Fiscal Policy, Relative Prices and Net Exports in a Currency Union

By Luisa Lambertini and Christian Proebsting*

The hoped-for silver lining of euro-area austerity programs was to raise external competitiveness and improve current accounts. Using product- and industry-level data for 12 countries over 1999-2018, we show that reductions in government spending reduce prices and wages, but only for products with low import content and industries with low export shares. This leads to asymmetric expenditure switching, with net exports improving through lower imports rather than higher exports. The standard small-open-economy model fails to rationalize these findings, but home bias in government spending and frictions preventing factor prices from equalizing across sectors, considerably improves the fit of the model.
JEL: E62, F41, F45

There is a need to implement an ambitious structural reform agenda to strengthen external competitiveness [and] accelerate reallocation of resources from the non-tradable to the tradable sector. [...] Inflation needs to be reduced significantly below the euro area average for Greece to regain swiftly price competitiveness. Domestic demand tightening [...] through fiscal adjustment [...] will be essential to bring inflation down in a meaningful way.

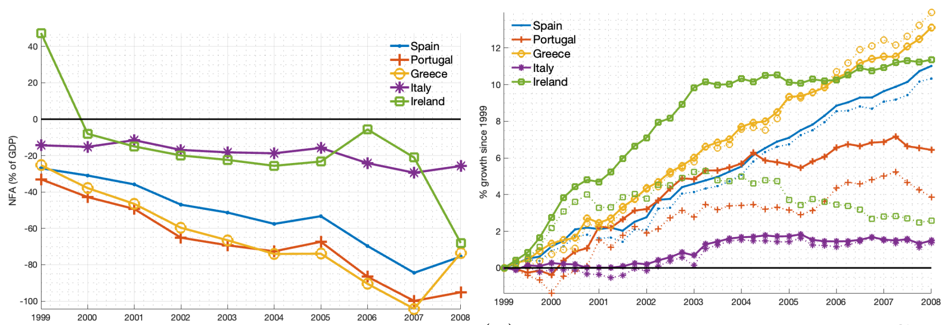
The Economic Adjustment Programme for Greece, 2010

The goal of our paper is to study the effects of government spending on net exports, the terms of trade and expenditure switching in countries that belong to a monetary union and do not have an independent exchange rate. We are motivated by the experience of the euro area, whose periphery members pursued austerity programs after the Great Recession with the primary purpose of addressing their fiscal imbalances in the hope of also improving their external imbalances. In fact, the adjustment to current account imbalances in member countries of a monetary union must rely on fiscal policy, as countries cannot resort to an exchange rate

* Lambertini: EPFL — École Polytechnique Fédérale de Lausanne, Route Cantonale, 1015 Lausanne, Switzerland, Luisa.Lambertini@epfl.ch. Proebsting: EPFL — École Polytechnique Fédérale de Lausanne, Route Cantonale, 1015 Lausanne, Switzerland, Christian.Probsting@epfl.ch. We thank seminar participants at the IMF workshop "The Euro at 20" held at the Central Bank of Ireland, 2018, the conferences on Computing in Economics and Finance in Milan, 2018 and Ottawa, 2019; the INFER REM Workshop on New Challenges for Fiscal Policy in Lisbon, 2019; the conference in honor of Francesco Giavazzi at Bocconi University, 2019; the ECB 2019 Conference on Fiscal Policy and EMU Governance, and the workshop "It Takes Two to Tango. The Policy Mix a Decade After the Crisis" in Clermont-Ferrand, 2020; and the virtual conference of the European Economic Association, 2020. We thank Benjamin Born, Nestor Sawadogo and Cezara Vinturis for their insightful discussion. Lambertini gratefully acknowledges financial support from the Swiss National Science Foundation grant 100018_182257.

devaluation relative to other member countries. From a policy perspective, it is important to understand how fiscal policy affects relative prices and the current account.

Following the creation of the euro area, cross-border capital flows intensified, especially from the center to the periphery, leading to current account deficits and debt accumulation in the economies of the periphery. For instance, Spain, Portugal and Greece increased their external debt by about 60% of GDP between the introduction of the euro in 1999 and the onset of the Great Recession (see Figure 1a). These current account deficits were accompanied by a real exchange rate (RER) appreciation, with prices in some countries increasing by around 10% relative to the euro area. With the exception of Ireland and Portugal, this RER appreciation was also driven by higher prices for traded goods, which raised concerns about these economies' competitiveness (see Figure 1b).



(a) Net Foreign Asset Position

(b) Relative Price Evolution: CPI and CPI of Traded Goods

Figure 1. : Imbalances: GIIPS Economies

Note: Figure depicts the net foreign asset position of the GIIPS economies, as well as their price developments relative to the twelve initial euro area members. Data on net foreign asset positions is taken from Lane and Milesi-Ferretti (2007). Consumer prices are displayed relative to their level in 1999. A value of 10 indicates that consumer prices in that country rose by 10% more than they did for the euro area. Continuous line refers to the overall CPI, the dotted line refers to the CPI of traded goods.

The global financial crisis of 2007-08 and the ensuing Great Recession led to large fiscal deficits and a surge in public debt in the euro area periphery. These fiscal developments, together with the external imbalances and inflation differentials observed in the first decade of the euro area, have been blamed for causing the euro area debt crisis (Krugman, 2012; European Commission, 2016).[1] Emergency programs accompanied by austerity measures were introduced in Greece, Ireland, Portugal, Spain, and Cyprus; even though Italy neither requested nor re-

[1]Since the global financial crisis revealed that large current account imbalances were "key factors in triggering the debt crisis" (European Commission, 2016), the European Union introduced a "Macroeconomic Imbalance Procedure" in autumn 2011 to keep current accounts within the range of -4% to 6% of GDP.

ceived aid, it implemented some austerity policies in response to market pressure on its government bond prices.

As exemplified by the quote from the Economic Adjustment Programme for Greece, media and policy circles alike have suggested that fiscal austerity in the GIIPS countries, even if mainly implemented to reduce fiscal deficits and counter pressure from financial markets, had the silver lining of allowing these countries to regain competitiveness by mimicking the effects of an exchange rate devaluation. At the core of these recommendations lies the assumption that fiscal austerity leads to (i) an improvement in competitiveness thanks to a deterioration of the terms of trade that renders domestically-produced traded goods cheaper relative to foreign goods; (ii) ensuing expenditure switching by domestic and foreign consumers towards domestically-produced goods; and (iii) a demand effect that reduces imports (through a fall in overall demand) and thereby improves net exports. Since current account adjustment is two-sided, many have also advocated a fiscal expansion in Germany to reduce its external surplus and help the periphery countries that are pursuing austerity.[2]

We focus on a sample of twelve countries that adopted the euro early on, for which we have collected data for 20 years (1999 - 2018). We use professional forecasts by the OECD on government spending to correct for anticipation and extract unanticipated shocks. In a first exercise, we use local projections to estimate cumulative spending multipliers for net exports, the terms of trade and the RER.

Our empirical analysis lends support to the idea that spending cuts indeed improve net exports, but this improvement is almost entirely driven by falling imports rather than stronger exports. Consequently, the response of net exports is quantitatively small: a reduction in government spending of 1 euro raises net exports by about 35 cents over two years for the average country in our sample with a trade share of 25%. The improvement in net exports goes along with lower inflation and an RER depreciation, but crucially, we find little evidence for export prices to fall. As a matter of fact, export and import prices display a surprising co-movement in response to austerity, i.e. the terms of trade do not react, a phenomenon we refer to as the *missing terms-of-trade deterioration* of fiscal austerity. The muted response of both exports and the terms of trade cast doubt on the idea that austerity improves current accounts through improved external competitiveness.

We next collect additional empirical moments to better understand the muted response of exports and the terms of trade and to guide our theoretical model: In particular, we study the response of retail prices and consumption at the product level. Exploiting a new data set on input-output linkages, we calculate import shares for 90 different consumption categories that are included in the

[2]As Sinn (2014) puts it: "What Europe needs is austerity in the south and inflationary growth in the north to improve the competitiveness of the south and to structurally improve the current account imbalances."

CPI. Empirically, we observe that spending cuts are deflationary with a cut of 1 percent of GDP, lowering retail prices by roughly a third over a 2-year horizon. But this negative price response is entirely driven by goods and services with a low (< 10 percent) import share (henceforth non-traded), whose prices fall by almost 1 percent, whereas the prices of goods and services with moderate and high import share (henceforth traded) do not move. That is, in terms of the exchange rate decomposition proposed by Engel (1999), the RER depreciation stems from movements in the relative price of non-traded goods, rather than fluctuations in the price of traded goods across countries. Relying on data on consumption by product category, we show that these relative price movements go along with expenditure switching towards goods with lower import shares, in line with our findings that imports respond more than GDP to spending cuts.

Based on industry-level regressions, we show that these relative price movements between non-traded and traded goods at the retail level can be explained by the underlying changes in relative producer prices and wages across sectors. Wages and producer prices of industries operating in traded sectors react substantially less to spending cuts than their counterparts in non-traded industries. This also helps explain the muted response of exports, which goes along with a weak response of export prices.

Taken together, our findings suggests that fiscal policy is only partially successful in correcting current account imbalances: On the one hand, fiscal austerity reduces imports both through a demand effect and a decrease in the relative price of domestic non-traded goods; on the other hand, fiscal austerity has little effect on producer prices in the traded sector and hence exports. That is, fiscal austerity leads to *asymmetric expenditure switching* in the sense that domestic consumers switch towards domestically produced goods but foreign consumers do not.

The second part of our paper presents a DSGE model to rationalize our empirical findings. We rely on a small-open economy model of a monetary union along the lines of Galí and Monacelli (2005) (GM) with some extensions. In particular, we account for the strong home bias in government spending, restrict capital mobility across sectors in the short run, specify preferences where labor across sectors are imperfect substitutes (as in Horvath, 2000), and add distribution services for the traded retail good. These extensions are crucial in capturing the relative price and consumption movements following a spending shock observed in the data. The strong home bias in government spending pushes down labor and capital demand in the non-traded sector in response to the fall in spending. Since labor supplied to different sectors are imperfect substitutes, wage differentials persist in equilibrium (as we document in the data), and firms in the non-traded sector pass lower production costs on to lower retail prices. In the traded sector and the distribution sector, factor costs remain high, which, together with the higher import share, explains the muted response of traded good prices.

We demonstrate that a number of alternative extensions of the GM model are unable to account for the patterns observed in the data: Whereas a higher trade elasticity could explain the muted response of the terms of trade, it is inconsistent with the weak response of exports. Adding pricing-to-market to the standard GM model reduces the response of the terms of trade as well, but the model fails to account for the relative cross-sector movements of wages and retail prices. Similarly, assuming a high import content of exports moves the model in the right direction, but quantitatively, the effect is too small.

Equipped with our benchmark model, we consider two counterfactual policy experiments to reduce the costs of correcting current account deficits. In line with the data, our baseline model suggests that improving net exports by 1 euro would require a spending cut of close to 3 euros and result in a similar fall of 3 euros in GDP. Our discussion hints towards how to lower these costs: Structural reforms that improve factor substitutability across sectors would make government spending a more effective tool in tackling current account imbalances. In a baseline model with perfectly integrated factor markets, the output cost would be cut by more than half. Similarly, concentrating spending cuts on traded goods would cut the costs by up to 70 percent. That being said, empirically, only 15 percent of government spending falls on traded goods, making it difficult to exploit this lever for cyclical policies.

The rest of the paper is organized as follows. After reviewing the relevant literature, we present our methodology for estimating fiscal policy shocks and discuss data sources in Section I. Our empirical results are shown in Section II. We present the model in Section III and discuss our model results in Section IV.

