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

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PRELIMINARY

Abstract

This paper studies the effects of fiscal policy on net exports, the terms of trade and expenditure switching. Using data on government spending and consumption taxes for twelve euro area countries over 1996 to 2018, it shows that fiscal austerity shocks improve net exports. This improvement in the trade balance is driven by falling imports while exports do not respond; export and import prices co-move and the terms of trade does not deteriorate in response to an austere shock. The empirical evidence confirms asymmetric expenditure switching, as domestic consumers switch towards domestically produced goods while foreign consumers fail to do so. In a second step, we rationalize these findings in a multi-product small-open DSGE model that features GHH preferences, a non-traded consumption good and pricing to market.

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1 Introduction

The introduction of the euro was intended to foster economic ties among the members of the monetary union. Indeed, 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 several sectors of the economies of the periphery. The global financial crisis and the imbalances developed in the first decade of the euro area triggered the euro area debt crisis.

The adjustment to current account and fiscal imbalances in member countries of a monetary union must necessarily rely on fiscal policy, as monetary policy is common to all union members and an exchange rate devaluation relative to other member countries is not available. Media and policy circles alike have suggested that GIIPS countries rely on fiscal devaluations as proposed by Farhi et al. (2013), namely on revenue-neutral changes in the value-added tax (VAT) and the payroll tax that mimic the effects of an exchange rate devaluation. 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. 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 domestic 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 and thereby improves net exports.

The case for fiscal austerity and internal devaluation for members of a monetary union with external and internal imbalances has been heavily debated since the beginning of the debt crisis in the euro area. A large body of recent research has brought new evidence on the effects of fiscal policy on output. However, we know little about how fiscal policy affects the trade balance, whether the adjustment of relative prices, such as the terms of trade and the real exchange rate, actually takes place and the extent of expenditure switching following a fiscal shock.

The goal of our paper is to study the effects of fiscal policy 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. Our analysis explicitly accounts for the fact that different final products have different import shares. Goods and services with lower import share are likely to respond more to domestic fiscal developments than goods and services with higher import share, thereby generating a change in relative prices that is at the heart of the expenditure switching mechanism.

We focus on a sample of twelve countries that adopted the euro early on, for which we have collected data for more than 20 years (1996 to 2018).[1] Retail inflation data comes from the Harmonized Index of Consumer Prices (HICP), which breaks down the aggregate consumption basket into 90 categories. We combine this data with information from national input-output tables to calculate import shares for each of these consumption categories and countries in our sample. In this step, we exploit a new data source, a detailed input-output table for the Danish economy that allows us to link inputs to specific consumption categories.

We consider two measures of fiscal policy: government spending and consumption tax rates. We use professional forecasts by the OECD on government spending to correct for anticipation and extract unanticipated shocks. We then use local projections to estimate cumulative fiscal multipliers for our variables of interest.

Our empirical analysis suggests that fiscal austerity improves net exports. A reduction in government spending of 1 percent of GDP generates a peak net exports cumulative multiplier of 1.75 after two years; the peak of the cumulative multiplier of an increase in consumption taxes of the same size is almost 3 after 3.5 years. While consumption taxes are more effective in raising net exports for the same improvement of the government budget, they are far more recessionary than government spending; as a result, the empirical output cost of improving net exports is twice as large for consumption taxes.

When we look separately at exports and imports, we find that the cumulative multiplier of exports is zero at all horizons while for imports it is significantly different from zero (positive for government spending and negative for consumption taxes) and larger than the real GDP multiplier. These findings suggest that exports do not improve in response to fiscal austerity while imports fall and are solely responsible for the improvement in net exports. The larger response of imports relative to real GDP can also be interpreted as (indirect) evidence of expenditure switching toward domestically produced goods and services.

Looking at prices, we find that export and import prices display a surprising co-movement in response to austerity: the multipliers are zero in the short run and peak at 0.5 after 3.5 years in response to a government spending and 2 after 3.5 years in response to a consumption tax increase. As a result, the terms of trade, which we define as the price of exports relative

[1] These countries are Austria, Belgium, Germany, Finland, France, Luxembourg, the Netherlands, Greece, Italy, Ireland, Portugal and Spain.

to imports, does not deteriorate in response to austerity. This *missing terms-of-trade deterioration* is puzzling because domestic producer prices respond significantly to fiscal policy. Overall, the empirical analysis points to an improvement in net exports driven by the demand effect of austerity, namely by the fact that austerity is recessionary, and to *asymmetric expenditure switching* in the sense that domestic consumers switch towards domestically produced goods but foreign consumers do not. Further evidence of the latter effect comes from our product-level regressions, which document a reduction in the relative price of non-traded to traded goods following a cut in government spending.

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 Gali and Monacelli (2005) with some extensions. In particular, we allow for Greenwood et al. (1988) preferences, a non-traded consumption good and government spending with a bias on such non-traded good, and non-CES demand as in Kimball (1995) to generate variable markups and pricing to market. The model goes some way to explain the puzzling behavior of export and import prices, especially with pricing to market. Pricing to market helps rationalize the weak terms of trade response despite movements in underlying marginal costs. In a counterfactual exercise without pricing to market, we show that the output costs of correcting current account imbalances through fiscal policy would have been 20 percent lower if the terms of trade fully reflected the changes in marginal costs.

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 2. We present our empirical results in Section 3. We present the model in Section 4 and discuss our results in Section 5.

1.1 Literature

Our paper relates to a large literature that estimates the effects of fiscal policy on economic activity – see Ramey (2011) and Ramey (2018) for comprehensive surveys. Our approach to identify fiscal policy shocks builds on Blanchard and Perotti (2002) in assuming that discretionary fiscal policy does not respond to economic conditions within a period; as in Auerbach and Gorodnichenko (2012b) and Miyamoto et al. (2018), we use professional forecast information to eliminate anticipated shocks. Two features distinguish our paper from many in the existing literature. First, our measure of fiscal policy includes government spending as well as consumption taxes.[2] Second, our focus is on the effects of fiscal policy on prices, the terms of trade and the current account.

Within this empirical literature on the impact of fiscal policy, only few studies have explicitly analyzed the reaction of inflation measured as the percentage change in the GDP deflator. One of these is Perotti (2004) that extends the structural VAR approach presented in Blanchard and Perotti (2002) to a panel of OECD countries. He finds that government spending typically has small effects on inflation. The findings in Auerbach and Gorodnichenko (2012a), based on the local projection method introduced by Jordà (2005), suggest that this result might hide variation across recessionary and booming periods. They conclude that generally, government spending shocks lead to inflationary contemporaneous responses in expansions and deflationary responses in recessions, but these effects are only weakly statistically significant. We consider different aggregate domestic price measures (the GDP deflator and the CPI), product-specific prices as well as the terms of trade.

In addition to the literature that solely relies on time-series variation in government spending, a small literature has recently developed that exploits cross-sectional variation in fiscal policy in a currency union. This literature typically focuses on output to calculate so-called “local multipliers. For example, Nakamura and Steinsson (2014) exploit cross-state variation in military spending for the U.S. to estimate a GDP multiplier of approximately 1.5. Auerbach et al. (2019) estimate fiscal multipliers and spillovers across cities in the United States. As pointed out in Chodorow-Reich (2019), the size of these multipliers and spillovers across locations largely depends on expenditure switching and the response of trade flows and relative prices, which are not observed at sufficient detail at the subnational level in the United States. We address this issue by shifting our focus on the euro area, where high-quality at the subunion level is available and allows us to shed light on the response of trade flows and relative prices to fiscal shocks.

In that sense, we also connect to Blanchard et al. (2016) and House et al. (2017), who point out that countries in the euro area that implemented more “austere fiscal policy in the aftermath of the Great Recession experienced both less inflation and less economic activity. Both studies only look at overall inflation and ignore the dynamic patterns of the response. Using the rich level of detail provided by the European CPI data, we follow up on these empirical findings by looking at the good-level response of inflation at a sub-annual frequency

[2] Riera-Crichton et al. (2016) study the impact of VAT changes in 15 industrialized economies, but do not consider government spending.

and relate this response to a good's import share. We show that price adjustment take time and, in response to a government spending shock, are stronger for non-traded goods.

Our paper also contributes to the literature that studies the relationship between government spending and real exchange rate. The findings of this literature are mixed. Ravn et al. (2007) and Monacelli and Perotti (2010) suggest the existence of a "real exchange rate puzzle" because they find that government spending cuts lead to real exchange rate appreciations in a sample of floating exchange rate countries. Ilzetzki et al. (2013a) and Auerbach and Gorodnichenko (2012a) also report ambiguous results. Our empirical findings are consistent with a real exchange rate depreciation following government spending cuts; our results are in line with those in Born et al. (2013) and Beetsma et al. (2008). Similarly, Canova and Pappa (2007) find that deficit-financed expansionary fiscal disturbances increased price differentials in line with real exchange rate appreciations. Unlike most of these studies, we study fiscal policy within a currency union and therefore in the absence of nominal exchange rates; moreover we include the terms of trade and the ratio of non-traded to traded prices in our analysis, thereby capturing several facets of relative price movements.

Several papers have emphasized the importance of non-traded inputs in explaining price dispersion across countries – see Engel (1999), Crucini et al. (2005) and the relevant literature in Burstein and Gopinath (2014). Most contributions in this area consider flexible exchange rate economies. An exception is Berka et al. (2018), that explicitly consider euro zone real exchange rates and relate these price differences to shocks to total factor productivity and the labor wedge. We complement these findings by studying how fiscal shocks affect domestic prices (consumer and producer as well as tradable and non-tradable) and relative prices.

Our theoretical model emphasizes the role of pricing-to-market behavior in the transmission of fiscal austerity in open economies. We therefore connect to an active literature in international finance that has developed models of pricing to market and variable markups to rationalize the incomplete pass through of exchange rates into import and export prices (see Burstein and Gopinath, 2014, for an overview). In contrast to this literature, we emphasize that pricing-to-market behavior amplifies the transmission of domestic rather than exchange rate shocks.

2 Methodology and Data

In this section, we analyze the empirical relationship between fiscal policy, relative prices and the trade balance in twelve countries of the European Union between 1996 and 2018.[3]

2.1 Measuring Fiscal Policy

We consider two measures for fiscal policy: government consumption and consumption tax rates. Measuring the effect of fiscal policy 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 fiscal policy that is unrelated to contemporaneous economic conditions, we follow Blanchard and Perotti (2002) and subsequent papers (e.g Auerbach and Gorodnichenko, 2012a; Ilzetzki et al., 2013b) and assume that fiscal policy 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.[4]

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. 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, 2012a; Born et al., 2013), so as to extract the purely unexpected part.

To implement this strategy, we follow Miyamoto et al. (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 the fiscal policy shocks. To illustrate this approach, we focus on government spending as our fiscal policy tool. We identify unanticipated innovations in government spending by estimating the following regression:

$$\Delta \ln G_{i,t} = \alpha_i^g + \beta_f^g F_{t-1} \Delta \ln G_{i,t} + \beta_{\mathbf{z}}^{\mathbf{g}} \psi(L) \mathbf{z_{i,t-1}} + \varepsilon_{i,t}^g, \tag{2.1}$$

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

[3] Austria, Belgium, France, Finland, Germany, Luxembourg, the Netherlands, Greece, Italy, Ireland, Portugal and Spain.

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

controls. In our specification, we allow for country-specific intercepts to capture differences in average growth rates across countries over the sample period, but we restrict the coefficients β_f^g and $\beta_{\mathbf{z}}^{\mathbf{g}}$ to be the same across countries. We take the estimated residuals, $\hat{\varepsilon^g}_{i,t}$, 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 government spending growth rates, we include the growth rate of real GDP and the unemployment rate in our set of controls for economic conditions. We add two lags of the control variables in the regression.

When implementing this strategy for extracting shocks to consumption tax rates, we face the problem that, to the best of our knowledge, professional forecasts for consumption tax rates do not exist. In our benchmark setup, we therefore assume that consumption tax rate changes were not forecasted and only control for lagged macroeconomic conditions:

$$\Delta\tau_{i,t} = \alpha_i^\tau + \beta_{\mathbf{z}}^\tau \psi(L)\mathbf{z_{i,t-1}} + \varepsilon_{i,t}^\tau. \tag{2.2}$$

Data Sources For government purchases, we take data on nominal final consumption of the general government deflated by the sample-wide GDP deflator.[5] 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.[6]

We measure changes in the consumption tax rate as the difference between consumer price inflation and consumer price inflation measured at constant tax rates. Data on consumer price inflation is provided by the Harmonized Index of Consumer Prices (HICP) that measures the change in retail prices for all countries of the European Union using a common methodology. Eurostat also publishes an HICP at constant tax rates that keeps VAT and excise duties (e.g. on alcoholic beverages, tobacco and energy items) constant. By subtracting this constant-tax-rate inflation from the actual inflation rate, we obtain an implicit measure of the change in

[5]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, 2014; Miyamoto et al., 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.

[6]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.

consumption taxes. One advantage of this measure relative to changes in the standard VAT rate is that it encompasses all consumption tax changes and weights them according to the basket weights of the HICP. 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.[7]

Extracted Shocks Table 1 displays the estimated coefficients and the R^2. Forecasts and lagged controls (plus the country-specific intercepts) explain a reasonable share (51 percent) 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 coefficient when we omit either regressor in equation (2.1). The resulting lower R^2's indicate that both forecasts and macroeconomic controls contain independent information that helps predicting changes in government spending. Changes in consumption tax rates are less well explained by lagged controls: Adding lagged controls to the country fixed effects raises the R^2 by only 7 percentage points. This is may lbe not too surprising because we directly use tax *rates* as the relevant fiscal instrument, as opposed to many previous studies that measure tax *revenues* (see e.g. Blanchard and Perotti, 2002). Tax revenues display a cyclical component that makes them more predictable than tax rate changes.

Figure 1 illustrates the importance of controlling for forecasts and lagged macroeconomic variables. It plots the actual, detrended fiscal policy variable (either government spending or the consumption tax rate) and the cumulative extracted fiscal shocks that control for forecasts and macroeconomic variables for a subset of countries in our sample. The data is normalized to the second semester of 2009 to better visualize the period of austerity policies following the Great Recession. We see that in several countries that are typically labelled as 'austerity countries' (Greece, Portugal, Ireland, Spain and Italy), changes in fiscal policy were unanticipated in 2010 and 2011, but subsequent movements in fiscal policy were either forecasted or captured by lagged macroeconomic controls. That is, only the initial implemented austerity programs came as a surprise in these countries.

To better compare the size and composition of fiscal policy shocks, Figure 2 plots the estimated fiscal policy shocks for both government spending and consumption tax rates for

[7]See the Appendix for more details.

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 fiscal policy across time rather than (potential) variation in the *average* fiscal stance across countries. To make the two shocks visually comparable, we express them in terms of GDP, i.e. we are plotting $\hat{\varepsilon}^g_{i,t}\frac{G_i}{Y_i}$ and $\frac{\varepsilon^\tau_{i,t}}{1+\tau_i}\frac{C_i}{Y_i}$.

The figure reveals that (i) government spending shocks are fairly volatile and display a larger standard deviation than consumption taxes (1.4% vs. 0.14%); (ii) consumption tax increases tend to go along with unexpected reductions in government spending (see e.g. increase in consumption taxes in 2010-2011 in Greece or in 2007 in Germany), but the correlation is somewhat weak (-0.12); and (iii) although several countries implemented fiscal "contractions" during the period 2010 - 2012, there is variation both in timing and size across countries.

