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IMPERFECT MOBILITY OF LABOR ACROSS SECTORS AND FISCAL TRANSMISSION*

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Abstract

Our paper investigates the sectoral effects of government spending shocks and highlights the role of labor mobility. Our VAR evidence for sixteen OECD countries reveals that a shock to government consumption by 1% of GDP increases non-traded value added by 0.7% of GDP and generates a decline in traded value added. The value added share of non-tradables rises by 0.35% of GDP, thus implying that the reallocation of resources accounts for 50% of the sectoral fiscal multiplier. Consistently, our estimates show that the non-traded sector is highly intensive in the government spending shock and experiences a labor inflow. The shift of hours worked toward the non-traded sector is, however, subject to mobility costs which vary across countries. When we explore quantitatively the sectoral effects of a shock to government consumption that is highly intensive in non-traded goods, we find that the model can replicate the magnitude of the rise in the share of non-tradables we document empirically once we allow for both labor mobility and capital installation costs. Financial openness also matters as it further biases the demand shock toward non-tradables. To account for the cross-country dispersion in the responses of sectoral shares we estimate empirically, we have to let the degree of labor mobility vary across countries.
Keywords: Fiscal policy; Labor mobility; Investment; Current account; Non-tradables; Sectoral wages.
JEL Classification: E22; E62; F11; F41; J31.

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As documented recently, the global financial crisis has led to an output decline in OECD countries which varies along the tradedness of industries. Using sectoral data for Spain, Arellano et al. [2018] find that non-traded production has decreased significantly more than traded production between 2007 and 2013. Evidence by De Ferra [2018] reveals that non-exporting firms experienced the largest drop in sales, hours worked and investment in Italy in 2009-2013. Using U.S. data between 2007 and 2009, Mian and Sufi [2014] find that non-traded employment has been more vulnerable to the recession than employment in traded industries as non-traded firms rely heavily on local demand. To the extent that expansionary fiscal policy targets non-traded industries, a rise in government spending could potentially be an appropriate tool to stabilize output in non-exporting sectors, as emphasized by Schmitt-Grohé and Uribe [2013]. Yet at an empirical and theoretical level, the systematic exploration of how a rise in government spending impacts the non-traded vs. the traded sector is still lacking. In the present paper we address the following question: Do shocks to government consumption affect sectors symmetrically and if not, what are the causes of this asymmetry? We find that shocks to government consumption tend to disproportionately benefit the non-traded sector by producing a labor reallocation toward this sector, and all the more so in countries where workers' costs of switching sectors are lower.

To guide our quantitative analysis, we document VAR evidence on the sectoral effects of a rise in government consumption for sixteen OECD countries. First, a shock to government consumption has a strong expansionary effect on output in the non-traded sector relative to the traded sector. More specifically, we find empirically that a rise in government spending by 1% of GDP increases non-traded value added by 0.7% of GDP on impact and leads to a decline in traded value added. The expansion in the non-traded sector is associated with a rise in the value added share of non-tradables by 0.35% of GDP. Since the latter result indicates that non-traded value added would increase by 0.35% if GDP remained constant, the reallocation of resources toward the non-traded sector thus contributes to 50% of the rise in non-traded value added. The remaining 0.35% of GDP represents the rise in non-traded value added caused by the aggregate fiscal multiplier split across sectors in accordance with their value added share. A necessary condition for the share of non-tradables to increase is that this sector must receive a disproportionate share of the shock to government spending. Our estimates corroborate this hypothesis as we find empirically that government consumption of non-tradables contributes 90% on average to increases in government spending.

For the increase in the share of non-tradables to materialize, productive resources, in particular labor, must be reallocated toward the non-traded sector. The second set of our half of this increase being caused by the reallocation of labor. The shift of labor is subject to labor mobility costs, however, since we detect empirically a significant increase in non-traded relative to traded wages. These findings accord well with the evidence documented by Artuç et al. [2010], Dix-Carneiro [2014], Lee and Wolpin [2006] who find substantial barriers of mobility between sectors and furthermore that wages are not equalized across sectors in the short run nor in the long run.

A first way to gauge the role of labor mobility costs for fiscal transmission is to investigate how impact responses of relative sector size vary over time and whether their movements are positively related to labor reallocation following our identified government spending shock. Our estimates reveal that the responses of sectoral shares are reduced over time by about 40% and that this reduction is concomitant and highly correlated with the decline in the rate of workers shifting from one sector to another. When we turn to international differences, the responses of sectoral value added and hours worked shares display a wide cross-country dispersion. Motivated by the cross-country variations in labor mobility costs documented by Artuç et al. [2015], we estimate the elasticity of labor supply across sectors and empirically detect a positive cross-country relationship between the change in relative sector size following a government spending shock and the degree of labor mobility.

To account for our evidence on fiscal transmission, we put forward an open economy version of the neoclassical model with tradables and non-tradables. In calibrating the model to a representative OECD economy, we assume that the non-traded sector receives a share of the rise in government spending which is larger than its relative size, in line with our evidence, so that the government shock is biased toward non-tradables. Our quantitative results show that the model is successful in replicating the sectoral effects of government spending shocks as long as we allow for imperfect mobility of labor (IML henceforth) and capital adjustment costs.[1]

With these two features, the model produces a rise in the share of non-tradables by 0.38% of GDP, close to our empirical findings. If we remove both or either one of these ingredients, the model fails to account quantitatively for our evidence on fiscal transmission, in particular the responses of sectoral output shares which we estimate empirically. Intuitively, if we do not allow for capital adjustment costs, a government spending shock leads to a dramatic fall in investment which offsets the rise in government consumption. As a result, the excess demand in the non-traded goods market is low or even nil. Due to low incentives to shift resources toward the non-traded sector, the open economy experiences a trade balance surplus resulting in the model substantially understating the rise in the share of non-

[1]To generate IML, we consider limited substitutability in hours worked across sectors along the lines of Horvath [2000]. See e.g., Bouakez et al. [2011], Cardi and Restout [2015] who assume that sectoral hours worked are aggregated by means of a CES function in order to account for the evidence related to monetary policy shocks or the long-run effects of productivity shocks biased toward the traded sector.

is mitigated, which leads to significant excess demand in the non-traded goods market. However, if we impose perfect mobility of labor across sectors (PML henceforth), high incentives to shift resources toward the non-traded sector result in a large trade balance deficit which leads the model to overstate the rise in the share of non-tradables considerably.

By tilting the demand shock toward non-tradables, financial openness and the tradability of goods are also key dimensions that allow our model with IML to account for the evidence. Shutting down the response of the current account leads the model to understate the rise in the share of non-tradables, the latter increasing by an amount which is twice as small as that estimated empirically. The reason is that when the fiscal stimulus is temporary and the economy has perfect access to world capital markets, households find it optimal to borrow abroad to avoid a large decline in consumption and/or a large increase in labor supply. Since traded goods can be imported and non-traded goods must be produced domestically, access to foreign borrowing further biases the demand shock toward non-tradables.

The final exercise we perform is to investigate whether the model can account for cross-country differences in the responses of sectoral output shares to a fiscal shock. We thus calibrate the model to country-specific data. We find quantitatively that impact responses of sectoral output shares to a government spending shock are sensitive to the degree of labor mobility, as they vary between 0.26% and 0.49% of GDP for non-tradables when we move from the lowest to the highest value of elasticity of labor supply across sectors. In line with the evidence, the cross-country dispersion in the sectoral share responses is the result of international differences in the degree of labor mobility, the rise in the output share of non-tradables being more pronounced in countries with a higher degree of labor mobility.

So far, we have not said much about the sectoral fiscal multiplier which is the result of the change in the sectoral share and the rise in real GDP. Because changes in the sectoral value added and the sectoral share are positively correlated, raising the non-tradable content of the government spending shock or the degree of labor mobility across sectors increases the fiscal multiplier for non-tradables. At an aggregate level, a government spending shock produces a larger fiscal multiplier by targeting the sector that has the highest labor compensation share, i.e., the non-traded sector.[2] By contrast, by mitigating the rise in non-traded wages and thus aggregate wage growth, a higher degree of labor mobility reduces the magnitude of the aggregate fiscal multiplier.

Related Literature. We contribute to the extensive literature investigating fiscal transmission both empirically and theoretically by focusing on the reallocation effect of

[2] Baqaee [2018] provides a decomposition of the contribution of sectors to the aggregate fiscal multiplier and highlights the key role of both the sectoral composition of government purchases and sectoral labor intensity in determining employment effects like us but the mechanism is very different.

of the composition of government spending in understanding the sectoral effects of a fiscal shock. In contrast to the authors who consider three episodes of expansionary defense spending in the United States driven by foreign policy, we identify exogenous increases in government consumption by assuming that discretionary government spending is subject to certain decision and/or implementation lags, as proposed by Blanchard and Perotti [2002]. Putting aside the advantages and disadvantages inherent to the narrative and SVAR approaches, the identification scheme does matter, as the identified government spending shock can be intensive either in tradables or non-tradables. While the Ramey-Shapiro narrative approach suggests that military shocks, which are heavily concentrated in the manufacturing sector, are intensive in traded goods, our study reveals that government spending shocks, identified on the basis of Blanchard-Perotti assumption, lead to a sharp increase in non-traded relative to traded output.

This finding is in line with estimates documented by Monacelli and Perotti [2008], Benetrix and Lane [2010] which show that an increase in government spending disproportionately benefits the non-traded sector. In contrast to the authors who restrict their attention to sectoral output or labor effects and thus do not investigate the reallocation effects, our paper analyzes and rationalizes the labor composition effect caused by shocks to government consumption like Bredemeier et al. [2019]. Differently, the authors contrast the effects across occupations rather than between sectors.

One additional key finding with respect to the papers mentioned above is that international differences in workers' costs of switching sectors can account for the cross-country dispersion in the responses of sectoral shares, as we uncover a positive cross-country relationship between the degree of labor mobility and the changes in relative sector size. In this regard, our study can be viewed as complementary to the work by Ilzetzki et al. [2013], Born et al. [2013], Brinca et al. [2016] who contrast the effects of fiscal policy on output across a number of country characteristics. In contrast to these papers focusing on the aggregate fiscal multiplier, we explore the size of sectoral fiscal multipliers resulting from the reallocation of resources across sectors.

Finally, our paper also relates to a broad literature which studies fiscal transmission by breaking down aggregate government spending into sub-categories. While Baxter and King [1993] differentiate between government consumption and government investment, we restrict attention to government consumption in accordance with the bulk of the literature investigating fiscal transmission. In contrast to a growing literature exploring the impact on private activity of shocks to government purchases from the private sector and the government sector (the latter essentially consisting of compensation of government employees), respectively, see e.g., Bermperoglou et al. [2017], we focus on the sectoral distribution of an sector. Nekarda and Ramey [2011] estimate the effects of a rise in industry-specific government purchases and find that industries with higher concentration and unionization rates experience larger increases in output. Differently, we focus on the asymmetric effects across sectors caused by an increase in government consumption by breaking down sectoral effects into reallocation and aggregate effects.

The remainder of the paper is organized as follows. In section 2, we investigate empirically the sectoral effects of a government spending shock and highlight the role of labor reallocation. In section 3, we develop an open economy version of the neoclassical model with IML. In section 4, we report the results of our numerical simulations and assess the ability of the model to account for the evidence. In section 5, we summarize our main results and present our conclusions. An Online Appendix contains more empirical results and robustness checks, and solves analytically a restricted version of the model to build up intuition on the implications of labor mobility costs.[3]

2 Evidence on Fiscal Transmission across Sectors

In this section, we revisit the time-series evidence on fiscal transmission by differentiating the effects between the traded and non-traded sectors. We first estimate sectoral fiscal multipliers and the responses of sectoral shares to a government spending shock. Then we document evidence which aims to explain the rise in the share of non-tradables along with its variation across time and space. We denote below the level of the variable in upper case, the logarithm in lower case, and the percentage deviation from its initial steady-state by a hat.

2.1 VAR Model and Identification

In order to shed some light on fiscal transmission and guide our quantitative analysis, we estimate a VAR model in panel format on annual data. We use i to index countries and t to index time periods (years). Denoting the vector of endogenous variables by $Z_{i,t}$, the reduced-form VAR reads:

$$Z_{i,t} = \alpha_i + \beta_i t + \sum_{k=1}^{2} A^{-1} B_k Z_{i,t-k} + A^{-1} \epsilon_{i,t}, \tag{1}$$

where k is the number of lags; the specification includes country fixed effects, α_i, and country-specific linear time trends; A is a matrix that describes the contemporaneous relation among the variables collected in vector $Z_{i,t}$, B_k is a matrix of lag specific own- and cross-effects of variables on current observations, and the vector $\epsilon_{i,t}$ contains the structural disturbances which are uncorrelated with each other. In line with the common practice in

[3] A longer version of the paper by Cardi et al. [2018] provides the steps to solve the model laid out in section 3, and proposes additional robustness checks and several theoretical extensions of the model.

data, see e.g., Beetsma and Giuliodori [2011], we include two lags in the regression model and use a panel OLS regression to estimate the coefficients $A^{-1}B_k$ and the reduced-form innovations $A^{-1}\epsilon_{i,t}$.

To identify the VAR model and recover the government spending shocks, we need assumptions on the matrix A as the reduced form of the VAR model that we estimate contains fewer parameters than the structural VAR model. Like Blanchard and Perotti [2002], we base the identification scheme on the assumption that discretionary government spending is subject to certain decision and implementation lags that prevent government spending from responding to current output developments. Since there are some delays inherent to the legislative system, this is a natural assumption when using quarterly data. However, this argument may not necessarily be true when using annual data since some adjustment could be possible. To address the potential endogeneity issue, we ran a number of robustness checks which confirm that our identifying strategy is not altered by the use of annual data.[4] An additional obstacle is to identify unexpected fiscal events. We conducted an investigation of the potential presence of anticipation effects by using a dataset constructed by Born, Juessen and Müller [2013] which contains one year-ahead OECD forecasts for government spending. It turns out that differences are moderate when we control for the anticipation effects and that our main results are not affected by the inclusion of forecasts for government spending growth.

2.2 Data Construction

Before presenting the VAR model specification, we briefly discuss the dataset we use. Our sample contains annual observations and consists of a panel of 16 OECD countries. The baseline period is running from 1970 to 2007. Table 1 provides a list of countries and data sources while more details can be found in the Online Appendix A. All quantities are logged, expressed in real terms and scaled by the working age population. Government final consumption expenditure ($G_{i,t}$) in volume is taken from OECD Economic outlook. We describe below how we construct time series at a sectoral level.

We use the EU KLEMS [2011] and OECD STAN [2011] database which provides domestic currency series of value added in current and constant prices, labor compensation and number of hours worked for eleven 1-digit ISIC-rev.3 industries. To split these eleven

[4] To support our identifying assumption, we performed several robustness exercises detailed in Online Appendix E.1 and E.2. Our results accord well with the conclusion reached by Born and Müller [2012] whose test reveals that the assumption that government spending is predetermined within the year cannot be rejected. In particular, we investigate whether our main conclusions hold when adopting a narrative approach which has the advantage of identifying fiscal policy changes that are exogenous to current economic developments. We use narratively-identified government spending shocks from the dataset constructed by Guajardo, Leigh, and Pescatori [2014] whose dataset contains 173 fiscal policy changes for 17 OECD countries over the period 1978-2009. The main conclusions reached in this paper are robust to the identification approach.