A. *Related Literature*

Our work connects to a large literature on how fiscal policy transmits in open economies through relative price movements and expenditure switching. A large body of recent research has brought forth new evidence regarding the effects of government spending on output (Ramey, 2018), but the profession has not yet reached a consensus on its effects on the trade balance. Moreover, it is still unclear whether relative prices - such as the terms of trade and the RER, both of which are at the core of the transmission of fiscal shocks in open economies - actually adjust, as well as to what extent expenditure switching takes place following a fiscal shock. For example, using U.S. data Kim and Roubini (2008) and Müller (2008) observe net exports to fall after a spending cut, whereas Monacelli and Perotti (2010) and Ravn, Schmitt-Grohé and Uribe (2012) find a positive response when expanding the data set to include more countries. While the RER is often found to appreciate in the aforementioned studies, the cross-country analyses in Ilzetzki, Mendoza and Végh (2013), Kim (2015) and Miyamoto, Nguyen and Sheremirov (2019) show that this response is not robust to different country samples.[3]

[3] A similar point can be made for the response of the terms of trade: Studies focusing on flexible exchange rate countries find contradictory results. In response to a spending cut, the terms of trade are

In our view, the large variation of findings across studies might be driven by the response of monetary policy to fiscal shocks.[4] Depending on the assumed monetary policy response and whether prices are invoiced in domestic or foreign currency, New Keynesian models are consistent with either an RER appreciation or a depreciation in response to a fiscal expansion. This makes it difficult to discriminate between model mechanisms—such as e.g. the presence of deep habits, consumption-hours complementarities in the utility function or rule-of-thumb consumers—on the basis of the empirically observed RER response to a fiscal shock. To circumvent this problem, we follow Nakamura and Steinsson (2014) and Chodorow-Reich (2019) and study fiscal shocks within a currency union where monetary policy is common to all member states. In such a setting, the reaction of monetary policy does not contaminate the response of the RER, the terms of trade and the trade balance. Studying the movements of relative prices and quantities in the euro area therefore provides us with a powerful diagnostic tool for distinguishing between competing macroeconomic models and sets us apart from the previous literature.

A further contribution relative to the existing literature is that we collect additional empirical moments, decomposing the RER response into a non-traded and a traded component, decomposing the terms of trade into export and import prices and further studying the response of producer prices and wages for both traded and non-traded good producers using product-level and industry-level data. We show that, consistent with the standard GM model, the RER depreciates in response to a spending cut. While this is in contrast to findings in studies focusing on floating exchange rate countries (Monacelli and Perotti, 2010; Ravn, Schmitt-Grohé and Uribe, 2012; Kim and Roubini, 2008; Enders, Müller and Scholl, 2011), it corroborates results of a weak, but generally negative inflation response found in samples of fixed exchange rate countries (Born, Juessen and Müller, 2013; Beetsma, Giuliodori and Klaassen, 2008; Canova and Pappa, 2007). More importantly, we find that the aggregate response of the RER hides large variations across products, with prices of non-traded goods reacting substantially more than prices of traded goods, which helps rationalize the muted response of the terms of trade.

We focus on the effect of government spending. While Farhi, Gopinath and Itskhoki (2013) show that an appropriate combination of tax changes can in principle mimic exchange rate movements, in practice most of the observed austerity measures during the European debt crisis were concentrated on cuts to government spending (Lambertini and Proebsting, 2019).

found to deteriorate in Müller (2008) and Monacelli and Perotti (2010), while they appreciate in Enders, Müller and Scholl (2011) and Corsetti and Müller (2008). Similarly, the effect on inflation has been found to be ambiguous: Perotti (2004), Auerbach and Gorodnichenko (2012) and Ilzetzki, Mendoza and Végh (2013) conclude that the effects of fiscal shocks on inflation are typically small and not significant. Studies by Fatas and Mihov (2001) and Mountford and Uhlig (2009) even find a weak increase in the GDP deflator after a cut in government spending.

[4]See also Nakamura and Steinsson (2014) for a similar argument to rationalize the wide range of views on the output multiplier of government spending.

Our findings are important for the emerging literature that estimates cross-sectional output multipliers and spillovers across geographical units in the United States (see e.g. Auerbach, Gorodnichenko and Murphy, 2019; Conley and Dupor, 2013; Leduc and Wilson, 2013). While informative, these studies lack high-quality data on relative price changes and trade flows at the sub-national level. They therefore cannot test the key mechanism of expenditure switching that underpins the size of open-economy fiscal multipliers and spillovers across locations, as emphasized by Chodorow-Reich in his survey on cross-sectional fiscal multipliers (Chodorow-Reich, 2019). By shifting our focus towards the euro area, where high-quality data at the sub-union level is available, we show that consumers react to relative price changes, but that the response of net exports is muted because traded good prices and the terms of trade do not respond to spending shocks.

Our model emphasizes home bias in government spending and limited factor substitutability across sectors as key ingredients for the transmission of spending shocks. Several papers explicitly acknowledge that government spending is more biased towards domestic goods than private spending and include this assumption in their quantitative models, (see e.g. Cacciatore and Traum, 2018; Blanchard, Erceg and Lindé, 2016; Müller, 2008). We show that home bias in government spending is not sufficient to match the empirical response of RERs; it is its combination with reduced factor substitutability that helps bring model predictions closer to the data. This links us to research on the prevalence of factor market segmentation. Early research stressing the low mobility of capital across sectors include Ramey and Shapiro (1998). Imperfect labor substitutability across sectors has seen renewed interest in the business cycle literature in recent years. It has become an important aspect to solve the co-movement puzzle in multi-sector DSGE models (Boldrin, Christiano and Fisher, 2001). For instance, Iacoviello and Neri (2010) and Calza, Monacelli and Stracca (2013) find that imperfect labor substitutability across sectors is necessary to explain the observed positive comovement of employment in the housing sector and the non-durable sector. In addition, imperfect labor substitutability across sectors helps explain how independent sectoral shocks can drive aggregate business cycle fluctuations (Horvath, 2000), rationalizes the observed response of relative wages across sectors to productivity shocks (Cardi and Restout, 2015), and explains why the asymmetric price response across sectors to monetary policy shocks persists over time (Carlstrom et al., 2006). Imperfect labor substitutability has also been emphasized in the growing literature in international trade, which has found slow adjustment in labor markets in response to trade shocks that shift countries' trade patterns (Autor, Dorn and Hanson, 2016).[5]

[5] In the wake of this renewed interest of labor immobility, several studies have estimated costs for workers to change industries based on structural models. For instance, Lee and Wolpin (2006) find large mobility costs in the United States for moving between goods sectors and service sectors in response to long-run sector-biased technological changes. Artuç and McLaren (2015) estimate that moving from one broadly aggregated sector of the economy to another corresponds to 3 times annual wages in the United States. Exploiting a trade liberalization episode in Brazil, Dix-Carneiro (2014) estimates mobility costs

I. Measuring Fiscal Policy

Measuring the effect of government spending on the economy faces the challenge that output and prices can directly affect fiscal policy, making the fiscal stance endogenous to the state of the economy. To extract variation in government spending that is unrelated to contemporaneous economic conditions, we follow Blanchard and Perotti (2002) and subsequent papers (e.g Auerbach and Gorodnichenko, 2012; Ilzetzki, Mendoza and Végh, 2013) and assume that government spending only reacts to *lagged*, but not concurrent changes in economic conditions. Compared to these previous papers, this assumption is somewhat more restrictive, as we use semi-annual rather than quarterly data.[6]

As emphasized by Ramey (2011), controlling for lagged economic conditions, however, is not sufficient to estimate fiscal multipliers because the residual changes in fiscal policy might still be anticipated, e.g. if governments announce and implement multi-annual fiscal plans (Alesina, Favero and Giavazzi, 2015). To the extent that households and firms react to news about future policy changes, our estimates will be biased. Several papers have therefore proposed to control for expected fiscal policy changes using professional forecasts (see e.g. Auerbach and Gorodnichenko, 2012; Born, Juessen and Müller, 2013), so as to extract the purely unexpected part.

To implement this strategy, we follow Miyamoto, Nguyen and Sergeyev (2018) and use a two-step estimation procedure to compute the effect of fiscal policy on our variables of interest. The first step consists in extracting unexpected shocks to government spending. In a second step, we use these extracted fiscal policy shocks as instruments for changes in government spending.

Extracting Government Spending Shocks. — We identify unanticipated innovations in government spending by estimating the following regression:

$$\Delta \ln G_{i,t} = \alpha_i + \beta_f F_{t-1} \Delta \ln G_{i,t} + \beta_{\mathbf{z}} \psi(L) \mathbf{z}_{i,t-1} + \varepsilon_{i,t}, \tag{1}$$

where $\Delta \ln G_{i,t}$ is the log change in real per capita government spending in country i at time t, $F_{t-1}\Delta \ln G_{i,t}$ is its forecast done in $t-1$, $\psi(L)$ is a lag operator and $\mathbf{z_{i,t-1}}$ contains a set of controls. In our specification, we allow for country-specific intercepts, α_i, to capture differences in average growth rates across countries over the sample period, but we restrict the coefficients β_f and $\beta_{\mathbf{z}}$ to be the same across countries. We take the estimated residuals, $\hat{\varepsilon}_{i,t}$, as our government spending shocks because they are orthogonal to both the forecasted log-change in government spending and (lagged) economic controls. In addition to lags of

that amount to twice the annual wage.

[6] Born and Müller (2012) argue that this assumption is reasonable, even at an annual frequency. Born, Juessen and Müller (2013) also use semi-annual data and require the same assumption to identify their shocks.

government spending growth rates, we include two lags of the growth rate of real GDP and the unemployment rate in our set of controls for economic conditions.[7,8]

Our sample includes the first twelve euro area countries (Austria, Belgium, Germany, Finland, France, Luxembourg, the Netherlands, Greece, Italy, Ireland, Portugal and Spain) and covers semi-annual data for the period 1999 - 2018. Data on economic variables is provided by Eurostat. For government purchases, we take data on nominal final consumption of the general government deflated by the sample-wide GDP deflator.[9] Forecast data on government purchases comes from the OECD Economic Outlook. The OECD prepares forecasts of government spending in June and December of each year, that is at the end of an observation period. Forecasts are published for the current semester and the next 2-3 semesters ahead.[10]

Table 1 displays the estimated coefficients and the R^2. Forecasts and lagged controls (plus the country-specific intercepts) explain a reasonable share (51%) of the variation in the actual log change of government spending, suggesting that government spending is partially predictable and reacts to lagged economic conditions. The second and third columns display the results when we omit either regressor in equation (1). The resulting lower R^2's (0.44 and 0.40) indicate that both forecasts and macroeconomic controls contain independent information that helps predicting changes in government spending. In both cases, the R^2 is substantially larger than the R^2 of a regression that only includes country fixed effects (0.03, column 4).

Figure 2 plots the estimated government spending shocks for Greece, Spain, Portugal and Germany. By construction, these policy shocks are mean zero because we include country fixed effects in our estimation equation. We later exploit country-specific variation in government spending across time rather than (potential) variation in the *average* fiscal stance across countries. The shocks are expressed in terms of GDP, i.e. we are plotting $\hat{\varepsilon}_{i,t}\frac{G_i}{Y_i}$. The figure reveals that

[7] We do not include time fixed effects in this regression, as in Nakamura and Steinsson (2014), and consequently, the residual $\varepsilon_{i,t}$ can therefore still be contaminated by shocks common to all countries, such as movements in monetary policy enacted by the ECB. We therefore add time fixed effects to our second stage regression (see 2), so that identification of fiscal multipliers stems from fiscal shocks in member countries *relative to the union's average fiscal shock.* This procedure effectively controls, among other things, for the response of monetary policy.

[8] In results not reported here, we also added other controls such as lagged values of government debt and lagged values of interest rates on government bonds. These variables added almost no explanatory power to our baseline specification. Hence, the extracted shocks were almost identical to the original series and the estimated multipliers were virtually unaffected.

[9] It is a common approach in the literature to deflate government spending by the GDP deflator (as opposed to the government spending deflator) (see e.g. Ramey and Zubairy, 2018; Miyamoto, Nguyen and Sergeyev, 2018) to capture e.g. cuts to government employment salaries that do not track overall wage developments. We follow Nakamura and Steinsson (2014) who also study fiscal policy in a monetary union and use the sample-wide GDP deflator to deflate government spending.

[10] More recently, the OECD has started to publish forecasts of quarterly data, but has kept the semi-annual publication cycle. In a few cases, only forecasts of annual data are available. In that case, our forecast for the growth rate of the first semester of year t is the forecast of the growth rate between t and $t-1$ published in December of year $t-1$, and our forecast for the growth rate of the second semester of year t is the forecast of the growth rate between t and $t-1$ published in June of year t.

Table 1—: First-Stage Regression

	(1)	(2)	(3)	(4)
$F_{t-1}\Delta \ln G_{i,t}$	0.56	0.85		
	(0.06)	(0.04)		
$\Delta \ln G_{i,t-1}$	0.14		0.25	
	(0.04)		(0.04)	
$\Delta \ln G_{i,t-2}$	0.03		0.15	
	(0.04)		(0.04)	
$\Delta \ln Y_{i,t-1}$	0.02		0.03	
	(0.04)		(0.05)	
$\Delta \ln Y_{i,t-2}$	0.14		0.12	
	(0.04)		(0.05)	
$\Delta u_{i,t-1}$	−0.34		−0.56	
	(0.13)		(0.14)	
$\Delta u_{i,t-2}$	0.29		0.44	
	(0.12)		(0.13)	
R^2	0.51	0.44	0.40	0.03
Obs	523	549	535	564

Note: Table displays the regression coefficient of regression (1). Dependent variable is $\Delta \ln G_{i,t}$. All regressions include country fixed effects.

government spending shocks are rather volatile, with a standard deviation of 0.28%. Shocks were particularly large in the early 2010s, when several countries such as Greece, Spain and Portugal, implemented austerity measures. Importantly for our estimation, the figure reveals a substantial variation in both timing and size across countries, with spending shocks in Germany, for example, being particularly small over that time period.