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

After having extracted government spending and tax rate shocks, we first estimate the response of fiscal policy variables to the extracted shocks. To this end we estimate a series of regressions at each horizon h:

$$x_{i,t+h} - x_{i,t-1} = \alpha^x_{n,h} + \alpha^x_{t,h} + \beta^x_h shock^g_{i,t} + \gamma^x_h shock^\tau_{i,t} + \beta_{\mathbf{z}}\psi(L)\mathbf{z}_{i,t-1} + \varepsilon^x_{t+h}, \tag{3.1}$$

where $x_{i,t}$ is the log of government spending or the log of the consumption tax rate of country i and $shock^g_{i,t}$ and $shock^\tau_{i,t}$ are the two fiscal shocks proxied by $\hat{\varepsilon}^g_{i,t}$ and $\hat{\varepsilon}^\tau_{i,t}$, respectively (see equations (2.1) and (2.2)). We include two lags of the variable of interest as controls.

Figure 3a shows the response of government spending to $shock^g_{i,t}$ (left panel) and $shock^\tau_{i,t}$ (right panel) of one percent of GDP. An unexpected increase in government spending further raises government spending in the next 8 semesters. This evidence suggests that our extracted shocks mark the beginning of fiscal plans that span several semesters, are typically back-loaded and involve both fiscal tools, as illustrated by the negative response of government spending to a consumption tax shock. This is also consistent with the evidence in Figure 1, which shows that while the introduction of austerity programs in Greece, Spain, Portugal and Ireland was unexpected, the rest of the program was widely anticipated, as emphasized by Alesina et al. (2016). This is to say that while the extracted shock is unanticipated at time t, the response of the fiscal variables from $t+1$ onward is fully anticipated.

The response of the consumption tax rate to $shock^g_{i,t}$ and $shock^\tau_{i,t}$ is reported in figure 3b. Most hikes in the consumption taxes have not been reversed after six years from their introduction.

Next we estimate empirical "multipliers" for various macroeconomic variables. We define multipliers as the average cumulative gain in e.g. output or inflation relative to government spending or consumption taxes 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 and is consistent with the definitions used in Mountford and Uhlig (2009) and Ramey and Zubairy (2014). The cumulative multiplier can be conveniently estimated using the following instrumental variable (IV) regression at each horizon h:

$$\sum_{s=0}^{h}(\log x_{i,t+s} - \log x_{i,t-1}) = \alpha^x_{n,h} + \alpha^x_{t,h} + M^g_h \sum_{s=0}^{h} \frac{G_{i,t+s} - G_{i,t-1}}{Y_{i,t-1}} \qquad (3.2)$$

$$+ M^\tau_h \times \frac{C_{i,t-1}}{(1+\tau_{i,t-1})Y_{i,t-1}} \sum_{s=0}^{h}(\tau_{i,t+s} - \tau_{i,t-1}) + \beta_{\mathbf{z}}\psi(L)\mathbf{z}_{i,t-1} + \varepsilon^x_{i,t},$$

where the instruments for $\frac{G_{i,t+j}-G_{i,t-1}}{Y_{i,t-1}}$ and $\tau_{i,t+j} - \tau_{i,t-1}$ are $shock^g_{i,t}$ and $shock^\tau_{i,t}$. The multipliers M^g_h and M^τ_h can then be interpreted as the percent change in prices or quantities between $t-1$ and $t+h$ for an increase of government spending by 1 percent of output, or 1 percentage point higher consumption tax rates. $\mathbf{z}_{i,t-1}$ is a vector of controls, which include two lags of the dependent variable.

Figure 4 displays the estimated multipliers for seven semesters to extracted government spending shocks. We observe that increases in government spending are inflationary. An increase in government spending amounting to one percent of GDP raises the GDP deflator upon impact by 0.65 percent and by one percent after 5 semesters. Retail prices as measured by the HICP increase less than the GDP deflator and their response is significant at 0.4 percent after 5 semesters. 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. Only a few studies have explicitly analyzed the effect of government spending on prices and with different results.[8] We deflate government spending

[8] Auerbach and Gorodnichenko (2012a) conclude that government spending shocks lead to inflationary contemporaneous responses in expansions and deflationary responses in recessions, but these effects are only

by the euro area GDP deflator to estimate of the impact of an increase in real government spending on the country's GDP deflator; in a SVAR, we could alternatively have accounted for the contemporaneous elasticity of the GDP deflator to a spending shock, as suggested by Perotti (2004). The weaker response of consumer relative to producer prices is in part explained by international linkages and we address this question below. The response of import prices is indeed muted in the short run.

Consistent with this fall in prices, real GDP falls as well, with the multiplier settling around 1.25 after 2 years. The multiplier is somewhat stronger than the average value observed in the recent literature review by Ramey (2018), and might reflect the missing, offsetting monetary policy response in a currency union.

We next shift our focus on the terms of trade and the trade balance.[9] As discussed, within a currency union, shifts in fiscal policy have often been motivated by a desire to move the trade balance in one direction or the other. Austerity measures in wake of the European Debt Crisis were thought to improve the current account by generating an internal devaluation. Similarly, calls on Germany to raise its government spending were based on the hope that this would lower Germany's current account and stimulate growth in other currency member countries. The reaction of export and import prices play a central role in this narrative, as they stimulate expenditure switching between goods produced in different countries.

But the empirical results displayed in Figure 4 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

weakly statistically significant; in Nakamura and Steinsson (2014) the effects are positive but statistically insignificantly different from zero; Perotti (2004) finds that the effects of fiscal shocks on inflation vary across countries but are typically small and not significant. On the other hand, earlier studies by Fatas and Mihov (2001) and Mountford and Uhlig (2009) find a weak negative relationship between an increase in government spending and the GDP deflator. Regarding the real exchange rate, Kim and Roubini (2008), Ilzetzki et al. (2013b) and Ravn et al. (2007) document real exchange rate depreciations in response to higher public spending.

[9] The terms of trade is measured as the ratio of the price of exports to the price of imports; the trade balance is measured as exports relative to imports.

2 percentage points; their response is entirely driven by imports because exports remain unchanged. Together with the missing terms-of-trade response, we can conclude that the reaction of net exports is mostly driven by a domestic demand effect rather than a relative price effect.

Our consumption tax data covers the Value Added Tax (VAT) and other excise taxes on goods and services (such as alcohol and tobacco). The VAT is a general, broadly based tax assessed on all goods and services sold for use of consumption; investment and exports are not subject to the tax while imports are. Nominal GDP is calculated at market prices including VAT. In response to higher consumption taxes (generating higher revenues on impact by one percent of GDP), consumer prices move up on impact by 0.75 percent and almost one percent after seven semesters as shown in Figure 5; the response of the GDP deflator is weaker as only part of domestic production is destined to internal consumption. Standard economic models would predict a terms-of-trade deterioration driven by an increase in import prices (due to the consumption tax) and a reduction in export prices stemming from lower marginal costs. Figure 5 shows that these predictions are not confirmed by the data: both import and export prices increase and the terms-of-trade deterioration is weak and not significant. The increase in export prices is particularly puzzling because the labor cost index (not shown) falls significantly in response to higher consumption taxes.

The cumulative multipliers of real variables are reported in the second row of Figure 5. An increase in consumption taxes is recessionary: The multiplier of real GDP is -0.8 percent on impact and it approaches -2 percent after seven semesters. The multipliers of real imports and real exports are reported as percentage of period $t-1$ real imports and exports, respectively, and not as percentage of GDP. The import multiplier is -1.5 on impact and -3 after seven semesters; the response of exports, on the other hand, is negative and not precisely estimated. Net exports (reported as percentage of period $t-1$ GDP) improve and their multiplier approaches 1.5 percent after seven semester.

Import Shares and Product-Level Inflation Responses In a next step, we look at how prices at the product level respond to aggregate fiscal policy shocks. Our goal is to estimate how price response depends on tradeability and reliance on imported intermediates. To do that, 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 the countries and time periods in our sample (see the Appendix for more details). Overall, there is large variation in import shares across products, with motor vehicles reaching import shares above 50 percent, whereas most services have import shares well below 10 percent. 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) below 50 percent.

To better understand the effect of fiscal policy on current account through price movements, we then run the following regression:

$$\sum_{s=0}^{h}\left(\log P_{i,t+s}^{j,ret}-\log P_{i,t-1}^{j,ret}\right)=(M_h^g+m_h^g\times im_j)\sum_{s=0}^{h}\frac{G_{i,t+s}-G_{i,t-1}}{Y_{i,t-1}}$$
$$+(M_h^\tau+m_h^\tau\times im_j)\times\frac{C_{i,t-1}}{(1+\tau_{i,t-1})Y_{i,t-1}}\sum_{s=0}^{h}(\tau_{i,t+s}-\tau_{i,t-1})+\mathbf{z}_{i,t-1}^{j}+\varepsilon_{i,t}^{j}, \qquad (3.3)$$

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, 2 lags of $P_{i,t+s}^{j,ret}$ and changes in the consumption tax rate for good j. The estimated price response for a good with import share im_j is then $\widehat{M}_h+\widehat{m}_h\times im_j$.

The upper panel of Figure 6 plots the estimated coefficients M_h^g and m_h^g for horizons spanning up to 4 years. 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 (see Figure 4), with the price multiplier reaching 1 after 4 years. The interaction with the import share is negative and statistically significant. For a good with an import share of 50 percent (e.g. motor vehicles), prices respond little (e.g. after 4 years, the multiplier would be: $0.95-1.8\times0.5=0.05$). These results suggest that it is 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 bottom panel of Figure 6 shows the estimated coefficients M_h^τ and m_h^τ. The retail price of purely non-traded goods increases with a multiplier of 0.7 that remains constant for up to 4 years; the interaction with the import share is zero and not significant, suggesting that traded and non-traded products respond similarly to consumption taxes. The fact that the non-traded retail price multiplier remains flat in spite of a significant reduction in the labor cost multiplier suggests an increase in markups.

4 Model

This section develops a small-open economy (SOE) model that can explain some of the main patterns between fiscal policy and prices found in Section 3. As in Gali and Monacelli (2005), we think of the SOE as one of a continuum of economies that together form a currency union.

We introduce four extensions to this well-known SOE framework: First, we allow for Greenwood et al. (1988)-style preferences. Second, we introduce a non-traded final consumption good to relate to our empirical findings on relative price and consumption movements of non-traded to traded goods. Third, we enrich fiscal policy by allowing the government to purchase non-traded goods and raise VAT. Fourth, we allow for non-CES demand as in Kimball (1995). This gives rise to variable markups and pricing-to-market behavior. As we will see, this latter extension is crucial in capturing the muted response of the terms of trade to austerity observed in the data.[10]

The SOE is populated by a representative household, several representative firms (non-traded good producer, traded good producer, wholesaler and a retailer), and a government. We start by discussing the household's problem.

4.1 Households

At date 0, the expected discounted sum of future period utilities for the representative household is given by

$$\sum_{t=0}^{\infty}\sum_{s^t}\pi\left(s^t\right)\beta^t\frac{1}{1-\frac{1}{\sigma}}\left(C\left(s^t\right)-\kappa\frac{L\left(s^t\right)^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}\right)^{1-\frac{1}{\sigma}},$$

where $\beta < 1$ is the subjective time discount factor, σ is the elasticity of intertemporal substitution, η is the Frisch labor supply elasticity, L_t is the household's labor input and C_t is

[10] Burstein and Gopinath (2014) present various models with variable markups, including models of strategic complementarities in pricing in an oligopolistic setup as in Atkeson and Burstein (2008) and the model with non-CES demand presented here. While these models differ in their microfoundations, they all generate a negative relationship between markups and relative prices. Conditional on this relationship, these models are observationally equivalent and our choice of one particular model is driven by its simplicity.

defined as[11]

$$C_t = C_{T,t}^{\gamma} C_{N,t}^{1-\gamma}. \tag{4.1}$$

That is, overall consumption C consists of two consumption goods, a traded good (T) and a non-traded good (N), with γ denoting the weight that the household puts on consumption of the traded good. The consumption goods' nominal retail prices are $P_{T,t}^{ret}$ and $P_{N,t}^{ret}$. Similarly, we assume that the investment good, I_t, consists of both of non-traded ($I_{N,t}$) and traded goods ($I_{T,t}$) that are combined following a similar Cobb-Douglas agreggator as in (4.1) and purchased at the nominal prices $P_{V,t}$ and $P_{N,t}$, respectively.

We adopt the utility function specification introduced by Greenwood et al. (1988) (GHH hereafter) that creates complementarities between consumption and labor, and eliminates the reaction of labor supply to changes in household consumption.

Households supply capital and labor to the producers and in return, earn nominal wages $W_t L_t$ and a nominal return to capital, $R_t K_{t-1}$. Households may also receive profits Π_t from firms and payments from state-contingent bonds, with $b_t(s_{t+1})$ denoting the quantity purchased by the household after history s^t and $a_t(s_{t+1})$ their corresponding nominal price (in units of the union's currency). Finally, households receive lump-sum transfers T_t from the government. Households choose state-contingent consumption sequences, $C_{T,t}$ and $C_{N,t}$, and labor sequences, L_t, to maximize the expected discounted sum of future period utilities subject to a sequence of budget constraints:

$$P_{T,t}^{ret} C_{T,t} + P_{N,t}^{ret} C_{N,t} + P_{V,t} I_{T,t} + P_{N,t} I_{N,t} + \sum_{s^{t+1}} a_t(s_{t+1})\, b_t(s_{t+1}) = W_t L_t + R_t K_{t-1} + \Pi_t + T_t + b_{t-1}(s_t).$$

and the following law of motion for capital:[12]

$$K_t = K_{t-1}(1-\delta) + \left[1 - f\left(\frac{I_t}{I_{t-1}}\right)\right] I_t.$$

The household optimally spends a constant fraction on the traded and the non-traded good

[11] In each period t the economy experiences one event st from a potentially infinite set of states. We denote by s^t the history of events up to and including date t. The probability at date 0 of any particular history s^t is given by $\pi(s^t)$. Unless confusion arises, we write X_t for $X(s^t)$.

[12] We assume adjustment costs in investment as in Christiano et al. (2005), with $f(1) = f'(1) = 0$ and $f''(1) > 0$.

for both the consumption good and the investment good:

$$P_{T,t}^{ret} C_{T,t} = \gamma P_t^{ret} C_t \qquad \text{and} \qquad P_{N,t}^{ret} C_{N,t} = (1-\gamma) P_t^{ret} C_t$$
$$P_{V,t} I_{T,t} = \gamma P_t I_t \qquad \text{and} \qquad P_{N,t} I_{N,t} = (1-\gamma) P_t I_t,$$

where the aggregate consumption retail price index and the aggregate investment price index are

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

The household's Euler equation for purchases of state contingent bonds $b_t(s_{t+1})$ requires

$$\frac{a\left(s^t, s_{t+1}\right)}{P^{ret}\left(s^t\right) C\left(s^t\right)} = \frac{\beta \pi (s^{t+1} | s^t)}{P^{ret}\left(s^{t+1}\right) C\left(s^{t+1}\right)}$$

and the labor supply condition is

$$\kappa L_t^{\frac{1}{\eta}} = \frac{W_t}{P_t^{ret}}.$$

4.2 Firms

Firms employ labor and rent capital to produce either a non-traded or a traded good. The non-traded good is sold either to the government or to retailers, either in form of consumption good or in form of distribution services. Traded goods are differentiated and are either sold to domestic wholesalers or exported. In either market, producers of traded goods face non-CES demand à la Kimball (1995) for their traded good variety, which gives rise to variable markups and pricing to market. That is, producers potentially set different prices for their varieties in their domestic and their export market. Wholesalers combine the domestic varieties with imported goods and sell their output to retailers. Retailers either sell varieties of non-traded or traded consumption goods to the household. Traded consumption goods require distribution services. Retailers are monopolistically competitive and their retail prices are sticky à la Calvo (1983).