Gregorio et al. [1994] that we updated by following Jensen and Kletzer [2006].[5]

Once industries have been classified as traded or non-traded, denoted by the superscripts T and N, respectively, series for sectoral value added in current (constant) prices are constructed by adding value added in current (constant) prices for all sub-industries k in sector $j = T, N$, i.e., $P^j_{i,t}Y^j_{i,t} = \sum_k P^j_{k,i,t}Y^j_{k,i,t}$ ($\bar{P}^j_i Y^j_{i,t} = \sum_k \bar{P}^j_{k,i}Y^j_{k,i,t}$ where the bar indicates that prices P^j are those at the base year), from which we compute price indices (or sectoral value added deflators), $P^j_{i,t}$. Normalizing base year price indices $\bar{P}^j$ to 1, the relative price of non-tradables, $P_{i,t}$, is defined as the ratio of the non-traded value added deflator to the traded value added deflator (i.e., $P_{i,t} = P^N_{i,t}/P^T_{i,t}$). The same logic applies to constructing series for hours worked ($L^j = \sum_k L^j_{k,i,t}$) and labor compensation in the traded and the non-traded sectors which allow us to construct sectoral wages, $W^j_{i,t}$. The relative wage, $\Omega_{i,t}$, is computed as the ratio of the non-traded wage to the traded wage (i.e., $\Omega_{i,t} = W^N_{i,t}/W^T_{i,t}$). The real consumption wage in sector j, $W^j_{C,i,t}$, is defined as the sectoral nominal wage, $W^j_{i,t}$, divided by the consumption price index, $P_{C,i,t}$. As detailed below, we also construct labor and value added shares, denoted by $\nu^{L,j}_{i,t}$ and $\nu^{Y,j}_{i,t}$.

< Please insert Table 1 about here >

2.3 Sector-Biased Government Spending Shock and Labor Reallocation

Most of the literature investigating the output effects of a government spending shock focuses on the aggregate fiscal multiplier which measures the percentage deviation of real GDP relative to its initial steady-state following a rise in government consumption by 1% of GDP, denoted by $\hat{Y}_R(t)$.[6] In the present paper, we consider an open economy which produces a traded and a non-traded good where the traded good is the numeraire and its price is normalized to 1. Real GDP, $Y_R(t)$, is equal to the sum of traded and non-traded value added at constant prices, i.e., $Y_R(t) = Y^T(t) + PY^N(t)$ where prices at the initial steady-state are those at the base year so that real GDP collapses to nominal GDP, Y, initially. Log-linearizing both sides of the equality in the neighborhood of the initial steady-state leads to $\hat{Y}_R(t) = \nu^{Y,T}\hat{Y}^T(t) + \nu^{Y,N}\hat{Y}^N(t)$ where $\nu^{Y,j} = P^jY^j/Y$ is the share of sector j in GDP. This expression simply states that following a shock to government consumption by 1% of GDP, the aggregate fiscal multiplier is equal to the sum of sectoral fiscal multipliers expressed in GDP units.

The contribution of each sector j to the aggregate fiscal multiplier will collapse to its

[5] In contrast to De Gregorio et al. [1994] who treat 'Financial intermediation' as non-tradable, we classify this industry as tradable in line with the evidence documented by Jensen and Kletzer [2006] on U.S. data. In Online Appendix D.2, we find that our classification does not drive our results.

[6] It should be mentioned in the interest of clarity that referring to $\hat{Y}_R(t)$ as the fiscal multiplier is an abuse of language as the latter should be computed as the ratio of the present value of the cumulative change in output to the present value of the cumulative change in government consumption. Since we base most of our analysis on impact effects such a simplification does not pose a problem.

in accordance with their share $\nu^{Y,j}$ in GDP. By contrast, if sector j receives a fraction of the rise in government spending which is larger than its value added share, $\nu^{Y,j}$, the shock to government consumption provides incentives to shift productive resources toward this sector. Henceforth, the government spending shock is biased toward sector j which increases its value added share by moving productive resources toward this sector.

To clarify this point, we first break down the sectoral fiscal multiplier into two components. A rise in government spending generates a deviation of sectoral value added relative to its initial steady-state value in percentage denoted by $\hat{Y}^j(t)$. Adding and subtracting the aggregate fiscal multiplier, i.e., $\hat{Y}^j(t) = \hat{Y}_R(t) + \left(\hat{Y}^j(t) - \hat{Y}_R(t)\right)$, and multiplying both sides by $\nu^{Y,j}$ allows us to decompose the sectoral fiscal multiplier as follows:

$$\nu^{Y,j}\hat{Y}^j(t) = \nu^{Y,j}\hat{Y}_R(t) + d\nu^{Y,j}(t), \tag{2}$$

where $d\nu^{Y,j}(t) = \nu^{Y,j}\left(\hat{Y}^j(t) - \hat{Y}_R(t)\right)$ is the change in the value added share of sector j at constant prices in GDP units. The first term on the RHS of eq. (2) (i.e., $\nu^{Y,j}\hat{Y}_R(t)$) captures the rise in sectoral value added if the intensity of sector j in the government spending shock were equal to its value added share, $\nu^{Y,j}$. The second term on the RHS of eq. (2) (i.e., $d\nu^{Y,j}(t)$) states that value added at constant prices of sector j further increases if the value added share of sector j rises. As shown below, for the value added share of sector j, $\nu^{Y,j}(t)$, to increase, the shock to government spending must be biased toward sector j. The same logic applies to sectoral hours worked, except that $d\nu^{L,j}(t)$ measures the differential between the responses of sectoral and total hours worked expressed in total hours worked units, i.e., $d\nu^{L,j}(t) = \alpha^{L,j}\left(\hat{L}^j(t) - \hat{L}(t)\right)$ where $\alpha^{L,j}$ is the labor compensation share of sector j.

Next, we derive a relationship between the change in the value added share of sector j and the biasedness of the shock to government consumption toward good j by using the equality between value added and its final use, i.e., $Y^j(t) = E^j(t) + G^j(t)$ where E^j and G^j stands for private and public demand for good j, respectively. Log-linearizing $Y^j(t) = E^j(t) + G^j(t)$ while keeping private demand fixed leads to $\nu^{Y,j}\hat{Y}^j(t) = P^j dG^j(t)/Y = \omega_{G^j} dG(t)/Y$ where $\omega_{G^j} = P^j G^j/G$ is the share of good j in government consumption. In deriving the last equality, we assume that a constant fraction of government expenditure is spent on good j in line with our evidence which shows that ω_{G^j} is fairly constant over time so that $G(t) = \omega_{G^N} G(t) + \omega_{G^T} G(t)$. Focusing on the non-traded sector, using the fact that $\hat{Y}_R(t) = dG(t)/Y$ because we keep private demand fixed, and subtracting $\nu^{Y,N}\hat{Y}_R(t)$ from both sides of $\nu^{Y,N}\hat{Y}^N(t) = \omega_{G^N} dG(t)/Y$ enables us to relate the change in the value added share of non-tradables to the intensity of the non-traded sector in the government spending shock:

$$d\nu^{Y,N}(t) = \left(\omega_{G^N} - \nu^{Y,N}\right)\left(dG(t)/Y\right). \tag{3}$$

The term $\omega_{G^N} - \nu^{Y,N}$ is a measure of the biasedness of the shock to government consumption a share ω_{G^N} of the rise in government spending equal to the share of non-tradables in GDP, $\nu^{Y,N}$, the relative size of the non-traded sector remains unchanged, i.e., $d\nu^{Y,N}(t) = 0$. According to eq. (2), under this assumption, the fiscal multiplier of non-tradables, $\nu^{Y,N}\hat{Y}^N(t)$, boils down to the aggregate fiscal multiplier weighted by the non-traded value added share, $\nu^{Y,N}\hat{Y}_R(t)$. By contrast, when the shock to government consumption is biased toward non-tradables, i.e., $\omega_{G^N} > \nu^{Y,N}$, the non-traded sector experiences a demand boom which provides an incentive to shift productive resources toward this sector. As long as mobility costs are not prohibitive, the value added share of non-tradables increases, i.e., $d\nu^{Y,N}(t) > 0$. The lower the labor mobility costs, the more labor is reallocated toward the non-traded sector which amplifies the rise in the value added share of non-tradables. It is worth mentioning that in deriving eq. (3), we shut down the responses of the private sector's demand components. As shown in Online Appendix C where we solve analytically a restricted version of the model and as discussed in section 4 where we solve numerically the full model, the endogenous reaction of the current account to the fiscal shock also matters in determining the response of the sectoral share $\nu^{Y,N}(t)$.

In the sequel, we estimate empirically the change in the sectoral value added at constant prices expressed in GDP units, $\nu^{Y,j}\hat{Y}^j(t)$ (i.e., the LHS term of eq. (2)), and the change in the sectoral value added share, $d\nu^{Y,j}(t)$ (i.e., the second term on the RHS of eq. (2)), following an increase in government consumption by 1% of GDP. Dividing the latter by the former allows us to measure the contribution of the reallocation of productive resources to the sectoral fiscal multiplier. To rationalize the change in the value added share of sector j (see eq. (3)), we estimate the intensity ω_{G^j} of each sector j in the government spending shock. Since the intensity ω_{G^j} varies little between OECD economies, we put forward international differences in labor mobility costs to account for the cross-country dispersion in the responses of sectoral shares to the shock to government consumption we document empirically.

2.4 VAR Specification

In order to investigate the size of sectoral fiscal multipliers, along with the contribution of the reallocation of resources to sectoral fiscal multipliers, we consider three alternative VAR specifications in which the choice of variables is motivated by the variables discussed in the quantitative analysis. To alleviate notations, price indices at the base year are normalized to 1, i.e., $\bar{P}_i^j = 1$, so that (logged) value added at constant prices is reduced to $y_{i,t}^j$ and $y_{i,t}$ stands for (logged) real GDP when this causes no confusion.

- To investigate the magnitude of the sectoral fiscal multiplier (i.e., the LHS term of eq. (2)), we consider a VAR model that includes value added at constant prices in

j, $w^j_{C,i,t}$. Our vector of endogenous variables, is given by: $z^j_{i,t} = \left[g_{i,t}, y^j_{i,t}, l^j_{i,t}, w^j_{C,i,t}\right]$ with $j = T, N$.

- To estimate the change in the value added (hours worked) share of sector j (i.e., the second term on the RHS of eq. (2)), we consider a VAR model where we divide sectoral value added at constant prices (sectoral hours worked) by real GDP (total hours worked) in order to filter the change in sectoral output (sectoral hours worked) arising from real GDP (total hours worked) growth, which allows us to isolate the 'pure' reallocation effect and thus gauge the importance of the shift of resources across sectors for the sectoral fiscal multiplier. Our vector of endogenous variables, is given by: $z^{S,j}_{i,t} = \left[g_{i,t}, y^j_{i,t} - y_{i,t}, l^j_{i,t} - l_{i,t}, w^j_{C,i,t}\right]$.

- Finally, to gain further insight into fiscal transmission, we estimate empirically the effects of a government spending shock on the relative price (p) and relative wage (ω), and thus consider a VAR model where we replace sectoral quantities with the ratio of sectoral quantities for both the product and the labor market. Our vector of endogenous variables, is given by: $z^P_{i,t} = \left[g_{i,t}, y^T_{i,t} - y^N_{i,t}, p_{i,t}\right]$ and $z^W_{i,t} = \left[g_{i,t}, l^T_{i,t} - l^N_{i,t}, \omega_{i,t}\right]$.

While in the main text we concentrate on the sectoral effects, in a longer version of the paper, we also document evidence on the aggregate effects of a government spending shock by estimating a VAR model which includes government final consumption expenditure, real GDP, total hours worked, private investment, and the real consumption wage, i.e., $z_{i,t} = [g_{i,t}, y_{i,t}, l_{i,t}, je_{i,t}, w_{C,i,t}]$.[7] We take this model as the baseline to calibrate the government spending shock in the quantitative analysis.[8]

2.5 Sectoral Effects of Government Spending Shocks: VAR Evidence

We generated impulse response functions which summarize the responses of variables to an increase in government spending by 1% of GDP. As displayed in the solid blue line in the left panel of Fig. 1, the response of government consumption is hump-shaped, peaking after one year and then gradually declining; it shows a high level of persistence over time as it is about 8 years before the shock dies out.[9]

Sectoral fiscal multipliers. In Fig. 2, we report results for our three VAR models.[10] The horizontal axis measures time after the shock in years and the vertical axis measures

[7] Aggregate effects of a government spending shock are displayed and discussed in Online Appendix D.1.

[8] Because we consider alternative VAR models, the fact that identified government spending shocks display substantial differences across VAR specifications might be a concern. To address this issue, we ran a number of robustness checks by augmenting each VAR model with the same identified spending shock, ordered first. Results reveal that the discrepancy in the estimated effects is insignificant, see Online Appendix E.3.

[9] The black line with squares in the left panel of Fig. 1 shows the endogenous response of G over the period 1995-2015 as we estimate the responses of G^T and G^N over this period.

[10] For reasons of space, we do not show the responses of real consumption wages which are relegated to Online Appendix D.2. Point estimates at a one-, two-, and four-year horizon are contained in a Table in Online Appendix D.1.

mate, while the shaded area indicates the 90% confidence bounds obtained by bootstrap sampling. The first column displays fiscal multipliers for output. We find that a rise in government consumption has a strong expansionary effect on non-traded output which increases significantly on impact by 0.70% of GDP. During the first four years after the shock, the non-traded output multiplier of government spending averages out at about 0.47% of GDP. In contrast, the traded sector displays a negative fiscal multiplier over this period as the government spending shock generates a decline in traded output which remains below trend. Furthermore, as shown in the second column of Fig. 2, higher non-traded output is associated with a sharp increase in hours worked on impact, while the traded sector experiences a gradual decline in hours worked for the first five years.

Sectoral shares. The third column of Fig. 2 enables us to gauge the contribution of the reallocation of inputs, labor especially, to the expansion of the relative size of the non-traded sector. The second row shows that the labor share of tradables declines by 0.27% of total hours worked (see the blue line with squares) while the reverse is true for non-tradables (see the solid black line). Since non-traded hours worked rise by 0.55% of total hours worked, half of this increase is the result of labor reallocation.[11] As shown in the first row of the third column, a fiscal shock lowers the output share of tradables (see the blue line with squares) and substantially increases that of non-tradables (see the solid black line). Henceforth, our evidence shown in Fig. 2 reveals that the government spending shock is biased toward non-tradable goods as it benefits the non-traded sector which experiences a capital and labor inflow. Responses of sectoral shares to a shock to government consumption also enable us to quantify the contribution of the reallocation of resources to the sectoral fiscal multiplier. Quantitatively, since non-traded output rises by 0.7% of GDP while the output share of non-tradables rises by 0.35% of GDP, the shift of resources toward the non-traded sector alone contributes 50% of non-traded output growth.[12]

Relative price of non-tradables. As shown analytically in Online Appendix C.2, all else being equal (i.e., keeping private demand fixed), for the relative price of non-tradables to appreciate, the government spending shock must be biased enough toward non-traded goods, i.e., $\omega_{G^N} > \nu^{Y,N}$. The last column of Fig. 2 supports the conjecture that an aggregate government spending shock triggers a demand shock in favor of non-tradables. More specifically, the relative price of non-tradables (see the solid black line) appreciates

[11] Because we focus on sectoral hours worked, labor reallocation across sectors can occur at the intensive as well as the extensive margin. In Online Appendix D.3, we find that both the rise in hours worked per worker and higher employment contribute to the increase in the labor share of non-tradables while the other way around is true for tradables.

[12] In Online Appendix D.6, we explore empirically which industry drives the responses of sectoral shares following a rise in government spending by 1% of GDP. Our empirical results show that most of the decline in the share of tradables can be attributed to 'Manufacturing' while 'Community Social and Personal Services', 'Construction', and 'Real Estate, Renting, and Business Services' mostly drive the rise in the share of non-tradables.

while the ratio of traded output relative to non-traded output decreases substantially (see the blue line with squares).

Relative wage of non-tradables. While the appreciation in the relative price of non-tradables provides incentives for labor to shift away from the traded toward the non-traded sector, our evidence suggests the presence of intersectoral labor mobility costs. As can be seen in the second row of the last column of Fig. 2, the sharp decline in hours worked in the traded relative to the non-traded sector (see the blue line with squares) is associated with a significant increase in non-traded wages relative to traded wages (see the solid black line). The positive response of the relative wage to a government spending shock indicates that workers experience costs of switching sectors.