Response of Fiscal Variables to Extracted Government Spending Shocks. — After having extracted government spending shocks, we estimate the response of government spending itself to the extracted shocks. To this end we estimate a series of regressions at each horizon $0 \leq h \leq 8$:

$$\ln G_{i,t+h} - \ln G_{i,t-1} = \alpha_{i,h} + \alpha_{t,h} + \beta_h \hat{\varepsilon}_{i,t} + \beta_{\mathbf{z}} \psi(L) \mathbf{z}_{i,t-1} + \epsilon_{t+h}, \quad (2)$$

where the fiscal shocks, $\hat{\varepsilon}_{i,t}$, are the residuals from equation (1), and $\alpha_{i,h}$ and $\alpha_{t,h}$ are country and time fixed effects. We include two lags of the variable of interest as controls, $\mathbf{z}_i$. Figure 3a shows that an unexpected increase in government spending further raises government spending in the next 8 semesters. This

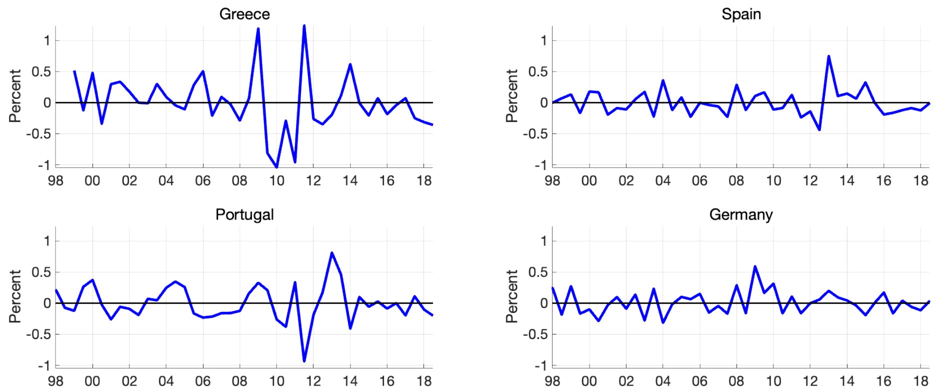


Figure 2. : Extracted Government Spending Shocks

Note: Figures depict the estimated government spending residuals from regressions (1) for selected countries. Residuals are expressed in percent of GDP, i.e. the figure displays $\hat{\varepsilon}_{i,t}\frac{G_i}{Y_i}$, where G_i and Y_i are average values of government spending and GDP for the sample period.

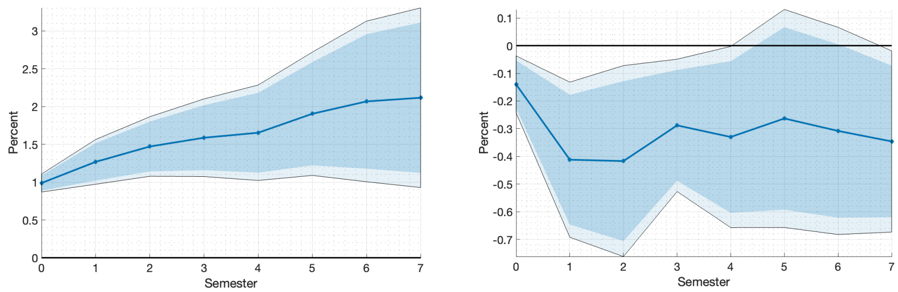
evidence suggests that our extracted shocks might mark the beginning of fiscal plans that span several semesters (see e.g. Alesina, Favero and Giavazzi, 2015).[11]

While our procedure extracts the purely unexpected part of a change in government spending, a reasonable concern might be that governments implement several fiscal measures at once, such as a government spending cut and a tax hike. In that case, we might wrongly attribute the effects of a tax change to a change in government spending. Of particular concern might be changes in VAT rates because several countries implemented non-negligible hikes in consumption tax rates in the wake to the European debt crisis (see e.g. Lambertini and Proebsting, 2019), and it is reasonable to assume that these tax rate changes translated into higher after-tax retail prices, directly counterbalancing potentially deflationary effects of spending cuts.

To test whether this concern is justified, we regress percentage point changes in consumption tax rates on the extracted government spending shocks along the lines of regression (2). We measure changes in the consumption tax rate as the difference between consumer price inflation and consumer price inflation measured at constant tax rates. Inflation at constant tax rates, published by Eurostat, keeps VAT and excise duties (e.g. on alcoholic beverages, tobacco and energy items) constant. Our tax measure therefore encompasses all consumption tax changes (and not only changes in the standard VAT rate) and weighs them according to the basket weights of the CPI.[12] The right panel of Figure 3a shows

[11]The response of government spending starts returning towards zero from semester 9 onward.

[12]We use the change in the Harmonized Index of Consumer Prices (HICP) as our measure of consumer price inflation. The HICP at constant tax rates is provided by Eurostat at the overall level for most countries since 2003. To complement this data, we exploit the database in Benedek et al. (2015) on VAT changes by detailed good category and month and collect additional information on VAT changes from national statistical agencies. See the Online Appendix for more details.



(a) Government Spending (b) Consumption Tax Rate

Figure 3. : Impulse Responses to Extracted Spending Shocks

Note: Figure depicts the response of government spending (left panel) and the consumption tax rate (right panel) to a government spending shock. The shocks are measured in percent of GDP. The response in the consumption tax rate is in percentage points. 90 percent and 95 percent confidence intervals are displayed, based on Driscoll-Kraay standard errors clustered at the country and time level. The response of government spending starts returning towards zero from semester 9 onwards (not shown).

indeed that positive spending shocks prompt persistent cuts in VAT rates. An increase in spending by 1% of GDP is followed by a cut in the consumption tax rate by about 0.3-0.4 percentage points. This result suggests that we should control for tax changes when estimating the response of economic variables to spending shocks.[13]

II. Empirical Relationships Between Fiscal Policy, Relative Prices and the Trade Balance

A. Aggregate Responses

To study the response of macroeconomic variables to fiscal policy shocks, we estimate empirical "multipliers". We define multipliers as the average cumulative gain in e.g. output or inflation relative to government spending over a given horizon. In contrast to simply looking at the outcome response at a given horizon relative to the initial shock, this definition takes the entire path of both the outcome variable and the fiscal variable into account (Mountford and Uhlig, 2009; Ramey and Zubairy, 2018). The cumulative multiplier is estimated using the

[13]The Online Appendix displays our main empirical results (that we present in the next section) without controling for changes in the VAT rate. The main difference is that aggregate retail prices increase less in response to a positive spending shock if we do not control for the VAT rate, in line with our finding that a positive spending shock is associated with a decrease in the VAT.

following instrumental variable (IV) regression at each horizon h:

$$\sum_{s=0}^{h}(\ln x_{i,t+s} - \ln x_{i,t-1}) = M_h \sum_{s=0}^{h} \frac{G_{i,t+s} - G_{i,t-1}}{Y_{i,t-1}} + \beta_{\mathbf{h}} \mathbf{z^h}_{i,t-1} + \varepsilon^{x}_{i+h,t}, \tag{3}$$

where the instruments for $\frac{G_{i,t+j}-G_{i,t-1}}{Y_{i,t-1}}$ are $\hat{\varepsilon}_{i,t}$ from regression (1). The multiplier M_h is then interpreted as the percent change in prices or quantities between $t-1$ and $t+h$ for an increase of government spending by 1% of output over that time period. The control vector $\mathbf{z}^h_{i,t-1}$ includes country fixed effects and time fixed effects, as well as changes in the consumption tax rate, $\sum_{s=0}^{h}(\tau_{i,t+s} - \tau_{i,t-1})$, and two lags of the dependent variable, $\ln x_{i,t-1}$ and $\ln x_{i,t-2}$.[14]

When interpreting our estimate of the spending multiplier, three things are worth keeping in mind. First, our specification includes time fixed effects to control (among other things) for changes in monetary policy, which—given our focus on euro area member states—are common to all countries in our sample. Our estimate is therefore robust to the response of monetary policy to fiscal policy shocks (see e.g. Nakamura and Steinsson, 2014; House, Proebsting and Tesar, 2019, for a similar setup).[15] Second, for each horizon h, we estimate an *average* multiplier across countries and time. While we acknowledge that multipliers are bound to differ both across countries and time, our goal is to uncover empirical patterns that underlie open economies' adjustment to fiscal shocks in general and that are not specific to a certain country or time period. Third, our regression also controls for simultaneous changes in consumption taxes. The estimated coefficient M_h therefore refers to the spending multiplier conditional on the government keeping consumption taxes constant. For this to be meaningful, we condition on tax *rates* rather than tax revenues. Tax revenues would respond to fluctuations in private spending induced by government spending shocks and including them would therefore bias our estimate of M_h. Tax rates, in contrast, are the relevant policy instrument under direct control of the policy maker.

Before presenting our empirical estimates of the multipliers, we have to test whether our instruments are relevant. We follow the literature and implement the test for weak instruments proposed in Olea and Pflueger (2013). This test is particularly suited for panel data as it adjusts the F-test thresholds to correct for both possible serial correlation of errors and their heteroskedasticity. Figure 4 plots the F-statistics obtained in the test for horizons of up to 8 semester along

[14]Note that we added lagged controls for economic conditions (growth rate of real GDP and the unemployment rate) in regression (1) that extract the fiscal shocks. The fiscal shocks are therefore orthogonal to these controls and it would therefore be redundant to add them to regression (3).

[15]Nakamura and Steinsson (2014) rely on a similar argument in their study of the effects of military spending across U.S. states. An important difference between their study and our study is, however, that their estimates are the sum of a pure spending multiplier and a transfer multiplier: Military spending in the United States is financed at the federal level, so that cross-state variation in military spending contracts involve transfers across states. This is in contrast to our setting where country-level spending is financed at the country level.

with the thresholds for 5% and 10% critical values for testing the null hypothesis that the two-stage least squares bias exceeds 10% of the ordinary least squares (OLS) bias. For short horizons, the instrument is highly relevant with F-statistics exceeding the threshold by a factor of 5 or more. Even at longer horizons—although declining—the F-statistic remains above the thresholds, indicating the relevance of our instrument.

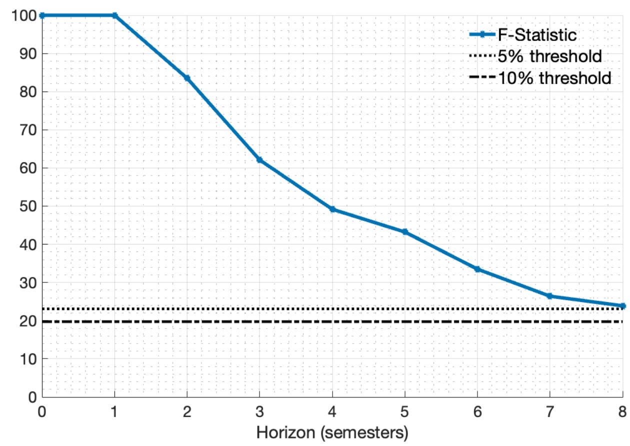


Figure 4. : Test for Weak Instruments

Note: Figure displays the F-statistics to test the relevance of the instrument $shock^g_{i,t}$ in regression (3). The figure also plots the critical values at both the 5% and 10% level for testing the null hypothesis that the two-stage least squares bias exceeds 10% of the OLS bias. F-statistics are capped at 100. Errors are robust to heteroskedasticity and serial autocorrelation. Tests are implemented using the Stata command `weakivtest` (Pflueger and Wang, 2015).

Turning to the results from regression (3), Figure 5 displays the estimated multipliers for 8 semesters to extracted government spending shocks. We observe that increases in government spending are inflationary. An increase in government spending amounting to 1% of GDP raises the GDP deflator upon impact by 0.6% and by 0.9% after 5 semesters. Retail prices as measured by the HICP increase less than the GDP deflator, steadily growing from 0.2% to 0.55% over the horizon of 4 years.[16] Hence, our empirical results are consistent with a real exchange rate appreciation in response to a government spending increase, both when measured using consumer and producer prices.