We augment this production structure by a value added tax. In accordance with laws in the EU, value added taxes are also paid on imports, but are rebated for exports. These value added taxes are assessed incrementally, based on the increase in value of a product at each stage of production. In our framework, this would suggest that intermediate good producers pay VAT on their value added. Since we assume flexible prices of intermediate goods and VAT rates are identical within markets, producers would simply pass through the tax burden to retailers. The tax incidence among firms is therefore irrelevant for the dynamics of the model. For expositional purposes, we therefore assume that only retailers pay the value added tax on the total value of their output. In accordance with retailer practice in Europe, we assume that the retail price *including VAT* is sticky.

We start in reverse order, first describing the demand for the consumption goods and the problem faced by the retailers. We then discuss the production of the non-traded and the traded good.

4.2.1 Final Demand for Consumption Goods

Households purchase the varieties, indexed by ξ, sold by retailers at price $P^{ret}_{j,t}(\xi)$, with $j = N, T$ indexing the traded or non-traded consumption good. For each consumption good, they assemble the various varieties according to a CES function with ψ_p denoting the elasticity of substitution across varieties. Household's demand for variety ξ of good j is then simply

$$C_{j,t}(\xi) = C_{j,t}\left(\frac{P^{ret}_{j,t}(\xi)}{P^{ret}_{j,t}}\right)^{-\psi_p}, \tag{4.2}$$

where the price index of good j is given by

$$P^{ret}_{j,t} = \left[\int_0^1 \left(P^{ret}_{j,t}(\xi)\right)^{1-\psi_p}\right]^{\frac{1}{1-\psi_p}} \tag{4.3}$$

4.2.2 Retailers

Retailers sell either non-traded or traded goods. Retailers selling traded consumption goods purchase final goods from wholesalers, $F_t(\xi)$, at price $P_{V,t}$, and combine them with distribution services, $D_t(\xi)$, purchased at price $P_{N,t}$, according to

$$C_{T,t}(\xi) = \left(\nu^{\frac{1}{\zeta}} D_t(\xi)^{\frac{\zeta-1}{\zeta}} + (1-\nu)^{\frac{1}{\zeta}} V_t(\xi)^{\frac{\zeta-1}{\zeta}}\right)^{\frac{\zeta}{\zeta-1}}. \tag{4.4}$$

We assume that retailers are monopolistically competitive and therefore charge a markup for their products. The desired price naturally depends on the demand curve (4.2). Cost minimization implies the following demand for the wholesale consumption good and distribution services

$$P_{V,t} = MC_{T,t}(\xi)(1-\nu)\frac{C_{T,t}(\xi)}{F_t(\xi)} \qquad \text{and} \qquad P_{N,t} = MC_{T,t}(\xi)\nu\frac{C_{T,t}(\xi)}{D_t(\xi)},$$

where the nominal marginal cost, $MC_{T,t}$, can then be expressed as

$$MC_{T,t} = P_{V,t}^{\nu} P_{N,t}^{1-\nu}\left(\frac{1}{\nu}\right)^{\nu}\left(\frac{1}{1-\nu}\right)^{1-\nu}.$$

For a retailer selling the non-traded good, the nominal marginal cost is simply the production price of the non-traded good:

$$MC_{N,t} = P_{N,t}.$$

Pricing We assume that retailers have to pay a value added tax to the government. The tax rate $\tau_{j,t}$ is applied to the pre-tax price. Tax payments per sold product are therefore given by $\frac{\tau_{j,t}}{1+\tau_{j,t}}P_{j,t}^{ret}(\xi)$.

The nominal prices of the varieties are adjusted only infrequently according to the standard Calvo mechanism. In particular, there is a probability θ^p that the retailer cannot change its price that period. When a retailer can reset its price it chooses an optimal reset price to maximize the discounted value of profits. We can write the maximization problem of a retailer that can reset its price at date t as

$$\max_{P_{j,t}^{ret,opt}(\xi)} \sum_{h=0}^{\infty}(\theta_p\beta)^h \sum_{s^{t+h}} \pi(s^{t+h}|s^t)\frac{U_{1,t+h}}{P_{t+h}^{ret}}\left(\frac{1}{1+\tau_{j,t+h}}P_{j,t}^{ret,opt}(\xi) - MC_{j,t+h}\right) C_{j,t+h}\left(\frac{P_{j,t}^{ret,opt}(\xi)}{P_{j,t+h}^{ret}}\right)^{-\psi_p}.$$

The solution to this optimization problem requires

$$P_{j,t}^{ret,opt} = \frac{\psi_p}{\psi_p-1}\frac{\sum_{h=0}^{\infty}(\theta^p\beta)^h\sum_{s^{t+h}}\pi(s^{t+h}|s^t)\frac{U_{1,t+h}}{P_{t+h}^{ret}}\left(P_{j,t+h}^{ret}\right)^{\psi_p} MC_{j,t+h}C_{j,t+h}}{\sum_{h=0}^{\infty}(\theta^p\beta)^h\sum_{s^{t+h}}\pi(s^{t+h}|s^t)\frac{U_{1,t+h}}{P_{t+h}^{ret}}\left(P_{j,t+h}^{ret}\right)^{\psi_p}\frac{1}{1+\tau_{j,t+h}}C_{j,t+h}}.$$

Because the variety producers adjust their prices infrequently, the nominal price of the consumption good j is sticky. In particular, using (4.3), this nominal price evolves according to

$$P_{j,t}^{ret} = \left[\theta^p \left(P_{j,t-1}^{ret}\right)^{1-\psi_p} + (1-\theta^p)\left(P_{j,t}^{ret,*}\right)^{1-\psi_p}\right]^{\frac{1}{1-\psi_p}}. \tag{4.5}$$

4.2.3 Production of Non-Traded Goods

Perfectly competitive firms hire labor, $L_{N,t}$, at a nominal wage W_t, and rent capital, $K_{N,t}$, at a rental rate R_t, to produce the non-traded good. The production function is Cobb-Douglas,

$$Q_{N,t} = K_{N,t}^{\alpha} L_{N,t}^{1-\alpha},$$

where $Q_{N,t}$ describes the amount of non-traded goods. Some of these non-traded goods are sold at price $P_{N,t}$ either to the government, or directly to households as investment goods, or to retailers, either as distribution services or as final consumption goods. Perfect competition and free entry ensure that the price of the non-traded good equals marginal costs:

$$P_{N,t} = \left(\frac{R_t}{\alpha}\right)^{\alpha} \left(\frac{W_t}{1-\alpha}\right)^{1-\alpha}.$$

4.2.4 Production of Traded Goods

Traded goods are produced in a two-stage process. In a first stage, monopolistically competitive firms produce differentiated varieties from labor and capital that are subsequently either sold domestically or exported. In a second stage, wholesalers combine domestic and imported varieties to a final good that is then either sold to retailers or directly to households as traded investment goods. Retailers combine the final good with distribution services to sell it to the household.

Producers Each monopolistically competitive firm hires $L_{T,t}(\iota)$ units of labor at wage W_t and rents $K_{T,t}(\iota)$ units of capital at rate R_t to produce $Q_{T,t}(\iota)$ units of variety ι according to the Cobb-Douglas production function:

$$Q_{T,t}(\iota) = \left(K_{N,t}(\iota)\right)^{\alpha} \left(L_{N,t}(\iota)\right)^{1-\alpha}.$$

Variety producers $[0, \omega]$ produce for the domestic market and variety producers $[\omega, 1]$ produce for the export market. Given their market power, these firms charge a markup for their products that will naturally depend on the demand curve they face. In particular, profit maximization gives rise to a simple pricing rule with a markup over marginal costs, (which is the same as the marginal cost for producers of non-traded goods, i.e. $P_{N,t}$), given by

$$\mathcal{M}_t(\iota) = \frac{\varepsilon_t(\iota)}{\varepsilon_t(\iota) - 1},$$

where $\varepsilon_t(\iota)$ is the elasticity of demand that the firm faces in its market.

Wholesalers Wholesalers are perfectly competitive in both input and output markets. They purchase varieties of the traded good both at home and abroad to produce a final good, V_t, according to

$$1 = \int_0^{\omega} \Upsilon\left(\frac{H_t(\iota)}{V_t}\right) d\iota + \int_{\omega}^{1} \Upsilon\left(\frac{M_t(\iota)}{V_t}\right) d\iota. \tag{4.6}$$

Here, $H_t(\iota)$ denotes the quantity of the domestically produced variety ι, $M_t(\iota)$ is the quantity of the imported variety ι, ω is the share of domestic varieties, and Υ is a Kimball (1995) aggregator. In this setup, the demand for (domestic) variety ι is

$$H_t(\iota) = \Upsilon'^{-1}\left(Z_t \frac{P_{H,t}(\iota)}{P_{V,t}}\right) V_t,$$

where $P_{H,t}(\iota)$ is the price associated with $H_t(\iota)$, $P_{V,t}$ is the price of the final good produced by the wholesalers and Z_t is a term that is constant around a symmetric steady state up to a first-order approximation (see the Appendix for its definition).

We follow Klenow and Willis (2006) and choose the specification of Υ such that

$$\Upsilon'^{-1}\left(Z_t \frac{P_{H,t(\iota)}}{P_{V,t}}\right) = \left[1 - \theta \log\left(Z_t \frac{P_{H,t}(\iota)}{P_{V,t}}\right)\right]^{\frac{\psi}{\theta}}.$$

In that case, the elasticity of demand for a specific variety is given by

$$\varepsilon_t(\iota) = -\frac{\partial \log H_t(\iota)}{\partial \log P_{H,t}(\iota)} = \frac{\psi}{1 - \theta \log\left(Z_t \frac{P_{H,t}(\iota)}{P_{V,t}}\right)}.$$

This demand elasticity is constant and equal to ψ if $\theta \to 0$ (which corresponds to the CES case). In a symmetric steady state, where all variety producers charge the same price, ψ corresponds to the elasticity of substitution between varieties (and therefore has to be larger than 1). Notice that this elasticity also describes the elasticity of substitution between domestic and imported inputs. If $\theta > 0$, the demand elasticity is increasing in a variety's relative price $\frac{P_H(\iota)}{P_V}$. This implies that variety producers find it optimal to adjust their markup in response to price movements by their competitors. As shown in the Appendix, the elasticity of the markup to a relative price change is:

$$\Gamma(\iota) = \frac{\theta}{\psi - 1 + \theta \log\left(Z_t \frac{P_{H,t}(\iota)}{P_{V,t}}\right)}.$$

When competitors lower their price (i.e. a fall in $P_{V,t}$), the variety producer faces a higher elasticity of demand and responds by reducing their markup. The parameter θ controls how quickly the demand elasticity rises in this case and therefore controls the degree of strategic complementarities in pricing.

Exports We assume that wholesalers abroad import varieties from the SOE to assemble them with other varieties according to a production function similar to (4.6). Exporting variety producers therefore face a demand curve for their product given by

$$X_t(\iota) = \Upsilon'^{-1}\left(Z^* \frac{P_{X,t}(\iota)}{P_V^*}\right) V^*,$$

where $X_t(\iota)$ denote exports of variety ι, $P_{X,t}(\iota)$ is the corresponding price, and variables with an asterisk refer to the rest of the world. In our SOE setup, we assume that these variables are unaffected by economic conditions in the SOE and are constant throughout.

4.3 Fiscal Policy

The government has access to three fiscal instruments: purchases of the government consumption good, G_t, value added taxes levied on non-traded and traded consumption goods, $\tau_{N,t}$ and $\tau_{T,t}$, and lump-sum transfers, T_t. We assume that government purchases entirely fall on non-traded goods. This is in line with data from input-output tables that typically report very small import shares for government purchases of 1 percent or less (see e.g. Bussière et al., 2011). We later discuss the role of this home bias in our quantitative results. Both government purchases and the value added tax rate follow an auto-regressive process:

$$G_t = (1 - \rho_G)\, G + \rho_G G_{t-1} + \varepsilon_t^G \qquad \text{and} \qquad \tau_{j,t} = (1 - \rho_\tau)\, \tau + \rho_\tau \tau_{j,t-1} + \varepsilon_{j,t}^\tau \quad \forall j = N, T.$$

We assume that lump-sum transfers always adjust to satisfy the government budget constraint:

$$P_{N,t}G_t + T_t = \frac{\tau_{T,t}}{1+\tau_{T,t}} P^{ret}_{T,t} C_{T,t} + \frac{\tau_{N,t}}{1+\tau_{N,t}} P^{ret}_{N,t} C_{N,t}.$$

4.4 Market Clearing

The market clearing for the non-traded good requires its production, $Q_{N,t}$, to equal purchases by consumers, the government and retailers (for distribution services):

$$Q_{N,t} = C_{N,t} + I_{N,t} + G_t + D_t.$$

The traded good produced from labor $Q_{T,t}$ is either purchased by domestic wholesalers or exported

$$Q_{T,t} = H_t + X_t.$$

The traded wholesale good is either sold to retailers or directly to households as traded investment good:

$$V_t = F_t + I_{T,t}.$$

Labor and capital market clearing imply $L_t = L_{T,t} + L_{N,t}$ and $K_{t-1} = K_{T,t} + K_{N,t}$. Real GDP is defined as value added evaluated at constant market prices, which, in our model, is equal to

$$Q_t = P^{ret} C_t + P_t I_t + P_N G + P_X X_t - P_M M_t,$$

where we evaluate the value of production at steady-state prices. Since GDP is calculated at market prices, changes in value added taxes directly affect the GDP deflator.

4.5 Calibration

The model is solved with a first-order approximation of the equilibrium conditions around the model's non-stochastic steady state. Table 2 displays the values we choose for the relevant model parameters. We later discuss how our quantitative results change under different parameter values and model specifications.

Most parameters are standard and are either taken from the literature or calibrated to observed shares in the data: The elasticity of intertemporal substitution is set to a value of 0.5 as in Heathcote and Perri (2002) and Backus et al. (1994). We choose a Frisch elasticity of labor supply of $\eta = 1.5$. This value is somewhat higher than the value of 1 often used in the macro literature (see e.g. Nakamura and Steinsson, 2014), but smaller than the value of 1.9 proposed by Hall (2009) who argues that such a high elasticity better reflects the extensive margin of labor supply in a search and matching framework.

The depreciation rate is set to a standard value of 2 percent per quarter. We adjust the capital share α in the production function to match the share of investment in GDP over the sample period (≈ 0.24). We choose a small value for the investment adjustment cost ($f'' = 0.2$), which implies that a 1% increase in the price of capital causes investment to increase by roughly 5%. The Calvo price setting hazard is set to roughly match observed frequencies of price adjustment in the micro data. We choose a value of $\theta = 0.70$, which implies an average price duration of about 10 months, consistent with evidence in Alvarez et al. (2006).

We take the elasticities for the markup, Γ and the elasticity of substitution across domestic and foreign goods, ψ, from Lambertini and Proebsting (2019) who estimate these parameters on a sample of euro area countries. They find a markup elasticity of 1.25, implying that producers put a 55% weight on their competitors' prices (as opposed to their own marginal costs), and a trade elasticity of 2.4.

The share of traded goods in consumption ($\gamma = \frac{2}{3}$) and the import content of traded retail goods ($\frac{(1-\nu)(1-\omega)}{1+\tau} = 0.52$) are in the range of values for European countries reported in Lambertini and Proebsting (2018). The share of distribution services in the final retail good is set to $\nu = 0.35$ in line with values reported by Goldberg and Campa (2010). Overall, this implies a trade share of 0.33, which breaks down as follows for the various demand components: 0 for government purchases, 0.35 for consumption goods and 0.67 for investment goods. We follow Berka et al. (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 not a good substitute for the actual consumption good.