Relative Size of Countries. Our sample comprises OECD economies which differ greatly across size. Because smaller countries display a higher trade openness and a lower degree of labor mobility due to greater industrial specialization, we perform a split-sample analysis to investigate whether we detect empirically significant differences in the behavior of key variables we focus on in this paper, say sectoral shares, the relative price and the relative wage of non-tradables. In Online Appendix D.7, we provide an empirical analysis for the full set of variables. We split the sample into two groups of countries on the basis of the working age population and run the same VAR model for one sub-sample at a time. The group of large countries includes Australia, Canada, France, Italy, Japan, Spain, the U.K, and the U.S. and the group of small countries includes Austria, Belgium, Denmark, Finland, Ireland, the Netherlands, Norway, Sweden. Empirical results for large countries are shown in the dashed blue line with triangles and those for small countries are displayed in the red line with circles. The solid black line shows baseline results when considering the full sample with the shaded area indicating 90% confidence bounds. While all of the conclusions mentioned above hold, we may notice some differences quantitatively however. As can be seen in the first and the second column of Fig. 3, small countries experience variations of output and labor shares which are less pronounced on impact due probably to a lower degree of labor mobility across sectors. Indeed, Fig. 3(c) reveals that the relative wage of non-tradables increases significantly more in small than in large economies, thus suggesting that labor mobility costs are greater in the former group of countries. While switching costs mitigate labor reallocation, the first two columns of Fig. 3 also show that after four years, the group of small countries experiences greater and more persistent variations in sectoral shares. As shown by Cardi and Müller [2011], more open economies run larger current account deficits following a rise in government spending which should in turn amplify the demand boom for non-tradables. As can be seen in Fig. 3(f), the relative price of non-tradables appreciates more after four years in the group of small countries which provides greater incentives to shift labor toward the non-traded sector, thus explaining the larger

< Please insert Figures 1-3 about here >

2.6 Intensity of Government Spending Shock in Non-Tradables

We first investigate empirically whether the government spending shock is biased enough toward non-traded goods to increase the relative size of the non-traded sector. In order to quantify the intensity of the government spending shock in non-tradables we split government final consumption expenditure between government consumption on non-tradables, g^N, and tradables, g^T, by using the COFOG database from the OECD which provides a breakdown of government expenditure by function.[13] The sample covers 13 OECD countries over the period 1995-2015, as shown in Table 1. We chose this period as time series for government consumption by function are not available before 1995 for most of the countries in our sample, while the period 1995-2007 would be too short to obtain consistent estimates. Then, we estimate a VAR model in panel format on annual data that includes unanticipated government spending shocks, $\epsilon^G_{i,t}$, ordered first, government consumption spending and sectoral government consumption on non-tradables and tradables. To identify exogenous and unanticipated fiscal shocks, $\epsilon^G_{i,t}$, we estimate the VAR model that includes aggregate variables, i.e., $z_{i,t} = [g_{i,t}, y_{i,t}, l_{i,t}, je_{i,t}, w_{C,i,t}]$, and adopt a Cholesky decomposition. The middle and right panels of Fig. 1 display the response of government consumption of non-tradables and tradables to an exogenous and unanticipated increase in government spending by 1% of GDP, respectively. On impact, government consumption of non-tradables increases by 0.88%. Its contribution to the government spending shock averages 90% and is quite stable over time as it varies from 88% up to 91%.[14] Moreover, we find that the responses of sectoral government consumption to an exogenous fiscal shock are both hump-shaped and seem to mimic the adjustment of government spending shown in Fig. 1(a).

Since $\omega_{G^N} = 90\%$ and the non-tradable content of GDP is 63% in OECD countries (see the last line of the first column of Table 2), the condition under which a shock to government consumption is biased toward non-tradables, as described by inequality (3), is fulfilled. As a result of the high intensity of the non-traded sector in the government spending shock, labor shifts toward the non-traded sector which increases its value added share. We show below that labor reallocation is subject to mobility costs, however, which in turn mitigate the rise in the share of non-tradables.

2.7 Implications of the Degree of Labor Mobility across Sectors

The presence of labor mobility costs preventing wage equalization after a government spending shock squares well with the evidence documented by Artuç et al. [2010], Dix-Carneiro

[13] See Online Appendix A.2 for details about the breakdown of g into g^N and g^T.

[14] See Table 5 in Online Appendix B.2 which displays the mean responses of the two components of government consumption.

wages are not equalized across sectors following either trade liberalization episodes or sector-biased technological change. To assess the importance of IML for fiscal transmission, we investigate below whether the responses of sectoral shares vary across time and space, and whether these variations are positively related to differences in labor mobility.

Labor mobility and sectoral shares across time. A first way to gauge the role of labor mobility costs in determining the adjustment of the relative sector size to a government spending shock is to investigate whether the responses of sectoral shares vary over time and explore their relationship with the extent of labor reallocation across sectors triggered by a rise in government spending. To perform this experiment, we compute the responses of selected variables by using a two-step estimation procedure. We first identify government spending shocks by considering the baseline VAR model that includes aggregate variables, i.e., $z_{i,t} = [g_{i,t}, y_{i,t}, l_{i,t}, je_{i,t}, w_{C,i,t}]$, where government spending is ordered before the other variables. In the second step, we estimate the effects in a rolling 25-year window by using Jordà's [2005] single-equation method.[15] The local projection method amounts to running a series of regressions of each variable of interest on a structural identified shock for each horizon $h = 0, 1, 2, ...$:

$$x^j_{i,t+h} = \alpha^j_{i,h} + \beta^j_{i,h} t + \psi^j_h(L)\, z_{i,t-1} + \gamma^j_h \,.\epsilon^G_{i,t} + \eta^j_{i,t+h}, \tag{4}$$

where we include country fixed effects and country-specific linear trends respectively; x^j is the logarithm of the variable of interest of sector j, z is a vector of control variables (i.e., past values of government spending and of the variable of interest), $\psi^j_h(L)$ is a polynomial (of order two) in the lag operator and $\epsilon^G_{i,t}$ is the identified government spending shock. We allow for two lags on the variable of interest and government spending collected in vector z. Since we concentrate on impact effects, horizon h is set to zero in eq. (4). Given that we are primarily interested in the reallocation effects, we estimate the effect of a government spending shock on the labor and the value added share of tradables and non-tradables, i.e., $x^j = \nu^{L,j}, \nu^{Y,j}$ (with $j = T, N$). As can be seen in Fig. 4 which reports impact responses of sectoral shares to the government spending shock (i.e., γ^j_0) in the solid black line for the output share and the blue line with circles for the labor share, the magnitude of changes in relative sector size decreases over time, i.e., γ^N_0 becomes less positive and γ^T_0 less negative.

One obvious candidate to explain a decline in $|\gamma^j_0|$ is an increase in labor mobility

[15] By decoupling the shock identification and the estimate of the responses, the first advantage of Jordà's [2005] projection method is that traded and non-traded variables respond to the same shock. However, our robustness check shows that the shock is identical across all VAR models. The second advantage over the standard VAR approach is that it considerably reduces the number of coefficients and thus is particularly suited when estimating the sectoral effects over overlapping subperiods of fixed length. The third advantage is that it does not impose the dynamic restrictions implicitly embedded in VARs and can accommodate non-linearities in the response function. By imposing fewer restrictions, impulse responses obtained by using the local projection method are rather erratic. Since we contrast empirical with theoretical responses in the quantitative analysis and smooth impulse responses are therefore more appropriate for this exercise, we stick to the VAR methodology, however, for most the empirical analysis undertaken in this paper. That said, both methods lead to very similar, if not identical, results on impact and even at a longer time horizon.

should result in a smaller reallocation of labor between the traded and the non-traded sector. Following Wacziarg and Wallack [2004], we compute the labor reallocation index in year t for country i denoted by $LR_{i,t}$ as the absolute change in sectoral hours worked, $L^j_{i,t}$, resulting from pure shifts of labor across sectors:

$$LR_{i,t}(\tau) = \frac{\sum_{j=T}^{N} |L^j_{i,t} - L^j_{i,t-\tau}| - \left|\sum_{j=T}^{N} L^j_{i,t} - \sum_{j=T}^{N} L^j_{i,t-\tau}\right|}{0.5\sum_{j=T}^{N}(L^j_{i,t-\tau} + L^j_{i,t})}, \tag{5}$$

where $\tau = 5$. Next, using eq. (4) with $x = LR$, we run a series of regressions of labor reallocation on the structural identified shock to government consumption.

As can be seen in the dotted black line in Fig. 4, the decline in the magnitude of changes in relative sector size is associated with less labor reallocation following a government spending shock, in line with our hypothesis. More specifically, our estimates reveal that, in about fifteen years, the responses of sectoral shares have been reduced over time by about 40% while the shift of labor between sectors has decreased by the same amount as well.[16] Time-varying responses of labor and value added shares are highly correlated with those of labor reallocation, with the correlation coefficient ranging from 0.82 to 0.86. This finding thus suggests that increasing labor mobility costs have contributed to declining effects of fiscal policy on relative sector size over time.

< Please insert Figures 4-5 about here >

Measure of the degree of labor mobility across sectors. We now investigate whether the sectoral effects vary across space. To conduct this study, we explore the cross-country relationship between changes in the relative size of sectors and the magnitude of workers' costs of switching sectors. To measure the degree of labor mobility, we draw on Horvath [2000] and estimate the elasticity of labor supply across sectors for each country i denoted by ϵ_i. Denoting the exogenous weight attached to labor supply in sector $j = T, N$ by ϑ^j_i, the labor supply schedule, which reads as follows $\frac{L^j_{i,t}}{L_{i,t}} = \vartheta^j_i \left(\frac{W^j_{i,t}}{W_{i,t}}\right)^{\epsilon_i}$, states that the share of hours worked in sector j rises by ϵ_i% following a 1% increase in the relative wage. When ϵ takes higher values, workers' mobility costs are lower, which in turn implies a higher degree of labor mobility. In order to estimate consistently the degree of labor mobility between the traded and the non-traded sector, we consider a situation where the labor market clears. Inserting labor demand in sector j, i.e., $W^j_{i,t} = \frac{\theta^j_i P^j_{i,t} Y^j_{i,t}}{L^j_{i,t}}$ where θ^j

[16] While higher mobility costs cause a decline in labor reallocation following a rise in government spending, the rate of workers switching sectors could also decrease as a result of a time-declining intensity of non-tradables in the government spending shock and/or a fall in financial openness. Since the share of government spending in non-tradables is stable over time and financial openness is increasing over the period of estimation, the fall in the LR index can only be attributed to higher labor mobility costs according to our model's predictions. When breaking down the impact response of the wage differential between non-tradables and tradables by skill, our estimates reveal that the skills attached to jobs created in the non-traded sector highly intensive in medium-skilled workers became more sector-specific over time, and this trend has contributed to put upward pressure on labor mobility costs, see Online Appendix F.4. However, we cannot exclude that other factors, such as the extent of capital mobility across sectors and labor demand developments, could also contribute to the decline in the LR index.

compensation, $W_{i,t}L_{i,t}$, is equal to the sum of labor compensation across sectors, solving for the labor share of sector j and differentiating leads to $\hat{l}^j_{i,t} - \hat{l}_{i,t} = \gamma_i \hat{\beta}^j_{i,t}$ where $\gamma_i = \frac{\epsilon_i}{\epsilon_i+1}$ and $\beta^j_{i,t} = \frac{\theta^j_i P^j_{i,t} Y^j_{i,t}}{\sum_j \theta^j_i P^j_{i,t} Y^j_{i,t}}$.

To estimate γ_i and pin down the value for the elasticity of labor supply across sectors, ϵ_i, we run the regression in panel format on annual data of the percentage change in the labor share of sector j on the percentage change in the relative share of output paid to workers in sector j. The causes of labor market frictions hampering the shift of labor across sectors are diverse. Part of the lack of labor reallocation results from psychological (see e.g., Dix-Carneiro [2014]) and geographical mobility costs (see e.g., Kennan and Walker [2011]). Country fixed effects included in the regression capture these costs which are assumed to be the same for all periods. Differently, parameter ϵ_i we recover by estimating γ_i captures the elasticity of labor supply across sectors with respect to a sectoral wage differential. More specifically, workers accept to join the labor force in sector j as long as the wage differential covers the disutility caused by labor reallocation. As the elasticity of labor supply across sectors takes lower values, workers experience greater disutilities when shifting. The utility loss caused by a shift to a different sector captures barriers to mobility such as sector-specific human capital which may not be perfectly transferable across sectors (see e.g., Lee and Wolpin [2006], Kambourov [2009], Dix-Carneiro [2014]).[17]

Responses of sectoral shares and degree of labor mobility across countries. Once we have estimated the magnitude of workers mobility costs for each country, we then estimate the same model as in eq. (1) but for a single country at a time.[18] In Fig. 5, we plot the impact responses of sectoral labor and sectoral output shares on the vertical axis against our measure of the degree of labor mobility, denoted ϵ, on the horizontal axis. This

[17]Mobility costs captured by the parameter ϵ accord well with the sector-specific skills theory according to which a substantial amount of human capital may be destroyed upon switching industry. We find empirically that our measure of the degree of labor mobility across sectors is positively correlated with the share of young (share of workers aged 15-24 years in total labor force) and low-education workers (share of workers with primary education in total labor force), in line with the evidence documented by Kambourov and Manovskii [2009] which reveals that industry (and occupational) mobility declines with worker's age and education. Intuitively, younger and unskilled workers accumulate relatively less sector-specific human capital, and thus are expected to be more prone to shift from one sector to another. Our results also show that ϵ takes lower values in countries where employment protection legislation (adjusted with the share of permanent workers) is stricter and union density is higher. Drawing on Tang [2012], in countries where labor laws are more protective or where employees are more protected by labor unions, workers expect a more stable relationship with their employers and obtain higher bargaining power vis-a-vis their employers. Thus, they have more incentives to acquire firms specific skills relative to general skills on the job and thus are less prone to change jobs/sectors. Empirical results are contained in Online Appendix F.2.

[18]When estimating the responses of sectoral labor and sectoral output shares to a government spending shock for each country, we omit $w^j_{C,i,t}$ in order to economize some degrees of freedom; the vector of endogenous variables is thus $z^{S,j}_{i,t} = \left[g_{i,t}, \nu^{Y,j}_{i,t}, \nu^{L,j}_{i,t}\right]$. We also estimated the VAR model by including $\omega^j_{C,it}$ and find that the results are similar. We allow for two lags (i.e., $k = 2$ in eq. (1)), as we did for the panel data estimate. It is worth mentioning that Jordà's local projection method gives similar results, except for the cross-country relationship. As shown in Online Appendix D.3, impact responses obtained with VAR and local projection methods are highly correlated, and cross-country relationships between $d\nu^{Y,j}(0)$ and ϵ display the same pattern. However, the slopes of the trend line obtained with the local projection method display substantial differences between tradables and non-tradables which would undermine the quantitative analysis because the slopes by construction should be identical.

varies considerably across countries and there is substantial uncertainty surrounding point estimates given the relatively small number of observations available per country.

The cross-country analysis displayed in Fig. 5 highlights two major findings. First, as shown in the top panels, whether we use labor or output, almost all countries in our sample experience a fall in the relative size of the traded sector as impact responses from the VAR model are below the X-axis. The bottom panels reveal that the reverse is true for the non-traded sector which benefits from the reallocation of inputs. This evidence supports our earlier conjecture according to which a government spending shock is strongly biased toward non-tradables. Second, as can be seen in the top panels of Fig. 5, countries where workers have lower mobility costs experience a larger decline in the share of tradables while the bottom panels show that the relative size of non-tradables increases more in these economies. In sum, our findings reveal that the magnitude of the change in relative sector size following a government spending shock increases with the degree of labor mobility across sectors.

3 Small Open Economy Model with IML

We consider a small open economy populated by a constant number of identical households and firms that have perfect foresight and live forever. The country is small in terms of both world goods and capital markets, and faces a given world interest rate, $r^{\star}$.[19] One sector produces a traded good denoted by the superscript T which can be exported at no cost, invested and consumed domestically. A second sector produces a non-traded good denoted by the superscript N which can be consumed domestically or invested. The traded good is chosen as the numeraire. Time is continuous and indexed by t.