Consistent with this increase in prices, real per capita GDP rises as well, with the multiplier reaching a high of 1.2 after 3 years. The multiplier is somewhat stronger than the average value observed in the recent literature review by Ramey

[16]Roughly 15% - 20% of all consumption in the HICP falls on products with ‘administered’ prices. These prices are partially or fully set by the government (e.g. pharmaceuticals, railway tickets) and therefore do not fully obey market forces. Eurostat publishes an HICP index that excludes these product categories. It is that price index that we use here.

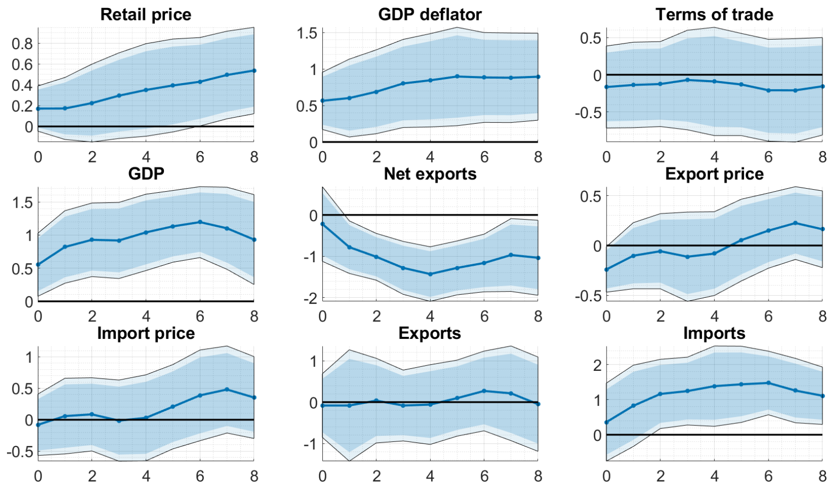


Figure 5. : Empirical Government Spending Multipliers

Note: Figures depict the estimated government spending multipliers $\widehat{M}_h^g$ from regression (3), as a function of the horizon h. 90 percent and 95 percent confidence intervals are displayed, based on Driscoll-Kraay standard errors clustered at the country and time level.

(2018), and might reflect the missing, offsetting monetary policy response in a currency union.

We next shift our focus to the terms of trade (defined as the price of exports over the price of imports) and the trade balance.[17] The reaction of export and import prices play a central role in the narrative of internal devaluation through fiscal austerity, as they stimulate expenditure switching between goods and services produced in different countries. But the empirical results displayed in Figure 5 lend little support to this view: The terms of trade move little in response to an increase in government spending. Even though producer prices increase (as reflected by the rising GDP deflator), this does not translate into a terms of trade improvement. When we break down the terms of trade into the reaction of export and import prices, we observe that the two prices display a similar response: Export prices initially even go down and only start raising after two years and import prices do not respond in the short run and start going up at the same time as export prices. The lack of response of export prices and the missing terms-of-trade improvement are puzzling and inconsistent with standard theory. In contrast to the terms of trade, net exports decrease by about 1.4% (or: 0.35% of GDP for the average country in our sample with a trade share of a quarter); their response is strongly driven by imports with exports moving very little. Together with the missing terms-of-trade response, this suggests that the reaction of net exports is mostly driven by an increase in domestic demand rather

[17]The price of exports (imports) is measured as the price deflator for exports (imports) taken from the national accounts.

than a relative price effect.

B. Inflation and Consumption Responses at the Product Level

In a next step, we look at how prices at the product level respond to aggregate government spending shocks. In response to a positive shock, we have observed that producer prices (measured by the GDP deflator) rose twice as fast as consumer prices. One possible explanation for this difference could be that some consumer goods are imported rather than produced domestically. Prices of these imported consumer goods should experience less upward pressure from a rise in domestic factor costs. To test this, we estimate how the retail price response depends on a consumption good's reliance on imports. We use data on disaggregated inflation data published by Eurostat. The HICP data is published for 90 different goods and services. Based on input-output tables, we calculate the import share for each product and average it across countries and time periods in our sample (see Table A2 in the Online Appendix). Overall, there is large variation in import shares across products, with motor vehicles reaching import shares above 50%, whereas most services have import shares well below 10%. In calculating these import shares, we take into account that many products rely on local distribution services, so that even entirely imported goods (e.g. tobacco products) might have import shares (measured at the retail level) well below 50%.

We then run the following regression:

$$\begin{aligned}\sum_{s=0}^{h}\left(\log P_{i,t+s}^{j,ret}-\log P_{i,t-1}^{j,ret}\right)\\ =(M_h+m_h\times im_j)\sum_{s=0}^{h}\frac{G_{i,t+s}-G_{i,t-1}}{Y_{i,t-1}}+\beta_{\mathbf{h}}\mathbf{z}_{i,t-1}^{j}+\varepsilon_{i,t+h}^{j},\end{aligned} \tag{4}$$

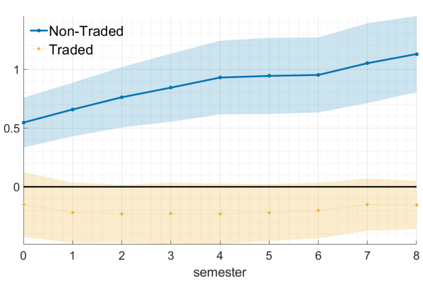
where im_j is good j's sample-average import share and $\mathbf{z}_{i,t-1}^{j}$ contains several controls, including country fixed effects, time fixed effects, two lags of $\log P_{i,t}^{j,ret}$ and changes in the consumption tax rate, $\sum_{s=0}^{h}(\tau_{i,t+s}-\tau_{i,t-1})$.[18] Similar to the interaction term with a good's import share, we also include a term for good j's durability interacted with the fiscal shock. We control for this term because traded goods tend to be more durable and we want to isolate the effect driven by a good's tradeability rather than its durability.[19] The estimated price response

[18]We exclude product categories with administered prices, as we did for the aggregate CPI. We rely on sample-average import shares for each good because 20% of import shares at the product-country level are missing and our estimates of these import shares rely only on a single year, 2010, for which data is available. To estimate more reliably country-good import shares, a longer time series would be desirable.

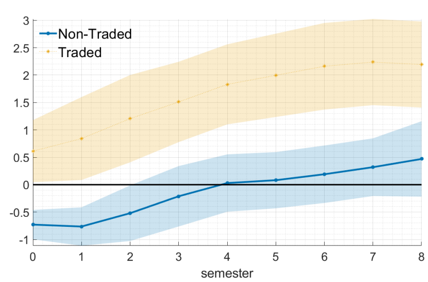
[19]The COICOP classification assigns products into one of four categories: non-durables, semi-durables, durables and services. We assign a 0 to non-durables and services, a 0.5 to semi-durables and a 1 to durables.

for a good with import share im_j is then $\widehat{M}_h + \widehat{m}_h \times im_j$.

Panel (a) of Figure 6 plots the estimated coefficients for a non-traded good ($\widehat{M}_h$) and a typical traded good with an import share of 30% (e.g. furniture, $\widehat{M}_h + \widehat{m}_h \times 0.3$) for horizons spanning up to 4 years, together with one-standard deviation error bands. We observe that consumer prices of purely non-imported goods increase substantially more in response to a government spending shock relative to the general HICP, with the price multiplier exceeding 1.2 after 4 years against the HICP multiplier of 0.6 as shown in Figure 5. The typical traded good, however, experiences a close to zero response in its price. The difference between the two price trajectories is both economically and statistically highly significant, with the one-standard deviation error bands not overlapping. It is therefore prices of non-imported goods that react to government spending rather than prices of imported goods. This observation might then also help explain why retail price inflation reacts less to an increase in spending than producer price inflation because the former includes a significant amount of imported goods whose prices react little to domestic public spending. The very weak response of traded goods' prices is, however, somewhat puzzling because even for imported goods, domestic costs typically account for two thirds of the overall retail price (through the contribution of local goods and distribution margins), suggesting that their retail prices should also feel some pressure from higher factor costs. One possible explanation that we investigate below is that the rise in production costs following a government spending shock is not even across sectors, but is mostly concentrated in sectors producing non-traded goods.



(a) Retail Prices



(b) Real Consumption

Figure 6. : Empirical Multipliers at the Product Level

Note: Figures depict the estimated government spending multipliers for the effect on retail prices (a) and real consumption (b) estimated at the product level from regression (4). Panels display the estimated coefficient for a non-traded good ($\widehat{M}_h$) and a good with an import share of 30% (calculated as the linear combination of the estimated coefficients $\widehat{M}_h + 0.3 \times \widehat{m}_h$). One-standard-deviation error bounds are displayed, based on Driscoll-Kraay standard errors clustered at the country and time level.

It is useful to link these results back to the narrative on fiscal policy and current accounts. For instance, calls on Germany to raise its government spending were based on the hope that this would raise Germany's imports and stimulate growth in other currency members. Since most government spending falls on non-traded goods, this increase in imports has to come via households (and firms) switching towards imported goods. For this to happen, the relative prices of non-traded goods have to rise, which we have found they do in the data. We now examine whether these price movements are actually associated with movements in quantities. To do so, we re-run regression (4) replacing retail prices by consumption as the explained variable. Data on consumption is published at a somewhat less detailed level than inflation data (38 categories instead of 90) and is only available at annual frequency. Eurostat also publishes quarterly data for 4 rough consumption categories (durables, semi-durables, non-durables and servics) that we use to interpolate our annual data following the method proposed in Chow and Lin (1971).

The results from regressing changes in real consumption on government spending are displayed in panel (b) of Figure 6, distinguishing again between a non-traded good and a typical traded good. The results are consistent with expenditure switching taking place in response to government spending shocks. For consumption goods that fully rely on domestic inputs, consumption initially falls by 0.8% in response to a government spending shock amounting to 1% of GDP. In contrast, consumption of a typical imported good rises by 0.6% upon impact with the multiplier reaching 2 after 4 years. Relative consumption movements are therefore consistent with relative price movements, and also help explain the strong increase in aggregate imports observed in Figure 5: Government spending crowds out consumption of non-traded goods, but crowds in consumption of tradeable goods, leading to a rise of aggregate imports.

C. Value Added Deflator Response at the Industry Level

The muted price response of traded consumption goods to government spending shocks cannot be explained by their reliance on imported goods alone because for the typical traded consumption good, about two thirds of its inputs are domestically sourced, either through distribution services or locally produced traded goods. An alternative explanation is that producer prices of locally produced traded goods do not increase to the same extent as producer prices of non-traded goods.

To test this hypothesis, we consider the gross value added (GVA) deflator at the industry level as a measure of producer prices. Eurostat publishes data on GVA for 64 industries based on the NACE Rev.2 classification.[20] Based on the 2010-benchmark input-output tables, we calculate export shares for each industry. Similar to our observations for consumption goods, we observe a large variation in export shares across industries, with some industries exporting about 90% of

[20] The data is only available at annual frequency. We interpolate this data based on the Chow-Lin method using quarterly data for a less detailed classification (10 industries).

their products, especially in smaller countries; the average export share in our sample is 22%, and the export share of a typical traded good is about 50% (e.g. furniture).

Based on this data, we run a specification similar to (4) where public spending shocks are interacted with the industry's export share, ex:

$$\begin{aligned}
&\sum_{s=0}^{h}\left(\log P_{i,t+s}^{k}-\log P_{i,t-1}^{k}\right) \\
&\quad=\left(M_h+m_h\times ex_{i,k}\right)\sum_{s=0}^{h}\frac{G_{i,t+s}-G_{i,t-1}}{Y_{i,t-1}}+\beta_{\mathbf{h}}\mathbf{z}_{i,t-1}^{j}+\varepsilon_{i,t+h}^{k},
\end{aligned} \tag{5}$$

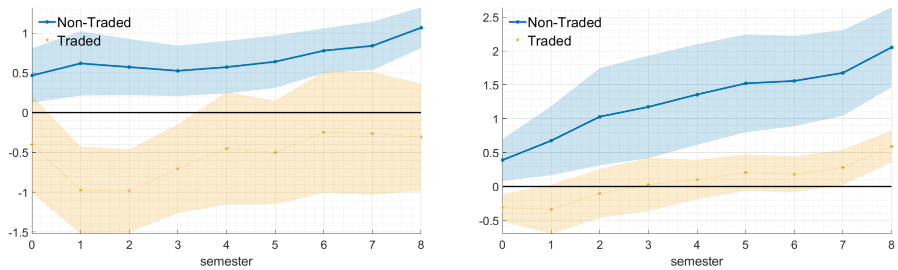
where $k = 1, \ldots, 64$ is the industry index and P^k is the GVA deflator.[21]

Panel (a) of Figure 7 reports the response of the value added deflator to a government spending shock. We observe that the increase in the GDP deflator at the aggregate level is driven by industries that serve primarily the domestic market. The value added deflator multiplier is 1.1 after 4 years for industries with zero export share, whereas for an industry exporting 50% of its products it is statistically indistinguishable from zero. Initially, the GVA deflator even falls for export-oriented industries. Similar to retail prices, the difference between non-traded and traded goods is economically and (at most horizons) statistically significant. Seen in this light, the muted response of traded retail prices is therefore less puzzling. Traded retail prices react little to government spending shocks because the underlying producer prices of both imported and locally produced goods react little.