The share of government purchases in GDP is set to 0.22 to match the value for the typical country in our sample for the period 1999–2018. The steady-state VAT (for both traded and non-traded goods) is set to 0.19 for traded goods and 0.12 for non-traded goods. The standard deviation of the changes in the VAT is roughly equal across both traded and non-traded goods. When evaluating the model, we therefore consider an increase in the VAT that equally falls on both traded and non-traded goods.

5 Model Results

We start our analysis by considering the model's response to two types of (unexpected) fiscal shocks: an increase in government spending and an increase in the consumption tax. As with the data, we calculate dynamic net present value multipliers to make the model-data comparison easier. Figures A1 and A2 display 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 both policies are inflationary, both in terms of retail price inflation and the GDP deflator. An increase in G raises prices due to higher factor and hence retail prices, whereas factor prices remain fairly flat when the consumption tax gets raised, but the tax itself automatically raises retail prices.

The output multipliers are on the lower side of those estimated in the data, but the dynamic response following an increase in G is somewhat off: In the data, the multiplier increases over time, suggesting that output requires some time to respond. In the model instead, the output response is immediate and, due to the feedback loop of labor-consumption complementarities inherent in the GHH preference specification, particularly strong in the beginning.[13]

The GDP response drives the response of imports, both in the data and the model. The model also matches the net export multiplier for G of around -1.5 after 2 years, but it is driven by both a decrease in exports and an increase in imports. In the data, the net export response is primarily driven by imports. This discrepancy stems from relative price movements and resulting expenditure switching by foreign households which the model somewhat overstimates: Export prices are predicted to increase by about 0.4 percent (for higher spending amounting to 1 percent of GDP), whereas export prices in the data do not seem to react, especially in the first two years. This discrepancy arises despite the fact that our model features a substantial amount of pricing to market that implies that firms lower their markups instead of passing higher production costs through to prices. The red line displays the model response without pricing to market. We observe that export prices would have been about a third higher and consequentially (through expenditure switching by foreign households), exports about a third lower. Interestingly, the net export response would not have been affected by this change because imports would have been lower due to a weaker response in GDP.

In response to a tax shock, factor prices remain rather flat and neither export nor import

[13] Results with separable preferences can be found in the Appendix.

prices substantially move, and, as a result, the terms of trade move little (as in the data). The net export multiplier after 2 years is slightly above 1 and shy of the response in the data. Part of this discrepancy is driven by the GDP response, which is too muted in the model and translates into a fall in imports that is too small compared to the data. Despite the small response of factor prices, both retail prices and the GDP deflator go up (both in the data and the model) because they are measured at market prices that include consumption taxes. The model predictions with and without pricing to market are very similar. This is because factor prices and hence producers' marginal costs move little in response to a tax shock, so that the competitive pressure remains similar. It is only when firms' marginal costs move that pricing to market affects the dynamics of the model.

Finally, we compare data and model predictions for the relative price movements within consumption goods. In the data, we estimated that the response of retail prices is positive to an increase in government spending, but less so for highly imported goods. For an increase in the consumption tax, we did not find a clear relationship between a good's import share and its price response. While we estimated these relationships based on 90 different consumption good categories, our model only has two types of retail goods: a completely non-traded good and a traded good that consists of both imports and domestically produced goods. By comparing the price responses of these two goods in the model, we can derive the differential effect of retail prices as a function of the import share and compare this effect to the interaction term coefficient (m_h^g and m_h^τ) in regression (3.3). We overlay these model responses on top of the estimated responses from the data in Figure 9. A positive G shock raises the price of non-traded retail goods, both in the model and the data, but less so for goods with higher import shares. This relative price movement is somewhat stronger in the data than in the model. As discussed, in the model, factor prices in response to a G shock go up, raising the price of the non-traded good. Goods with higher import shares do not experience the same pressure on their prices because import prices raise substantially less than domestic prices. For a positive tax shock, we observe little relative price movements, both in the data and in the model. This is consistent with our previous finding that the model predicts little factor price movements in response to a positive tax shock.

5.1 Output Cost of Raising Net Exports

As discussed above, the lack of monetary policy at the member state level calls for fiscal policy as the main tool to correct current account imbalances between member states in a currency union. The hope is 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.

Table 3 summarizes our results on the output cost of correcting net exports, both in the data and the model. It displays the net export and GDP multiplier after 2 years following either a government purchase shock or a consumption tax shock. Again, the multipliers are defined as the cumulative response to a fiscal policy change amounting to 1 percent of GDP, so that we can directly compare the size of the multipliers across the two cases. In the data, a cut in G or an increase in the tax achieve a similar improvement in net exports, with a multiplier around 1.75. But this goes along with a substantially larger output cost for the consumption tax (2.8 vs. 1.1). Overall, these numbers suggest that current account improvements are fairly costly in the data: Improving net exports by 1 percent requires a fall in output of 0.64 percent for a cut in G and 1.54 percent for an increase in the tax. Here, it is important to recall that net exports are expressed in percent of average trade. Given a trade share of roughly 1/3 among euro area countries, the output cost of correcting net exports by 1 percent *of GDP* is between 2 (for government purchases) and 4.5 percent (for consumption taxes), which are quite substantial numbers.

These figures look somewhat rosier in the model (between 0.9 ($\approx 3 \times 0.31$) and 3.4 ($\approx 3 \times 1.12$), mainly because the model undepredicts the GDP multiplier. Part of why the output cost is lower is that the model overstates the relevance of relative price movements in driving net exports. This is despite the introduction of pricing to market in our model that stifles terms of trade movements: Without pricing to market, i.e. if the markup elasticity is constant, $\Gamma = 0$, the output costs of raising net exports would fall even more, by about 20 percent (0.25 vs. 0.31 and 0.89 vs. 1.12) because a larger part of net export movements would come from relative price movements rather than fluctuations in GDP: For example, in response to a cut in government spending, exporters would pass through lower production costs to their export prices, which stimulates demand abroad and raises exports. Similarly, consumers would switch from imports to lower-priced domestic goods. Both effects would dampen the fall in GDP and raise net exports, thereby lowering the output cost of raising net exports.

6 Conclusion

STILL TO DO

- We already look at relative prices of consumption goods. We could also look at the response of producer prices at the industry level, sorting industries by their trade share. Do relative producer prices move? For example, an increase in spending (which almost entirely falls on non-traded goods in the data) could raise prices in the non-traded good sector, but not in the traded good sector. This could help explain why export prices move little in response to fiscal shocks, especially in the short run.

- Analyzing the relevance of re-exports. Export and import price move hand in hand in the data. This could be driven by re-exports, i.e. exports of previously imported goods. An increase in the price of imported goods would therefore translate in a price increase of exports.

- Replicating the path of fiscal variables in response to their own innovation. Currently, we assume that government spending follows an AR(1) process whereas tax rates (virtually) follow a unit root. This is not fully borne out by the data, as we have shown (see Figure 3). Both government spending and tax rates increase somewhat for a few semesters before going down. To model this, we can impose a moving average structure for the shock, similar to e.g. Miyamoto et al. (2018), so as to perfectly match the impulse response in Figure 3. In other words, as a shock hits, households learn that the fiscal policy change will even be somewhat bigger in the near future (news). This should have some effect on the multipliers predicted by the model.

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Table 1: First-Stage Regression

	$\Delta \ln G_{i,t}$				$\Delta\tau_{i,t}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$F_{t-1}\Delta \ln G_{i,t}$	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)			
$\Delta\tau_{i,t-1}$					0.13	
					(0.05)	
$\Delta\tau_{i,t-2}$					0.08	
					(0.05)	
$\Delta \ln Y_{i,t-1}$	0.02		0.03		−0.01	
	(0.04)		(0.05)		(0.01)	
$\Delta \ln Y_{i,t-2}$	0.14		0.12		0.00	
	(0.04)		(0.05)		(0.01)	
$\Delta u_{i,t-1}$	−0.34		−0.56		0.07	
	(0.13)		(0.14)		(0.02)	
$\Delta u_{i,t-2}$	0.29		0.44		−0.07	
	(0.12)		(0.13)		(0.02)	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.51	0.44	0.40	0.03	0.12	0.05
Obs	523	549	535	564	513	540

Notes: Table displays the regression coefficient of regression (2.1) and (2.2).

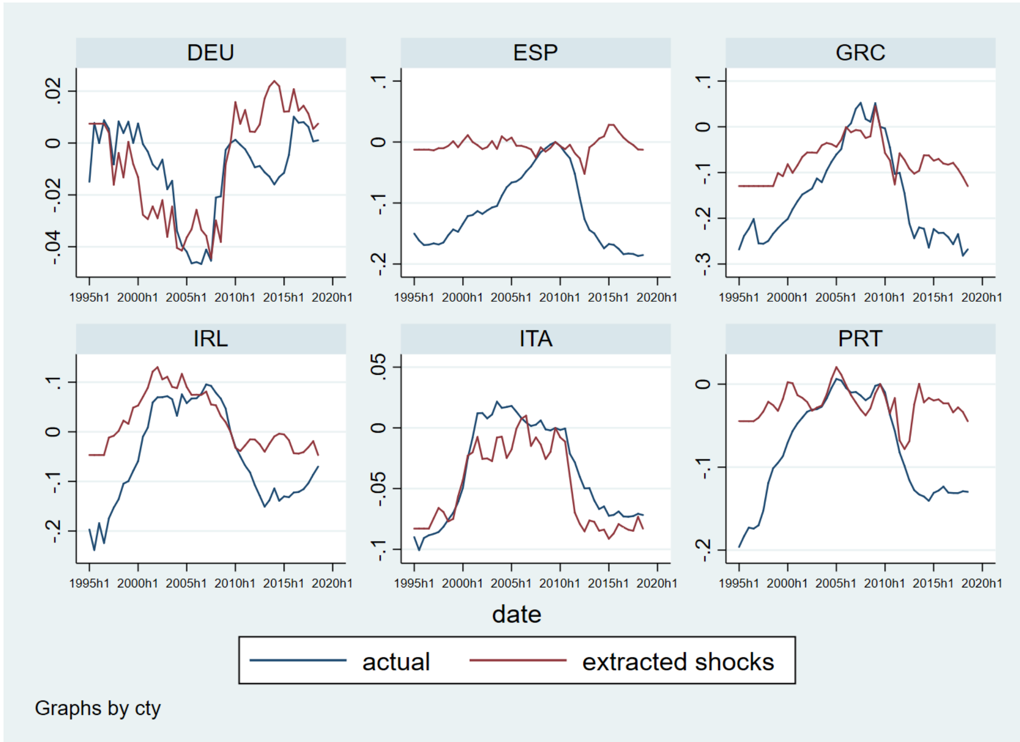
Table 2: Calibration

Parameter		Value	Target / Source
Preferences			
Elasticity of intertemporal substitution	σ	0.50	Standard value, Heathcote and Perri (2002), Backus et al. (1994)
Elasticity of labor supply	η	1.50	Nakamura and Steinsson (2014), Hall (2009)
Production			
Capital share	α	0.32	Investment to GDP ratio (Eurostat, 1999–2018)
Depreciation rate	δ	0.02	Standard value
Investment adjustment cost	f''	0.2	
Calvo price stickiness	θ_p	0.70	Alvarez et al. (2006)
Elast. of subst. btw. consumption varieties	ψ	10	Standard value
Markup elasticity	Γ	1.25	Lambertini and Proebsting (2019)
Trade			
Trade demand elasticity	ψ	2.42	Lambertini and Proebsting (2019)
Share traded goods in consumption	γ	0.67	Lambertini and Proebsting (2018)
Home bias for traded good	ω	0.1	Lambertini and Proebsting (2018)
Share of distribution services in traded good	ν	0.35	Goldberg and Campa (2010)
Elast. of subst. btw. traded good and distribution services	ζ	0.25	Berka et al. (2018)
Fiscal Policy			
Share of gov't purchases in GDP	G	0.22	Eurostat (1999–2018)
Value added tax traded goods	τ	0.19	Eurostat (1999–2018)
Value added tax non-traded goods	τ	0.12	Eurostat (1999–2018)
Persistence gov't purchase shock	ρ_G	0.95	Standard value

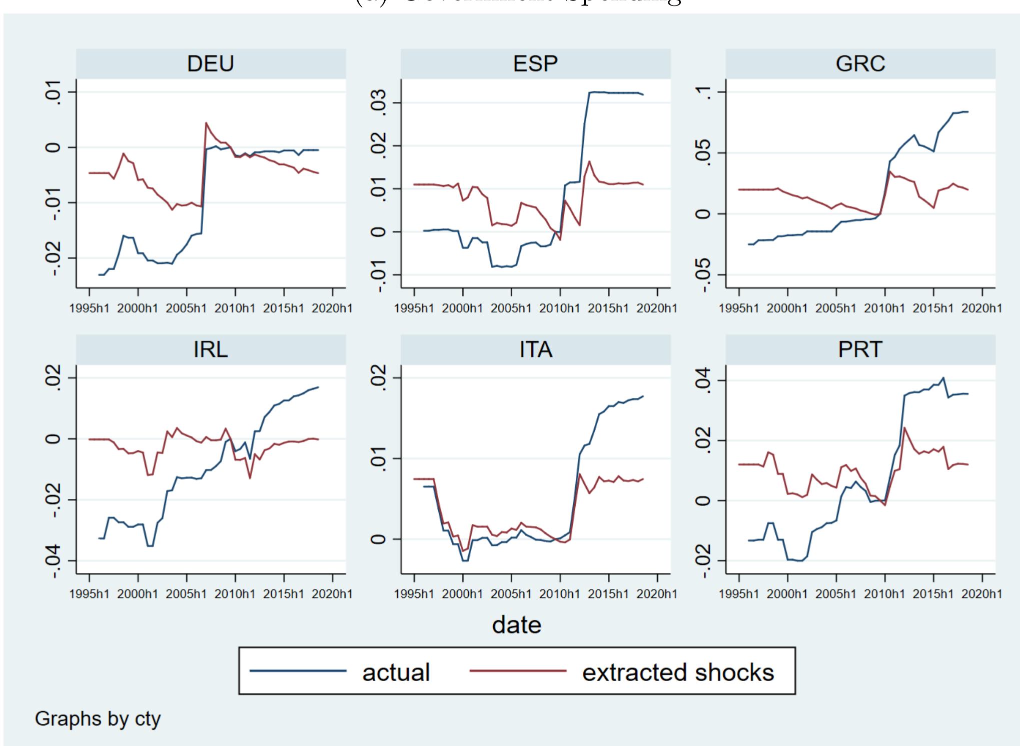
Table 3: Output Cost of Correcting Net Exports

	Gov't purchases			Consumption tax		
	M(NX)	M(Y)	$\frac{M(Y)}{M(NX)}$	M(NX)	M(Y)	$\frac{M(Y)}{M(NX)}$
Data						
	−1.72	1.09	−0.64	1.80	−2.78	−1.54
Model						
Baseline	−1.82	0.56	−0.31	1.17	−1.31	−1.12
No pricing to market	−1.82	0.45	−0.25	1.61	−1.43	−0.89

Notes: Table displays the multiplier for net exports and output as well as their ratio for a fiscal shock amounting to 1 percent of GDP.



(a) Government Spending



(b) Consumption Tax Rate

Figure 1: Actual Fiscal Policy Data and Extracted Shocks

Note: Figure depicts actual de-trended; and estimated government spending / consumption tax rate residuals from regression (2.1) and (2.2) for selected countries. Series are normalized to 0 in 2009S2.

