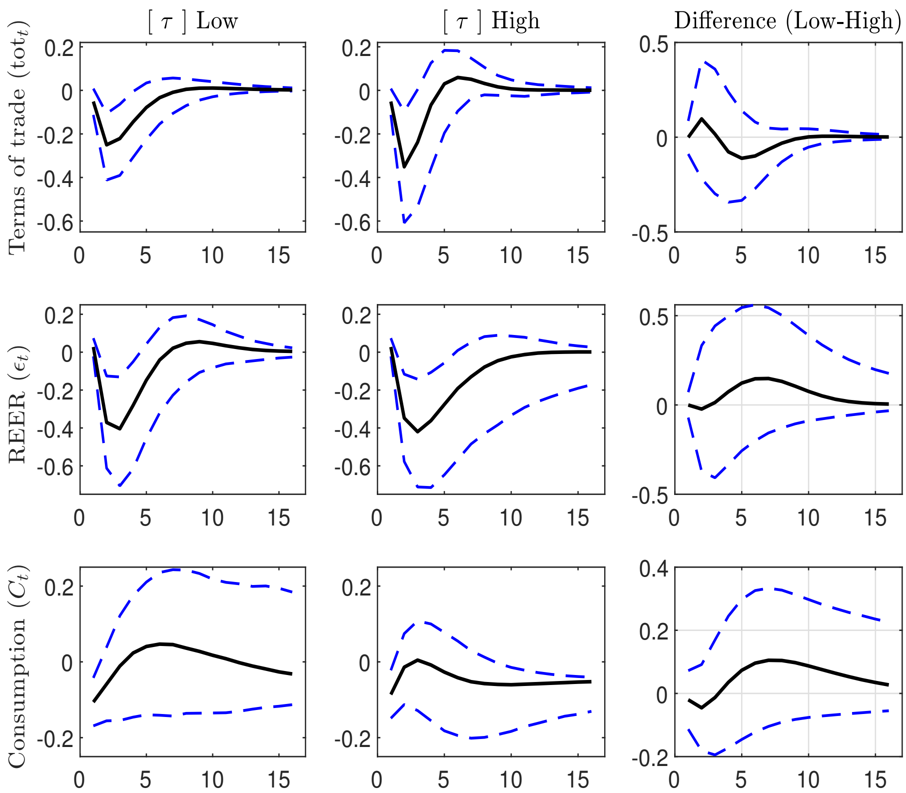
The values refer to the median of the corresponding posterior distribution of the IPVAR model. *RPNT* refers to the relative price of nontradable goods and *Horizon* indicates *quarters*. The columns *Low* and *High* refer to the 20th or 80th percentile of the cross-country distribution in the share of nontradables (τ) and the import share (ν) used for the computation of the forecast error variance decomposition.

share of nontradables. The multiplier is significantly different from zero when the share of nontradables is at above 0.34. Below this value, fiscal spending shocks do not trigger significant effects on output. For high values of the share of nontradables, the IPVAR model gives rise to a fiscal spending multiplier of around 0.4.

The second subplot in Figure 8 shows the fiscal spending multiplier as a function of the import share. The multiplier is positive and significant for values of the import share below 0.4. Moreover, the multiplier is negative and significant for values of the import share above 0.8. For values of the import share between 0.4 and 0.8, the fiscal spending shocks do not trigger statistically significant effects on output.

4.3.2. *Forecast error variance decomposition.* Table 2 reports the results for the forecast error variance decomposition along two dimensions: (i) for different horizons (two, four and eight quarters) and (ii) for different values of the share of nontradables and the import share. As can be seen, the share of variation in GDP explained by fiscal spending shocks depends both on the horizon and the specific value of the interaction variables. Fiscal spending shocks explain a low fraction of the variance of GDP when the horizon considered is short and the share of nontradables production is low. In contrast, they explain up to 17 percent at horizons of eight quarters when the share of nontradables is high. A different picture emerges when the import share is considered. The importance of fiscal spending shocks in explaining fluctuations in GDP still increases with the horizon but decreases with the import share.

FIGURE 9. Effects of a fiscal spending shock by share of nontradables – additional variables



Note: The subplots in the first column depict IRFs and corresponding 95 percent credible interval when the share of nontradables has a low level (20th percentile). The subplots in the second column depict IRFs and corresponding 95 percent credible interval when the share has a high level (80th percentile). The third column shows the difference of the two IRFs and the corresponding 95 percent credible interval.

A different pattern arises for the trade balance. While the share of explained variance decreases with the share of nontradable goods, it increases with the import share. Finally, fiscal spending shocks explain a comparably large fraction of the fluctuations in the relative price of nontradables. For high values of τ, fiscal spending shocks explain up to 45 percent of the fluctuations at the two year horizon, highlighting the role of demand shocks in shaping domestic price dynamics. The high degree of inertia in changing the relative size of the two sectors explains this result. For a significant change in the share of nontradable to tradable goods production to occur, a shift is required in the input factors to production, which takes time. As an immediate consequence, the short run effect of the fiscal stimulus is characterised by a significant rise in relative prices of nontradable goods.

4.4. **Omitted variables.** Separate Ljung-Box tests on each residual time series cannot reject the null hypothesis that they follow processes which are uncorrelated over time. However, it is still possible that omitted variables matter for the results. To check whether the identified fiscal spending shock is correlated with other (omitted) variables, we first assess the changes in results when additional variables are added to the block-exogenous IPVAR model, and secondly, we follow Glocker and Towbin (2015) and compute correlations of the estimated structural disturbance with variables that a large class of general equilibrium models suggests as being jointly generated by various shocks.