The differential response of the GVA deflator also helps understand the lack of response of export prices and the associated missing terms-of-trade improvement: Value added deflators are going up, but mostly for firms that are not exporting. But this raises the question of what is causing this differential response across firms. One possible explanation is that firms respond to changing demand conditions by adjusting their markup ("pricing to market"). Despite higher factor costs, firms might choose to keep their export prices low, which will be reflected in a more muted response of their GVA deflator. An alternative explanation could be that government spending shocks mostly fall on non-traded industries. This, together with imperfect labor substitutability across industries, would lead to wage differentials across industries that could then explain differences in producer prices.

To discriminate between the two hypotheses, we re-run equation (5) replacing the GVA deflator P^k on the left hand side by the nominal wage per employee in sector k, W^k. The wage per employee is calculated as compensation of employees

[21] Controls $\mathbf{z}_{i,t-1}^{j}$ include country fixed effects, time fixed effects, two lags of log $P_{i,t}^{j,ret}$ and changes in the consumption tax rate, $\sum_{s=0}^{h}\left(\tau_{i,t+s}-\tau_{i,t-1}\right)$.



(a) GVA Deflator (b) Nominal Wage per Employee

Figure 7. : Empirical Multipliers at the Industry Level

Note: Figures depict the estimated government spending and consumption tax multipliers for the effect on the GVA deflator (a) and nominal wage per employee (b) estimated at the industry level from regression (5). Panels display the estimated coefficient for a non-traded good ($\widehat{M}_h$) and a good with an export share of 50% (calculated as the linear combination of the estimated coefficients $\widehat{M}_h + 0.5 \times \widehat{m}_h$). One-standard-deviation error bounds are displayed, based on Driscoll-Kraay standard errors clustered at the country and time level.

over the number of employees for each industry. Panel (b) of Figure 7 lends support to the hypothesis that labor movements across industries are not sufficient to equalize the response of wages. Production costs measured through wages immediately go up in industries that predominantly serve the domestic market, whereas in export-oriented industries wages only go up after several semesters: For every 1% of GDP increase in government spending, wages in non-traded industries go up by about 2% in non-traded industries after 4 years, but only half a percent in traded industries.

D. Summary of Empirical Findings

The first part in Table 3 summarizes our main empirical findings by displaying spending multipliers at the 2-year horizon. We observe that, in response to a positive spending shock, the domestic price level rises (i.e. the real exchange rate appreciates, column 1). This is purely driven by higher non-traded retail prices, whereas retail prices of traded goods are not affected (column 5). As traded goods become relatively cheaper, private consumption switches towards them (column 6). The relative retail price movements are also reflected in relative producer price movements and relative wage movements (column 7 and 8). Since traded goods' prices are not affected, raising government spending does not hamper external competitiveness in the sense that the terms of trade remain basically unaffected (column 2). In line with the weak terms-of-trade response, the fall in net exports (column 3) is driven by an increase in imports rather than a fall in exports (as shown in Figure 5).

Government spending moves the real exchange rate through its impact on the relative price of non-traded to traded goods (column 5), rather than a change in the relative price of traded goods across countries (column 2). This leads to "asymmetric" expenditure switching confined to the domestic economy: Domestic consumers switch from non-traded to traded goods (column 6), whereas the weak export response suggests that foreign consumers do not switch towards goods produced by the economy experiencing the spending shock. Next, we examine whether a DSGE model can rationalize both qualitatively and quantitatively these empirical findings.

III. Model

This section develops a small-open economy (SOE) model that we use to explain the main patterns between public spending and prices found in Section II. As in Galí and Monacelli (2005), we think of the SOE as one of a continuum of economies that together form a currency union. The driving forces in our model are shocks to government purchases. To speak to our empirical findings, our model features both a non-traded and a traded good sector. We adhere to this classical dichotomous distinction of goods (rather than explicitly modeling 90 different retail goods) to keep the model tractable.

As we will see, the standard SOE is unable to reproduce the relative price movements in response to a spending shock that we observe in the data. We therefore introduce three extensions that, guided by the empirical evidence, we suspect might help reconcile model predictions and empirical patterns: First, we allow for a strong home bias in government purchases, i.e. a large fraction of public spending falls on non-traded goods, as observed in the empirical data. Second, traded goods (e.g. food bought in grocery stores) rely on distribution services such as retail, wholesale and transport services, as in Devereux (1999).[22] Third, we segment factor markets by restricting the degree of labor substitutability across sectors as in Horvath (2000) and by introducing investment adjustment costs at the sector level. As a result, factor prices do not equalize across sectors in response to asymmetric fiscal shocks.

The SOE is populated by a representative household, several representative firms (producer, wholesaler and retailer), and a government. Figure 8 gives a brief overview of the model structure.

A. Households

The recent literature on fiscal policy has emphasized the role of hand-to-mouth consumers to generate realistic government spending multipliers (see e.g. Galí, López-Salido and Vallés, 2007). We therefore impose a hand-to-mouth restriction on a fraction χ of a household's members in the economy. These household members receive income in proportion to their consumption share of total income (i.e. GDP) and spend the entire amount on current consumption,

[22] The importance of distribution costs in real exchange rate determination has been emphasized in the literature (see e.g. Burstein, Neves and Rebelo, 2003; Engel, 1999).

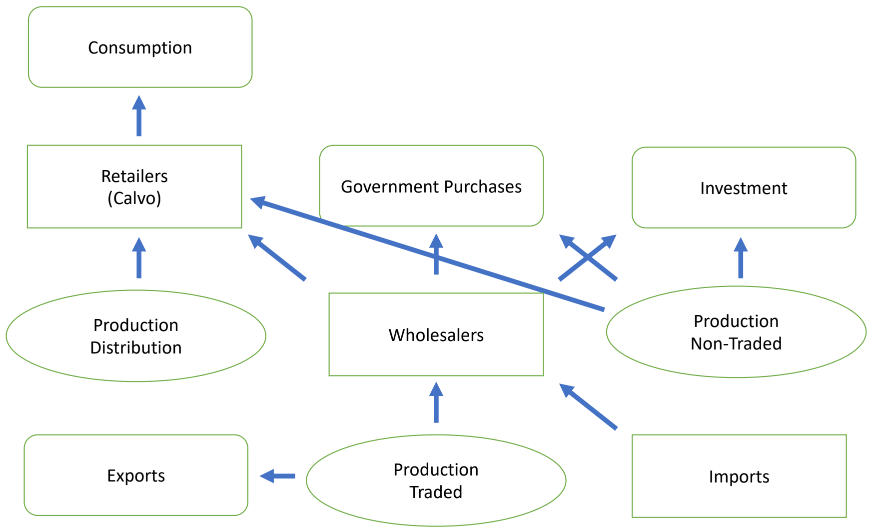


Figure 8. : Model Overview

Note: Figure provides an overview of the production structure in the model. Rectangles with rounded edges are final demand components. Oval shapes denote production that generates value added. Sticky prices are introduced at the retail level.

$C_t^{htm} = \frac{C}{GDP} GDP_t$. The remaining $1-\chi$ members of the representative household choose their consumption (C_t^{opt}) optimally and thus behave in accordance with the permanent income hypothesis. Aggregate consumption is then simply $C_t = \chi C_t^{htm} + (1-\chi) C_t^{opt}$.[23]

At date 0, the expected discounted sum of future period utilities for the optimizing household members is given by $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t^{opt}, L_t)$ with

$$U(C,L) = \frac{C^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} - \kappa \frac{L^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}, \tag{6}$$

where $\beta < 1$ is the subjective time discount factor, σ is the elasticity of intertemporal substitution, η is the Frisch labor supply elasticity and C_t is defined as

$$C_t = C_{T,t}^{\gamma_C} C_{N,t}^{1-\gamma_C}. \tag{7}$$

That is, overall consumption C_t consists of two consumption goods, a traded good (T) and a non-traded good (N), with γ_C denoting the weight that the household

[23]Following the literature (e.g. Erceg and Lindé, 2013), we assume that hand-to-mouth consumers' labor supply schedule follows the schedule of optimizing household members.

puts on consumption of the traded good. The consumption goods' nominal retail prices are $P^{ret}_{T,t}$ and $P^{ret}_{N,t}$. As discussed below, the traded good is composed of a (traded) wholesale good and distribution services.

Households supply labor to either the traded, non-traded or the distribution sector. We define total labor supply L_t as the CES aggregate of labor supplied to these three sectors:

$$L_t = \left(L^{1+\xi}_{T,t} + L^{1+\xi}_{N,t} + L^{1+\xi}_{D,t} \right)^{\frac{1}{1+\xi}}, \tag{8}$$

where ξ is the inverse of the elasticity of substitution between labor inputs across sectors. Our utility function follows the specification introduced by Horvath (2000), which allows for imperfect substitutability between labor inputs across sectors whenever $\xi > 0$.

In addition to purchasing consumption goods, households also invest in capital. Capital stocks are sector-specific. For each sector $j = N, T, D$, the investment good, $I_{j,t}$, consists of both non-traded ($I^N_{j,t}$) and (traded) wholesale goods ($I^V_{j,t}$) that are combined following a similar Cobb-Douglas aggregator as in (7) (with γ_I denoting the weight on wholesale investment goods) and purchased at the nominal prices $P_{N,t}$ and $P_{V,t}$, respectively.

Households supply capital and labor to the producers and, in return, earn nominal wages, $W_{j,t}L_{j,t}$, and a nominal return to capital, $R_{j,t}K_{j,t-1}$, in each sector j. Households may also receive profits Π_t from firms and lump-sum transfers T_t from the government. Every period, households invest in internationally traded nominal bonds, B_t, denominated in the union's currency, that pay nominal interests at rate i_t. Households choose consumption, $C_{j,t}$, labor supply, $L_{j,t}$, investment $I_{j,t}$, capital stocks, $K_{j,t}$ and bond holdings B_t to maximize the expected discounted sum of future period utilities subject to a sequence of budget constraints

$$\begin{aligned} &\sum_{j=N,T} P^{ret}_{j,t} C_{j,t} + \left(\sum_{j=N,T,D} P_{V,t} I^V_{j,t} + P_{N,t} I^N_{j,t} \right) + \frac{B_t}{1+i_t} \\ &\qquad = \left(\sum_{j=N,T,D} W_{j,t} L_{j,t} + R_{j,t} K_{j,t-1} \right) + \Pi_t + T_t + B_{t-1}, \end{aligned} \tag{9}$$

the following law of motion for capital in each sector $j = N, T, D$:

$$K_{j,t} = K_{j,t-1}(1-\delta) + \left[1 - f\left(\frac{I_{j,t}}{I_{j,t-1}} \right) \right] I_{j,t} \tag{10}$$

and the hand-to-mouth restriction $C^{htm}_t = \frac{C}{GDP} GDP_t$. The law of motion for capital features adjustment costs in investment as in Christiano, Eichenbaum and Evans (2005), with $f(1) = f'(1) = 0$ and $f''(1) > 0$.