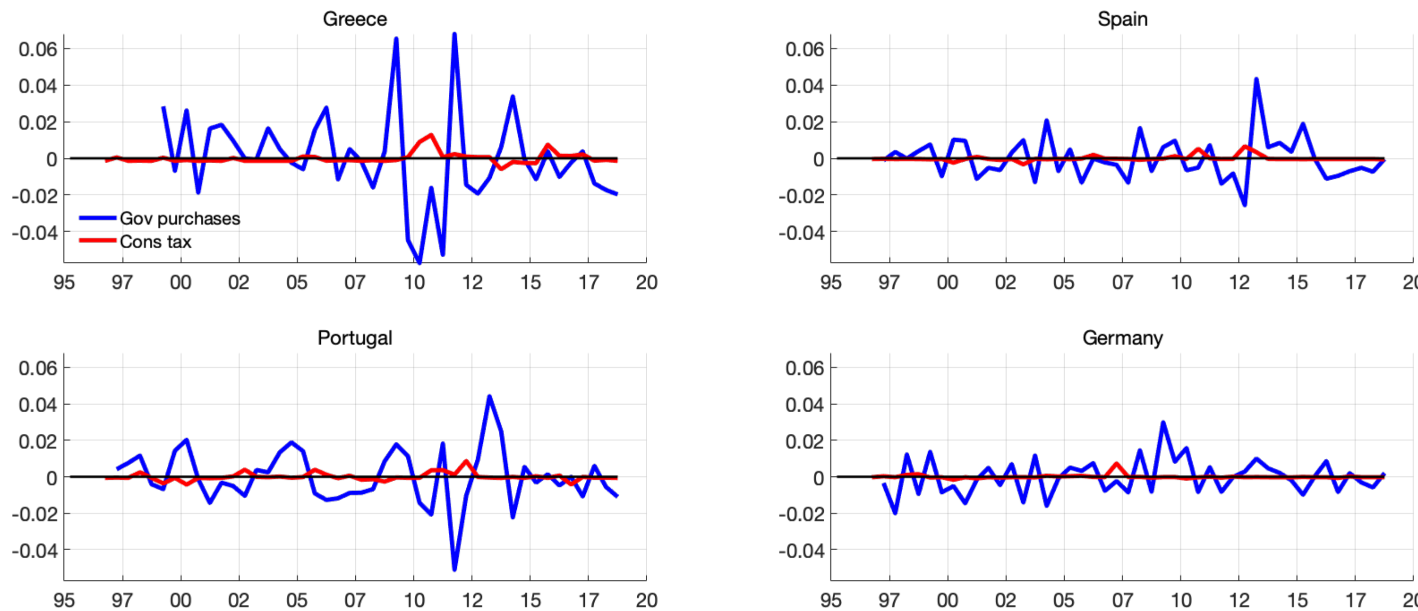
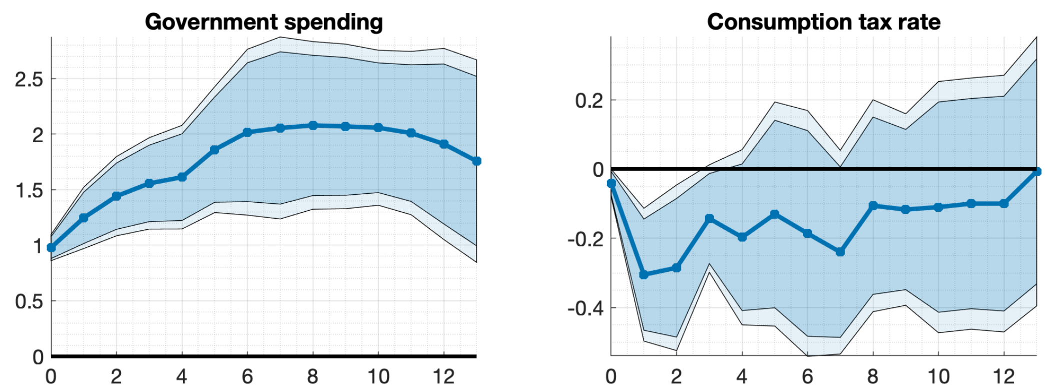
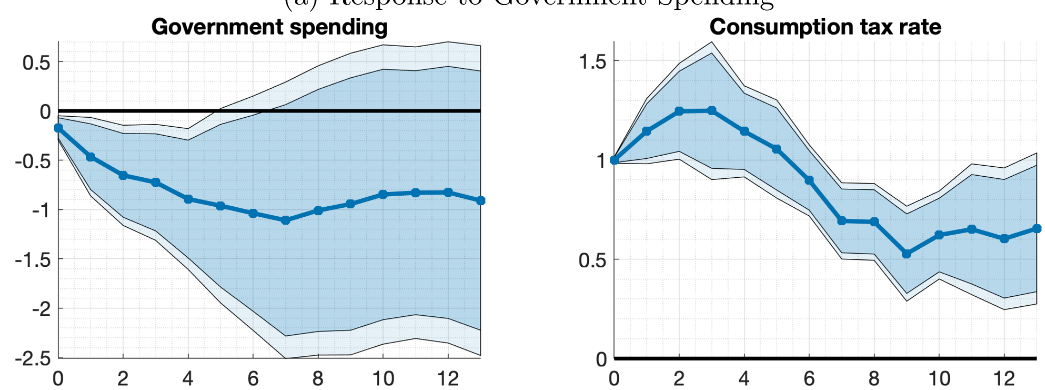


Figure 2: Extracted Shocks in Government Spending and Tax Rates

Note: Figures depict the estimated government spending residuals and consumption tax rate residuals from regressions (2.1) and (2.2) for selected countries. Residuals are expressed in percent of GDP, i.e. for government spending, the figure displays $\hat{\varepsilon}^{g}_{i,t}\frac{G_i}{Y_i}$ and for the consumption tax rates, the figure displays $\frac{\hat{\varepsilon}^{\tau}_{i,t}}{1+\tau_i}\frac{C_i}{Y_i}$, where G_i, Y_i, C_i and τ_i are average values for the sample period.



(a) Response to Government Spending



(b) Response to Consumption Tax Rate

Figure 3: Impulse Responses to Extracted Shocks

Note: Figure depicts the response of government spending (left panel) and the consumption tax rate (right panel) to a government spending shock (a) and to a consumption tax rate shock (b). The shocks are measured in percent of GDP.

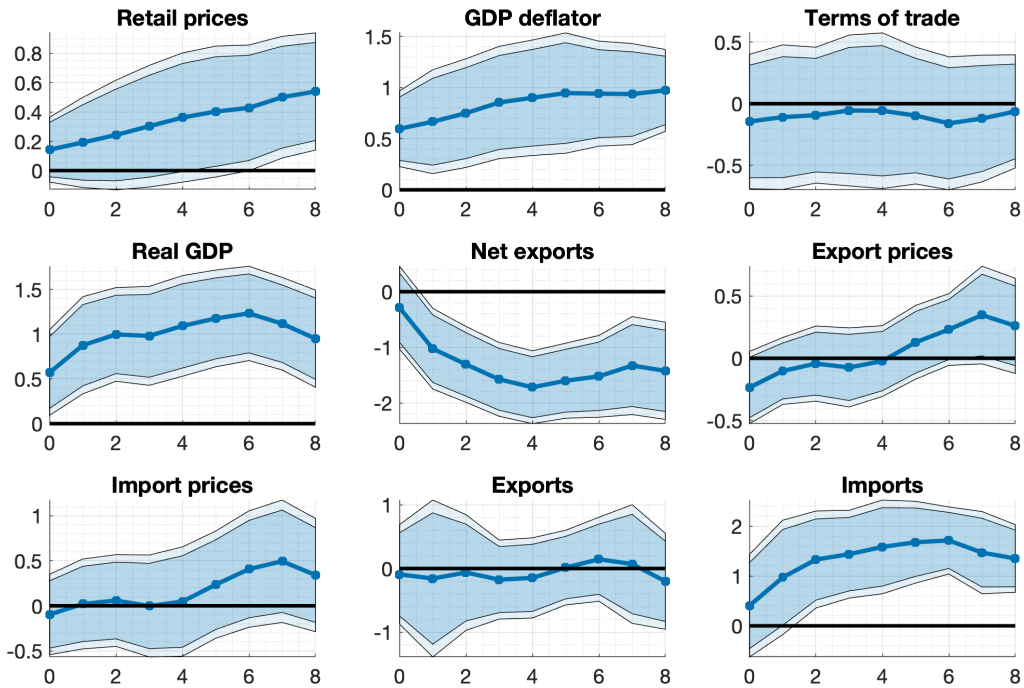


Figure 4: Empirical Government Spending Multipliers

Note: Figures depict the estimated government spending multipliers $\widehat{M}_h^g$ from regression (3.2), 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.

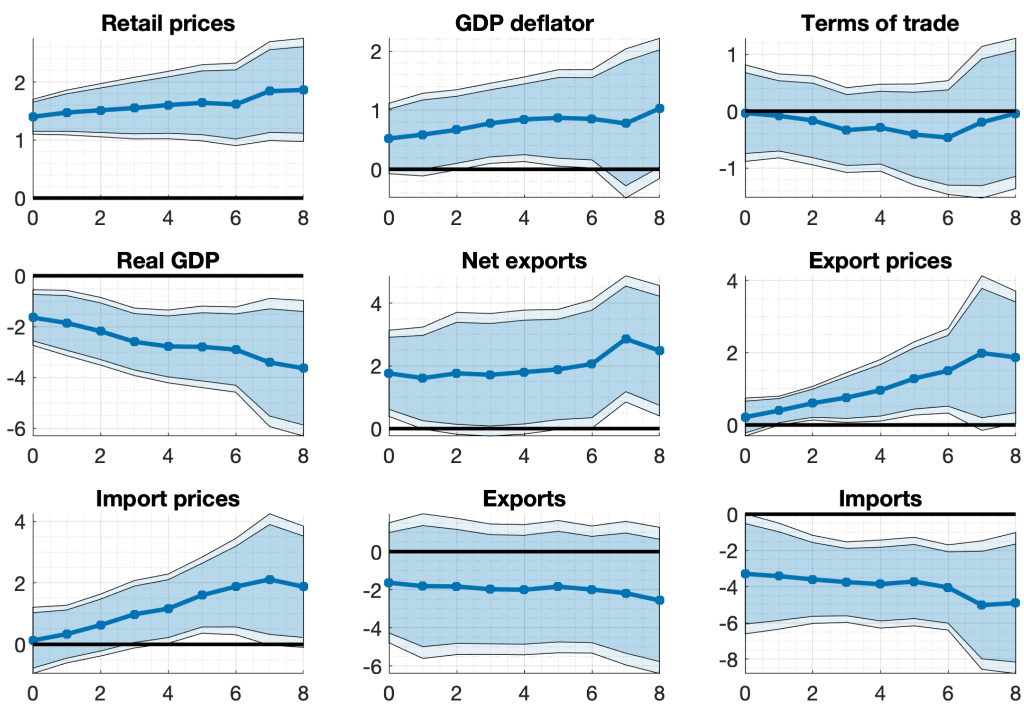
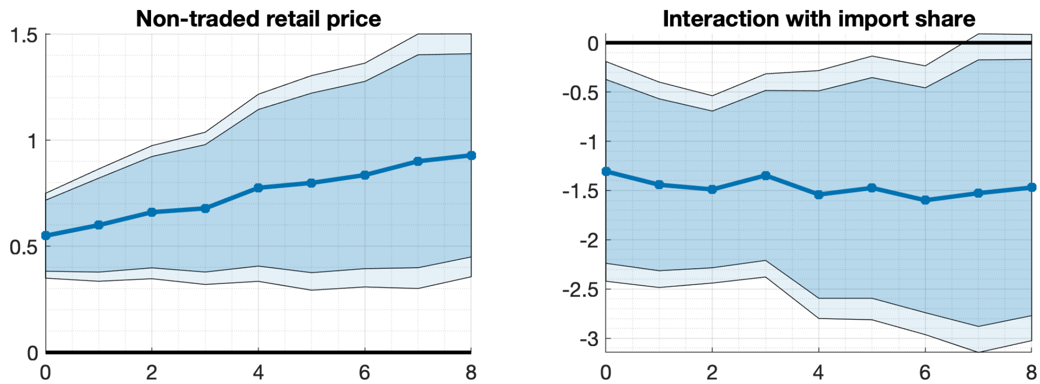
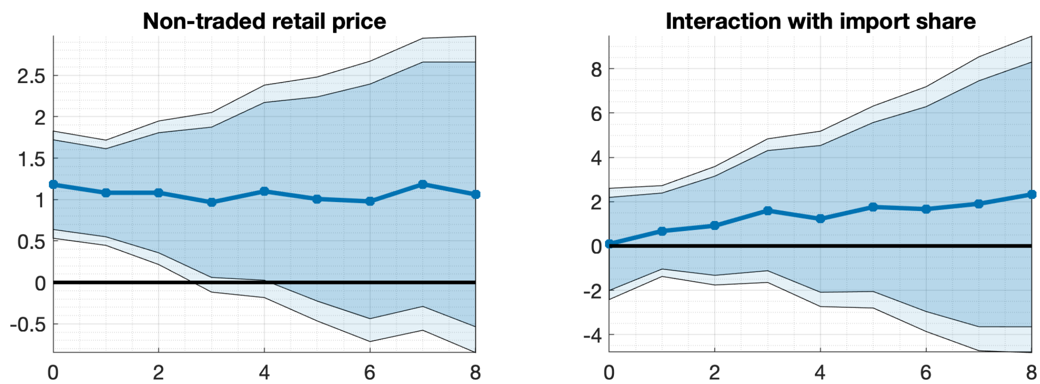


Figure 5: Empirical Consumption Tax Multipliers

Note: Figures depict the estimated consumption tax multipliers $\widehat{M}_h^\tau$ from regression (3.2), as a function of the horizon h. See Figure 4 for confidence intervals.



(a) Government Spending



(b) Consumption Tax

Figure 6: Empirical Multipliers at the Product Level

Note: Figures depict the estimated government spending and consumption tax multipliers for the effect on retail prices estimated at the product level from regression (3.3). The left panel displays the estimated coefficient $\widehat{M}_h^g$, whereas the right panel displays the estimated coefficient $\widehat{m}_h^g$. The estimated price response for a product with import share im_j is given by $\widehat{M}_h^g + \widehat{m}_h^g \times im_j$. 90 percent and 95 percent confidence intervals are displayed, based on Driscoll-Kraay standard errors clustered at the country and time level.

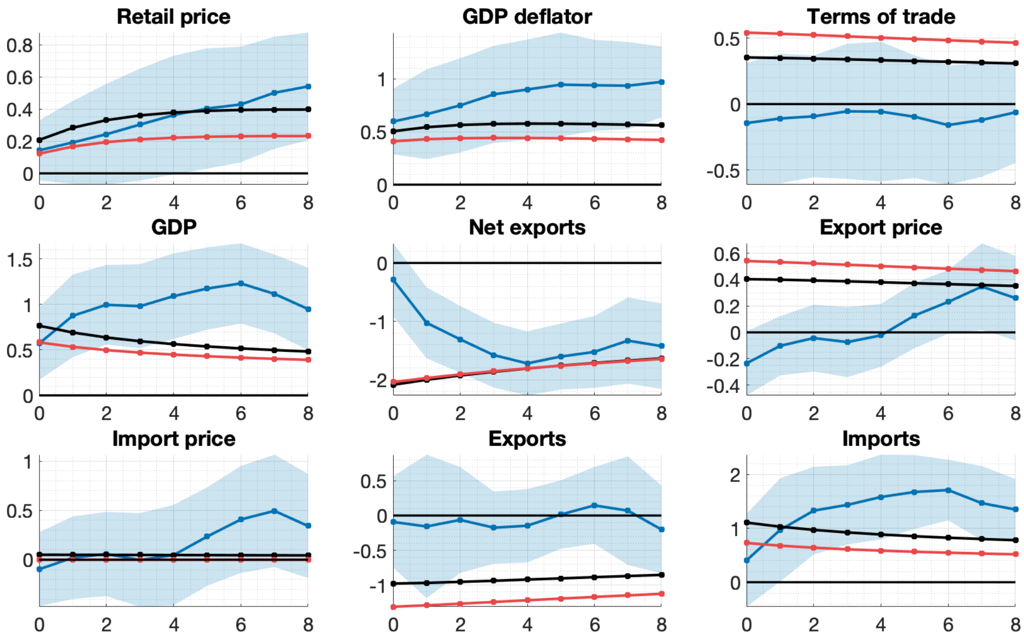


Figure 7: Government Spending Multipliers: Data vs. Model

Note: See Figure 4. 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 drop in government spending. The red line is the model response without pricing to market ($\Gamma = 0$).