Concerning the first point, we extend the IPVAR model by variables which have been found important within the transmission channel of fiscal spending shocks. These are, among others, real private household consumption spending,[19] the terms of trade and the real effective exchange rate. We add each variable individually to the IPVAR model outlined in Section 4.1. The responses of these additional variables in the expanded model after an expansionary fiscal spending shock are displayed in Figure 9. The subplots show the IRFs for different sizes of the share of nontradables (first and second column) and the difference between them (third column). We find that the expansionary fiscal spending shock triggers a sizeable appreciation of the real effective exchange rate (ϵ_t) and the terms of trade (tot_t). This result is in line with Beetsma et al. (2008) and Berka et al. (2018). Berka et al. (2018) argue that real effective exchange rates in countries of the Eurozone closely reflect differences in the relative prices of nontradables across countries.[20] The appreciation is accompanied by a drop in consumption, which is, however, small.[21] Considering the third column, the reaction of these three variables does not appear to depend on the particular size of the share of nontradables.

As regards the second aspect, in line with Glocker and Towbin (2015) we compute correlations up to six leads and lags between the shock and the growth rate of local stock market indexes, the stock market index of the Eurozone (EURO STOXX 50), the implied volatility index of the EURO STOXX 50 (VSTOXX), the oil price[22], monetary policy interest rates, short term government bond interest rates, inflation rates captured by means of the GDP deflator and employment. The cross-correlations indicate that none of the omitted variables correlates significantly with the structural shock.[23]

[19]Data are taken from the EUROSTAT database: *Actual individual final consumption of households at constant prices* (ESA 2010-code: P.41), where the consumption deflator is used as price measure.

[20]Additionally, Berka et al. (2018) provide evidence that the appreciation of the real exchange rates in the countries of the Eurozone also reflects differences in the relative productivity levels in the tradable versus nontradable sectors, which – together with the relative price of nontradables – conforms with the Balassa-Samuelson hypothesis.

[21]When using investment (Gross Fixed Capital Formation) instead of consumption, we observe a small increase, which is, however, only marginally significant. This confirms the results in Beetsma et al. (2006).

[22]We use the cyclical component of the oil price obtained after applying the Christiano-Fitzgerald filter on the logarithm of the oil price.

[23]The statistical importance of the cross-correlations has been judged by means of the upper and lower limits of an asymptotic 95 percent confidence tunnel for the null hypothesis of no cross-correlation.

Additional robustness checks are provided in Appendix D, where we assess the role of other factors that have been found important in shaping the output response to fiscal spending shocks (see Capek and Crespo Cuaresma, 2020, for further details).

5. Conclusion

In this contribution, we assess the role of the production structure in shaping fiscal spending multipliers. To this purpose, we decompose the production of goods and services into tradable and nontradable goods and services. Since the concept of tradability is inherently related to the openness of an economy, we also consider the import share as an additional mediator between fiscal shocks and output responses. Our two-sector small open economy model highlights that the degree of openness is determined uniquely by the import share and the share of nontradable goods. Considering the response to shocks in fiscal spending, the model has two key conclusions: First, if a higher degree of openness is due to a lower share of nontradable goods, then fiscal spending multipliers decrease with the degree of openness. Furthermore, if a higher degree of openness is due to a higher import share, then the effect of the degree of openness on the size of fiscal spending multipliers is given by an inverted U-shaped relationship.

We validate the model empirically by means of an interacted panel VAR model, which is estimated using data for EU countries. The results provide strong evidence for the fact that fiscal spending multipliers increase with the share of nontradable goods. For high values, the IPVAR model estimates an output multiplier of 0.4. In line with other studies, we find fiscal spending multipliers to decrease with the import share, which conforms with the theory of increased import leakage in response to a rise in fiscal spending.

Overall, our results indicate that the effect of fiscal spending on the economy crucially depends on the share of nontradable goods and services produced and hence on the production structure. From a policy perspective, this implies that the drag of fiscal consolidations is smaller in countries with a low share of nontradable goods, a result that may help to explain why European economies with a high share of nontradable goods experienced by far the largest drop in output in response to the fiscal consolidation in the wake of the European debt crisis.

References

Abbritti, Mirko, and Sebastian Weber (2018) 'Reassessing the role of labor market institutions for the business cycle.' *International Journal of Central Banking* 14(1), 1–34

Alcalá, Francisco, and Antonio Ciccone (2004) 'Trade and productivity.' *Quarterly Journal of Economics* 119(2), 613–646

Barro, Robert J. (1990) 'Government spending in a simple model of endogenous growth.' *Journal of Political Economy* 98(5), 103–126

Beetsma, Roel, and Massimo Giuliodori (2010) 'Discretionary fiscal policy: Review and estimates for the EU.' CESifo Working Paper Series 2948, CESifo Group Munich, February

Beetsma, Roel, Massimo Giuliodori, and Franc Klaassen (2006) 'Trade spill-overs of fiscal policy in the European Union: A panel analysis.' *Economic Policy* 21(48), 639–687

______ (2008) 'The effects of public spending shocks on trade balances in the European Union.' *Journal of the European Economic Association* 6(23), 414–423

Bénétrix, Augustín, and Philip Lane (2013) 'Fiscal shocks and the real exchange rate.' *International Journal of Central Banking* 9(3), 6–37

Benigno, Gianluca, and Christoph Thoenissen (2008) 'Consumption and real exchange rates with incomplete markets and non-traded goods.' *Journal of International Money and Finance* 27(6), 926–948

Berka, Martin, Michael B. Devereux, and Charles Engel (2018) 'Real exchange rates and sectoral productivity in the Eurozone.' *American Economic Review* 108(6), 1543–1581

Cacciatore, Matteo, and Nora Traum (2018) 'Trade flows and fiscal multipliers.' Working Paper