In this setup, relative consumption is inversely related to relative retail prices:

$$\frac{C_{T,t}}{C_{N,t}} = \frac{P_{N,t}^{ret}}{P_{T,t}^{ret}} \tag{11}$$

and the price index of the consumption good reflects the retail prices of the underlying consumption goods:[24]

$$P_t^{ret} = \left(\frac{P_{T,t}^{ret}}{\gamma_C}\right)^{\gamma_C} \left(\frac{P_{N,t}^{ret}}{1-\gamma_C}\right)^{1-\gamma_C}. \tag{12}$$

Segmented Factor Markets. — Factor markets are segmented in our model in the sense that factor prices are not necessarily equalized across sectors in equilibrium. In the labor market, labor supply in sector j obeys

$$\kappa L_t^{\frac{1}{\eta}} \left(\frac{L_{j,t}}{L_t}\right)^{\xi} = \frac{W_{j,t}}{P_t^{ret}} U_{1,t}. \tag{13}$$

For $\xi = 0$, this formulation converts back to the standard labor supply condition with wages being equalized across sectors, i.e. $W_{j,t} = W_t$ with $\kappa L_t^{\frac{1}{\eta}} = \frac{W_t}{P_t^{ret}} U_{1,t}$. For small enough values of ξ, labor supplied across sectors remain substitutes in the sense that an increase in labor supplied in a sector $\neq j$ reduces labor supplied in sector j. A special case arises whenever $\xi = \frac{1}{\eta}$, which implies that labor supply separately enters the utility function so that labor supply in sector j does not depend on labor supplied to other sectors, i.e. $\kappa L_{j,t}^{\xi} = \frac{W_{j,t}}{P_t^{ret}} U_{1,t}$.[25]

Capital markets are segmented as well because each sector features its own, pre-

[24] Similarly, the price index of the investment good is

$$P_t = \left(\frac{P_{V,t}}{\gamma_I}\right)^{\gamma_I} \left(\frac{P_{N,t}}{1-\gamma_I}\right)^{1-\gamma_I}$$

and the demand for investment goods is given by

$$P_{V,t} I_{j,t}^V = \gamma_I P_t I_{j,t} \qquad \text{and} \qquad P_{N,t} I_{j,t}^N = (1-\gamma_I) P_t I_{j,t}.$$

[25] While we emphasize the role of limited substitutability of labor across sectors in accounting for observed wage differentials in response to sector-specific shocks, the way we implement this is just one among many. As a matter of fact, a large literature has studied why wage differentials across sectors are a common empirical phenomenon. Explanations for wage differentials have relied on nonpecuniary and pecuniary mobility costs (Artuç, Chaudhuri and McLaren, 2010), segmented labor markets (Dickens and Katz, 1986), industry-specific human capital (Helwege, 1992; Neal, 1995), nonpecuniary attributes of employment (Brown, 1980) or differential labor quality (Gibbons and Katz, 1992). In either case, and important for our application, these explanations manifest themselves as a more sluggish response of labor to short-run relative labor demand shocks.

determined capital stock. This is in contrast to a model, where capital can freely adjust within a period across sectors.[26] We also add investment adjustment costs at the sectoral level, which ensure that differences in rental prices across sectors persist in the medium run. To see this, notice that the optimal choice of capital is described by the first-order condition:

$$\mu_{j,t} U_{1,t} = \beta \mathbb{E}_t \left[U_{1,t+1} \left(\frac{R_{j,t+1}}{P^{ret}_{t+1}} + \mu_{j,t+1}(1-\delta) \right) \right], \tag{14}$$

where $\mu_{j,t} U_{1,t}$ is the Lagrange multiplier on the law of motion for capital. Notice that without any adjustment costs in investment, $\mu_{j,t} = \mu_t$ and the expected return to capital is equalized across sectors, implying that one period after a shock, rental prices would be equalized across sectors.

B. Firms

The economy is populated by three types of firms: producers, wholesalers and retailers. We first provide an overview of the production process based on market clearing conditions. Producers employ labor and rent capital to produce either one of three goods, $j = N, T, D$. Production of non-traded good, $Q_{N,t}$, is sold either to retailers in form of a consumption good, or to households as an investment good, or to the government:

$$Q_{N,t} = C_{N,t} + \left(\sum_{j=N,T,D} I^N_{j,t} \right) + G_{N,t}. \tag{15}$$

Output of the traded good, $Q_{T,t}$, is either purchased by domestic wholesalers or exported:

$$Q_{T,t} = Q^{dom}_{T,t} + Q^{exp}_{T,t}. \tag{16}$$

Wholesalers combine domestically produced traded goods, $Q^{dom}_{T,t}$, with imported goods, $Q^{imp}_{T,t}$, to produce a wholesale good, V_t. Some of these wholesale goods, F_t, are sold to retailers who combine them with distribution services, $Q_{D,t}$ to produce the traded consumption good, $C_{T,t}$. The rest of the wholesale good is either sold

[26] Our model is an extreme case of the model in Ramey and Shapiro (1998) that allows for within-period reallocation of capital subject to a cost. They estimate that at least 50% of capital is lost when it is reallocated, which substantially reduces the benefits of reallocation. As a matter of fact, the cost is so high that no capital is reallocated in response to a government spending shock in their benchmark model. We therefore directly rule out reallocation of used capital.

directly to households as a traded investment good, or to the government:

$$V_t = F_t + \left(\sum_{j=N,T,D} I^V_{j,t} \right) + G_{T,t}. \tag{17}$$

We next provide a few more details on the production process. We start in reverse order, first describing the production of retail goods before discussing the optimization problem of wholesalers and the actual production of the underlying inputs.

Retailers. — We implement sticky prices at the retail level using the standard Calvo mechanism giving rise to standard, log-linear Phillips curves (where $\tilde{x}$ denotes the log change in the variable x relative to its non-stochastic steady state):

$$\tilde{\pi}^{ret}_{j,t} = \frac{(1-\theta)(1-\theta\beta)}{\theta} \left(\widetilde{MC}_{j,t} - \tilde{P}^{ret}_{j,t} \right) + \beta \mathbb{E}_t \tilde{\pi}^{ret}_{j,t+1} \tag{18}$$

for both non-traded and traded retail goods, $j = N, T$. Here, θ is the Calvo probability of price rigidty, $\pi^{ret}_{j,t} = \frac{P^{ret}_{j,t}}{P^{ret}_{j,t-1}}$ is inflation of the retail good j. The nominal marginal cost, $MC_{j,t}$, is different for non-traded and traded goods. For a retailer selling the non-traded good, the nominal marginal cost is simply the production price of the non-traded good:

$$MC_{N,t} = P_{N,t}. \tag{19}$$

Retailers selling traded goods purchase final goods from wholesalers, F_t, at price $P_{V,t}$, and combine them with distribution services, $Q_{D,t}$, purchased at price $P_{D,t}$, according to

$$C_{T,t} = \left(\nu^{\frac{1}{\zeta}} Q_{D,t}^{\frac{\zeta-1}{\zeta}} + (1-\nu)^{\frac{1}{\zeta}} F_t^{\frac{\zeta-1}{\zeta}} \right)^{\frac{\zeta}{\zeta-1}}, \tag{20}$$

where ζ is the elasticity of substitution across inputs. This gives rise to the following marginal cost function:

$$MC_{T,t} = \left(\nu P_{D,t}^{1-\zeta} + (1-\nu) P_{V,t}^{1-\zeta} \right)^{\frac{1}{1-\zeta}}. \tag{21}$$

Wholesalers. — Wholesalers are perfectly competitive in both input and output markets. They combine domestically produced traded goods and imported traded goods using a CES production function:

$$V_t = \left(\omega^{\frac{1}{\psi}} \left(Q^{dom}_{T,t}\right)^{\frac{\psi-1}{\psi}} + (1-\omega)^{\frac{1}{\psi}} \left(Q^{imp}_{T,t}\right)^{\frac{\psi-1}{\psi}}\right)^{\frac{\psi}{\psi-1}}, \tag{22}$$

where ω is the weight on the domestically produced traded good, and ψ is the trade demand elasticity. The price of the wholesale good then simply reflects the input costs:

$$P_{V,t} = \left(\omega P^{1-\psi}_{T,t} + (1-\omega)1\right)^{\frac{1}{1-\psi}}, \tag{23}$$

where the price of imports is constant (due to our SOE setup) and normalized to 1.

PRODUCTION. — Production of non-traded and traded goods as well as distribution services takes place by perfectly competitive firms operating in one of the three sectors. In either sector j, firms hire labor, $L_{j,t}$, at a nominal wage $W_{j,t}$, and rent capital, $K_{j,t}$, at a rental rate $R_{j,t}$, to produce their output using a standard Cobb-Douglas production

$$Q_{j,t} = K^{\alpha}_{j,t} L^{1-\alpha}_{j,t}. \tag{24}$$

Perfect competition and free entry ensure that the output price equals marginal cost:

$$P_{j,t} = \left(\frac{R_{j,t}}{\alpha}\right)^{\alpha} \left(\frac{W_{j,t}}{1-\alpha}\right)^{1-\alpha}. \tag{25}$$

Importantly, and in contrast to standard SOE models, factor markets are segmented such that output prices potentially differ across sectors.

EXPORTS. — Producers of traded goods export part of their output. We assume that wholesalers abroad import varieties from the SOE to assemble them with other varieties according to a production function similar to (22). Producers of traded goods therefore face an export demand curve for their product given by

$$Q^{exp}_{T,t} = P^{-\psi}_{T,t} V^{*}, \tag{26}$$

where V^* is a demand shifter that we assume to be constant.

C. Fiscal Policy

The government has access to two fiscal instruments: purchases of the government consumption good, G_t, and lump-sum transfers, T_t. We assume that a share γ_G of G falls on traded goods, i.e. $G_{T,t} = \gamma_G G_t$ and $G_{N,t} = (1 - \gamma_G)G_t$. In our calibration, we set the value of γ_G relatively low and discuss the role of this home bias in our quantitative results.

Following Miyamoto, Nguyen and Sergeyev (2018), we characterize government spending policy by a steady-state ratio of government spending over GDP, and by the path of government spending after a government spending shock. We assume that government spending after a spending shock equals the point estimate of the empirical impulse responses for the first 16 quarters; then government spending reverts to its steady state according to an AR(1) process. Formally, the percent deviation from steady state of government spending, denoted by $\widehat{G}_t$, follows

$$\widehat{G}_t = \widehat{G}_t^{emp} \quad \text{for } 0 \leq t \leq 15 \quad \text{and} \quad \widehat{G}_t = \rho_G \widehat{G}_{t-1} \quad \text{for } t > 15, \tag{27}$$

where $\widehat{G}_t^{emp}$ is the empirical point estimate.[27] We assume that lump-sum transfers always adjust to satisfy the government budget constraint.

D. Definitions

With an eye on comparing the response of the model to government spending shocks to the response observed in the data, we define the model counterparts to the economic variables studied in the empirical section.

The CPI is defined by the aggregate consumption retail price index, (12). The GDP deflator is the ratio of nominal GDP to real GDP. Nominal GDP is defined as value added evaluated at market prices, which in our model is equal to

$$NGDP_t \equiv P_t^{ret} C_t + P_t I_t + P_{N,t} G_{N,t} + P_{V,t} G_{T,t} + P_{T,t} Q_{T,t}^{exp} - Q_{T,t}^{imp}. \tag{28}$$

We choose steady-state prices as the base year prices to calculate real GDP. In our model, GDP is equal to GVA because the model abstracts from any changes in the VAT. In line with our empirical section, we define the terms of trade as the price of exports divided by the price of imports (which is equal to 1),

$$ToT_t \equiv P_{T,t}. \tag{29}$$

Real net exports are defined as exports less imports, evaluated at constant steady-

[27] Recall that our empirical estimates are bi-annual. To implement this formulation we assume the same value across the two quarters within a semester.

state prices:

$$NX_t \equiv P_T Q_{T,t}^{exp} - Q_{T,t}^{imp}. \tag{30}$$

On the consumption side, retail prices and private consumption of traded and non-traded goods are given by $P_{T,t}^{ret}$, $P_{N,t}^{ret}, C_{T,t}$, and $C_{N,t}$. On the producer side, the empirical counterpart of industries with low export shares includes both non-traded goods (N) and distribution services (D). We therefore calculate e.g. the nominal wage in the non-traded sector as a weighted average, $\frac{W_N L_N W_{N,t} + W_D L_D W_{D,t}}{W_N L_N + W_D L_D}$. Wages of traded goods are simply given by $W_{T,t}$.

E. Calibration

The model is solved with a first-order approximation of the equilibrium conditions around the non-stochastic steady state. Table 2 displays the values we choose for the model parameters, and we discuss the most relevant ones hereafter.

We choose a Frisch elasticity of labor supply of $\eta = 1$, which is a standard value in the macro literature and corresponds to the estimate reported in Barsky et al. (1997). The elasticity of substitution of labor supply across sectors, $\frac{1}{\xi}$, governs the comovement of relative labor and relative wages across sectors. In Online Appendix Section B.1, we find that empirically relative wages and labor respond by the same amount to a government spending shock. This suggests a value of $\xi = 1$, implying that labor supplied to the various sectors are neither complements nor substitutes, i.e. labor enters separably in the utility function: An increase in the wage in a given sector raises labor supply in that sector without having a direct effect on labor in the other sectors.[28] Our estimate of $\xi = 1$ exactly corresponds to the estimate by Horvath (2000) who estimates this value in a model of US 2-digit SIC sectors and also corresponds to the case considered by Calza, Monacelli and Stracca (2013).