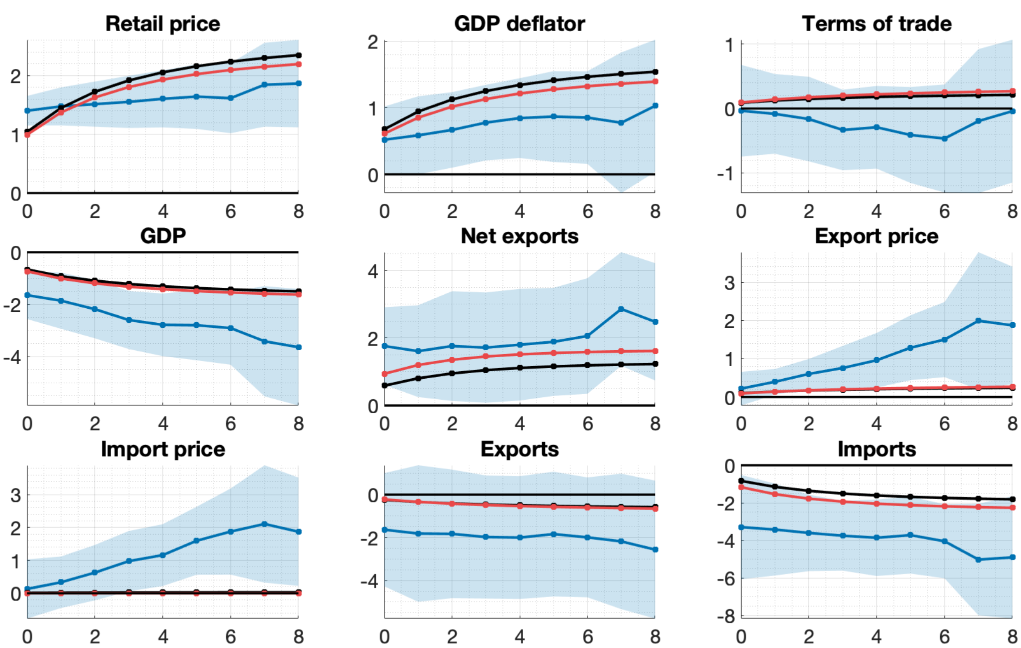
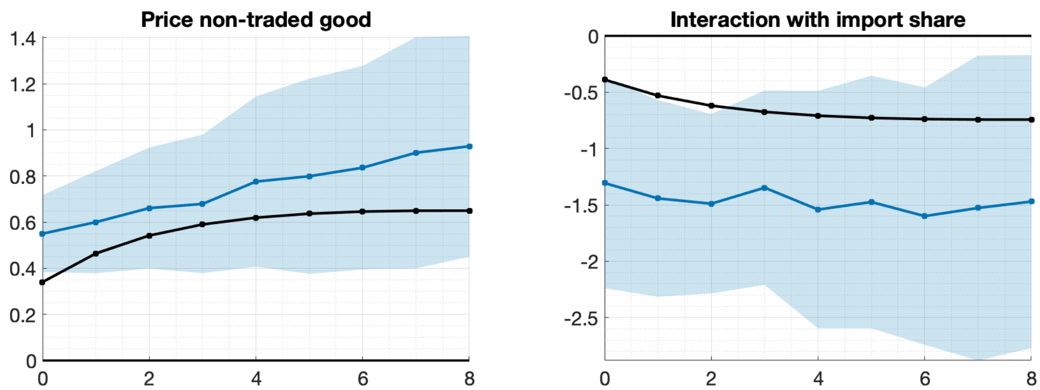
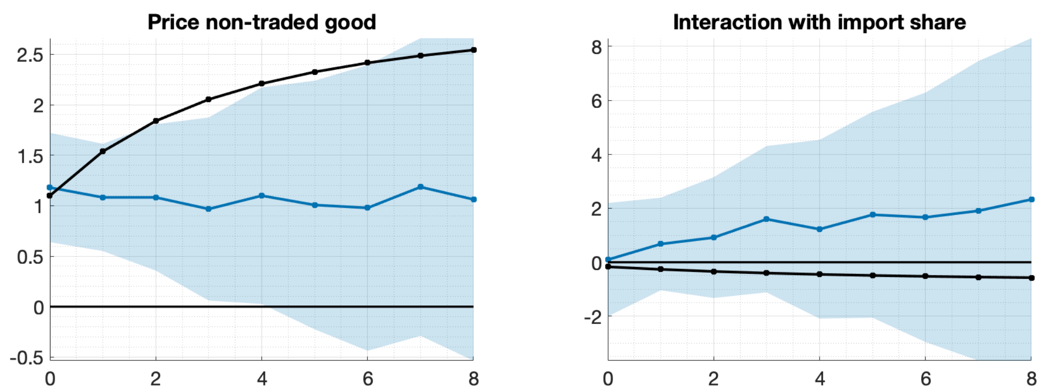


Figure 8: Consumption Tax Multipliers: Data vs. Model

Note: See Figure 5. The blue line is the response in the data. The black line is the consumpton tax multiplier derived from the model in response to an increase in the consumption tax rate. The red line is the model response without pricing to market ($\Gamma = 0$).



(a) Government Spending: Data vs. Model



(b) Consumption Tax: Data vs. Model

Figure 9: Empirical Multipliers at the Product Level

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

A Data

A.1 Price Inflation Data

Price inflation data is provided by Eurostat and covers all countries in the European Union. Eurostat publishes two price indices, the Harmonized Index of Consumer Prices (HICP) and the HICP at constant tax rates. The HICP is the European counterpart of the CPI (calculated by the BLS) and implements a common methodology in all European Union memberstates. The HICP is a Laspeyres index with weights being updated at an annual frequency. The HICP is divided into $J = 90$ categories (COICOP level 4). Let $P_{n,t}$ be the HICP in country n at time t. It is defined as follows:

$$P^{ret}_{n,t} = \sum_j \nu_{j,n,t} P^{ret}_{j,n,t}$$

where $P^{ret}_{j,n,t} = P_{j,n,t}(1 + \tau^c_{j,n,t})$ is the retail price of good j in country n at time t relative to a base year, $\tau^c_{j,n,t}$ is the corresponding ad-valorem net tax rate relative to a base year tax rate and $\nu_{j,n,t}$ is the weight with $\sum_j \nu_{j,n,t} = 1$.

The HICP at constant tax rates subtracts any changes in consumption tax rates from the HICP:

$$P_{n,t} = \sum_j \nu_{j,n,t} P_{j,n,t}.$$

Imputation. This HICP at constant tax rates is provided by Eurostat at the overall level and for five main categories since 2003, and at the detailled level for most countries since 2006.[14] We impute missing values in two different ways: First, we impute the index at the detailled level by assuming that tax changes have been the same across all categories within a common main category. Let $p(j)$ index the main category that good j belongs to. Further suppose that the price index for good j is available at time t, but only the price index for the main category $p(j)$ is available at time s. Then, we calculate the tax rate of good j at time s

[14]These five main categories are 'Processed food including alcohol and tobacco', 'Unprocessed food', 'Non-energy industrial goods', 'Energy', 'Services'

as follows:

$$1+\tau^c_{j,n,s} = \left(1+\tau^c_{j,n,t}\right)\frac{1+\tau^c_{j,n,s}}{1+\tau^c_{p(j),n,t}},$$

and the price index at constant tax rates is simply the ratio of the price index (including taxes) and the tax rate: $P_{j,n,s} = \frac{P_{j,n,s}(1+\tau^c_{j,n,s})}{1+\tau^c_{j,n,s}}$.

Second, if some data is still missing, we use data on value-added tax changes by country, month and COICOP categories collected by Benedek et al. (2015), as well as data collected by ourselves based on information provided by the statistical agencies.

Aggregate indices. To calculate price indices for tradable and non-tradable goods, we have to aggregate price indices across several goods categories. Time series for these aggregate indices are chain-linked. That is, the aggregate price index in month m of year t is

$$P^m_{n,t} = P^{Dec}_{n,t-1}\frac{\sum_j \frac{P^m_{j,n,t}}{P^{Dec}_{j,n,t-1}}\nu_{j,n,t}}{\sum_j \nu_{j,n,t}}.$$

All indices are normalized so that

$$\frac{1}{12}\sum_m P^m_{j,n,2015} = 100.$$

A.2 Administered Prices

Prices of some of the COICOP categories are mainly or fully administered by governments (e.g. 'Water supply'). Inflation rates across countries for these categories are likely to reflect direct government interventions instead of changes in underlying costs or other market forces as a consequence of fiscal policy changes, especially over our sample period that includes the European debt crisis characterized by austere fiscal policies in certain European countries. We therefore exclude these goods from our analysis. Eurostat classifies all COICOP categories into 'Fully administered', 'Mainly administered' and 'Not administered'. This classification changes both over time and across countries. To obtain a single classification, we first assign a '0' to all categories that are not administered, and a '1' otherwise, across all countries and time periods. We then classify all COICOP categories as 'administered' if, in 2009, at least a third of the countries in our sample declared that category as administered. We retain 17 categories (e.g. 'Pharmaceutical products' (COICOP 06.11) and 'Water supply'

(COICOP 04.41)), accounting for almost one fifth of consumers total expenses). Table A3 in the Appendix contains a complete list of COICOP categories by the share of countries that administer prices.

A.3 More Details on Input Coefficients and Import Shares

Our two main data sources are detailed use tables from Statistics Denmark for 2010, national use tables provided by Eurostat as well as the EU-inter country Supply, Use and Input-Output Tables (called FIGARO). Here we provide a few more details.

First, as discussed in the main body of the text, we calculate the input cost shares a_j^s with $\sum_s a_j^s = 1$ for the 90 COICOP categories from the use tables provided by Statistics Denmark. Here, we briefly discuss how we create a concordance between product classifications and consumption good classifications used by Statistics Denmark and Eurostat.

Second, we adjust these COICOP-specific input coefficients $a_{j,n}^s$ for each country n to be consistent with the aggregate consumption input coefficients derived from the official use tables.

Third, to calculate input-specific import shares, $\omega_n^{s,i}$, we rely on both national use tables and the FIGARO tables provided by Eurostat.

A.3.1 Concordance between Statistics Denmark Categories and Eurostat Categories

It is straightforward to match the products used by Statistics Denmark to those used by Eurostat because both rely on the same classification (CPA 2008). We simply aggregate up the Danish 4-digit level product categories to the 64 2-digit level product categories used by Eurostat.

In terms of consumption groups, Statistics Denmark uses a coarser classification than what is commonly used for reporting inflation data. Eurostat reports inflation data according to 4-digit level COICOP groups. Statistics Denmark's classification of consumption groups is based on Eurostat's COICOP, but sometimes uses more aggregated groups (e.g. the Danish category 'Regular maintenance and repair of the dwelling' encompasses Eurostat's categories 'CP0431: Materials for maintenance and repair of the dwelling', and 'CP0432: Services for maintenance and repair of the dwelling'.) In certain cases, we disaggregate the information into the underlying Eurostat categories by exploiting the details offered on the supply side. For instance, for 'Regular maintenance and repair of the dwelling', we assign all supplies provided by the industries 'Professional repair and maintenance of buildings' and 'Own-account repair and maintenance of buildins' (both forming part of the sector 'Construction') to the category 'CP0432: Services for maintenance and repair of the dwelling'. All supplies provided by the remaining industries (which all form part of the sectors 'Manufacturing' or 'Wholesale and retail trade') are classified under 'CP0431: Materials for maintenance and repair of the dwelling'. In some cases, we cannot distinguish between the underlying Eurostat categories. For instance, Statistics Denmark aggregates up the two categories 'CP0211: Spirits' and 'CP0212: Wine' into a single category. Both products rely on inputs from the beverage industry and from the retail sector. The tables are not disaggregated enough to distinguish between the supplies for 'Spirits' as opposed to the supplies for 'Wine'. In that case, we assume that the input mix and import share are the same across 'Spirits' and 'Wine'.

A.3.2 Adjusting the Input Coefficients

Data provided by Statistics Denmark allows us to calculate COICOP-specific input coefficients, $a^s_{j,DNK}$ with $\sum_s a^s_{j,DNK} = 1$. For instance, the cost shares for COICOP category x can be broken down into xx% CPA y,... . Given information on the basket weight for each COICOP category, we can directly calculate the use of each CPA good in households' consumption.

Although input coefficients are likely to be similar across our sample of (economically) rather homogenous countries, they might differ slightly. As a matter of fact, applying the Danish input coefficients to basket weights from a country other than Denmark, we obtain an implied use of each CPA good in that country's household consumption, which is inconsistent with data provided by national use tables. To be consistent with these national use tables, we therefore adjust the Danish input coefficients for each country separately. In doing so, we choose the input coefficients for country n, $a^s_{j,n}$, to be as "similar" as possible to the Danish input coefficients, $a^s_{j,DNK}$, while being consistent with country n's national use tables. In particular, we minimize

$$\min_{a^s_{j,n}} \sum_j \sum_s \frac{1}{2} \frac{\left(a^s_{j,DNK} - a^s_{j,n}\right)^2}{k + a^s_{j,DNK}}$$

subject to

$$\sum_{j}^{J} a_{j,n}^{s}\nu_{j,n} = a_{C,n}^{s} \qquad \forall s$$

$$\sum_{s} a_{j,n}^{s} = 1 \qquad \forall j = 1, ..., J$$

$$a_{j,n}^{s} \geq 0 \qquad \forall s, \quad \forall j = 1, ..., J$$

$$1 \geq a_{j,n}^{s} \qquad \forall s, \quad \forall j = 1, ..., J,$$

with $k > 0$.[15] Our loss function specifies our idea of "similarity" between the two matrices. The first constraint describes the constraint imposed by the data on input coefficients for overall consumption: When summing up the input coefficients $a_{j,n}^{s}$ for CPA good s across all consumption categories, j, weighted by their basket weights, $\nu_{j,n}$, we must obtain the input coefficient for overall household consumption, $a_{C,n}^{s}$. The second to fourth constraints are purely technical constraints on the parameters. In practice we set $k = 0.1$. This is a simple problem to solve. Let λ_s and λ_j denote the Lagrange multiplier on the first two constraints. We solve for these parameters using the two constraints and setting the preference weights to

$$a_{j,n}^{s} = min\left(1, max\left[0, a_{j,DNK}^{s} - (k + a_{j,DNK}^{s})\left(\lambda_j + \lambda_s\nu_{j,n}\right)\right]\right).$$

Two remarks:

- Real estate services: Use tables split up the CPA category 'L68' into 'L68A: Imputed rents of owner-occupied dwellings' and 'L68B: Real estate services excluding imputed rents'. Our consumption data only covers actual rentals (COICOP category CP041). Conceptually, we need to exclude imputed rents of owner-occupied dwellings from our list of CPA goods. For many countries, this means simply dropping category 'L68A' from the input-output tables. For some countries, the use tables do not distinguish between 'L68A' and 'L68B' (they report NaN for 'L68A'). Since the CPA category 'L68' is almost exclusively used for the consumption of category CP041, and category CP041 only requires CPA category 'L68' as an input, we directly adjust the share of category 'L68' in the use table for aggregate consumption to the basket weight of category CP041.
- Retail and wholesale services: Three countries (Roumania, Cyprus and Luxembourg)

[15]Notice that we require $k > 0$ because elements in $a_{j,DNK}^{s}$ might be equal to 0.

report that the CPA category 'G46: Wholesale trade services, except of motor vehicles and motorcycles' is not used for household consumption. It is, however used in other use categories (such as intermediate consumption). In these cases, we replace the input coefficient for household consumption $a^s_{C,n}$ by the input coefficient for total use, a^s_n. We proceed similarly for Luxembourg, which reports zero use of the CPA category 'G47: Retail trade services, except of motor vehicles and motorcycles'.