Capek, Jan, and Jesús Crespo Cuaresma (2020) 'We just estimated twenty million fiscal multipliers.' *Oxford Bulletin of Economics and Statistics, forthcoming*

Corsetti, Giancarlo, and Gernot Müller (2006) 'Twin deficits: squaring theory, evidence and common sense.' *Economic Policy* 21(48), 597–638

______ (2007) 'International dimensions of fiscal policy transmission.' 2007 Meeting Papers 726, Society for Economic Dynamics, January

______ (2008) 'Twin deficits, openness, and the business cycle.' *Journal of the European Economic Association* 6(2-3), 404–413

Corsetti, Giancarlo, André Meier, and Gernot Müller (2012) 'What determines government spending multipliers?' *Economic Policy* 27(72), 521–565

Crespo Cuaresma, Jesús, Gerhard Reitschuler, and Maria A. Silgoner (2011a) 'On the effectiveness and limits of fiscal stabilizers.' *Applied Economics* 43(9), 1079–1086

Crespo Cuaresma, Jesús, Markus Eller, and Aaron Mehrotra (2011b) 'The economic transmission of fiscal policy shocks from Western to Eastern Europe.' *Focus on European Economic Integration* 1(2), 44–68

De Gregorio, Jose, Alberto Giovannini, and Holger Wolf (1994a) 'International evidence on tradables and nontradables inflation.' *European Economic Review* 38(6), 1225–1244

De Gregorio, Jose, Alberto Giovannini, and Thomas Krueger (1994b) 'The behavior of nontradable-goods prices in Europe: Evidence and interpretation.' *Review of International Economics* 2(3), 284–305

Devereux, Michael, Karine Gente, and Changhua Yu (2019) 'Production network and international fiscal spillovers.' Working Papers halshs-02179890, HAL, June

Dotsey, Michael, and Margarida Duarte (2008) 'Nontraded goods, market segmentation, and exchange rates.' *Journal of Monetary Economics* 55(6), 1129–1142

Ederer, Stefan, and Peter Reschenhofer (2018) 'Macroeconomic imbalances and structural change in the EMU.' *Structural Change and Economic Dynamics* 46(C), 59–69

Estrada, Ángel, Jordi Galí, and David López-Salido (2013) 'Patterns of convergence and divergence in the Euro Area.' *IMF Economic Review* 61(4), 601–630

Frenkel, Jacob A., and Assaf Razin (1985) 'Government spending, debt, and international economic interdependence.' *Economic Journal* 95(379), 619–636

Friesenbichler, Klaus S., and Christian Glocker (2019) 'Tradability and productivity growth differentials across EU Member States.' *Structural Change and Economic Dynamics* 50, 1–13

Glocker, Christian, and Pascal Towbin (2012) 'Reserve requirements for price and financial stability: When are they effective?' *International Journal of Central Banking* 8(1), 65–114

______ (2015) 'Reserve requirements as a macroprudential instrument - Empirical evidence from Brazil.' *Journal of Macroeconomics* 44(C), 158–176

Glocker, Christian, Giulia Sestieri, and Pascal Towbin (2019) 'Time-varying government spending multipliers in the UK.' *Journal of Macroeconomics* 60(C), 180–197

Horvath, Roman, Lorant Kaszab, Ales Marsal, and Katrin Rabitsch (2020) 'Determinants of fiscal multipliers revisited.' *Journal of Macroeconomics (IN PRESS)*

Ilzetzki, Ethan, Enrique G. Mendoza, and Carlos A. Végh (2013) 'How big (small?) are fiscal multipliers?' *Journal of Monetary Economics* 60(2), 239–254

Lane, Philip R., and Roberto Perotti (1998) 'The trade balance and fiscal policy in the OECD.' *European Economic Review* 42(3-5), 887–895

Micossi, Stefano, and Gian Maria Milesi-Ferretti (1994) 'Real exchange rates and the prices of non-tradable goods.' IMF Working Papers 94/19, International Monetary Fund, February

Monacelli, Tommaso, and Roberto Perotti (2010) 'Fiscal policy, the real exchange rate and traded goods.' *Economic Journal* 120(544), 437–461

Obstfeld, Maurice, and Kenneth Rogoff (1995) 'Exchange rate dynamics redux.' *Journal of Political Economy* 103(3), 624–660

Pesaran, M. Hashem, and Ron Smith (1995) 'Estimating long-run relationships from dynamic heterogeneous panels.' *Journal of Econometrics* 68(1), 79–113

Ravn, Morten O., Stephanie Schmitt-Grohé, and Martín Uribe (2012) 'Consumption, government spending, and the real exchange rate.' *Journal of Monetary Economics* 59(3), 215–234

Sa, Filipa, Pascal Towbin, and Tomasz Wieladek (2014) 'Capital inflows, financial structure and housing booms.' *Journal of the European Economic Association* 12(2), 522–546

Sachs, Jeffrey, and Felipe Larrain (1993) *Macroeconomics in the Global Economy* (Prentice Hall)

Schmitt-Grohé, Stephanie, and Martín Uribe (2016) 'Downward nominal wage rigidity, currency pegs, and involuntary unemployment.' *Journal of Political Economy* 124(5), 1466–1514

Schmitt-Grohé, Stephanie, Martín Uribe, and Michael Woodford (2019) *International macroeconomics* Textbook Manuscript (Columbia University)

Towbin, Pascal, and Sebastian Weber (2013) 'Limits of floating exchange rates: The role of foreign currency debt and import structure.' *Journal of Development Economics* 101(C), 179–194

Uribe, Martín, and Stephanie Schmitt-Grohé (2017) *Open economy macroeconomics* Economics/Finance (Princeton University Press)