Several studies report empirical support for limited capital mobility across either firms or sectors (see e.g. Ramey and Shapiro, 2001; Caballero and Engel, 1999). But we are not aware of any studies estimating investment adjustment costs at the sectoral level. To be conservative and to acknowledge that investment is more volatile at the industry level than at the aggregate level, we choose a value for the investment adjustment cost ($f'' = 1$) that is substantially smaller than values typically estimated in aggregate DSGE models.[29]

The elasticity of substitution across domestic and foreign traded goods is set to $\psi = 2$, in line with the evidence provided in Feenstra et al. (2018).[30] We

[28]The case of $\xi = \frac{1}{\eta}$ can be thought of as a household that has 3 types of workers, a teacher, a factory worker and a cashier, that can only work in their respective sector, but cannot switch profession.

[29]In DSGE models with investment adjustment costs at the aggregate level, Christiano, Eichenbaum and Evans (2005) estimate $f'' = 2.48$, Del Negro et al. (2013) estimate $f'' = 4.01$ and Brave et al. (2012) estimate $f'' = 7.84$.

[30]Elasticities typically used in international RBC models are somewhat lower, ranging between 0.5

Table 2—: Calibration

Parameter		Value	Target / Source
Preferences			
Discount factor	β	0.995	Real interest rate of 2%
Elasticity of intertemporal substitution	σ	0.50	Heathcote and Perri (2002) Backus, Kehoe and Kydland (1994)
Elasticity of labor supply	η	1	Barsky et al. (1997)
EoS of labor across sectors	$\frac{1}{\xi}$	1	see Section B.1 in Online Appendix, Horvath (2000), Calza, Monacelli and Stracca (2013)
Share of hand-to-mouth consumers	χ	0.50	Galí, López-Salido and Vallés (2007) Mankiw (2000)
Production			
Capital share	α	0.32	Investment-to-GDP ratio: 0.24 (Eurostat, 1999–2018)
Depreciation rate	δ	0.02	Standard value
Investment adjustment cost	f''	1	Value on lower side of aggregate estimates (Christiano, Eichenbaum and Evans, 2005)
Calvo price stickiness	θ	0.80	Alvarez et al. (2006)
Trade			
Trade demand elasticity	ψ	2	Feenstra et al. (2018)
Share distr. services in traded good	ν	0.40	Goldberg and Campa (2010)
EoS traded good and distr. services	ζ	0.25	Berka, Devereux and Engel (2018)
Share traded retail good in consumption	γ_C	0.67	Share of goods with $\geq$ 10% import share (see Table A2 in Online Appendix)
Share dom. goods in wholesale good	ω	0.28	Import share of consumption: 0.29
Share wholesale good in investment	γ_I	0.51	Import share of investment: 0.37
Share wholesale good in gov't purchases	γ_G	0.15	Import share of gov't purchases: 0.11
Fiscal Policy			
Share of gov't purchases in GDP	G	0.22	Eurostat (1999–2018)
Persistence gov't purchase shock	ρ_G	0.97	Standard value

Note: EoS: elasticity of substitution.

follow Berka, Devereux and Engel (2018) and choose a low value for the elasticity of substitution between wholesale goods and distribution services ($\zeta = 0.25$) to reflect the fact that distribution services are far from being a perfect substitute for the actual consumption good.

The share of distribution services in the final retail good is set to $\nu = 0.4$, which is the average value for our sample reported in Goldberg and Campa (2010). Two thirds of all retail goods in our sample have an import share of more than 10% (see Table A2 in the Online Appendix). We take these goods as the empirical

and 1.5. These numbers refer to the elasticity between the whole set of produced goods (including non-traded goods) in one country compared to the whole set of produced goods in another country. We focus only on the set of traded goods, for which the trade elasticity is arguably larger. As shown in Feenstra et al. (2018), the relevant elasticity in our case is the "macro" elasticity between home and import goods, which they estimate to be lower than the "micro" elasticity between foreign sources of imports.

counterpart of our traded consumption goods and therefore set $\gamma_C = \frac{2}{3}$.

The shares of the domestically produced traded good in the wholesale good, (ω), as well as the share of the traded good in overall investment (γ_I) and government purchases (γ_G) are set to match the average (direct and induced) import shares for each demand component reported in Bussière et al. (2013).[31] These are 0.11 for government purchases, 0.29 for consumption goods and 0.37 for investment goods, implying an average import share of 0.27.[32]

IV. Model Results

We start our analysis by considering the model's response to an increase in government spending. As with the data, we calculate dynamic net present value multipliers to make the model-data comparison easier.

A. Benchmark Results

Figure 9 displays the model results (black line) along with the empirically estimated responses from the data (blue line). Overall, the model fit is rather good. In most cases, the model response lies within the confidence intervals of the data response. The model correctly predicts that spending increases are inflationary, both in terms of retail price inflation and the GDP deflator, because an increase in G raises prices through higher factor costs. The model correctly predicts an output multiplier of around 1 and only slightly overpredicts the net export multiplier (around -1.7 vs. -1.4). As in the data, the terms of trade move little and the net export response is mostly driven by an increase in imports rather than a fall in exports. The largest discrepancy between model and data is the lack of persistence in the model: In the data, the multipliers for output, imports and net exports build up over time, whereas the response in the model is more immediate.

Figures 10 and 11 display relative price and quantity movements at the product and industry level. For the model, we calculate multipliers separately for the non-traded and the traded good and compare them to the empirical multipliers for a completely non-traded good and a typical traded good. We then overlay the model responses on top of the estimated responses from the data. At the product level (Figure 10), the model correctly predicts the differential response of retail prices, with retail prices of non-traded goods responding substantially more than traded goods' prices and this difference also increasing over time. This relative price response goes along with expenditure switching of private consumption from non-traded goods towards traded goods, as observed in the data. While our model

[31]The induced import share measures the share of imports in total inputs used by suppliers of products bought by the government.

[32] A more thorough analysis of the input-output tables reveals that the low import share for government purchases is driven by the government buying products that *generally* have low import shares, as opposed to the government exhibiting a particularly strong home bias within each product category. This is in line with our assumption that differences in import shares across demand categories are due to differences in the share of demand falling on non-traded goods.

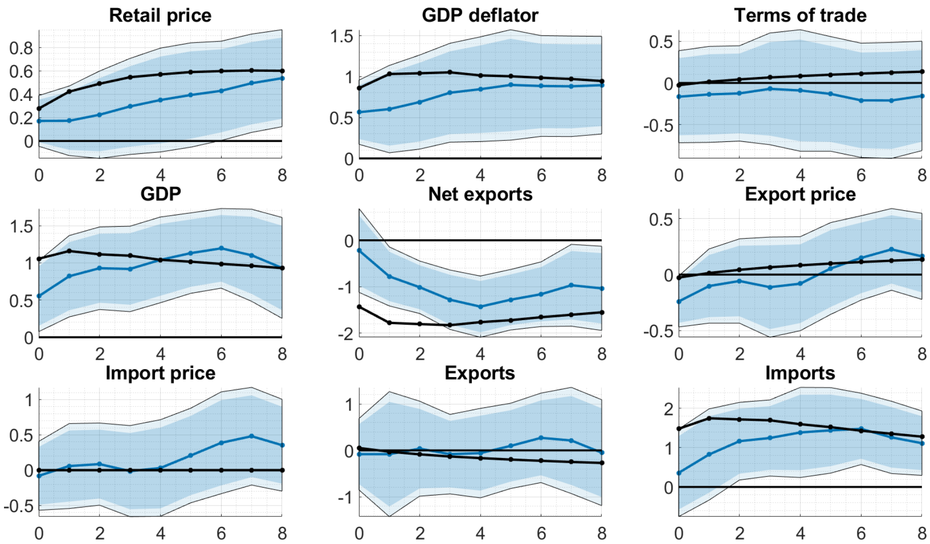


Figure 9. : Government Spending Multipliers: Data vs. Model

Note: See Figure 5. The blue line is the response in the data. The black line is the government spending multiplier derived from the model in response to a one-time increase in government spending.

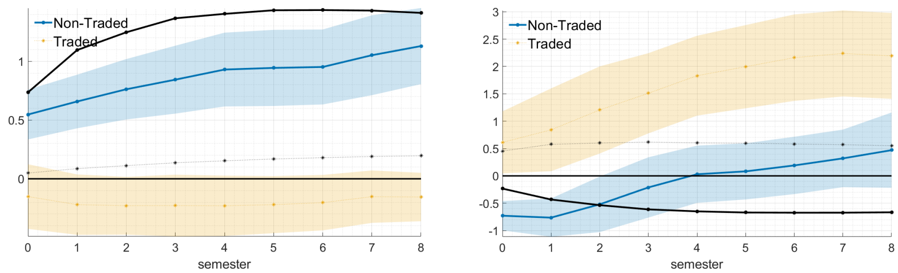
underpredicts the overall rise of consumption over time, it matches quite well the degree of expenditure switching in response to relative price changes. That is, our choice to set the elasticity of substitution between non-traded and traded goods to one yields a realistic degree of expenditure switching.

Our baseline model predicts reasonably well price and wage movements at the industry level in response to a positive spending shock (Figure 11). Similar to retail prices, the GVA deflator and wages move less in the traded sector than in the non-traded sector. The weak response of traded retail prices in the model is driven by two forces: (i) they rely more on imports and import prices do not react to spending shocks, and (ii) they rely on domestically produced traded goods whose production prices move little because government spending mostly falls on non-traded goods and therefore raises factor prices mostly in that sector.

B. Squaring Model and Data: Investigating the Mechanism

We now consider model variations to quantify the role of each feature in reconciling model predictions and empirical findings. Compared to a plain vanilla model, our model features (i) home bias in government spending, (ii) imperfect factor substitutability across sectors and (iii) distribution services for traded retail goods.

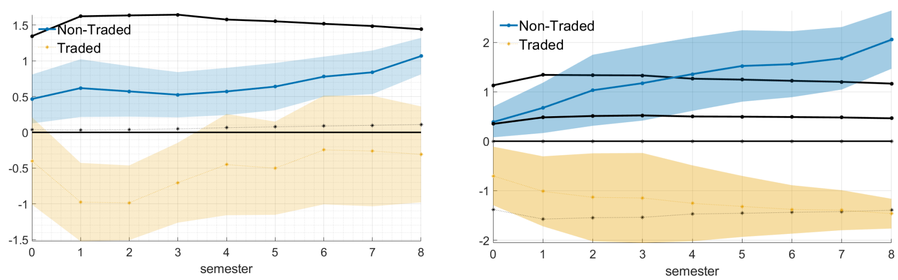
The first row of Table 3 summarizes the empirical government spending multipliers at the 2-year horizon; the following rows display multipliers as predicted by the model. Row 2 is the plain vanilla model with none of the three exten-



(a) Retail Prices (b) Real Consumption

Figure 10. : Multipliers at the Product Level: Data vs. Model

Note: See Figure 6. The colored line is the response in the data. The black line is the response in the model.



(a) GVA Deflator (b) Nominal Wage per Employee

Figure 11. : Multipliers at the Industry Level: Data vs. Model

Note: See Figure 7. The colored line is the response in the data. The black line is the response in the model.

sions. We then add incrementally the three extensions so that row 5 displays our benchmark model: We make the home bias in government spending stronger, we restrict factor substitutability across sectors and finally account for distribution services. When we adjust the home bias in government spending, γ_G, we also adjust the import share of the traded good, ω, to ensure that the economy's overall import share remains unaffected. The model without separate distribution services replaces these services by the non-traded good in the production function of the traded retail good (20). Perfect factor substitutability is achieved by setting $\xi = 0$ and assuming a common, economy-wide capital stock that firms from all sectors can rent capital from.