A.3.3 Constructing Import Shares of Inputs

National use tables on Eurostat report information on a product's origin—whether it is domestically produced or imported—conditional on its use.[16] These tables distinguish between 64 different products. We rely on the national use tables for the year 2010 because all countries in our sample provide data for that specific year. We complement this information with the FIGARO tables that themselves are based on the 2010 national use tables, but break down imports by country of origin. This allows us to calculate the import shares $\omega^{s,i}_n$ by partner country.

We face two main challenges when using these tables. First, the FIGARO tables report imports at FOB (free on board), whereas the national use tables report imports at CIF (cost, insurances and freight). Typically, for manufactured goods, imports valued at CIF exceed imports valued at FOB, whereas for services, the opposite is true. Second, the FIGARO tables do not report total imports, but only imports stemming from either of the 28 European Union countries. We therefore proceed as follows: If total imports (reported at FOB in the national use tables) is smaller than the sum of EU28 imports (reported at CIF in FIGARO), we adjust total imports up to match the sum of EU28 imports, and set non-EU28 imports to zero.

For certain product categories, we expect import shares to differ substantially across subproducts. For instance, within the category 'CPA A1: Products of agriculture, hunting and related products', cereals will have a lower import share than coffee, which is exclusively imported in the European Union. In ongoing work, we therefore use trade data from the COMEXT database as well as production data from the agricultural accounts and the database on manufactured products, PRODCOM, to calculate import shares at a a lower aggregation

[16]Practically, most statistical agencies apply the import proportionality assumption. This assumes that households consume imports of a product proportional to their total consumption of a product and in line with the economy-wide import share of that product. Statistical agencies apply the assumption at different levels of aggregation, with Denmark differentiating between more than 2'000 products.

level.

Table A1: LIST OF CPA CATEGORIES AND IMPORT SHARES

			Import Share		
Code	Name	Weight	50%	25%	75%
CPA_C26	Computer, electronic and optical products	10‰	89.9%	82.7%	94.9%
CPA_C13T15	Textiles, wearing apparel, leather and related products	19‰	86.5%	74.0%	94.2%
CPA_C29	Motor vehicles, trailers and semi-trailers	16‰	86.0%	70.9%	93.1%
CPA_C20	Chemicals and chemical products	5‰	82.7%	62.8%	89.1%
CPA_C21	Basic pharmaceutical products and pharmaceutical preparations	13‰	79.8%	71.5%	92.9%
CPA_C27	Electrical equipment	6‰	79.1%	64.9%	87.9%
CPA_C28	Machinery and equipment n.e.c.	1‰	74.7%	56.3%	88.1%
CPA_C22	Rubber and plastic products	2‰	72.4%	56.2%	86.6%
CPA_C24	Basic metals	0‰	66.2%	8.4%	71.2%
CPA_C30	Other transport equipment	2‰	62.6%	46.8%	81.3%
CPA_C17	Paper and paper products	2‰	62.4%	40.4%	79.4%
CPA_C31_32	Furniture and other manufactured goods	9‰	57.4%	52.7%	65.1%
CPA_A03	Fish and other fishing products; aquaculture products; support services to fishing	0‰	45.4%	29.4%	64.7%
CPA_C25	Fabricated metal products, except machinery and equipment	1‰	41.9%	23.7%	60.9%
CPA_C23	Other non-metallic mineral products	2‰	41.7%	32.1%	63.0%
CPA_C19	Coke and refined petroleum products	34‰	37.3%	29.2%	50.8%
CPA_A01	Products of agriculture, hunting and related services	14‰	36.7%	25.0%	50.7%
CPA_C10T12	Food, beverages and tobacco products	98‰	32.2%	21.5%	47.7%
CPA_H51	Air transport services	6‰	30.3%	10.5%	64.0%
CPA_C16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	1‰	27.7%	20.8%	49.0%
CPA_B	Mining and quarrying	10‰	25.8%	4.9%	73.3%
CPA_J58	Publishing services	11‰	18.2%	10.4%	30.2%
CPA_J62_63	Computer programming, consultancy and related services; Information services	0‰	8.3%	1.4%	19.9%
CPA_A02	Products of forestry, logging and related services	1‰	8.0%	1.5%	24.0%
CPA_J59_60	Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services	4‰	7.7%	3.1%	17.4%
CPA_M72	Scientific research and development services	0‰	6.1%	2.8%	21.1%
CPA_H50	Water transport services	1‰	5.4%	1.0%	37.4%
CPA_K64	Financial services, except insurance and pension funding	25‰	4.8%	0.7%	6.8%
CPA_M71	Architectural and engineering services; technical testing and analysis services	0‰	4.4%	0.0%	10.0%
CPA_R90T92	Creative, arts, entertainment, library, archive, museum, other cultural services; gambling and betting services	12‰	2.9%	0.3%	6.2%
CPA_J61	Telecommunications services	32‰	2.8%	0.0%	7.7%
CPA_H53	Postal and courier services	1‰	2.6%	0.0%	7.0%
CPA_M69_70	Legal and accounting services; services of head offices; management consultancy services	1‰	1.6%	0.0%	9.3%
CPA_D35	Electricity, gas, steam and air conditioning	30‰	1.5%	0.0%	6.3%
CPA_K65	Insurance, reinsurance and pension funding services, except compulsory social security	19‰	1.5%	0.0%	5.6%
CPA_H49	Land transport services and transport services via pipelines	18‰	0.9%	0.3%	5.3%
CPA_C18	Printing and recording services	0‰	0.6%	0.0%	1.4%
CPA_H52	Warehousing and support services for transportation	1‰	0.5%	0.0%	11.0%
CPA_E37T39	Sewerage services; sewage sludge; waste collection, treatment and disposal services; materials recovery services; remediation services and other waste management services	7‰	0.5%	0.0%	11.9%
CPA_N77	Rental and leasing services	6‰	0.5%	0.0%	11.1%
CPA_M74_75	Other professional, scientific and technical services and veterinary services	1‰	0.3%	0.0%	12.6%
CPA_F	Constructions and construction works	4‰	0.3%	0.0%	0.9%
CPA_C33	Repair and installation services of machinery and equipment	3‰	0.2%	0.0%	5.7%
CPA_Q86	Human health services	26‰	0.1%	0.0%	0.4%
CPA_I	Accommodation and food services	80‰	0.0%	0.0%	3.8%
CPA_S96	Other personal services	14‰	0.0%	0.0%	4.4%
CPA_R93	Sporting services and amusement and recreation services	8‰	0.0%	0.0%	2.7%
CPA_N80T82	Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services	5‰	0.0%	0.0%	1.8%
CPA_P85	Education services	16‰	0.0%	0.0%	0.2%
CPA_Q87_88	Residential care services; social work services without accommodation	12‰	0.0%	0.0%	0.3%
CPA_G45	Wholesale and retail trade and repair services of motor vehicles and motorcycles	30‰	0.0%	0.0%	0.2%
CPA_O84	Public administration and defence services; compulsory social security services	3‰	0.0%	0.0%	0.2%
CPA_N79	Travel agency, tour operator and other reservation services and related services	9‰	0.0%	0.0%	0.7%
CPA_S95	Repair services of computers and personal and household goods	1‰	0.0%	0.0%	0.2%
CPA_E36	Natural water; water treatment and supply services	5‰	0.0%	0.0%	0.2%
CPA_L68	Real estate services	43‰	0.0%	0.0%	0.0%
CPA_G47	Retail trade services, except of motor vehicles and motorcycles	129‰	0.0%	0.0%	0.3%
CPA_G46	Wholesale trade services, except of motor vehicles and motorcycles	57‰	0.0%	0.0%	0.6%
CPA_K66	Services auxiliary to financial services and insurance services	1‰	0.0%	0.0%	0.6%
CPA_M73	Advertising and market research services	0‰	0.0%	0.0%	0.0%
CPA_N78	Employment services	0‰	0.0%	0.0%	0.3%
CPA_S94	Services furnished by membership organisations	5‰	0.0%	0.0%	0.0%
CPA_T	Services of households as employers; undifferentiated goods and services produced by households for own use	3‰	0.0%	0.0%	0.0%
CPA_U	Services provided by extraterritorial organisations and bodies	0‰	0.0%	0.0%	0.0%

Notes: Table displays the list of CPA categories including their codes and description. We classify goods with an import share above 10% as high-import share goods (those above the horizontal line). Weight is the product's share in the overall HICP basket (averaged across countries) in promils. Summing up across weights gives a value of 879 ‰because 121 ‰of consumption falls on VAT.The 25%, 50% and 75% quantiles across countries of the import share are given as well.

Table A2: LIST OF COICOP CATEGORIES AND IMPORT SHARES

			Import Share		
Code	Name	Weight	50%	25%	75%
CP0712_0714	Motor cycles, bicycles and animal drawn vehicles	2‰	53.7%	32.7%	64.0%
CP0911	Equipment for the reception, recording and reproduction of sound and picture	5‰	50.7%	48.8%	53.2%
CP0711	Motor cars	33‰	49.8%	42.5%	55.5%
CP0531_0532	Major household appliances whether electric or not and small electric household appliances	9‰	49.6%	43.5%	57.6%
CP0912	Photographic and cinematographic equipment and optical instruments	2‰	48.0%	44.8%	50.4%
CP0512	Carpets and other floor coverings	2‰	46.1%	36.8%	48.2%
CP0611*	Pharmaceutical products	16‰	45.5%	41.2%	52.3%
CP0452*	Gas	12‰	44.4%	11.8%	73.3%
CP032	Footwear	11‰	41.6%	33.6%	43.7%
CP0733	Passenger transport by air	6‰	37.6%	11.7%	67.1%
CP0431	Materials for the maintenance and repair of the dwelling	5‰	36.3%	26.4%	44.9%
CP0312	Garments	38‰	35.2%	28.2%	36.9%
CP0931	Games, toys and hobbies	5‰	35.0%	32.8%	41.1%
CP0453	Liquid fuels	5‰	34.7%	27.9%	50.5%
CP0722	Fuels and lubricants for personal transport equipment	47‰	32.9%	24.9%	50.2%
CP0313	Other articles of clothing and clothing accessories	2‰	31.6%	25.6%	33.0%
CP0511	Furniture and furnishings	17‰	30.8%	25.5%	34.2%
CP1212_1213	Electrical appliances for personal care; other appliances, articles and products for personal care	17‰	29.0%	20.2%	31.8%
CP1232	Other personal effects	4‰	28.7%	23.4%	31.3%
CP0115	Oils and fats	6‰	27.8%	16.6%	42.7%
CP1231	Jewellery, clocks and watches	4‰	27.4%	25.6%	29.2%
CP052	Household textiles	5‰	26.3%	22.3%	28.3%
CP0111	Bread and cereals	30‰	26.1%	15.7%	40.4%
CP0612_0613	Other medical products, therapeutic appliances and equipment	4‰	25.6%	23.0%	30.9%
CP022	Tobacco	31‰	24.4%	19.5%	32.1%
CP0721	Spare parts and accessories for personal transport equipment	6‰	23.6%	18.2%	27.0%
CP054	Glassware, tableware and household utensils	5‰	23.5%	15.4%	31.3%
CP0561	Non-durable household goods	11‰	23.5%	19.4%	29.6%
CP0112	Meat	40‰	22.9%	13.9%	35.2%
CP055	Tools and equipment for house and garden	4‰	22.7%	18.2%	28.6%
CP0932	Equipment for sport, camping and open-air recreation	2‰	22.0%	20.4%	27.2%
CP0122	Mineral waters, soft drinks, fruit and vegetable juices	10‰	22.0%	13.3%	33.7%
CP0311	Clothing materials	0‰	21.6%	18.2%	22.4%
CP0921_0922	Major durables for indoor and outdoor recreation including musical instruments	2‰	21.4%	18.7%	25.0%
CP0116	Fruit	11‰	20.4%	15.2%	32.8%
CP0119	Food products n.e.c.	6‰	20.3%	13.3%	30.2%
CP0114	Milk, cheese and eggs	27‰	20.3%	12.5%	29.9%
CP0913	Information processing equipment	5‰	20.0%	15.9%	26.2%
CP0118	Sugar, jam, honey, chocolate and confectionery	11‰	19.6%	12.0%	29.7%
CP0212	Wine	8‰	18.1%	11.2%	27.5%
CP0117	Vegetables	16‰	18.1%	13.5%	28.7%
CP0951	Books	5‰	18.1%	9.4%	28.6%
CP0211	Spirits	8‰	17.8%	11.0%	26.9%
CP0213	Beer	9‰	17.8%	11.1%	27.5%
CP0933	Gardens, plants and flowers	5‰	17.6%	12.4%	28.7%
CP0953_0954	Miscellaneous printed matter; stationery and drawing materials	3‰	17.2%	11.3%	20.7%
CP082_083	Telephone and telefax equipment and services	33‰	16.9%	15.5%	23.2%
CP0952	Newspapers and periodicals	7‰	16.6%	8.7%	26.5%
CP0121	Coffee, tea and cocoa	5‰	15.8%	10.1%	22.0%
CP0934_0935	Pets and related products; veterinary and other services for pets	5‰	14.6%	10.7%	23.2%
CP0923	Maintenance and repair of other major durables for recreation and culture	0‰	13.5%	0.1%	26.3%
CP0113	Fish and seafood	8‰	11.1%	8.1%	15.3%
CP0914	Recording media	3‰	9.6%	5.1%	12.6%
CP0454	Solid fuels	4‰	6.2%	2.3%	18.9%
CP0513	Repair of furniture, furnishings and floor coverings	0‰	5.9%	0.6%	10.4%
CP0734	Passenger transport by sea and inland waterway	1‰	5.6%	1.6%	32.8%
CP126	Financial services n.e.c.	28‰	5.0%	0.3%	6.8%
CP0942	Cultural services	25‰	4.9%	1.9%	9.3%
CP0941	Recreational and sporting services	12‰	4.7%	3.5%	5.4%
CP081*	Postal services	1‰	2.7%	0.0%	7.5%
CP0455*	Heat energy	10‰	2.4%	0.2%	7.5%
CP127*	Other services n.e.c.	17‰	2.3%	1.2%	3.5%
CP125	Insurance	23‰	1.8%	0.0%	5.8%
CP0736	Other purchased transport services	0‰	1.7%	1.3%	6.9%
CP0724*	Other services in respect of personal transport equipment	7‰	1.6%	0.0%	13.8%
CP0915	Repair of audio-visual, photographic and information processing equipment	1‰	1.3%	1.2%	1.7%
CP0731*	Passenger transport by railway	4‰	1.2%	0.2%	4.5%
CP0451*	Electricity	25‰	1.1%	0.0%	6.5%
CP0314	Cleaning, repair and hire of clothing	1‰	1.0%	0.2%	3.7%
CP0732*	Passenger transport by road	12‰	1.0%	0.2%	3.1%
CP0735*	Combined passenger transport	4‰	1.0%	0.3%	3.1%
CP0443*	Sewerage collection	3‰	0.9%	0.0%	10.3%
CP0562	Domestic services and household services	6‰	0.9%	0.0%	4.1%
CP0442*	Refuse collection	3‰	0.7%	0.0%	9.8%
CP0723	Maintenance and repair of personal transport equipment	15‰	0.2%	0.0%	0.6%
CP0621_0623	Medical services and paramedical services	11‰	0.2%	0.0%	0.9%
CP0533	Repair of household appliances	1‰	0.1%	0.0%	1.4%
CP0622*	Dental services	8‰	0.1%	0.0%	0.5%
CP063	Hospital services	8‰	0.1%	0.0%	0.5%
CP0432	Services for the maintenance and repair of the dwelling	5‰	0.0%	0.0%	0.8%
CP0444	Other services relating to the dwelling n.e.c.	4‰	0.0%	0.0%	3.1%
CP1211	Hairdressing salons and personal grooming establishments	10‰	0.0%	0.0%	2.5%
CP1111	Restaurants, cafs and the like	62‰	0.0%	0.0%	3.9%
CP1112	Canteens	9‰	0.0%	0.0%	3.9%
CP112	Accommodation services	20‰	0.0%	0.0%	3.9%
CP10*	Education	15‰	0.0%	0.0%	0.9%
CP0441*	Water supply	6‰	0.0%	0.0%	0.1%
CP124*	Social protection	12‰	0.0%	0.0%	0.2%
CP041*	Actual rentals for housing	41‰	0.0%	0.0%	0.0%
CP096	Package holidays	10‰	0.0%	0.0%	0.6%

Notes: Table displays the list of COICOP categories including their codes and description. We classify COICOP categories with an import share above 10% as high-import share COICOP categories (those above the horizontal line). Weight is the average consumption basket weight (across countries and time) in promils.The 25%, 50% and 75% quantiles across countries of the import share are given as well.Categories classified as administered are marked with an asterisk.