3.1 Households

At each instant the representative household consumes traded and non-traded goods denoted by C^T and C^N, respectively, which are aggregated by means of a CES function:

$$C(t) = \left[\varphi^{\frac{1}{\phi}} \left(C^T(t)\right)^{\frac{\phi-1}{\phi}} + (1-\varphi)^{\frac{1}{\phi}} \left(C^N(t)\right)^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}, \tag{6}$$

where $0 < \varphi < 1$ is the weight of the traded good in the overall consumption bundle and ϕ corresponds to the elasticity of substitution between traded goods and non-traded goods.

The representative household supplies labor L^T and L^N in the traded and non-traded sectors, respectively. In line with our empirical findings which reveal that labor reallocation

[19] The price of the traded good is determined on the world market and exogenously given for the small open economy. In the empirical analysis, we control for the size of countries as we divide quantities by the working age population. However, countries such as the U.S. are large enough on world goods market to influence the price of its export goods. As shown in Online Appendix H, all results obtained in the main text are robust both qualitatively and quantitatively to the assumption of exogenous terms of trade.

between the extensive and intensive margin. To rationalize the rise in the non-traded relative to traded wages, we assume that workers experience a utility loss when shifting hours worked from one sector to another. More specifically, in the lines of Horvath [2000], we consider that hours worked in the traded and the non-traded sectors are imperfect substitutes and aggregated by means of a CES function:

$$L(t) = \left[\vartheta^{-1/\epsilon}\left(L^T(t)\right)^{\frac{\epsilon+1}{\epsilon}} + (1-\vartheta)^{-1/\epsilon}\left(L^N(t)\right)^{\frac{\epsilon+1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon+1}}, \tag{7}$$

and $0 < \vartheta < 1$ parametrizes the weight attached to the supply of hours worked in the traded sector and ϵ is the degree of substitutability in hours worked across sectors. The advantage of our modelling of IML is threefold. First, the formulation (7) lends itself easily to the estimation of the deep parameter ϵ for each country of our sample and thus serves our purpose which is to assess quantitatively the ability of the neoclassical model to account for our evidence. In this regard, the CES form (7) gives rise to a first-order condition which relates the labor flow in sector j to the sectoral wage differential as in Artuç et al. [2010] who specify a dynamic equilibrium model of costly labor adjustment. Second, the case of PML is nested under the assumption that ϵ tends towards infinity which makes our results directly comparable with those obtained in the special case where workers no longer experience switching costs. Finally, the assumption of limited substitutability of labor supply across sectors generates IML without deviating from the tractable representative agent framework which allows us to derive analytical results in Online Appendix C.

The representative agent is endowed with one unit of time, she/he supplies a fraction $L(t)$ as labor, and consumes the remainder $l(t) \equiv 1-L(t)$ as leisure. At any instant of time, households derive utility from their consumption and experience disutility from working. Assuming that the felicity function is additively separable in consumption and labor, the representative household maximizes the following objective function:

$$U = \int_0^\infty \left\{\ln C(t) - \frac{L(t)^{1+\frac{1}{\sigma_L}}}{1+\frac{1}{\sigma_L}}\right\} e^{-\beta t}\mathrm{d}t, \tag{8}$$

where β is the discount rate and $\sigma_L > 0$ is the Frisch elasticity of labor supply.

Factor income is derived by supplying labor $L(t)$ at a wage rate $W(t)$, and capital $K(t)$ at a rental rate $R(t)$. In addition, households accumulate internationally traded bonds, $B(t)$, that yield net interest rate earnings of $r^\star B(t)$. Denoting lump-sum taxes by $T(t)$, households' flow budget constraint states that real disposable income (on the RHS) can be saved by accumulating traded bonds, consumed, $P_C(t)C(t)$, or invested, $P_J(t)J(t)$:

$$\dot{B}(t) + P_C(t)C(t) + P_J(t)J(t) = r^\star B(t) + R(t)K(t) + W(t)L(t) - T(t), \tag{9}$$

where $P_C\left(P(t)\right)$ and $P_J\left(P(t)\right)$ are consumption and the investment price index, respectively, which are a function of the relative price of non-traded goods, $P(t)$. The aggregate

$$W(t) = \left[\vartheta \left(W^T(t)\right)^{\epsilon+1} + (1-\vartheta) \left(W^N(t)\right)^{\epsilon+1}\right]^{\frac{1}{\epsilon+1}}, \tag{10}$$

where $W^T(t)$ and $W^N(t)$ are wages paid in the traded and the non-traded sectors. The investment good is produced (costlessly) using traded good and non-traded good inputs according to a constant returns to scale function which is assumed to take a Cobb-Douglas form (in accordance with estimates documented by Bems [2008] for OECD countries):

$$J(t) = \left(\frac{J^N(t)}{\alpha_J}\right)^{\alpha_J} \left(\frac{J^T(t)}{1-\alpha_J}\right)^{1-\alpha_J}, \tag{11}$$

where α_J and $1-\alpha_J$ are the shares of investment expenditure on non-tradables and tradables, respectively. Installation of new investment goods involves increasing and convex costs, assumed quadratic, of net investment. Thus, total investment $J(t)$ differs from effectively installed new capital, $I(t)$:

$$J(t) = I(t) + \frac{\kappa}{2}\left(\frac{I(t)}{K(t)} - \delta_K\right)^2 K(t), \tag{12}$$

where the parameter $\kappa > 0$ governs the magnitude of adjustment costs to capital accumulation, and $0 \leq \delta_K < 1$ is a fixed depreciation rate. Net investment gives rise to capital accumulation according to the dynamic equation:

$$\dot{K}(t) = I(t) - \delta_K K(t). \tag{13}$$

Households choose consumption, worked hours and investment in physical capital by maximizing lifetime utility (8) subject to (9) and (13) together with (12). Denoting by λ and Q' the co-state variables associated with (9) and (13), the first-order conditions characterizing the representative household's optimal plans are:

$$C(t) = \left(P_C(t)\lambda(t)\right)^{-1}, \tag{14a}$$

$$L(t) = \left(W(t)\lambda(t)\right)^{\sigma_L}, \tag{14b}$$

$$\frac{I(t)}{K(t)} = \frac{1}{\kappa}\left(\frac{Q(t)}{P_J(t)} - 1\right) + \delta_K, \tag{14c}$$

$$\dot{\lambda}(t) = \lambda(t)\left(\beta - r^\star\right), \tag{14d}$$

$$\dot{Q}(t) = \left(r^\star + \delta_K\right) Q(t) - \left\{R(t) + P_J(t)\frac{\kappa}{2}\left(\frac{I(t)}{K(t)} - \delta_K\right)\left(\frac{I(t)}{K(t)} + \delta_K\right)\right\}, \tag{14e}$$

and the transversality conditions $\lim_{t\to\infty} \lambda B(t)e^{-\beta t} = 0$, $\lim_{t\to\infty} Q(t)K(t)e^{-\beta t} = 0$. To derive (14c), we used the fact that $Q(t) = Q'(t)/\lambda$ which is the shadow value of capital in terms of foreign assets. In an open economy model with a representative agent who has perfect foresight, a constant rate of time preference and perfect access to world capital markets, we impose $\beta = r^\star$ in order to generate an interior solution. Setting $\beta = r^\star$ into (14d) yields $\lambda = \bar{\lambda}$. Eq. (14c) states that investment is an increasing function of Tobin's q, which is defined as the shadow value to the firm of installed capital, $Q(t)$, divided by its this causes no confusion.

Applying Shephard's lemma (or the envelope theorem) to consumption expenditure yields the following demand for the traded and non-traded good, respectively:

$$C^T = \varphi \left(1/P_C\right)^{-\phi} C, \qquad C^N = (1-\varphi) \left(P/P_C\right)^{-\phi} C. \tag{15}$$

Denoting the share of non-traded goods in consumption expenditure by α_C, expenditure in non-tradables and tradables is given by $PC^N = \alpha_C P_C C$ and $C^T = (1-\alpha_C) P_C C$.

Applying the same logic for labor, given the aggregate wage index (10), we can derive the allocation of aggregate labor supply to the traded and non-traded sectors:

$$L^T = \vartheta \left(W^T/W\right)^{\epsilon} L, \qquad L^N = (1-\vartheta) \left(W^N/W\right)^{\epsilon} L, \tag{16}$$

where ϵ is the elasticity of labor supply across sectors. As ϵ takes higher values, more labor shifts from one sector to another and thus the degree of labor mobility increases. Denoting by α_L the labor compensation share of non-tradables, labor income from supplying hours worked in the non-traded and the traded sectors are $W^N L^N = \alpha_L W L$ and $W^T L^T = (1-\alpha_L) W L$.

3.2 Firms

Each sector consists of a large number of identical firms which use labor, L^j, and physical capital, K^j, according to a constant returns to scale technology:

$$Y^j = Z^j \left(L^j\right)^{\theta^j} \left(K^j\right)^{1-\theta^j}, \tag{17}$$

where Z^j represents the TFP index which is introduced for calibration purposes only and θ^j corresponds to the share of labor income in the value added of sector j. Firms lease capital from households and hire workers. They face two cost components: a capital rental cost equal to R, and wage rates in the traded and non-traded sectors equal to W^T and W^N, respectively. Both sectors are assumed to be perfectly competitive and thus choose capital and labor by taking prices as given. Since capital can move freely between the two sectors, the value of marginal products in the traded and non-traded sectors equalizes while costly labor mobility implies a wage differential across sectors:

$$Z^T \left(1-\theta^T\right) \left(k^T\right)^{-\theta^T} = P Z^N \left(1-\theta^N\right) \left(k^N\right)^{-\theta^N} \equiv R, \tag{18a}$$

$$Z^T \theta^T \left(k^T\right)^{1-\theta^T} \equiv W^T, \tag{18b}$$

$$P Z^N \theta^N \left(k^N\right)^{1-\theta^N} \equiv W^N, \tag{18c}$$

where $k^j \equiv K^j/L^j$ denotes the capital-labor ratio for sector $j = T, N$.

Aggregating over the two sectors gives us the resource constraint for capital:

$$K^T + K^N = K. \tag{19}$$

The final agent in the economy is the government. Total government spending, G, goes on goods, G^N, produced by non-traded firms and goods, G^T, produced by traded firms. Both components of government spending are determined exogenously. The government finances public spending by raising lump-sum taxes, T. As a result, Ricardian equivalence obtains and the time path of taxes is irrelevant for the real allocation. We may thus assume without loss of generality that government budget is balanced at each instant:[20]

$$G = G^T + PG^N = T. \tag{20}$$

3.4 Model Closure and Equilibrium

To fully describe equilibrium, we first impose the market clearing condition for non-tradables:

$$Y^N(t) = C^N(t) + J^N(t) + G^N(t). \tag{21}$$

Equality between non-traded output and its demand counterpart is achieved through adjustments to the relative price of non-tradables, $P(t)$.

Regarding the allocation of government consumption to good $j = T, N$, we consider a rise in G which is split between non-tradables and tradables in accordance with their respective shares in government expenditure, i.e.,

$$dG(t) = \omega_{G^N} dG(t) + \omega_{G^T} dG(t). \tag{22}$$

where ω_{G^j} is the share of good j in government consumption which is assumed to be constant over time in line with our evidence. In order to account for the non-monotonic pattern of the dynamic adjustment of $G(t)$ (see Fig. 1(a)), we assume that the deviation of government spending relative to its initial value as a percentage of initial GDP is:

$$\left(G(t) - \tilde{G}\right)/\tilde{Y} = e^{-\xi t} - (1-g)\, e^{-\chi t}, \tag{23}$$

where we denote the steady-state value with a tilde; $g > 0$ parametrizes the magnitude of the exogenous fiscal shock, $\xi > 0$ and $\chi > 0$ parametrize the degree of persistence of the fiscal shock; as ξ and χ take higher values, government spending returns to its initial level more rapidly. More specifically, eq. (23) allows us to generate an inverted U pattern for the endogenous response of $G(t)$: if $\chi > \xi$, we have $\dot{G}(t) > 0$ following the exogenous fiscal shock and then $G(t)$ declines after reaching a peak at some time t.

After inserting appropriate first-order conditions into the non-traded good market clearing condition (21) and the no arbitrage condition (14e), it can be shown that the adjustment of the open economy towards the steady-state is described by a dynamic system

[20] In a longer version of the paper, we allow for distortionary labor taxation and consider a rise in government spending which is debt-financed. Quantitative results displayed in Online Appendix H show that the sectoral impact of fiscal policy is similar to that obtained when assuming a balanced-budget government spending shock.

$\dot{K}(t) \equiv \Upsilon\left(K(t), Q(t), G(t)\right)$ and $\dot{Q}(t) \equiv \Sigma\left(K(t), Q(t), G(t)\right)$. Linearizing these equations in the neighborhood of the steady-state and using (22) leads to a system of first-order linear differential equations which can be solved by applying standard methods and making use of (23) (see Buiter [1984] who presents the continuous time adaptation of the method of Blanchard and Kahn [1980]):

$$K(t) - \tilde{K} = X_1(t) + X_2(t), \quad Q(t) - \tilde{Q} = \omega_2^1 X_1(t) + \omega_2^2 X_2(t), \tag{24}$$

where we denote the negative eigenvalue by ν_1, the positive eigenvalue by ν_2, and ω_2^i is the element of the eigenvector associated with the eigenvalue ν_i (with $i = 1, 2$) and $X_1(t)$ and $X_2(t)$ are solutions which characterize the trajectory of $K(t)$ and $Q(t)$:[21]

$$X_1(t) = e^{\nu_1 t}\left[\left(K_0 - \tilde{K}\right) + \Gamma_2\left(1 - \Theta_2\right) - \Gamma_1\left(1 - \Theta_1\right)\right] + \Gamma_1\left(e^{-\xi t} - \Theta_1 e^{-\chi t}\right), \tag{25a}$$

$$X_2(t) = -\Gamma_2\left(e^{-\xi t} - \Theta_2 e^{-\chi t}\right), \tag{25b}$$

where K_0 is initial stock of physical capital.

Using the fact that $R(t)K(t) + W(t)L(t) = Y^T(t) + P(t)Y^N(t)$ and inserting the market clearing condition for non-tradables (21) into (9) gives the current account equation:

$$\dot{B}(t) = r^\star B(t) + Y^T(t) - C^T(t) - G^T(t) - J^T(t). \tag{26}$$

Substituting appropriate short-run solutions, eq. (26) can be written as a function of state and control variables, i.e., $\dot{B}(t) = r^\star B(t) + \Xi\left(K(t), Q(t), G(t)\right)$. Linearizing around the steady state, substituting the solutions for $K(t)$ and $Q(t)$ given by (24), solving and invoking the transversality condition leads to the intertemporal solvency condition:[22]

$$\tilde{B} - B_0 = -\frac{\omega_B^1}{\nu_1 - r^\star} + \frac{\omega_B^2}{\xi + r^\star}, \tag{27}$$

where B_0 is the initial stock of traded bonds. The assumption $\beta = r^\star$ implies that temporary policies have permanent effects. In this regard, eq. (27) determines the steady-state change in the net foreign asset position following a temporary fiscal expansion.

4 Quantitative Analysis

In this section, we analyze the effects of a temporary and unanticipated rise in government consumption quantitatively. For this purpose we solve the model numerically.[23] We begin

[21] The coefficients of the Jacobian matrix are partial derivatives evaluated at the steady-state, e.g., $\Upsilon_X = \frac{\partial \Upsilon}{\partial X}$ with $X = K, Q$, and the direct effects of an exogenous change in government spending on K and Q are described by $\Upsilon_G = \frac{\partial \Upsilon}{\partial G}$ and $\Sigma_G = \frac{\partial \Sigma}{\partial G}$, also evaluated at the steady-state. The terms on the RHS of eq. (25) are functions of parameters and read as $\Gamma_i = -\frac{\Phi_i \tilde{Y}}{\nu_1 - \nu_2}\frac{1}{(\nu_i + \xi)}$, $\Phi_1 = \left(\Upsilon_K - \nu_2\right)\Upsilon_G + \Upsilon_Q \Sigma_G$, $\Phi_2 = \left(\Upsilon_K - \nu_1\right)\Upsilon_G + \Upsilon_Q \Sigma_G$, and $\Theta_i = (1 - g)\frac{\nu_i + \xi}{\nu_i + \chi}$ (with $i = 1, 2$).