Wickens, Michael (2012) *Macroeconomic Theory: A Dynamic General Equilibrium Approach* Economics/Finance, 2 ed. (Princeton University Press)

Wierzbowska, Agata, and Masahiko Shibamoto (2018) 'Cross-country evidence on determinants of fiscal policy effectiveness: The role of trade and capital flows.' *Applied Economics* 50(32), 3493–3514

Appendix A. Log-linearised equations

The following equations describe the equilibrium of the model in log-linearised form as referred to in Section 3.5. A hat denotes the percent deviation from the steady state and a tilde denotes level deviations. The price index for final goods (P_t) is used as numéraire. For relative prices ($P_{T,t}/P_t$, $P_{H,t}/P_t$, $P_{N,t}/P_t$, w_t/P_t, S_t/P_t and $P_{N,t}/P_{T,t}$) the log-deviation is the same as the absolute deviation (denoted by $\pi_{T,t}$, $\pi_{H,t}$, $\pi_{N,t}$, ω_t, ϵ_t, and q_t), since the steady state value is set to unity.

Production

- Tradable and nontradable goods production

$$\hat{y}_{N,t} = \alpha \hat{h}_{N,t}, \quad (1-\nu)\hat{y}_{H,t} + \nu \hat{y}^*_{H,t} = \alpha \hat{h}_{H,t},$$

  where $y_H/(y_H + y^*_H) = 1 - \nu$ as implied by the demand functions (8) and (9).
- Labour demand

$$\begin{aligned} \omega_t - \pi_{N,t} &= \hat{y}_{N,t} - \hat{h}_{N,t}, \\ \omega_t - \pi_{H,t} &= (1-\nu)\hat{y}_{H,t} + \nu \hat{y}^*_{H,t} - \hat{h}_{H,t}. \end{aligned}$$

- Final and composite-tradable goods production

$$\begin{aligned} \hat{y}_{T,t} &= (1-\nu)\hat{y}_{H,t} + \nu \hat{y}_{F,t} \qquad \text{with} \qquad \nu = y_F/y_T, \\ \hat{Y}_t &= (1-\tau)\hat{y}_{T,t} + \tau \hat{y}_{N,t} \qquad \text{with} \qquad \tau = y_N/Y. \end{aligned}$$

Price index

- Composite-tradable goods prices

$$\pi_{T,t} = (1-\nu)\pi_{H,t} + \nu \hat{\epsilon}_t.$$

Households

- Consumption-saving decision

$$E_t \hat{C}_{t+1} - \hat{C}_t = \hat{r}_t,$$

  where the (gross) real rate of interest r_t is given by: $\hat{r}_t = \hat{\imath}_t - E_t \pi_{t+1}$.
- Uncovered interest parity condition

$$\hat{r}_t + \psi^*_B \tilde{B}^*_t = E_t \left(\hat{\epsilon}_{t+1} - \hat{\epsilon}_t \right),$$

  where $\bar{B}^* = 0$, that is, in the steady state foreign bonds are in zero net supply and $\epsilon = S_t/P_t$ is the real exchange rate.[24]

[24] An increase in ϵ implies a depreciation of the currency of the *home* economy in real terms.

- Labour supply

$$\hat{h}_t = \frac{1}{\phi}\left(\omega_t - \hat{C}_t\right).$$

Market clearing

- Domestic demand for nontradable, domestic and foreign tradable goods

$$\begin{aligned}
\hat{y}_{N,t} - \hat{Y}_t &= -\kappa\pi_{N,t}, \\
\hat{y}_{H,t} - \hat{Y}_t &= (\theta-\kappa)\pi_{T,t} - \theta\pi_{H,t}, \\
\hat{y}_{F,t} - \hat{Y}_t &= (\theta-\kappa)\pi_{T,t} - \theta\hat{\epsilon}_t.
\end{aligned}$$

- Foreign demand for domestic tradable goods

$$\hat{y}^*_{H,t} = \theta^*\left(\hat{\epsilon}_t - \pi_{H,t}\right).$$

- Labour market

$$\hat{h}_t = (1-\lambda)\hat{h}_{H,t} + \lambda\hat{h}_{N,t} \qquad \text{with} \qquad \lambda = h_N/h.$$

- Final goods market

$$\hat{Y}_t = c_y\hat{C}_t + (1-c_y)\hat{G}_t + \tilde{B}^*_t - \bar{\imath}^*\tilde{B}^*_{t-1}.$$

- Balance of payments

$$\tilde{B}^*_t = \bar{\imath}^*\tilde{B}^*_{t-1} + y^*_H\left(\hat{y}^*_{H,t} + \pi_{H,t}\right) - y_F\left(\hat{y}_{F,t} + \hat{\epsilon}_t\right),$$

  where $y_F = y^*_H = \nu(1-\tau)$ and the steady state value of Y is normalized to unity.

Policy

- Fiscal policy

$$\hat{G}_t \sim N(0, \sigma^2_G).$$

Appendix B. Solving the model

In order to obtain a tractable analytical solution, we impose that $\alpha = \phi = \theta^* = 1$, $\theta = \kappa$ and $\psi^*_B \to 0$.