The plain vanilla model (row 2) replicates the standard view of the effect of government spending on the real exchange rate and net exports (see e.g. Galí, López-Salido and Vallés, 2007). Retail prices increase and net exports substantially deteriorate. This real exchange rate appreciation goes along with a terms

Table 3—: Alternative Model Specifications: Spending Multipliers

	Aggregate Multipliers				Relative Multipliers			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	P^{ret}	ToT	NX	GDP	$\frac{P_N^{ret}}{P_T^{ret}}$	$\frac{C_N}{C_T}$	$\frac{GVA_N^{defl}}{GVA_T^{defl}}$	$\frac{W_N}{W_T}$
Data								
	0.35	−0.09	−1.43	1.04	1.16	−1.80	1.02	1.26
	[-0.02; 0.72]	[-0.70; 0.52]	[-1.98; -0.88]	[0.56; 1.52]	[0.57; 1.75]	[-2.75; -0.85]	[-0.13; 2.17]	[0.00; 2.52]
Model								
(2): Plain Vanilla	0.28	0.55	−3.44	0.88	0.14	−0.14	0.04	0.00
(3): (2) + Home bias in G	0.37	0.79	−3.70	0.95	0.23	−0.23	0.07	0.00
(4): (3) + Imperfect factor substitutability	0.79	0.11	−2.02	1.14	0.76	−0.76	2.00	1.64
(5): (4) + Distribution services (Benchmark)	0.57	0.08	−1.76	1.04	1.25	−1.25	1.51	1.47
(6): (2) + High trade elasticity	0.10	0.19	−4.36	0.52	0.05	−0.05	0.01	0.00
(7): (2) + Pricing to market	0.36	0.29	−3.05	0.96	0.18	−0.18	0.33	0.00

Note: Table displays the estimated cumulative government spending multipliers at a horizon of 4 semesters in the data and the model. The second row shows the 90% confidence interval of the estimated response in the data. Columns 5 and 6 display the relative price and consumption response of a non-traded good relative to a traded good with an import share of 30%, i.e. the displayed coefficient corresponds to $-0.3 \times m^g$, where m^g is the estimated effect of the interaction term with the import share from regression (4). Similarly, columns 7 and 8 display the relative response of gross value added and wages of a non-traded sector relative to a sector with an export share of 50%, i.e. the displayed coefficient corresponds to $-0.5 \times m^g$, where m^g is the estimated coefficient of the interaction term with the export share from regression (5).

of trade improvement (i.e. export prices rise more than import prices) and a weak increase in the relative retail price of non-traded goods. On the producer side, relative prices and wages remain unaffected. Compared to the data, the plain vanilla model underpredicts the real exchange rate appreciation, but overpredicts the net export response. In addition, the real exchange rate appreciation in the model is driven to a large extent by a terms-of-trade movement, rather than changes in the relative price of non-traded goods, whereas in the data it is non-traded good prices that move the real exchange rate.

One way to bring the model somewhat closer to the data is to re-calibrate the home bias in government spending to reflect its low import share observed in the data (row 3). This leads to a stronger real exchange rate appreciation, which is more consistent with the data. But it overpredicts the response of net exports even more. Most of the real exchange rate appreciation is still driven by the terms-of-trade improvement. Compared to the plain vanilla model, spending falls less on imports and more on domestic goods. This raises labor demand and puts upward pressure on wages and prices. Even though spending mostly falls on non-traded goods, factor mobility ensures that marginal costs equalize across sectors, implying that production costs rise both in the non-traded and the traded sector. This directly translates into higher export prices (and hence a worsening of net exports) and a terms-of-trade improvement, whereas relative prices across non-traded and traded goods are affected much less. The asymmetry of government spending, namely its bias towards non-traded goods, is not sufficient to generate a realistic movement in the real exchange rate and relative prices.

To create a wedge in marginal costs across sectors, we complement the strong home bias in government spending by imperfect factor substitutability (row 4). This brings the relative price and consumption movements in the model closer to those observed in the data: Retail prices rise substantially more, that is the real exchange rate appreciates, whereas the terms of trade remain unaffected. Instead, it is the relative price of non-traded goods that drives the real exchange rate. Intuitively, home bias in government spending together with imperfect factor substitutability imply that wages and marginal costs rise more in the sector where government purchases fall. As a result, government spending puts little pressure on production costs in the traded sector and on export prices. The economy therefore remains competitive with little expenditure switching from the domestically produced traded good to the traded good produced abroad. That is, exports decline less compared to the plain vanilla case and imports go up less, as well. This drastically reduces the effect of government spending on net exports, cutting it by almost half. At the same time, we also observe that the GDP multiplier increaeses somewhat.

While this version of the model is able to replicate the movements in relative GVA deflators and wages across sectors, it still underpredicts the increase in the relative price of non-traded good. This stems from the fact that we assume that marginal costs in distributions services—which account for 40% of the retail price of traded goods—go hand-in-hand with marginal cost developments in the non-traded sector. This pushes up the retail prices of traded goods. If, instead, we consider distribution services as a separate sector and take into account that government purchases do not fall on distribution services (row 5), we are able to match the relative price movements of retail prices quite well.

In sum, it is the combination of home bias in government spending and imperfect factor substitutability that replicates the empirical finding of real exchange rate movements driven by the relative price of non-traded goods rather than the terms of trade.

C. Alternative Mechanisms

We briefly discuss whether alternative mechanisms might account for the muted response of the terms of trade: a higher trade elasticity, pricing to market due to strategic complementarities across traded goods, and exporters relying on imports.

A higher trade elasticity. — Our benchmark calibration sets the trade elasticity to 2 in line with evidence provided in Feenstra et al. (2018). The trade literature has identified larger long-run elasticities in the range of 4 - 10 (see e.g. Fontagné, Guimbard and Orefice, 2019; Broda, Greenfield and Weinstein, 2006). Row 6 of Table 3 displays results for the plain-vanilla model if we set the trade elasticity to $\psi = 10$. This model generates a more muted response of the terms of trade, moving the model's response closer to the observed empirical response. But it also implies stronger expenditure switching and hence a stronger but counterfactual net export response, driven by a stronger but counterfactual fall in exports. The puzzle unveiled by our empirical findings is that the weak response in the terms of trade goes along with a weak response in exports. Simply assuming a high trade elasticity cannot resolve this puzzle.

Pricing to market. — Amiti, Itskhoki and Konings (2014, 2016) emphasize that firms might be reluctant to pass-through changes in production costs to consumers if they face competition from other firms. This could explain why we observe a muted response of export prices in response to a government spending shock. To investigate its role, we augment the plain-vanilla benchmark by a standard pricing-to-market model, based on non-CES demand (Kimball, 1995) and variable markups, where producers potentially set different prices in their domestic and export markets (see Online Appendix Section B.3). Our calibration assumes that producers put a 45% weight on their competitors' prices (as opposed to their own marginal costs), which is at the upper range of values reported by Amiti, Itskhoki and Konings (2016).

As can be seen in row 7 of Table 3, the model generates indeed a muted response of the terms of trade, but the effect is quantitatively too small. Pricing to market also fails to account for other empirical patterns that our analysis has revealed: in particular the muted response of traded good retail prices as well as the increase in relative movement of wages. While it is not surprising that pricing to market has little bearing on relative wages, one might expect it to have an impact on the retail price of traded goods. After all, with pricing to market domestic producers of traded goods do not raise their prices one-for-one with higher production costs, both in their export market and at home where they are competing with foreign exporters. But by the same token, imports become more expensive as foreign exporters take advantage of a higher price level in the small open economy and raise their prices. These two effects wash out once we consider the aggregate retail price of traded (domestically produced and imported) goods, generating a similar response of traded good retail prices as in the plain vanilla model. Pricing to market therefore cannot explain why non-traded prices rose much more than traded good prices.[33]

High import content of exports. — Finally, the muted terms-of-trade response could be a result of exporters being also importers, so that their input costs increase less than for non-exporters when fiscal expenditures increase. Data from

[33]This result should not be seen as evidence against pricing to market: Adding pricing-to-market behavior to our benchmark model has only a negligible effect because imperfect factor substitutability keeps marginal costs in the traded sector (which is the one that is exposed to foreign competition) unresponsive to spending shocks. Pricing to market only has bite if marginal costs differ across competitors. In other words, while pricing to market is not a necessary feature of the model, the data does no reject the presence of pricing to market when we look at the data through the lens of the model.

the OECD Trade in Value Added database indicate, for the countries in our sample, an import content of exports of roughly 25%. A back-on-the-envelope calculation suggests that this should offset exporters' increase in marginal costs (and hence their prices) by 25%, which would not sufficiently attenuate the response of the retail price of traded goods and the terms of trade. In combination, the pricing to market and a high import content of exports might have a bigger impact, but they offset each other to some extent: Pricing to market only matters if exporters experience a change in their marginal costs, but assuming exporters to be importers reduces their change in marginal costs in response to a government spending shock.

D. Output Cost of Correcting Current Account Imbalances

We can relate our findings to the policy debate on correcting current account imbalances through fiscal policy. As discussed, the hope underlying some of the austerity packages implemented after the Great Recession was that fiscal policy, similar to exchange rate movements, would lead to relative price movements that move the current account. The larger these relative price movements, so the argument, the lower the output cost of correcting external imbalances. Our empirical results suggest that the output costs of correcting current account imbalances through government spending cuts were substantial: Assuming a trade share of roughly a quarter, improving the current account by 1 euro would require a cut in government spending of $(0.25 \times 1.43)^{-1} = 2.8$ euros, leading to a drop in GDP of 2.8 euros. As observed in Figure 1a, by 2009, Greece, Ireland, Portugal and Spain had accumulated external debt amounting to about 100% of GDP. A quick back-on-the-envelope calculation that abstracts from interest payments suggests that reducing external debt to 60% over 10 years would imply output losses of more than 10% per year.[34] This is in contrast with the plain vanilla model that, thanks to relative price movements and expenditure switching, would predict a lower GDP cost of about $(0.25 \times 3.44)^{-1} \times 0.91 = 1.1$ euros for every euro of net export improvement, or a 4.5% output loss per year. Our model suggests that the main culprit for the high output cost of correcting current account imbalances is a lack of factor substitutability. One interpretation of these results would therefore be that structural reforms that improve factor substitutability across sectors would help make fiscal policy a more effective tool in correcting external imbalances in a monetary union. Alternatively, cyclical fiscal policy could focus on adjustments to the part of government spending that falls on traded goods, $G_{T,t}$, rather than general G. Such a policy would generate a net export multiplier of -3.22 and an output multiplier of 0.6 (not reported in the Table), implying an output cost of correcting net exports of $(0.25 \times 3.22)^{-1} \times 0.6 = 0.75$ euros for every euro of net export improvement, or a 3% output loss per year. That

[34]Roughly speaking, bringing debt down to 60% over 10 years would require a current account improvement of 4% per year, which would translate into an output loss of $4\% \times 2.8 \approx 11\%$.

being said, only 15 percent of government spending falls on traded goods, which strongly restricts this option.

V. Conclusion

Economic adjustment programs imposed during the European debt crisis recommended domestic demand tightening through government spending cuts as a way not only to reduce public debt and lower interest rates on government bonds, but also to bring down inflation, strengthen external competitiveness and improve the current account. More recently, there have been calls on Germany for a fiscal expansion to reduce its external surplus and help the periphery countries that are pursuing austerity. At the core of these recommendations lies the assumption that fiscal policy can alter the real exchange rate and influence the current account through expenditure switching.

Testing these predictions in a panel of twelve euro area countries spanning 20 years of data, we find support for the view that a spending cut indeed is deflationary and leads to a real exchange rate depreciation. Yet this fall in prices is surprisingly asymmetric: Retail prices of non-traded goods fall substantially more than prices of traded goods, which basically stay flat. Similar patterns in relative prices can also be found for wages and GVA deflators. As a result of these price movements, we observe what we call asymmetric expenditure switching: Domestic consumers switch towards non-traded goods, whereas the demand for traded goods, either by domestic or foreign consumers is muted. This implies that, following a government spending reduction, net export dynamics are mostly driven by imports rather than exports.

We show that these empirical findings are at odds with predictions from standard small open economy models that emphasize real exchange rate movements driven by changes in terms of trade. A few extensions are key to bring the model closer to the data: Accounting for government spending to fall mostly on non-traded goods (as observed in the data), a spending cut pushes downward pressure on factor prices in the non-traded sector. To avoid factors prices from equalizing across sectors, the model requires a sufficient degree of market segmentation, where neither labor nor capital can freely flow across sectors. Distribution services help further insulate the dynamics of traded product prices from non-traded ones. Taking these frictions into account substantially raises the output cost associated with current account adjustments and are therefore key for policy makers and researchers alike in predicting the effect of fiscal policy on current accounts. That being said, our analysis does not analyze how these frictions shape the welfare effects of fiscal policy and we leave this question for future research.

What are the implications of our model beyond studies of government spending shocks? Limited labor substitutability is likely to matter for any shock that hits some sectors more than others. In the introduction we emphasize a large body of research that builds on the idea of limited factor substitutability across sectors to explain e.g. the co-movement puzzle in multi-sector DSGE models. However, other models precisely rely on factor price equalization across sectors. Prominently, the Balassa-Samuelson effect rationalizes how an increase in traded-good productivity appreciates the RER through rising wages in the non-traded sector. Using data for the euro area Berka, Devereux and Engel (2018) find indeed empirical evidence for such an appreciation in response to higher productivity in the traded sector at business cycle frequency. In the Online Appendix (Section B.2), we show that our model generates a similar relationship, although via a different mechanism. In the presence of incomplete financial markets and / or hand-to-mouth consumers, an increase in productivity in the traded-good sector raises income and consumption, which in turn leads to an increase in non-traded good prices and an RER appreciation. Hence, collecting further empirical evidence to better discriminate between these explanations is a fruitful avenue for future research.

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