Table A3: LIST OF CATEGORIES WITH ADMINISTERED PRICES

Code	Name	Weight	Share Admin
CP0441	Water supply	5.76‰	92.59%
CP0443	Sewerage collection	2.96‰	88.89%
CP081	Postal services	1.34‰	88.89%
CP0442	Refuse collection	3.02‰	74.07%
CP0732	Passenger transport by road	12.03‰	70.37%
CP0611	Pharmaceutical products	16.36‰	66.67%
CP0731	Passenger transport by railway	4.24‰	66.67%
CP0451	Electricity	24.60‰	62.96%
CP0735	Combined passenger transport	3.66‰	59.26%
CP0452	Gas	12.42‰	51.85%
CP127	Other services n.e.c.	16.78‰	48.15%
CP124	Social protection	12.16‰	44.44%
CP0455	Heat energy	10.23‰	40.74%
CP10	Education	15.20‰	40.74%
CP041	Actual rentals for housing	41.07‰	37.04%
CP0622	Dental services	8.35‰	33.33%
CP0724	Other services in respect of personal transport equipment	6.84‰	33.33%
CP0621_0623	Medical services and paramedical services	10.93‰	29.63%
CP063	Hospital services	8.01‰	29.63%
CP0734	Passenger transport by sea and inland waterway	1.14‰	18.52%
CP0942	Cultural services	25.40‰	18.52%
CP0444	Other services relating to the dwelling n.e.c.	4.47‰	11.11%
CP1112	Canteens	8.85‰	11.11%
CP0612_0613	Other medical products, therapeutic appliances and equipment	4.34‰	7.41%
CP082_083	Telephone and telefax equipment and services	33.05‰	7.41%
CP0941	Recreational and sporting services	12.44‰	7.41%
CP0951	Books	4.81‰	7.41%
CP112	Accommodation services	20.07‰	7.41%
CP022	Tobacco	30.77‰	3.70%
CP0432	Services for the maintenance and repair of the dwelling	4.68‰	3.70%
CP0453	Liquid fuels	4.68‰	3.70%
CP0562	Domestic services and household services	5.74‰	3.70%
CP0733	Passenger transport by air	6.26‰	3.70%

Notes: Table displays the share of countries that had imposed administered prices in 2009 by COICOP category. Based on this table, we classify categories as administered if a third or more countries had imposed administered prices (those above the horizontal line). The weight corresponds to the average weight in the consumer basket across countries and time periods.

Table A4: LIST OF CATEGORIES INPUT-COMPETING WITH GOVERNMENT PURCHASES

Code	Name	Weight	*gcomp*
CP10	Education	15.20‰	69.06%
CP063	Hospital services	8.01‰	68.64%
CP0622	Dental services	8.35‰	67.05%
CP0621_0623	Medical services and paramedical services	10.93‰	66.73%
CP124	Social protection	12.16‰	46.52%
CP0513	Repair of furniture, furnishings and floor coverings	0.28‰	23.74%
CP0942	Cultural services	25.40‰	13.47%
CP0724	Other services in respect of personal transport equipment	6.84‰	13.34%
CP0941	Recreational and sporting services	12.44‰	13.30%
CP0611	Pharmaceutical products	16.36‰	10.99%
CP127	Other services n.e.c.	16.78‰	9.37%
CP0723	Maintenance and repair of personal transport equipment	15.44‰	8.01%
CP0443	Sewerage collection	2.96‰	7.98%
CP0442	Refuse collection	3.02‰	7.74%
CP0732	Passenger transport by road	12.03‰	4.51%
CP0731	Passenger transport by railway	4.24‰	4.49%
CP0735	Combined passenger transport	3.66‰	4.47%
CP0444	Other services relating to the dwelling n.e.c.	4.47‰	4.16%
CP0454	Solid fuels	4.11‰	4.10%
CP0452	Gas	12.42‰	3.98%
CP0923	Maintenance and repair of other major durables for recreation and culture	0.06‰	3.95%
CP022	Tobacco	30.77‰	3.87%
CP0736	Other purchased transport services	0.45‰	3.18%
CP0441	Water supply	5.76‰	3.01%
CP041	Actual rentals for housing	41.07‰	2.64%
CP0914	Recording media	2.75‰	2.41%
CP0562	Domestic services and household services	5.74‰	2.39%
CP0722	Fuels and lubricants for personal transport equipment	47.14‰	2.36%
CP0921_0922	Major durables for indoor and outdoor recreation including musical instruments	2.47‰	2.19%
CP0934_0935	Pets and related products; veterinary and other services for pets	4.69‰	2.13%
CP0511	Furniture and furnishings	16.95‰	2.00%
CP0931	Games, toys and hobbies	4.75‰	1.75%
CP0612_0613	Other medical products, therapeutic appliances and equipment	4.34‰	1.70%
CP0113	Fish and seafood	8.31‰	1.66%
CP0312	Garments	37.58‰	1.62%
CP0952	Newspapers and periodicals	7.17‰	1.61%
CP052	Household textiles	4.59‰	1.60%
CP1211	Hairdressing salons and personal grooming establishments	9.58‰	1.55%
CP1231	Jewellery, clocks and watches	3.72‰	1.53%

Notes: Table displays the average input competition index with government purchases by COICOP category. Only COICOP categories with an index above 1.5% are shown.Those categories above the horizontal line display an input-competition index above the mean. The weight correspondsto the average weight in the consumer basket across countries and time periods.

Table A5: LIST OF COICOP CATEGORIES

Code	Name	Code	Name
CP0111	Bread and cereals	CP0622	Dental services
CP0112	Meat	CP063	Hospital services
CP0113	Fish and seafood	CP0711	Motor cars
CP0114	Milk, cheese and eggs	CP0712_0714	Motor cycles, bicycles and animal drawn vehicles
CP0115	Oils and fats	CP0721	Spare parts and accessories for personal transport equipment
CP0116	Fruit	CP0722	Fuels and lubricants for personal transport equipment
CP0117	Vegetables	CP0723	Maintenance and repair of personal transport equipment
CP0118	Sugar, jam, honey, chocolate and confectionery	CP0724	Other services in respect of personal transport equipment
CP0119	Food products n.e.c.	CP0731	Passenger transport by railway
CP0121	Coffee, tea and cocoa	CP0732	Passenger transport by road
CP0122	Mineral waters, soft drinks, fruit and vegetable juices	CP0733	Passenger transport by air
CP0211	Spirits	CP0734	Passenger transport by sea and inland waterway
CP0212	Wine	CP0735	Combined passenger transport
CP0213	Beer	CP0736	Other purchased transport services
CP022	Tobacco	CP081	Postal services
CP0311	Clothing materials	CP082_083	Telephone and telefax equipment and services
CP0312	Garments	CP0911	Equipment for the reception, recording and reproduction of sound and picture
CP0313	Other articles of clothing and clothing accessories	CP0912	Photographic and cinematographic equipment and optical instruments
CP0314	Cleaning, repair and hire of clothing	CP0913	Information processing equipment
CP032	Footwear	CP0914	Recording media
CP041	Actual rentals for housing	CP0915	Repair of audio-visual, photographic and information processing equipment
CP0431	Materials for the maintenance and repair of the dwelling	CP0921_0922	Major durables for indoor and outdoor recreation including musical instruments
CP0432	Services for the maintenance and repair of the dwelling	CP0923	Maintenance and repair of other major durables for recreation and culture
CP0441	Water supply	CP0931	Games, toys and hobbies
CP0442	Refuse collection	CP0932	Equipment for sport, camping and open-air recreation
CP0443	Sewerage collection	CP0933	Gardens, plants and flowers
CP0444	Other services relating to the dwelling n.e.c.	CP0934_0935	Pets and related products; veterinary and other services for pets
CP0451	Electricity	CP0941	Recreational and sporting services
CP0452	Gas	CP0942	Cultural services
CP0453	Liquid fuels	CP0951	Books
CP0454	Solid fuels	CP0952	Newspapers and periodicals
CP0455	Heat energy	CP0953_0954	Miscellaneous printed matter; stationery and drawing materials
CP0511	Furniture and furnishings	CP096	Package holidays
CP0512	Carpets and other floor coverings	CP10	Education
CP0513	Repair of furniture, furnishings and floor coverings	CP1111	Restaurants, cafs and the like
CP052	Household textiles	CP1112	Canteens
CP0531_0532	Major household appliances whether electric or not and small electric household appliances	CP112	Accommodation services
CP0533	Repair of household appliances	CP1211	Hairdressing salons and personal grooming establishments
CP054	Glassware, tableware and household utensils	CP1212_1213	Electrical appliances for personal care; other appliances, articles and products for personal care
CP055	Tools and equipment for house and garden	CP1231	Jewellery, clocks and watches
CP0561	Non-durable household goods	CP1232	Other personal effects
CP0562	Domestic services and household services	CP124	Social protection
CP0611	Pharmaceutical products	CP125	Insurance
CP0612_0613	Other medical products, therapeutic appliances and equipment	CP126	Financial services n.e.c.
CP0621_0623	Medical services and paramedical services	CP127	Other services n.e.c.

Notes: Table displays the list of COICOP categories including their codes and description.

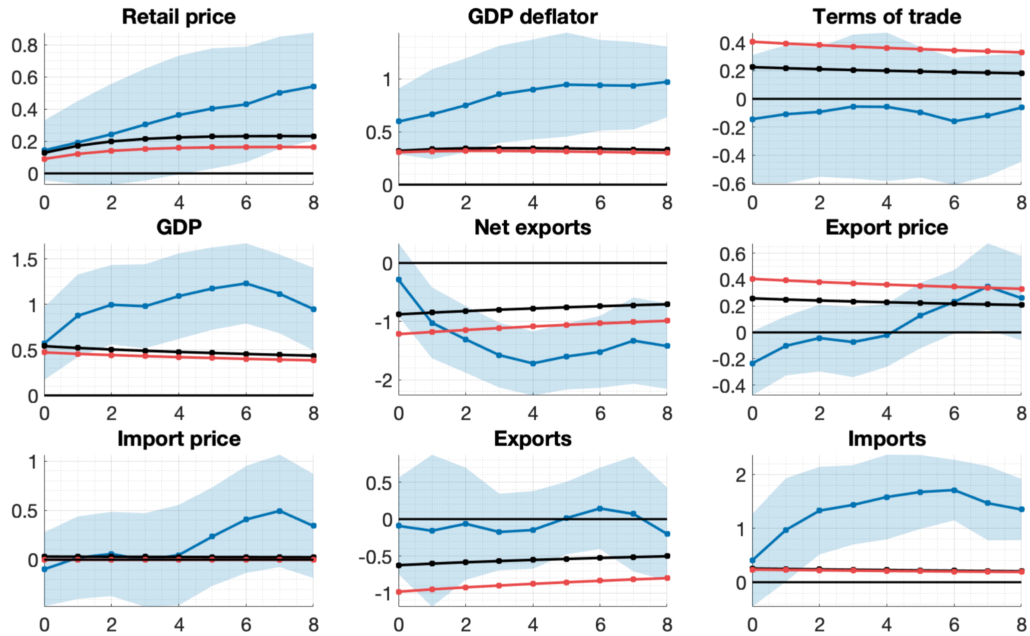


Figure A1: Government Spending Multipliers: Data vs. Model (Separable Preferences)

Note: Model features separable preferences instead of GHH preference. 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 drop in government spending. The red line is the model response without pricing to market ($\Gamma = 0$).

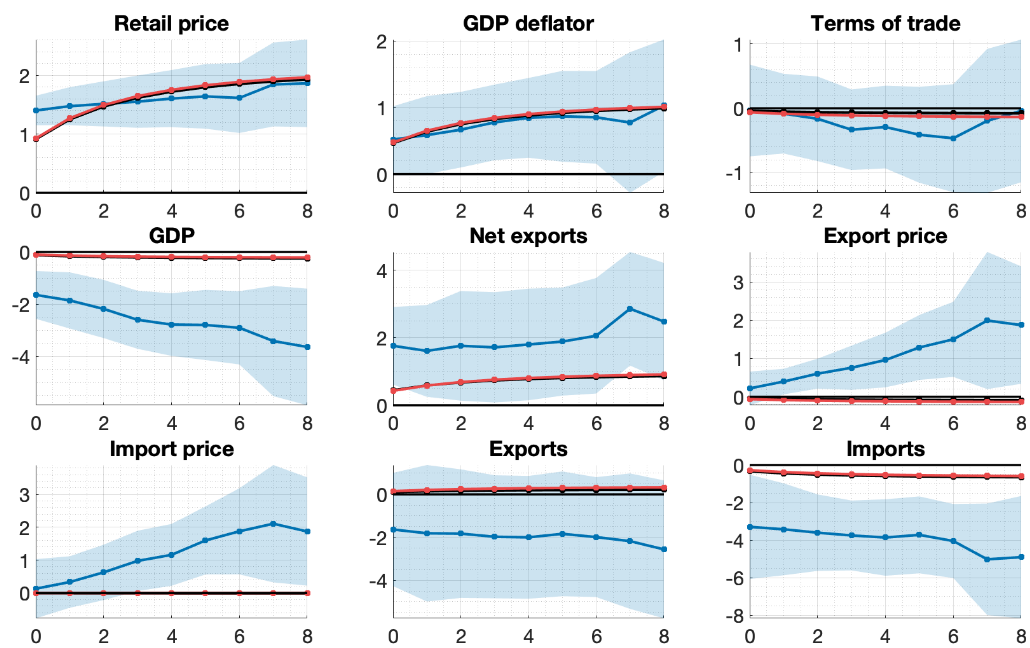


Figure A2: Consumption Tax Multipliers: Data vs. Model (Separable Preferences)

Note: Model features separable preferences instead of GHH preference. The blue line is the response in the data. The black line is the consumpton tax multiplier derived from the model in response to an increase in the consumption tax rate. The red line is the model response without pricing to market ($\Gamma = 0$).