[22] The terms in the RHS of eq. (27) are functions of parameters. The first term reads as $\omega_B^1 = \left[\Xi_K + \Xi_Q \omega_2^1\right]\left[\left(K_0 - \tilde{K}\right) + \Gamma_2\left(1 - \Theta_2\right) - \Gamma_1\left(1 - \Theta_1\right)\right]$, with $\Xi_K = \frac{\partial \Xi}{\partial K}$, $\Xi_Q = \frac{\partial \Xi}{\partial Q}$, $\Xi_G = \frac{\partial \Xi}{\partial G}$ evaluated at the steady-state. The second term reads as $\omega_B^2 = \Xi_G \tilde{Y}\left(1 - \Theta'\right) + \left[\Xi_K + \Xi_Q \omega_2^1\right]\Gamma_1\left(1 - \Theta_1'\right) - \left[\Xi_K + \Xi_Q \omega_2^2\right]\Gamma_2\left(1 - \Theta_2'\right)$ where $\Theta' = (1 - g)\frac{r^\star + \xi}{r^\star + \chi}$, and $\Theta_i' = \Theta_i \frac{r^\star + \xi}{r^\star + \chi}$ (with $i = 1, 2$).

[23] Technically, the assumption $\beta = r^\star$ requires the joint determination of the transition and the steady state since the constancy of the marginal utility of wealth implies that the intertemporal solvency condition

government consumption.

4.1 Calibration

To calibrate our model, we estimated a set of parameters so that the initial steady state is consistent with the key empirical properties of a representative OECD economy. As summarized in Table 1, our sample covers the sixteen OECD economies in our dataset and our reference period for the calibration is running from 1990 to 2007. The choice of this period was dictated by data availability for all the countries in the sample. Table 2 summarizes our estimates of the non-tradable content of GDP, employment, consumption, gross fixed capital formation, government spending, labor compensation, and gives the share of government spending on traded and non-traded goods in their respective sectoral output, the shares of labor income in output in both sectors, for all countries in our sample. Moreover, columns 12-14 of Table 2 display investment expenditure and government spending as a percentage of GDP together with the labor income share, respectively, for the whole economy. To capture the key properties of a typical OECD economy, chosen as the baseline scenario, we take unweighted average values, as shown in the last line of Table 2. As summarized in Table 3, some of the parameter values can be taken directly from the data, but others like φ, ϑ, δ_K together with initial conditions (B_0, K_0) need to be calibrated endogenously to fit a set of aggregate and sectoral ratios. We choose the model period to be one year and therefore set the world interest rate, r^*, which is equal to the subjective time discount rate, β, to 4%.

$<$ Please insert Tables 2-3 about here $>$

The degree of labor mobility captured by ϵ is set to 0.75, in line with the average of our estimates shown in the last line of column 16 of Table 2. Excluding the estimates for Denmark and Norway which are not statistically significant at 10% over 1970-2007, estimated values of ϵ range from a low of 0.22 for the Netherlands to a high of 1.39 for the U.S. and 1.64 for Spain. To explore the implications of the degree of labor mobility for sectoral effects, we allow for ϵ to vary between 0.22 and 1.64 .

Building on our panel data estimates, the elasticity of substitution ϕ between traded and non-traded goods is set to 0.77 in the baseline calibration since this value corresponds to the average of estimates shown in the last line of column 15 of Table 2.[24] The weight of consumption in non-tradables $1-\varphi$ is set to 0.51 to target a non-tradable content in total consumption expenditure, α_C, of 53%, in line with the average of our estimates shown in the last line of column 2. In our baseline parametrization, we set the intertemporal elasticity of substitution for labor supply σ_L to 0.4, in line with evidence reported by Fiorito and

(27) depends on eigenvalues and eigenvectors' elements, see e.g., Turnovsky [1997].

[24] The average value is calculated by excluding estimates for Italy which are negative.

to target a share of the non-tradable sector in total hours worked of 67%, in line with the average of our estimates shown in the last line of column 5 of Table 2.

We now describe the calibration of production-side parameters. We assume that physical capital depreciates at a rate δ_K of 6% to target an investment-to-GDP ratio of 21% (see column 12 of Table 2). Labor income shares in the traded (θ^T) and non-traded sectors (θ^N) are set to 0.58 and 0.68, respectively, which correspond roughly to the averages for countries with $k^T > k^N$ (see columns 9 and 10 of Table 2). Such values give an aggregate labor income share of 64% (see the last line of column 14 of Table 2). In line with our evidence shown in the last column of Table 2, we assume that traded firms are 28 percent more productive than non-traded firms; hence we set Z^T and Z^N to 1.28 and 1 respectively. We set the share of investment expenditure on non-tradable goods, α_J, to 64%, in accordance with the evidence shown in column 3 of Table 2. We choose the value of parameter κ so that the elasticity of I/K with respect to Tobin's q, i.e., Q/P_J, is equal to the value implied by estimates in Eberly, Rebelo, and Vincent [2008]. The resulting value of κ is equal to 17.

As shown in column 4 of Table 2, the non-tradable content of government spending, ω_{G^N}, averages 90%. We set government consumption on non-traded goods, G^N, and traded goods, G^T, so as to yield a non-tradable share of government spending, ω_{G^N}, of 90%, and government spending as a share of GDP to 20%.

We choose initial conditions for B_0 and K_0 so that trade is initially balanced. Since net exports are nil and $P_J I/Y = 21\%$ and $G/Y = 20\%$, the accounting identity according to which GDP is equal to the sum of the final uses of goods and services, leads to a consumption-to-GDP ratio of $P_C C/Y = 59\%$. It is worthwhile mentioning that the non-tradable content of GDP is determined endogenously by the non-tradable content of consumption, α_C, investment, α_J, and government expenditure, ω_{G^N}, along with the consumption-to-GDP ratio, ω_C, and the investment-to-GDP ratio, ω_J. More precisely, dividing the non-traded good market clearing condition (21) by Y leads to the non-tradable content of GDP:

$$PY^N/Y = \omega_C\alpha_C + \omega_J\alpha_J + \omega_{G^N}\omega_G = 63\%, \tag{28}$$

where $\omega_C = 59\%$, $\alpha_C = 53\%$, $\omega_J = 21\%$, $\alpha_J = 64\%$, $\omega_{G^N} = 90\%$, and $\omega_G = 20\%$. According to (28), the ratios we target are consistent with a non-tradable content of GDP of 63% found in the data (see the last line of column 1 of Table 2).

In order to capture the endogenous response of government spending to an exogenous fiscal shock, we assume that the dynamic adjustment of government consumption is governed by eq. (23). In the quantitative analysis, we set $g = 0.01$ so that government consumption increases by 1% of initial GDP. To calibrate ξ and χ that parametrize the shape of the dynamic adjustment of government consumption along with its persistence, we proceed as folwith $g' = 0.011265$ and $\dot{G}(1)/Y = -\left[\xi e^{-\xi} - \chi\,(1-g)\,e^{-\chi}\right] = 0$. Solving the system gives us $\xi = 0.408$ and $\chi = 0.415$. Left-multiplying eq. (23) by ω_{G^j} (with $j = N, T$) gives the dynamic adjustment of sectoral government consumption to an exogenous fiscal shock:

$$\omega_{G^j}\left(G(t) - \tilde{G}\right)/Y = \omega_{G^j}\left[e^{-\xi t} - (1-g)\,e^{-\chi t}\right], \qquad (29)$$

where ω_{G^j} is the fraction of government consumption in good j. To determine (29), we assume that the parameters that govern the persistence and shape of the response of sectoral government consumption are identical across sectors, while the sectoral intensity of the government spending shock is constant over time and thus corresponds to the share of government final consumption expenditure on good j, in line with the VAR evidence documented in subsection 2.6.[26]

As the baseline scenario, we take the model with IML and capital adjustments costs and we set $\epsilon = 0.75$ and $\kappa = 17$. We also conduct a sensitivity analysis with respect to these two parameters by setting alternatively ϵ to 0.22 and 1.64 and κ to 0.

4.2 Results

In this subsection, we analyze in detail the role of IML in shaping the dynamics of the open economy in response to a government spending shock. Our primary objective is to explain how workers' costs of switching sectors change the model's predictions in a way that makes them consistent with our empirical findings on fiscal policy transmission, especially the responses of sectoral value added shares.

Table 4 shows the simulated impact effects of an exogenous and unanticipated increase in government consumption by 1% of GDP while column 1 shows impact responses from our VAR model for comparison purposes. Column 2 shows results for the baseline model which we contrast with those obtained when we impose PML (i.e., we set $\epsilon \to \infty$) and abstract from capital installation costs (i.e., we set $\kappa = 0$), as displayed in column 7. Other columns give the results for the alternative scenarios discussed below. While in Table 4, we restrict our attention to impact responses, in Fig. 6 and 7 we show the dynamic adjustment to an unanticipated increase in government consumption by 1% of GDP. Figures display the model predictions together with the respective VAR evidence. In each panel, the solid blue line displays the point estimate of the VAR model, with the shaded area indicating the 90% confidence bounds; the thick solid black line with squares shows theoretical responses from the baseline model.

[25]Our calibration of the government consumption shock is based on estimates of the first VAR model $z_{i,t} = [g_{i,t}, y_{i,t}, l_{i,t}, je_{i,t}, w_{C,i,t}]$.

[26]The mapping between the non-tradable content of the government spending shock and the non-tradable content of government spending will be useful when we calibrate the model to country-specific data since the number of observations per country for sectoral government consumption is too small to estimate empirically the contribution of G^N to the identified government spending shock for each economy.

to an exogenous fiscal shock that we generate theoretically by specifying the law of motion (23) reproduces very well the dynamic adjustment from the VAR model, as the black line with squares and the blue line cannot be differentiated. The right panel of Fig. 6 contrasts empirical responses of sectoral government consumption to an exogenous fiscal shock with theoretical responses derived from eq. (29) by setting ω_{G^N} and ω_{G^T} to 0.9 and 0.1, respectively. The upper and lower lines show the responses of G^N and G^T, respectively. Overall, the theoretical responses perform well in reproducing the evidence and thus the assumptions underlying the dynamic equation (29) which governs the adjustment of G^j are consistent with data.

< Please insert Table 4 and Figures 6-7 about here >

Aggregate effects. We need to start with the whole picture since aggregate and sectoral effects are strongly intertwined. The rise in total hours worked and in real GDP determine the size of sectoral fiscal multipliers if the reallocation of resources were absent (see the first term on the RHS of eq. (2)). Differently, adjustments in investment and the current account determine the size of the reallocation effects by influencing excess demand in goods markets (see the second term on the RHS of eq. (2)).

Impact effects of a government spending shock on GDP, its demand components and labor market variables are shown in panels A and B of Table 4.[27] By producing a negative wealth effect, a balanced-budget government spending shock leads agents to supply more labor, which in turn increases real GDP. As shown in panel A, whether we impose PML (columns 7-8) or assume IML (column 2), both models understate the rise in total hours worked and in real GDP. Because labor mobility costs put upward pressure on the aggregate wage, the positive response of L and the size of the aggregate fiscal multiplier are amplified with IML which makes the model closer to the evidence.

A model imposing PML overstates the current account deficit or predicts a current account surplus depending on whether capital adjustment costs are included or not (see columns 8 and 7). On the contrary, the baseline model (see column 2) is able to produce a decline in investment and the current account on impact which accords well with our VAR estimates. Intuitively, following a temporary government spending shock, households lower their savings in order to avoid a large decrease in their consumption and/or mitigate the rise in their labor supply. Lower savings results in a decline in investment or the current account or both. With IML, capital shifts toward the non-traded sector which lowers k^T and increases the return on domestic capital. As a result, the fall in investment is mitigated and a current account deficit appears. Capital adjustment costs further moderate the decline in

[27]For reasons of space, the empirical and theoretical responses of GDP, its demand components and labor market variables are contrasted in Online Appendix G.1. It is worthwhile mentioning that the simulated responses from the baseline model lie within the confidence interval along the transitional adjustment for all aggregate variables, with the exception of the real consumption wage.

with a model imposing $\kappa = 0$ (see column 6).

We turn to the sectoral and reallocation effects. Panels C and D of Table 4 show impact responses of labor and product market variables, respectively. In Fig. 7, we report the model predictions together with the VAR evidence of sectoral variables. In Fig. 7, we also contrast the responses from the benchmark setup with those from a model imposing $\epsilon \to \infty$ and $\kappa = 0$, as displayed in the dotted black line.

PML. Focusing first on impact responses, column 7 of Table 4 shows that a model imposing PML can generate qualitatively a rise in the share of non-tradables but substantially understates its magnitude. More specifically, the model predicts a rise in the value added share of non-tradables by 0.24%, a value below what is estimated empirically (i.e., 0.35%). Because the model also understates the increase in real GDP, it produces a rise in Y^N by 0.28% which is far below the estimated value (0.70%). The inability of the model to account for the reallocation and distributional effects across sectors of a rise in government spending we document empirically lies in the combined effect of the absence of capital adjustment and labor mobility costs. The dramatic fall in investment caused by the absence of capital adjustment costs mitigates the excess demand for non-traded goods and thus the incentives for reallocating productive resources toward the non-traded sector. The absence of mobility costs leads labor to move instantaneously toward the non-traded sector to eliminate the excess demand in the non-traded goods market which further mitigates the incentives to shift capital toward this sector by leaving the relative price of non-tradables unchanged, in contradiction with our evidence. The relative wage of non-tradables is also unchanged because sectoral wages increase by the same amount. To assess the respective role of labor mobility and capital adjustment costs, we analyze below two restricted versions of the model where one of the two features is, respectively, shutdown.

PML and capital installation costs. Column 8 of Table 4 shows the predictions of a model imposing PML but allowing for capital installation costs. By mitigating the decline in investment, capital installation costs amplify the excess demand for non-tradables. However, without labor mobility costs, high incentives to shift productive resources toward the non-traded sector now lead the model to overstate the rise in the labor and value added share of non-tradables (0.74% and 0.76%, resp.) which are about three and two times larger, respectively, what is estimated empirically. Intuitively, workers are willing to shift their whole time to the sector that pays the highest wage. As a result, sectoral labor and thus sectoral output become unrealistically sensitive to a change in the relative price, the latter appreciating by 0.02% instead of 1.06% in the data.

IML and capital installation costs. In contrast, as displayed in column 2, the ability of the model with capital adjustment costs to account for the reallocation and distributional

To begin with, the baseline model can account for the rise in the relative wage. Intuitively, non-traded firms are encouraged to produce and thus to hire more to meet additional demand. As workers experience intersectoral mobility costs, non-traded firms must pay higher wages to attract workers which raises the relative wage, Ω, by 1.44%.

Because labor shifts toward the non-traded sector, the baseline model predicts a rise in hours worked in non-tradables by 0.44%, which accords well with the evidence shown in column 1. Labor reallocation pushes up non-traded output by 0.50%, the response being almost double that obtained with PML (see column 7). Intuitively, labor mobility costs put upward pressure on the aggregate wage which amplifies the rise in labor supply and thus further raises output in the non-traded sector since it is relatively more labor intensive.

As long as there is a difficulty in reallocating labor across sectors, excess demand shows up in the non-traded goods market. As a result, the price of non-traded goods relative to traded goods appreciates by 0.88%, as shown in the fourth line of panel D. The appreciation in P triggers a reallocation of capital and labor toward the non-traded sector which raises its output share by 0.38% of GDP, a value close to our estimates.

IML and no capital installation costs. To emphasize the importance of capital installation costs, column 6 reports impact responses from a model assuming IML while setting $\kappa = 0$. As investment is crowded out by a larger amount than if capital were subject to adjustment costs, the excess demand in the non-traded goods market is lower so that P appreciates less, resulting in smaller shifts of labor and capital toward the non-traded sector. As a result, the model generates a rise in the labor and value added share of non-tradables by 0.17% and 0.27% which are below the values we estimate empirically (0.27% and 0.35%, resp.).