Using the equations for (i) final and composite-tradable goods production, (ii) composite-tradable goods prices and (iii) domestic demand for nontradable, domestic and foreign tradable goods, implies

$$\omega_t = \pi_{N,t} = \pi_{H,t} = -\gamma_1\hat{\epsilon}_t,$$

with $\gamma_1 = \frac{(1-\tau)\nu}{1-\nu(1-\tau)} > 0$. From this we then get $\text{tot}_t = \hat{y}^*_{H,t} = (1+\gamma_1)\hat{\epsilon}_t$, $\tilde{y}^*_{H,t} = \nu(1-\tau)(1+\gamma_1)\hat{\epsilon}_t$, $\pi_{T,t} = (\nu - \gamma_1(1-\nu))\hat{\epsilon}_t$, $\hat{q}_t = -\nu(1+\gamma_1)\hat{\epsilon}_t$ and

$$\hat{Y}_t = \frac{-1}{1-\nu(1-\lambda)}\left(\hat{C}_t + (\gamma_1+\gamma_2)\hat{\epsilon}_t\right),$$

with $\gamma_2 = \nu(1-\lambda)(1+\gamma_1(1-\kappa)) + \gamma_1\kappa > 0$. From the system of demand equations we have: $\hat{y}_{H,t} - \hat{Y}_t = \kappa\gamma_1\epsilon_t$, $\hat{y}_{N,t} - \hat{Y}_t = \kappa\gamma_1\hat{\epsilon}_t$, $\hat{y}_{F,t} - \hat{Y}_t = -\kappa\hat{\epsilon}_t$, and for the trade balance we get $\widetilde{tb}_t = \vartheta\left(\kappa\hat{\epsilon}_t - \hat{Y}_t\right)$. Using the goods market equilibrium, the balance of payments identity and the previous equation for $\hat{Y}_t$, we obtain

$$\gamma_4\hat{C}_t + \gamma_5\hat{\epsilon}_t = -\gamma_6\hat{G}_t, \tag{31}$$

with

$$\begin{aligned}
\gamma_4 &= \frac{1}{1-\nu(1-\lambda)} + \frac{c_y}{1+\nu(1-\tau)} > 0,\\
\gamma_5 &= \frac{\gamma_1+\gamma_2}{1-\nu(1-\lambda)} + \frac{\kappa\nu(1-\tau)}{1+\nu(1-\tau)} > 0,\\
\gamma_6 &= \frac{1-c_y}{1+\nu(1-\tau)} > 0.
\end{aligned}$$

Equation (31) and the two intertemporal optimality conditions (equations (12) and (13)) can be put into a matrix system as follows

$$\tilde{A}_{-1}E_t\left[\tilde{x}_{t+1}\right] + \tilde{A}_0\tilde{x}_t = \tilde{\Psi}_0\hat{G}_t \quad \text{with} \quad \hat{G}_t \sim N(0,\sigma_G^2), \tag{32}$$

with

$$\tilde{x}_t = \begin{bmatrix}\hat{C}_t\\ \hat{\epsilon}_t\end{bmatrix}, \quad \tilde{A}_{-1} = \begin{bmatrix}1 & -1\\ 0 & 0\end{bmatrix}, \quad \tilde{A}_0 = \begin{bmatrix}-1 & 1\\ \gamma_4 & \gamma_5\end{bmatrix}, \quad \tilde{\Psi}_0 = \begin{bmatrix}0\\ -\gamma_6\end{bmatrix}. \tag{33}$$

We solve for the rational expectations solution by using the *method of undetermined coefficients*. For this we define and impose the equilibrium law of motion $\tilde{x}_t = \Gamma\hat{G}_t$. The solution for Γ is given by $\Gamma = \tilde{A}_0^{-1}\tilde{\Psi}_0$, which implies that

$$\begin{bmatrix}\hat{C}_t\\ \hat{\epsilon}_t\end{bmatrix} = -\tilde{\gamma}\begin{bmatrix}1\\ 1\end{bmatrix}\hat{G}_t, \tag{34}$$

with $\tilde{\gamma} = \frac{\gamma_6}{\gamma_4+\gamma_5} > 0$. From this it follows that

$$\widetilde{tb}_t = -\gamma_{tb}(\tau,\nu)\hat{G}_t \tag{35}$$

$$\hat{Y}_t = \gamma_Y(\tau,\nu)\hat{G}_t, \tag{36}$$

with $\gamma_{tb}(\tau,\nu) = \nu(1-\tau)(\kappa\tilde{\gamma} + \gamma_Y(\tau,\nu)) > 0$ and $\gamma_Y(\tau,\nu) = \frac{1+\gamma_1+\gamma_2}{1-\nu(1-\lambda)}\tilde{\gamma} > 0$, which simplifies to $\gamma_{tb}(\tau,\nu) = (1-c_y)\nu(1-\tau)(1+(1-\kappa)(1-\lambda)\nu+\kappa)/\eta$ and $\gamma_Y(\tau,\nu) = (1-c_y)(1+\nu(1-\lambda+\kappa(1-\tau)(1-(1-\lambda)\nu)))/\eta$, with $\eta = c_y((\lambda-1)\nu+1)(\nu(\tau-1)+$

1) − (2κ − 1)(λ − 1)ν²(τ − 1) − ν(2κ(τ − 1) + λ + τ − 2) + 1. We observe that

$$\begin{aligned}
\frac{\partial \gamma_{tb}(\tau,\nu)}{\partial \tau} &= -\frac{(1-c_y)\nu((1-c_y)(1-\lambda)\nu + c_y + 1)((1-\kappa)(1-\lambda)\nu+\kappa+1)}{[\,\cdot\,]^2} < 0,\\
\frac{\partial \gamma_{Y}(\tau,\nu)}{\partial \tau} &= \frac{(1-c_y)\nu(1-c_y+(1+c_y)(1-\lambda)\nu)(1+\kappa+(1-\kappa)(1-\lambda)\nu)}{[\,\cdot\,]^2} > 0,\\
\frac{\partial \gamma_{Y}(\tau,\nu)}{\partial \nu} &= \frac{(1-\nu(1-\lambda))\frac{\partial}{\partial\nu}[\tilde{\gamma}(1+\gamma_1+\gamma_2)] + \tilde{\gamma}(1+\gamma_1+\gamma_2)(1-\lambda)}{[\,\cdot\,]^2} \lesseqgtr 0,\\
\frac{\partial \gamma_{tb}(\tau,\nu)}{\partial \nu} &\propto \left(1+\frac{\nu}{\tilde{\gamma}}\frac{\partial\tilde{\gamma}}{\partial\nu} + \frac{\nu(1-\kappa)(1-\lambda)}{1+\kappa+\nu(1-\kappa)(1-\lambda)}\right)(1-\nu(1-\tau))(1-\nu(1-\lambda))\\
&\quad +\nu\left[(1-\tau)(1-\nu(1-\lambda)) + (1-\lambda)(1-\nu(1-\tau))\right] > 0.
\end{aligned}$$