Financial Openness. As shown analytically in Online Appendix C.2, in addition to IML, financial openness and the tradability of goods also matter in determining the responses of sectoral shares. A way to gauge the importance of access to foreign borrowing for sectoral effects of fiscal policy is to decompose the change in the share of non-tradables in demand components:

$$\begin{aligned} d\nu^{Y,N}(0) &= \underbrace{\left(\omega_{G^N} - \nu^{Y,N}\right) g}_{=+0.27} + \underbrace{\omega_C \left[\alpha_C \hat{C}^N(0) - \nu^{Y,N} \hat{C}(0)\right]}_{=-0.06} + \underbrace{\omega_J \left[\alpha_J \hat{J}^N(0) - \nu^{Y,N} \hat{J}(0)\right]}_{=-0.04} \\ &\quad \underbrace{-\nu^{Y,N} dCA(0)/Y}_{=+0.21}, \end{aligned}$$

where $g = dG(0)/Y$ normalized to 1% of GDP on impact. The figures below each demand component add up to 0.38% of GDP. When we abstract from general equilibrium effects, i.e., when the responses of private sector's demand components are shut down (see eq. (3)), $d\nu^{Y,N}(0)$ collapses to the first term on the RHS of the above equation which indicates that the relative intensity of non-tradables in the government spending shock causes the share on the RHS reveal that changes in consumption and investment following a government spending shock do not favor the non-traded sector since higher prices for non-tradables tilt consumption and investment toward traded goods. However, these relative price effects are more than offset by the impact of the current account deficit on expenditure on non-tradables, as captured by the last term on the RHS of the above equation which tilts the demand shock toward non-tradables. If the current account were unresponsive to the government spending shock, the share of non-tradables would rise by 0.17% of GDP only, an amount which is half what is estimated empirically. Conversely, the ability of the open economy to borrow abroad increases the share by non-tradables from 0.17% to 0.38%.[28]

Intensity of non-tradables in the government spending shock. To further emphasize the importance of general equilibrium effects, we set $\omega_{G^N} = \nu^{Y,N}$ in column 3 of Table 4. If private demand components were unresponsive, labor reallocation should be absent because the rise in government spending is split between sectors in accordance with their relative size. However, panel C indicates that labor shifts toward the non-traded sector whose output share increases by 0.25% of GDP (see panel D). While higher non-traded prices tilt the demand shock toward traded goods which lowers the share of non-tradables by -0.05% of GDP, the current account deficit by 0.48% of GDP increases the share of non-tradables by 0.30% of GDP.

Effect of higher labor mobility. As we move from column 4 to column 5 of Table 4, the utility loss resulting from the shift from one sector to another is reduced. As shown analytically in Online Appendix C, a rise in ϵ exerts two opposite effects on sectoral output shares: while workers are more willing to shift across sectors, P appreciates less, which mitigates the incentive for labor reallocation. We find numerically that raising ϵ from 0.22 to 1.64 amplifies the rise in the output share of non-tradables from 0.26% to 0.49% of GDP, in accordance with our evidence documented in section 2.7. Thus, the former effect more than offsets the latter.

Sectoral share/sectoral multiplier/aggregate multiplier. As shown in eq. (2), the sectoral fiscal multiplier is equal to the fraction of the aggregate fiscal multiplier received by the sector plus the change in the sectoral share. Across all scenarios, the change in sectoral value added is positively correlated with the change in the sectoral share. When ϵ is increased from 0.22 (column 4) to 1.64 (column 5), the share of non-tradables almost doubles while the fiscal multiplier for non-traded output increases from 0.41 to 0.59. The reason why the rise in non-traded value added does not double lies in the fact that as ϵ is increased, non-traded wages and thus W increase less which mitigates the rise in L. On

[28]Conversely, capital inflows exert a negative impact on the output share of tradables since foreign borrowing leads households to import traded goods, thus producing a trade balance deficit. Since less resources are necessary to produce traded goods domestically, inputs are reallocated toward the non-traded sector.

government spending (i.e., we move from column 3 to column 2). Intuitively, by targeting the sector that has the highest labor compensation share, IML puts upward pressure on wages in this sector which in turn increases W and amplifies the response of labor supply to the government spending shock.

Dynamics. Turning to the adjustment of sectoral variables following a government spending shock as shown by the solid black line with squares in Fig. 7, the dynamics of P and Ω are captured fairly well by the baseline model. As G falls and is restored to its initial level, excess demand in the non-traded goods market is reduced, which depreciates P along the transitional path, as shown in Fig. 7(a). Decreasing prices of non-tradables relative to tradables encourage non-traded firms to reduce hours worked and thus to lower output, in line with the evidence in Fig. 7(h) and 7(g). Because W^N falls relative to W^T during the transitional adjustment, as shown in Fig. 7(b), labor is reallocated toward the traded sector, which recovers gradually, while both hours worked and output remain below their initial levels for almost ten years. As shown in Fig. 7(e) and 7(d), the model tends to somewhat understate the contraction of L^T and Y^T in the medium run.

Conversely, as displayed by the dotted black line, the performance of the model declines when imposing $\epsilon \to \infty$ and setting $\kappa = 0$; in this special case, the model predicts a flat temporal path for Ω and P, which is in conflict with the evidence; while it understates the responses of sectoral output shares on impact, the model overstates their changes along the transitional path. The reason is that the capital stock falls sharply in the short-run and then recovers rapidly after two years, resulting in sharp changes in the relative size of sectors due to the Rybczynski effect.[29]

Taking stock. Overall, the baseline model with IML and capital adjustment costs captures well the sectoral effects of an exogenous increase in government spending but is subject to some caveats. As shown in Fig. 7(d), the model tends to somewhat overstate the decline in traded output over the first two years and understate its contraction afterwards. While the theoretical response of non-traded output lies within the confidence bounds of the point estimate, as can be seen in Fig. 7(g), the model still overstates the rise in Y^N relative to its trend after two years. We conducted several robustness checks with respect to the value of parameters we set and by relaxing several assumptions of our model and found that similar results obtain. Motivated by the rise in aggregate TFP following a rise in government spending documented by Jørgensen and Ravn [2018], we have investigated whether sectoral TFPs, Z^j, respond to a government spending shock. According to our empirical results, traded TFP increases above trend over the first two years and then declines which could explain the difficulty to reproduce well the dynamics for Y^T when keeping Z^T fixed. On the

[29] In Online Appendix G.3, we contrast the dynamic adjustment from the baseline model with the responses from the restricted model where one of the two features is shut down.

a rationale for the (moderate) discrepancy between empirical and theoretical responses for Y^N when assuming an exogenous non-traded TFP. Empirical results can be found in Online Appendix D.5 and we leave further analysis of these issues for future research.

4.3 Cross-Country Differences: Taking the Model to Data

We have shown above that the performance of the neoclassical model in replicating the evidence related to sectoral effects of a government spending shock improves as long as we allow for IML and capital adjustment costs. We now move a step further and assess the ability of the model to generate a similar cross-country relationship between the degree of labor mobility and changes in the relative size of sectors to that in the data.

To compute the impact responses of sectoral output shares to a government spending shock numerically, we calibrate our model to match the key characteristics of the OECD economies in our sample summarized in Table 2. While we explore the sectoral effects of a rise in G by 1% of GDP for each country in our sample, to be consistent with the calibration to a representative OECD economy described in section 4.1, we assume that the increase in public purchases is split between non-tradables and tradables in accordance with their respective shares in government spending (see column 4 of Table 2). Since the goal of our exercise below is to compare the rise in the share of non-tradables across countries when we allow for international differences in the degree of labor mobility across sectors, we exclude Australia and Ireland from our quantitative exercise as these two economies experience a fall the share of non-tradables and/or a rise in the share of tradables.[30]

< Please insert Figures 8-9 about here >

To explore the cross-country relationship quantitatively, we first plot in Fig. 8 the simulated responses of sectoral output shares on the vertical axis against the degree of labor mobility captured by the parameter ϵ on the horizontal axis. Impact changes in non-traded output relative to real GDP range from 0.26% of GDP for the Netherlands to 0.49% of GDP for Spain. Fig. 8(a) and 8(b) also show that these differences in the responses of sectoral output shares are positively correlated with the measure of the degree of labor mobility across sectors. This result thus reveals that the sectoral impact of fiscal policy increases with the degree of labor mobility, which accords with our evidence. Quantitatively, as we move along the trend line shown in Fig. 8(a), our model predicts that a country with a low degree of labor mobility, as captured by a value of ϵ of 0.15, will experience a decline in the output share of tradables of 0.3% of GDP, while a country with a higher degree of

[30] We find empirically that the output share of non-tradables does not increase on impact in Australia and Ireland. This result is puzzling since ω_{G^N} averages 88% and 90% for Australia and Ireland and thus the government spending shock should be biased toward non-tradables. Motivated by the evidence documented by Jørgensen and Ravn [2018], in Online Appendix D.5, we explore the responses of sectoral TFP to a government spending shock for these two countries and find that their movements overturn the positive impact of the government spending shock on the output share of non-tradables.

which is 50% larger.

In Fig. 9, we contrast the cross-country relationship from the calibrated baseline model shown by the solid black line with circles with the cross-country relationship from the VAR model shown by the solid blue line. When we calibrate our model to cross-country data, we obtain a correlation between the responses of sectoral output shares and the measure of the degree of labor mobility of -0.11 for tradables (t−stat = -5.90) and 0.11 for non-tradables (t−stat = 5.90). While it tends to understate the changes in the relative size of sectors since the cross-country relationship is higher for tradables and lower for non-tradables, the model is able to generate a cross-country relationship between the responses of sectoral output shares and the degree of labor mobility which is quite similar to that in the data.

5 Conclusion

This paper contributes to the literature related to the effects of a government spending shock both empirically and theoretically. From an empirical point of view, we provide new evidence on the sectoral effects of a shock to government consumption. Using a panel of 16 OECD countries over the period 1970-2007 and adopting a SVAR approach, our estimates reveal that the non-traded sector is very intensive in government spending shocks which trigger a shift of resources toward this sector. More precisely, our evidence reveals that the non-tradable content of the government spending shock averages 90%, while the reallocation of inputs alone contributes to 50% of non-traded output growth on impact. While the shift of labor is responsible for half of the increase in non-traded hours worked, our evidence points to the presence of labor mobility costs, as we detect empirically a significant increase in non-traded wages relative to traded wages. The degree of labor mobility across sectors appears empirically to be a key determinant of the response of the share of non-tradables to a government spending shock, which varies across time and space. Our estimates show that time-declining responses of sectoral shares are highly correlated with lower intersectoral reallocation of labor over time following a rise in government spending. Turning to international differences, we find that the relative size of the non-traded sector increases more in economies where the degree of labor mobility across sectors is higher.

To rationalize our evidence, we develop a two-sector open economy model with two key features. First, we allow the non-traded sector to be highly intensive in the government spending shock in line with our empirical findings while financial openness further biases the demand shock toward toward non-tradables. Second, as in Horvath [2000], agents cannot costlessly reallocate hours worked from one sector to another. Because mobility is costly in utility terms, workers demand higher wages in order to compensate for their cost of switching sectors. Calibrating the model to a representative OECD economy and considering a the model can account for the panel VAR evidence, in particular the changes in relative sector size, as long as we allow for adjustment costs to physical capital accumulation along with IML. The former feature mitigates the decline in investment and thus guarantees that the excess demand and therefore incentives to shift resources toward the non-traded sector are high enough. By reducing the elasticity of labor supply across sectors, the latter feature hampers the reallocation of labor and thus allows the model to match the changes in relative sector size quantitatively. In contrast, the restricted version of the model where one of the two features is shut down fails to account for the evidence.

When we calibrate our baseline model to each OECD economy in our sample, our numerical results reveal that international differences in the degree of labor mobility generate a wide dispersion in the responses of sectoral output shares as changes in the relative size of sectors are fifty percent stronger in countries with the highest degree of labor mobility than in economies with the lowest labor mobility. Importantly, our model reproduces pretty well the cross-country relationship between the degree of labor mobility and the responses of sectoral output shares that we estimate empirically.

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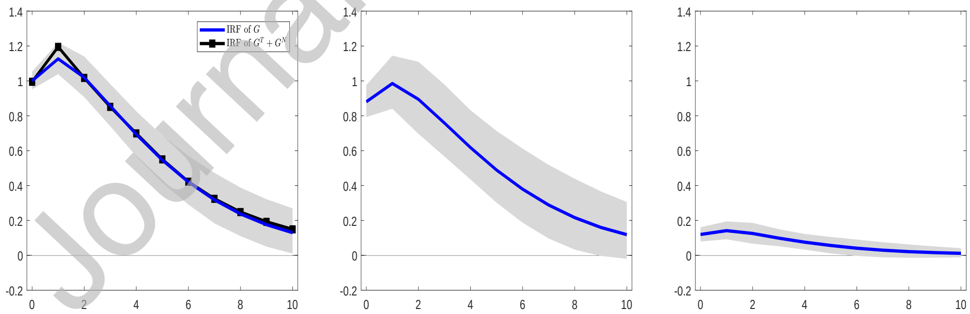
Table 1: Sample Range for Empirical and Numerical Analysis

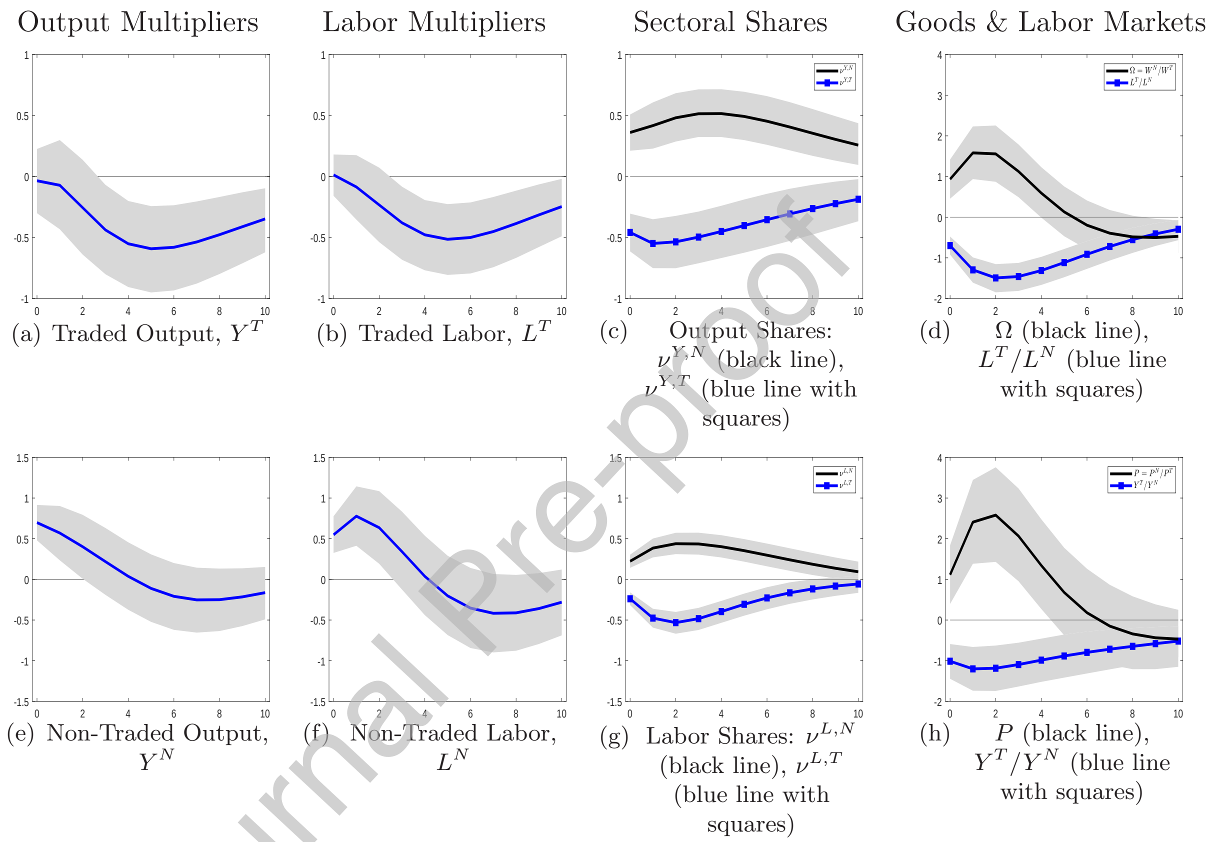
Country		Sectoral Effects		Sectoral Decomposition of G		Model Calibration
		Period	Obs.	Period	Obs.	Period
Australia	(AUS)	1970 - 2007	38	–	–	1990 - 2007
Austria	(AUT)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Belgium	(BEL)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Canada	(CAN)	1970 - 2007	38	–	–	1990 - 2007
Denmark	(DNK)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Spain	(ESP)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Finland	(FIN)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
France	(FRA)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Great Britain	(GBR)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Ireland	(IRL)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Italy	(ITA)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Japan	(JPN)	1974 - 2007	34	–	–	1990 - 2007
Netherlands	(NLD)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Norway	(NOR)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Sweden	(SWE)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
United States	(USA)	1970 - 2007	38	1995 - 2015	21	1990 - 2007
Total number of obs.			604		273	
Main data sources		OECD Economic Outlook EU KLEMS & OECD STAN		OECD Economic Outlook OECD COFOG		OECD Economic Outlook EU KLEMS & OECD STAN

Notes: The column 'period' gives the first and last observation available. Obs. refers to the number of observations available for each country. Data to construct time series for sectoral government consumption expenditure are available for all the countries in our sample except Canada. In efforts to have a balanced panel and time series of a reasonable length, Australia (1998-2015) and Japan (2005-2015) are removed from the sample, which leaves us with 13 OECD countries over the period 1995-2015.



(a) Government Final Consumption Expenditure, G (b) Gov. Exp. on Non-Tradables, G^N (c) Gov. Exp. on Tradables, G^T

Figure 1: Effects of Unanticipated Government Spending Shock on Government Final Consumption Expenditure and its Non-Tradable and Tradable Components. Notes: Exogenous increase of government consumption by 1% of GDP. The government spending shock is identified by estimating a VAR model that includes real government final consumption expenditure, GDP (constant prices), total hours worked, private fixed investment, and the real consumption wage. The baseline response of government final consumption expenditure is displayed by the solid blue line in the left panel with shaded area indicating the 90 percent confidence bounds obtained by bootstrap sampling; sample: 16 OECD countries, 1970-2007, annual data. The responses of (logged) government final consumption expenditure on non-tradables (i.e., g^N) and tradables (i.e., g^T) to the identified government spending shock (in the baseline VAR model) are displayed by solid blue lines in panels (b) and (c) with shaded area indicating the 90 percent confidence bounds; sample: 13 OECD countries, 1995-2015, annual data. The black line with squares in the left panel displays the dynamic response of government final consumption expenditure which has been computed by summing mean responses of government consumption expenditure on non-tradables and tradables.



(a) Traded Output, Y^T

(b) Traded Labor, L^T

(c) Output Shares: $\nu^{Y,N}$ (black line), $\nu^{Y,T}$ (blue line with squares)

(d) Ω (black line), L^T/L^N (blue line with squares)

(e) Non-Traded Output, Y^N

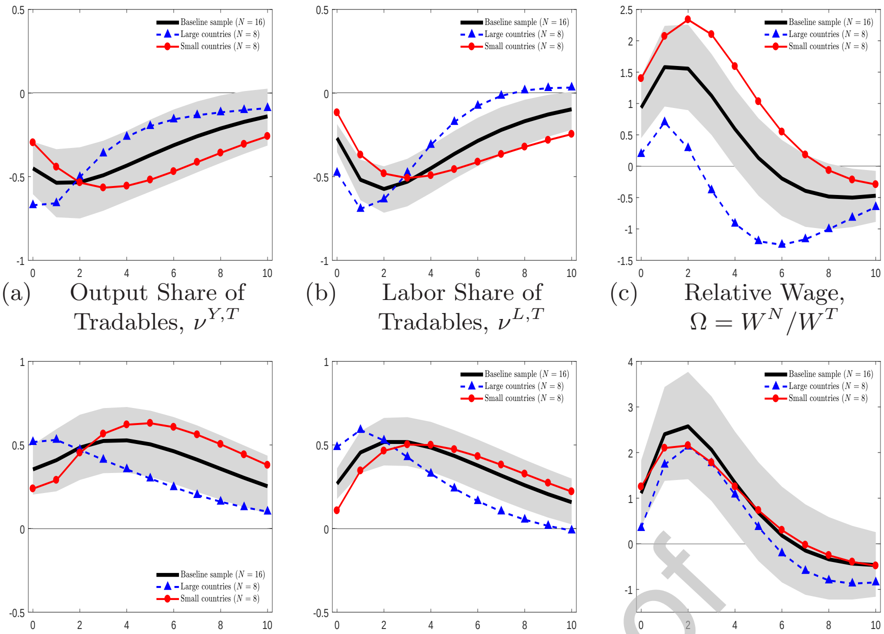
(f) Non-Traded Labor, L^N

(g) Labor Shares: $\nu^{L,N}$ (black line), $\nu^{L,T}$ (blue line with squares)

(h) P (black line), Y^T/Y^N (blue line with squares)

Figure 2: Sectoral Effects of Unanticipated Government Spending Shock. Notes: Exogenous increase of government consumption by 1% of GDP. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in output units (sectoral output, sectoral output shares), percentage deviation from trend in labor units (sectoral labor, sectoral labor shares), deviations from trend (ratio of traded value added to non-traded value added, ratio of hours worked of tradables to hours worked of non-tradables), and percentage deviation from trend (relative price, relative wage). Blue and black lines display point estimates. Solid black lines show responses of $\nu^{Y,N}$ in Fig. 2(c), $\nu^{L,N}$ in Fig. 2(g), Ω, in Fig. 2(d), P in Fig. 2(h); Blue lines with squares show responses of $\nu^{Y,T}$ in Fig. 2(c), $\nu^{L,T}$ in Fig. 2(g), L^T/L^N, in Fig. 2(d), Y^T/Y^N in Fig. 2(h). Shaded areas: bootstrapped 90% confidence intervals; sample: 16 OECD countries, 1970-2007, annual data.

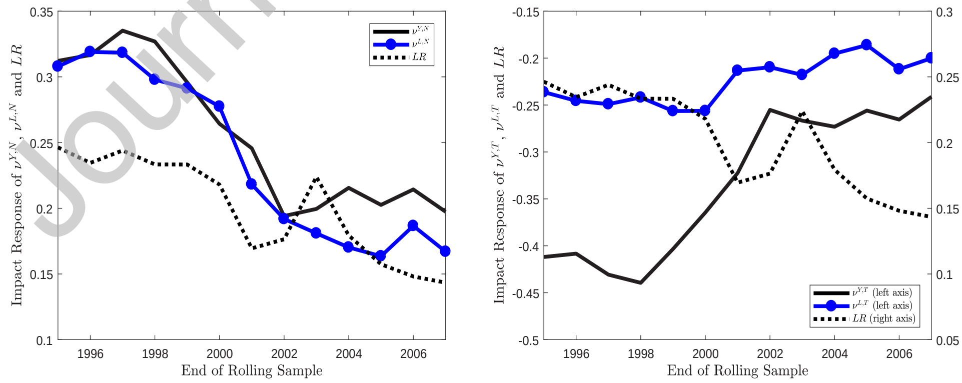
Output Shares | Labor Shares | Relative Wage and Relative Price



(a) Output Share of Tradables, $\nu^{Y,T}$ (b) Labor Share of Tradables, $\nu^{L,T}$ (c) Relative Wage, $\Omega = W^N/W^T$

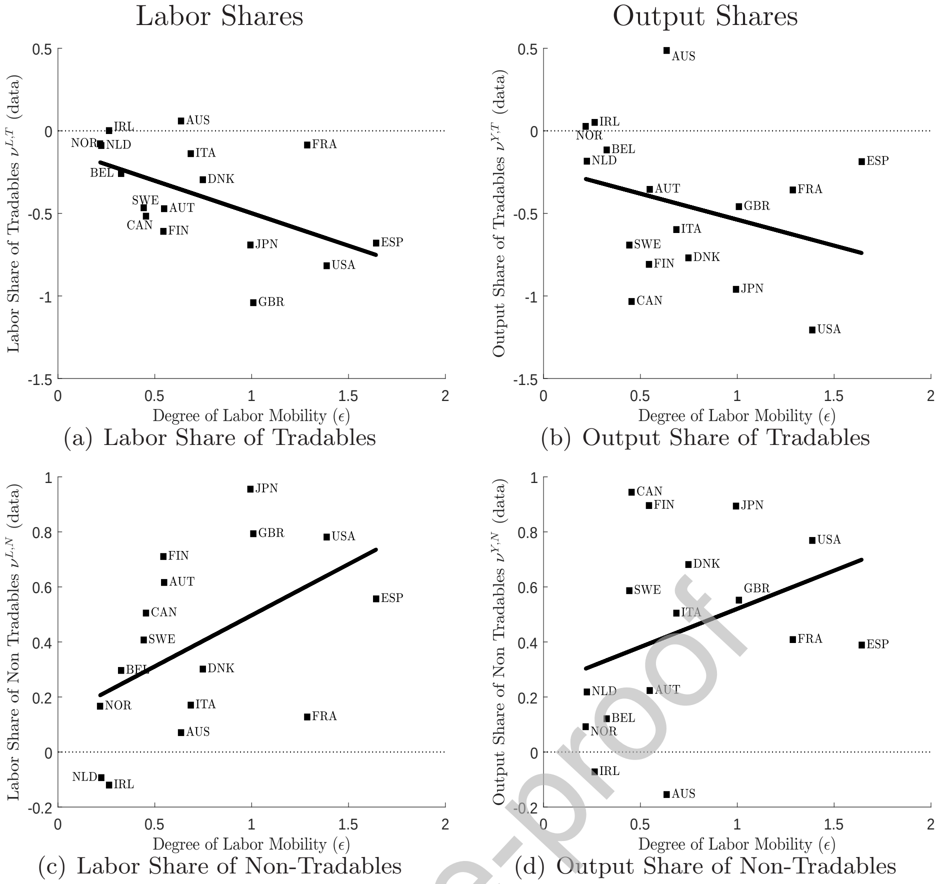
(d) Output Share of Non Tradables, $\nu^{Y,N}$ (e) Labor Share of Non Tradables, $\nu^{L,N}$ (f) Relative Price, $P = P^N/P^T$

Figure 3: Sectoral Effects of Unanticipated Government Spending Shock across Countries' Size. Notes: Exogenous increase of government consumption by 1% of GDP. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in output units (sectoral output shares), percentage deviation from trend in total hours worked units (sectoral hours worked shares) and percentage deviation from trend (relative price and relative wage of non-tradables). Results for the baseline (all countries) are displayed by the solid black line with the shaded area indicating 90 percent confidence bounds obtained by bootstrap sampling. We split the sample into two groups of countries on the basis of the working age population and run the same VAR model for one sub-sample at a time. The dashed blue line with triangles (red line with circles resp.) shows results for the group of large countries (small countries resp.). Sample: 16 OECD countries, 1970-2007, annual data.



(a) Non-Traded Goods Share, ν^N (b) Traded Goods Share, ν^T

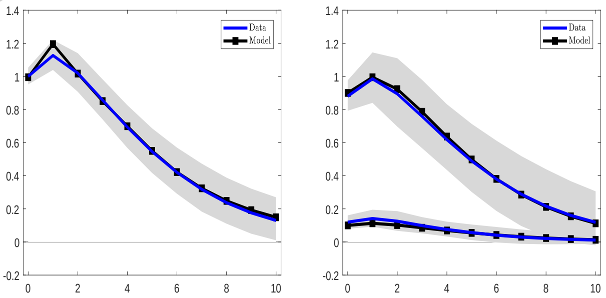
Figure 4: Plot of Impact Responses of Sectoral Shares to a Government Spending Shock in Rolling Sub-Samples against Impact Response of Intersectoral Labor Reallocation. Notes: Exogenous increase of government consumption by 1% of GDP. The government spending shock is identified by estimating a VAR model that includes real government final consumption expenditure, GDP (constant prices), total hours worked, private fixed investment, and the real consumption wage. We adopt the local projection method for estimating impulse responses of the sectoral shares (i.e., $\nu^{Y,j}, \nu^{L,j}$) and the labor reallocation index (i.e., LR) to identified government spending shock; as we restrict attention to impact effects, we run the regression of each variable of interest on the structural shock, setting $h = 0$ into eq. (4). To explore empirically time-varying effects of government spending shocks, we estimate impact effects on rolling 25-year window. The time-varying impact response of the value added (labor) share of sector j is shown in the solid black line (blue line with circles) while the time-varying impact response of intersectoral labor reallocation is displayed in the dotted black line; sample: 16 OECD countries, 1970-2007, annual data.



(a) Labor Share of Tradables (b) Output Share of Tradables

(c) Labor Share of Non-Tradables (d) Output Share of Non-Tradables

Figure 5: Effect of Government Spending Shocks on Sectoral Shares against the Degree of Labor Mobility across Sectors. Notes: Figure 5 plots impact responses of sectoral labor and sectoral output shares to a government spending shock. Impact responses shown in the vertical axis are obtained by running a VAR model for each country and are expressed in percentage point. Horizontal axis displays the elasticity of labor supply across sectors, ϵ, which captures the degree of labor mobility across sectors; panel data estimates for ϵ are taken from column 16 of Table 2.



(a) Government Spending (b) G^T and G^N

Figure 6: Effects of Unanticipated Government Spending Shock on Government Final Consumption Expenditure and Its Two Components: Empirical vs. Theoretical Impulse Response Functions. Notes: The baseline response of government final consumption expenditure is displayed by the solid blue line in the left panel with shaded area indicating the 90 percent confidence bounds obtained by bootstrap sampling; sample: 16 OECD countries, 1970-2007, annual data. The responses of government final consumption expenditure on non-tradables (i.e., g^N) and tradables (i.e., g^T) to the identified government spending shock (in the baseline VAR model) are displayed by solid blue lines in the right panel; sample: 13 OECD countries, 1995-2015, annual data. Theoretical responses of government final consumption expenditure, g, along with of those of its two components, g^N and g^T, are displayed by solid black lines with squares in the left and the right panel, respectively.