The ambiguity in the sign of $\partial\gamma_Y(\tau,\nu)/\partial\nu$ arises from $\frac{\partial}{\partial\nu}[\tilde{\gamma}(1+\gamma_1+\gamma_2)] = (1+\gamma_1+\gamma_2)\frac{\partial\tilde{\gamma}}{\partial\nu} + \tilde{\gamma}\left(\frac{\partial\gamma_1}{\partial\nu}+\frac{\partial\gamma_2}{\partial\nu}\right)$. Since $\partial\gamma_1/\partial\nu > 0$, $\partial\gamma_2/\partial\nu > 0$ and $\partial\tilde{\gamma}/\partial\nu < 0$, the first term is negative, while the second is positive, thus rendering the sign of $\partial\gamma_Y(\tau,\nu)/\partial\nu$ uncertain. Concerning the last derivative, $\partial\gamma_{tb}(\tau,\nu)/\partial\nu > 0$, despite $\partial\tilde{\gamma}/\partial\nu < 0$ – since the positive terms dominate throughout across a wide range of reasonable values of the structural parameters, the sign of the expression is unambiguous.

Appendix C. The terms of trade, relative productivity and the intertemporal margin

In this section we elaborate on the extent to which openness alters the transmission mechanism of fiscal spending shocks because movements in the terms of trade and relative sector prices trigger substitution effects in consumption along the intertemporal margin. To evaluate this, we turn to equation (12), which determines the optimal consumption/saving decision. Denoting the marginal utility of consumption by λ_t, optimality requires the following to hold

$$\lambda_t = \beta E_t\left[\lambda_{t+1}R_t^C\right], \tag{37}$$

where $R_t^C = \frac{i_t}{P_{t+1}/P_t}$ measures the consumption-based real interest rate. Note that in the competitive equilibrium, we have that for the sectoral relative price of domestic goods

$$q_{N,t} = \frac{P_{N,t}}{P_{H,t}} = \tilde{a}_{H,t} = -\mathrm{MRT}_t(y_N, y_H), \tag{38}$$

where $\tilde{a}_{H,t} = \tilde{A}_{H,t}/\tilde{A}_{N,t}$ is the relative labour productivity in the sector producing tradable goods and $\tilde{A}_{H,t} = \alpha(y_{H,t}+y^*_{H,t})/h_{H,t}$ and $\tilde{A}_{N,t} = \alpha y_{N,t}/h_{N,t}$ are the (time-varying) labour productivities in the tradable and nontradable sectors, while $\mathrm{MRT}_t(y_N, y_H)$ refers to the marginal rate of transformation between the production of tradable and nontradable goods.[25] Assuming a symmetric equilibrium with $\theta \to 1$ and $\kappa \to 1$, then the consumption-based real interest rate is given by

$$(39) \quad R_t^C = \frac{i_t}{P_{H,t+1}/P_{H,t}} \left(\frac{\text{tot}_t}{\text{tot}_{t+1}}\right)^{\vartheta} \left(\frac{q_{N,t}}{q_{N,t+1}}\right)^{\tau} = \frac{i_t}{P_{H,t+1}/P_{H,t}} \left(\frac{\text{tot}_t}{\text{tot}_{t+1}}\right)^{\vartheta} \left(\frac{\tilde{a}_{H,t}}{\tilde{a}_{H,t+1}}\right)^{\tau}.$$

Equation (39) establishes a direct link between the consumption-based real interest rate (R_t^C), the change in the terms of trade and the change in the relative productivity in the tradable goods sector. Let us first consider the case of $\alpha = 1$. It follows that $\tilde{a}_{H,t} = A_H/A_N$, due to the equations in (3) with the consequence that $\tilde{a}_{H,t} = \bar{\tilde{a}}_H$ and $q_{N,t} = \bar{q}_N \ \forall \ t$. This reduces equation (39) to an expression linking the consumption-based real interest rate to the terms of trade only. If the terms of trade appreciate on impact and then gradually return to their pre-shock level, we have $(\text{tot}_t/\text{tot}_{t+1}) < 1$, i.e. in response to the initial drop the terms of trade increase over time back to the steady state. As a result, a terms of trade appreciation which is gradually reversed, will *ceteris paribus* induce a lower consumption-based real interest rate. This effect is stronger, the more open an economy is: the terms of trade elasticity of R_t^C is given by $\vartheta = \nu(1-\tau)$. Hence, both a higher import share (ν) and a lower share of nontradable goods (τ) increase the elasticity of R_t^C with respect to the terms of trade. Intuitively, better terms of trade today imply a lower price of today's consumption basket, as imported goods are cheaper. Put differently, the appreciation of the terms of trade attenuates the negative wealth effect of higher future taxation in response to the rise in fiscal spending. This attenuation increases with the import share and decreases with the share of nontradables.