Table 2: Data to Calibrate the Two-Sector Model (1990-2007)

Countries	Non tradable Share						G^j/Y^j		LIS		Product.	Aggregate ratios			Elasticities	
	Output	Consump.	Inv.	Gov. Spending	Labor	α_L.	G^T/Y^T	G^N/Y^N	θ^T	θ^N	Z^T/Z^N	I/Y	G/Y	LIS	ϕ	ϵ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
AUS	0.63	0.56	n.a.	0.88	0.68	0.67	0.05	0.25	0.55	0.66	1.30	0.25	0.18	0.62	0.27	0.64
AUT	0.64	0.52	0.62	0.89	0.64	0.64	0.06	0.26	0.65	0.66	1.05	0.24	0.19	0.65	0.99	0.55
BEL	0.65	0.53	n.a.	0.89	0.68	0.66	0.07	0.30	0.65	0.67	1.28	0.21	0.22	0.66	0.80	0.33
CAN	0.63	0.54	0.67	n.a.	0.69	0.67	n.a.	n.a.	0.53	0.63	1.32	0.20	0.20	0.59	0.39	0.45
DNK	0.66	0.54	0.60	0.93	0.68	0.68	0.05	0.36	0.63	0.70	1.17	0.20	0.26	0.68	2.07	0.15
ESP	0.64	0.54	0.72	0.91	0.66	0.67	0.04	0.25	0.60	0.66	1.18	0.25	0.18	0.64	0.78	1.64
FIN	0.58	0.53	0.68	0.89	0.63	0.63	0.06	0.35	0.59	0.73	1.47	0.20	0.22	0.67	1.07	0.54
FRA	0.70	0.51	0.69	0.93	0.69	0.68	0.05	0.31	0.70	0.64	1.05	0.19	0.23	0.66	0.94	1.29
GBR	0.64	0.52	0.58	0.94	0.70	0.65	0.03	0.29	0.70	0.73	1.54	0.17	0.20	0.72	0.48	1.01
IRL	0.52	0.52	0.69	0.90	0.62	0.62	0.03	0.29	0.46	0.69	1.83	0.22	0.17	0.58	0.37	0.26
ITA	0.64	0.46	0.57	0.92	0.63	0.62	0.04	0.28	0.71	0.64	1.00	0.21	0.19	0.67	-	0.69
JPN	0.63	0.57	0.63	0.86	0.64	0.65	0.06	0.22	0.57	0.63	0.96	0.26	0.16	0.61	0.65	0.99
NLD	0.65	0.53	0.63	0.90	0.70	0.69	0.07	0.32	0.60	0.70	1.38	0.21	0.23	0.67	0.71	0.22
NOR	0.54	0.49	0.67	0.91	0.66	0.67	0.04	0.36	0.38	0.65	1.44	0.22	0.21	0.52	0.98	0.22
SWE	0.64	0.56	0.55	0.94	0.68	0.67	0.05	0.39	0.63	0.71	1.42	0.18	0.27	0.68	0.36	0.44
USA	0.69	0.63	0.64	0.88	0.73	0.69	0.06	0.20	0.61	0.63	1.12	0.19	0.16	0.62	0.67	1.39
Mean	0.63	0.53	0.64	0.90	0.67	0.66	0.05	0.30	0.60	0.67	1.28	0.21	0.20	0.64	0.77	0.75

Notes: The last line of Table 2 shows the mean of ratios and the mean of parameter values across countries. We take sixteen OECD countries' unweighted averages since in our empirical analysis, quantities are divided by the working age population and thus all countries receive the same weight. α_L refers to the labor compensation share of non-tradables. 'LIS' refers to the labor income share. The ratio G^j/Y^j is the share of government spending on good j in output of sector j; θ^j is the share of labor income in value added at current prices of sector $j = T, N$; Z^T/Z^N corresponds to the ratio of productivity of tradables to productivity of non-tradables. I/Y is the investment-to-GDP ratio and G/Y is government spending as a share of GDP. Because estimates of ϵ for Denmark and Norway over 1970-2007 are not statistically significant at a standard threshold, we exclude these two countries from the calculation of the average value for ϵ. When running the regression (34) over two sub-periods, we find a value for ϵ of 0.217 for Norway over 1970-1989. Since this value is statistically significant, we set ϵ to 0.217 for Norway when we calibrate the model to country-specific data.

Table 3: Baseline Parameters (Representative OECD Economy)

Definition	Value: OECD	Value: Sensitivity	Reference
Period of time	year	year	data frequency
A.Preferences			
Subjective time discount rate, β	4%	4%	equal to the world interest rate
Frisch elasticity of labor supply, σ_L	0.4	0.4	Fiorito and Zanella [2012]
Elasticity of labor supply across sectors, ϵ	0.75	0.2-1.6	our estimates (EU KLEMS [2011] and OECD STAN databases)
Elasticity of substitution between C^T and C^N, ϕ	0.77	0.77	our estimates (KLEMS [2011], OECD Economic Outlook)
Elasticity of substitution between J^T and J^N, ϕ_J	1	1	Bems [2008]
B.Non tradable share			
Weight of consumption in non-traded goods, $1-\varphi$	0.51	0.51	set to target $\alpha_C = 53\%$ (United Nations [2011])
Weight of labor supply to the non-traded sector, $1-\vartheta$	0.68	0.68	set to target $L^N/L = 67\%$ (KLEMS [2011])
Weight of non traded investment, $1-\varphi_J$	0.64	0.64	set to target $\alpha_J = 64\%$ (OECD Input-Output database [2012])
Non Tradable content of government expenditure, ω_{G^N}	0.90	0.63	our estimates (COFOG, OECD [2017])
Labor income share in the non-traded sector, θ^N	0.68	0.68	our estimates (EU KLEMS [2011] and OECD STAN databases)
Labor income share in the traded sector, θ^T	0.58	0.58	our estimates (EU KLEMS [2011] and OECD STAN databases)
Productivity of tradables relative to non-tradables Z^T/Z^N	1.28	1.28	our estimates (KLEMS [2011])
C.GDP demand components			
Physical capital depreciation rate, δ_K	6%	6%	set to target $\omega_J = 21\%$ (Source: OECD Economic Outlook Database)
Parameter governing capital adjustment cost, κ	17	0	set to match the elasticity I/K to Tobin's q (Eberly et al. [2008])
Government spending as a ratio of GDP, ω_G	20%	20%	our estimates (Source: OECD Economic Outlook Database)
D.Government spending shock			
Exogenous fiscal shock, g	0.01	0.01	To generate $dG(0)/Y = 1\%$
Persistence and shape of endogenous response of G, ξ	0.408675	0.408675	set to match $dG(1) = g'$ and $\dot{G}(1) = 0$
Persistence and shape of endogenous response of G, χ	0.415722	0.415722	set to match $dG(1) = g'$ and $\dot{G}(1) = 0$

Table 4: Impact Responses of Aggregate and Sectoral Variables to a Rise in Government Consumption (in %)

	Data	Imperfect Mobility					Perfect Mobility	
		Bench	N-Gov	Mobility		No Adj. Cost.	No Adj. Cost.	With Adj. Cost
		($\epsilon = 0.75$)	$\omega_{G^N} = 0.63$	($\epsilon = 0.22$)	($\epsilon = 1.64$)	($\kappa = 0$)	($\kappa = 0$)	($\kappa = 17$)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A.GDP & Components								
Real GDP, $dY_R(0)$	0.51	0.19	0.15	0.22	0.16	0.15	0.07	0.09
Investment, $dI(0)$	-0.01	-0.13	-0.09	-0.17	-0.08	-0.41	-0.84	0.04
Current account, $dCA(0)$	-0.30	-0.34	-0.48	-0.22	-0.46	-0.12	0.06	-0.75
B.Labor & Real Wage								
Labor, $dL(0)$	0.53	0.30	0.23	0.34	0.25	0.24	0.11	0.15
Real consumption wage, $d\left(W/P_C\right)(0)$	0.48	0.07	0.03	0.08	0.06	0.05	0.00	0.07
C.Sectoral Labor								
Traded labor, $dL^T(0)$	0.01	-0.14	-0.08	0.02	-0.29	-0.09	-0.20	-0.68
Non-traded labor, $dL^N(0)$	0.54	0.44	0.31	0.32	0.55	0.33	0.30	0.83
Relative labor, $d\left(L^T/L^N\right)(0)$	-0.71	-0.52	-0.33	-0.19	-0.86	-0.36	-0.53	-1.86
Relative wage, $d\Omega(0)$	0.93	1.44	0.91	1.87	1.03	1.02	0.00	0.00
Labor share of tradables, $d\nu^{L,T}(0)$	-0.27	-0.24	-0.15	-0.09	-0.38	-0.17	-0.23	-0.74
Labor share of non-tradables, $d\nu^{L,N}(0)$	0.27	0.24	0.15	0.09	0.38	0.17	0.23	0.74
D.Sectoral Output								
Traded output, $dY^T(0)$	-0.03	-0.31	-0.19	-0.19	-0.43	-0.21	-0.22	-0.72
Non-traded output, $dY^N(0)$	0.70	0.50	0.34	0.41	0.59	0.37	0.28	0.82
Relative output, $d\left(Y^T/Y^N\right)(0)$	-1.03	-0.97	-0.62	-0.64	-1.30	-0.64	-0.62	-3.16
Relative price, $dP(0)$	1.06	0.88	0.55	1.13	0.64	0.62	0.00	0.02
Output share of tradables, $d\nu^{Y,T}(0)$	-0.45	-0.38	-0.25	-0.26	-0.49	-0.27	-0.24	-0.76
Output share of non-tradables, $d\nu^{Y,N}(0)$	0.35	0.38	0.25	0.26	0.49	0.27	0.24	0.76

Notes: Effects of an unanticipated and temporary exogenous rise in government consumption by 1% of GDP. Panels A,B,C,D show the initial deviation in percentage relative to steady-state for aggregate and sectoral variables. Market product (aggregate and sectoral) quantities are expressed in percent of initial GDP while labor market (aggregate and sectoral) quantities are expressed in percent of initial total hours worked. To explore the aggregate effects empirically, we consider a VAR model that includes in the baseline specification (log) government consumption, $g_{i,t}$, GDP, $y_{i,t}$, total hours worked, $l_{i,t}$, private fixed investment, $je_{i,t}$, and the real consumption wage denoted by $w_{C,i,t}$. Our vector of endogenous variables, is given by: $z_{i,t} = \left[g_{i,t}, y_{i,t}, l_{i,t}, je_{i,t}, w_{C,i,t}\right]$. In the second specification we replace private investment with the current account expressed in percentage of GDP, $ca_{i,t}$; ϵ measures the degree of substitutability in hours worked across sectors and captures the degree of labor mobility; κ governs the magnitude of adjustment costs to capital accumulation. In our baseline calibration (labelled 'Bench'), we set $\epsilon = 0.75$ and $\kappa = 17$.

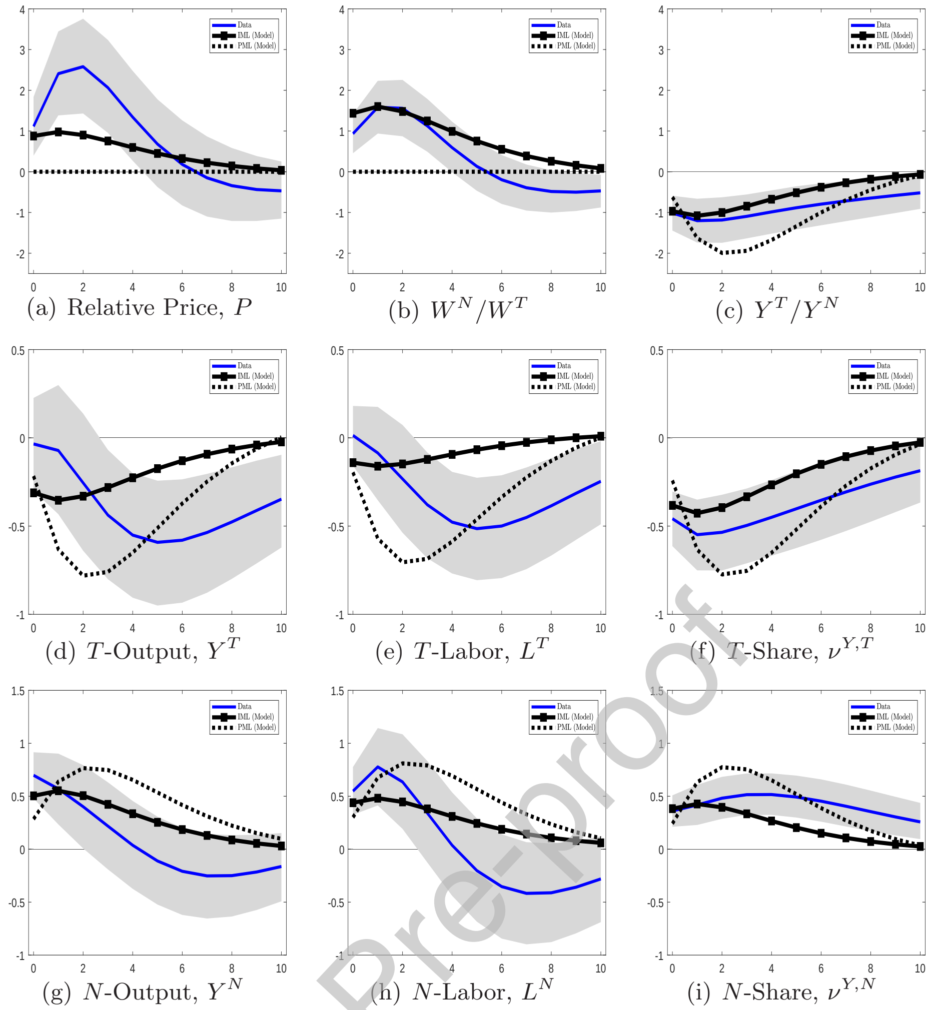


Figure 7: Theoretical vs. Empirical Responses Following Unanticipated Government Spending Shock. Notes: Solid blue line displays point estimate of VAR with shaded areas indicating 90% confidence bounds; the thick solid black line with squares displays model predictions in the baseline scenario with IML ($\epsilon = 0.75$) and capital installation costs ($\kappa = 17$) while the dotted black line shows predictions of the model imposing PML ($\epsilon \to \infty$) and abstracting from capital adjustment costs ($\kappa = 0$).

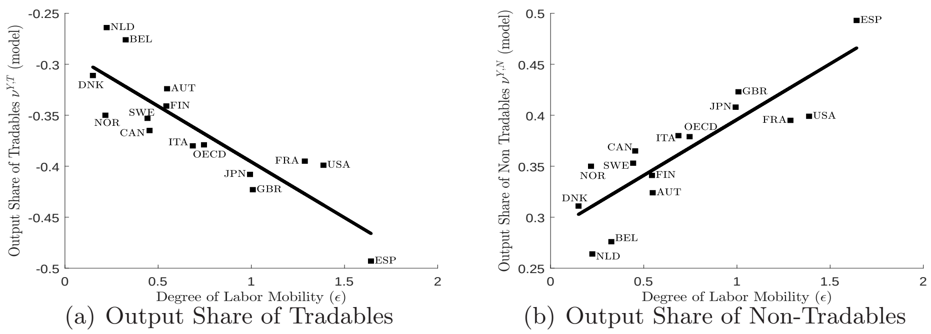
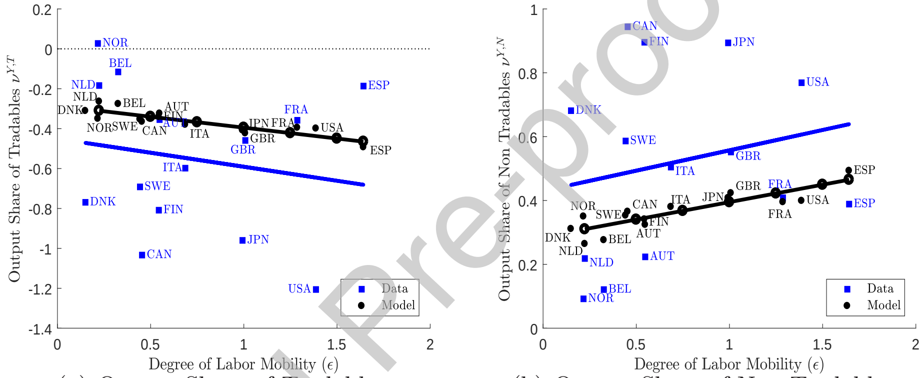


Figure 8: Cross-Country Relationship between the Responses of Sectoral Output Shares to Government Spending shock and the Degree of Labor Mobility across Sectors. Notes: Horizontal axes display panel data estimates of the elasticity of labor supply across sectors, ϵ, taken from the last column of Table 2, which captures the degree of labor mobility across sectors. Vertical axes report simulated impact responses from the baseline model with IML and adjustments costs to capital accumulation.



(a) Output Share of Tradables (b) Output Share of Non-Tradables

Figure 9: Cross-Country Relationship between Sectoral Output Responses and ϵ: Model vs. Data. Notes: Horizontal axes display panel data estimates of the elasticity of labor supply across sectors, ϵ, taken from the last column of Table 2, which captures the degree of labor mobility across sectors. Vertical axes report simulated responses from the baseline model (black circles) and impact responses from the VAR model (blue squares). The solid blue line shows the cross-country relationship from VAR estimates while the solid black line with circles displays the cross-country relationship from numerical estimates.