When allowing for $\alpha \in [0, 1)$, the term $(q_{N,t}/q_{N,t+1})$ enters equation (39) with elasticity τ. In response to the expansionary fiscal spending shock, the relative price of nontradable goods increases. This gives rise to $(q_{N,t}/q_{N,t+1}) > 1$, i.e. in response to the initial rise the relative price of nontradable goods decreases over time back to the steady state. Considering again equation (39), an increase in the relative price of nontradable goods which is gradually reversed, will *ceteris paribus* induce a higher consumption-based real interest rate. This effect is stronger, the larger the share of nontradable goods, as the elasticity of the relative price of nontradable goods is given by τ. Intuitively, a higher relative price of nontradables implies a higher price of today's consumption basket, as nontradable goods are more expensive. Hence, the rise in

[25] Using the two production functions from the expression given by equation (2) yields the following production possibility frontier (PPF):
$y_{N,t} = A_N \left[h_t - ((y_{H,t} + y^*_{H,t})/A_H)^{1/\alpha}\right]^{\alpha}$.

nontradable goods prices reinforces the negative wealth effect of higher future taxation in response to the rise in fiscal spending.

The latter argument can also be viewed from the perspective of productivity, which introduces a *Balassa-Samuelson effect*. To see this, note that, as implied by equation (38), an increase in the relative price of nontradables ($q_{N,t}$) *ceteris paribus* leads to an increase in the relative labour productivity of the tradable goods sector ($\tilde{a}_{H,t}$) – the positive co-movement of labour productivity of the tradable goods sector and the relative price of nontradable goods characterises the essence of the *Balassa-Samuelson effect*. Equation (39) contains the change in relative labour productivity of the tradable sector ($\tilde{a}_t/\tilde{a}_{t+1}$), which enters with elasticity τ. Relative labour productivity growth in the tradable goods sector increases in response to the expansionary fiscal spending shock. This gives rise to $(\tilde{a}_{H,t}/\tilde{a}_{H,t+1}) > 1$, i.e. in response to the initial rise the relative labour productivity of the tradable sector decreases over time back to the steady state. Hence, an increase in relative labour productivity of the tradable sector which is gradually reversed, will *ceteris paribus* induce a higher consumption-based real interest rate. This effect is stronger the larger the share of nontradable goods, as the elasticity of the relative labour productivity of the tradable sector is given by τ. Intuitively, higher relative labour productivity of the tradable goods sector implies a higher relative price of nontradable goods. This in turn induces final goods producing firms to substitute nontradable goods by tradable goods (see equation (7)). Part of the increased demand for tradables will be satisfied by higher imports. As a consequence the trade balance deteriorates and results in a drop in net foreign assets, which gives rise to a negative wealth effect. This reinforces the negative wealth effect of higher future taxation in response to the rise in fiscal spending.

The Balassa-Samuelson effect works in an opposite direction to the terms of trade effect in this context. The sole remaining question addresses the inequality $(\tilde{a}_{H,t}/\tilde{a}_{H,t+1}) > 1$ – why does relative labour productivity in the tradable sector rise in response to an increase in fiscal spending? Intuitively, the expansionary fiscal spending shock increases final goods demand (Y_t), which in turn raises demand for nontradable ($y_{N,t}$) and tradable goods ($y_{T,t}$) alike. The higher demand for tradables can partly be compensated by higher imports ($y_{F,t}$). In contrast to that, the higher demand for nontradables can only be met by higher domestic production of nontradables. This requires a reallocation of production input factors, in this case, a reallocation of labour from the tradable to the nontradable sector. Hence, the excessive relative demand for nontradables implies that

$q_{N,t}$ (and q_t) rise. The relative drop in labour in the tradable goods sector, despite an increase in demand for tradables, implies that relative labour productivity in the tradable sector ($\tilde{a}_{H,t}$) increases. In equilibrium, the adjustment in both of them is of equal size, satisfying $q_{N,t} = \tilde{a}_{H,t}$. The structural adjustment of the economy requires thus a shift not only in production, but also in relative prices. Assuming balanced trade initially, the increase in fiscal spending brings about three effects: (i) an increase in public and private consumption relative to income, (ii) a real exchange rate appreciation, meaning in this context, a rise in P_N/P_H (and in P_N/P_T), and (iii) a shift in production from tradable goods to nontradable goods.

Appendix D. Robustness

In this section we provide the results of further robustness checks. We assess the stability of our baseline results along two dimensions. The first addresses extensions of the country part of the IPVAR model, the second the global part. We consider extensions in the form of linear and quadratic trend specifications, different lag lengths, employing the interaction variables as additional individual regressors and changing the ordering within the Cholesky decomposition. We provide the results of these exercises only for the output response displayed in Figure 10.

Concerning the global part, we consider several extensions in form of additional variables being used in the vector y_t^G. Specifically, we consider the VIX index and the oil price as additional endogenous variables. In addition, we also assess our results when using global industrial production instead of global GDP. The results are provided only for the output response and are shown in Figure 11.

None of the extensions changes our baseline results. In all cases, we observe that the effect of an increase in government spending on output increases with the share of nontradable goods. The difference between low and high values of the share of nontradables is in all cases significantly different from zero.

As a further robustness check, we estimate a panel VAR (PVAR) model without interaction terms, but using the share of nontradable goods as an additional endogenous variable. The vector $y_{C,t}$ is now five-dimensional. We estimate the PVAR model and simulate the effects of an increase in fiscal spending. The results can provide insights as regards the plausibility in using the share of nontradables as exogenous variable in the baseline results. We let the share of nontradable goods enter the PVAR model as *fast* variable, i.e. changes in government spending are allowed to have an immediate effect on the share of nontradables, though not the other way around. We find that an increase in government spending by one percent induces an increase in the share of nontradable goods by 0.1 percentage points at the maximum. Given that the median of the share of nontradable goods across all EU countries is around 0.36 for the period 1999-2019, this result implies that the share of nontradables would increase to 0.361. This increase is negligibly small from a quantitative point of view. The simulations shown in Sections 4.3.1 and 4.3.2 use the 20th and 80th percentile of the distribution of the share of nontradables, which implies a share of nontradable goods equal to 0.32 in the first and 0.4 in the second case. Hence, we consider this results in favour of our baseline specification, which utilises the share of nontradables as an interaction variable, which in turn implies that this share is exogenous to fiscal spending shocks.

Another robustness check we carried out concerns the dummy variable in the IPVAR model as motivated in Towbin and Weber (2013); Sa et al. (2014). Our baseline results involve a dummy variable of this form. It allows for a time-invariant but country-specific variation in the coefficients. We compared the results thereof with those of a specification where this dummy-variable is absent. We find that this dummy-variable has no effect on the results; all conclusions drawn previously remain valid. This implies in turn that in this context country-specific variation does not play an important role for the partial effect of nontradable goods on fiscal multipliers.

As a final robustness check, we assessed the role of the exchange rate regime. Standard textbook-models highlight that fiscal spending multipliers are larger in case of a fixed-exchange rate regime. Against this background we constructed an exchange rate dummy variable for each country (flexible or fixed exchange rate; Euro-area membership is classified as fixed exchange rate) to assess the role of the exchange rate regime on our results (see Towbin and Weber, 2013, for details on this). The results of this extension are in line with our baseline results. This is primarily due to the fact that the coefficients of the exchange rate dummy variables are rather small for nearly all countries and not significantly different from zero in all cases.

FIGURE 10. Extensions 1: Effects of a fiscal spending shock

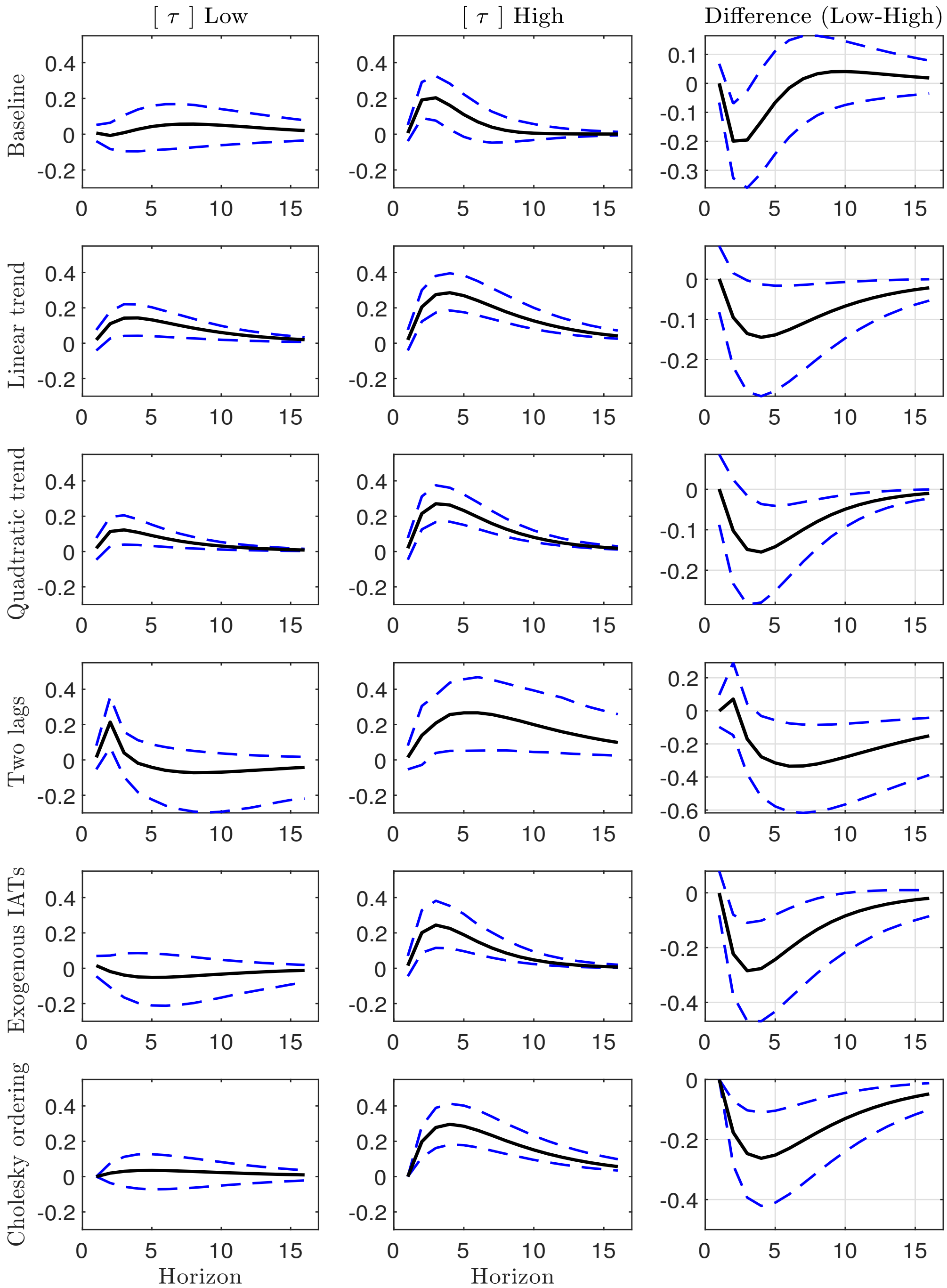


FIGURE 11. Extensions 2: Effects of a fiscal spending shock