IMPERFECT MOBILITY OF LABOR ACROSS SECTORS AND FISCAL TRANSMISSION*

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Abstract

Our paper investigates the impact of government spending shocks on relative sector size and contrasts the effects across countries. Using a panel of sixteen OECD countries over the period 1970-2007, our VAR evidence shows that a rise in government consumption i) increases the share of non tradables in labor and real GDP and lowers the share of tradables, and ii) causes a significant increase in non traded wages relative to traded wages. While the first finding reveals that the non traded sector is more intensive in the government spending shock and experiences a labor inflow that increases its relative size, the second finding suggests the presence of labor mobility costs preventing wage equalization across sectors. Turning to cross-country differences, empirically we detect a positive relationship between the magnitude of the impact responses of sectoral output shares and the degree of labor mobility across sectors. To account for our evidence, we develop an open economy version of the neoclassical model with tradables and non tradables. Our quantitative analysis shows that the model is successful in replicating the responses of sectoral output shares to a fiscal shock, as long as we allow for a difficulty in reallocating labor across sectors along with adjustment costs to capital accumulation. Finally, calibrating the model to country-specific data, we are able to generate a cross-country relationship between the degree of labor mobility and the responses of sectoral output shares which is similar to that in the data.
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1 Introduction

Does a government spending shock affect the production sectors in an open economy uniformly? If not, how can we explain the heterogeneity in the sectoral effects of a rise in government consumption? Does the magnitude of the sectoral effects vary across countries and what factors cause such differences? Our paper provides an attempt to answer these questions by exploring the sectoral effects of a government spending shock empirically and calibrating an open economy version of the neoclassical model with tradables and non tradables.

The motivation for the analysis of the sectoral effects of a rise in government consumption is based on our panel VAR evidence for 16 OECD countries over the period 1970-2007. First, our evidence reveals that a government spending shock has a strong expansionary effect on hours worked and output in the non traded sector relative to the traded sector. Such a finding suggests that the rise in government consumption is biased toward non traded goods. Second, we also find empirically that a government spending shock leads to a shift of labor toward the non traded sector that increases its relative size. Such a reallocation of labor toward the non traded sector is costly, however, as we detect empirically a significant increase in non traded wages relative to traded wages. Third, when we turn to cross-country differences, these labor mobility costs are found to play a pivotal role in explaining international differences in the sectoral impact of fiscal policy. More precisely, we find that both the increase in the share of non tradables and the decline in the share of tradables are more pronounced in countries where the degree of labor mobility across sectors is higher.

Estimates of the responses of sectoral output shares to a government spending shock allow us to evaluate the contribution of the reallocation of resources to sectoral fiscal multipliers empirically. More specifically, our evidence reveals that a rise in government spending by one percentage point of GDP increases non traded output by 0.7% of GDP on impact while the output share of non tradables rises initially by 0.35% of GDP. Since the latter result indicates that non traded output would increase by 0.35% if GDP remained constant, the reallocation of resources toward the non traded sector thus contributes to 50% of non traded output growth. The rise in the share of non tradables in real GDP also suggests that the non traded sector receives a disproportionate share of the shock to government spending. In this regard, our estimates show that government consumption of non tradables contributes to 90% on average of increases in government spending.

While government spending shocks are biased toward non tradables and generate a substantial reallocation of resources which significantly affects the relative size of sectors, our evidence suggests some difficulty in reallocating labor between sectors. To assess the extent of mobility costs, we estimate the elasticity of labor supply across sectors, which captures the degree of labor mobility, for each country in our sample. Estimating the panel VAR model for countries with a low and a high elasticity of labor supply across sectors, we find that non traded wages increase more relative to traded wages while hours worked (output) in tradables relative to non tradables fall less in countries where the elasticity is low. This corroborates our conjecture that in countries where mobility costs are higher, non traded firms wishing to produce more must pay much higher wages to attract workers. In order to emphasize the importance of mobility costs for fiscal transmission, we explore the cross-country relationship between the responses of sectoral output shares and the degree of labor mobility captured by the elasticity of labor supply across sectors. While the vast majority of the economies experience a rise (decline) in their output share of non tradables (tradables), we empirically detect a positive relationship between the size of the responses of sectoral output shares 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 allow for the fraction of higher government consumption expenditure on non tradables to be higher that the share of non tradables in real GDP, 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 across sectors and capital adjustment costs.[1] With these two features, the model produces a rise in the share of non tradables by 0.38 percentage point 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 abstract from 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 model understates substantially the rise in the share of non tradables. Conversely, if we allow for capital adjustment costs, the decline in investment is mitigated, which leads to significant excess demand in the non traded goods market. However, if we impose perfect mobility of labor across sectors, high incentives to shift resources toward the non traded sector lead the model to overstate the responses of sectoral output shares considerably.

The final exercise we perform is to investigate whether the model can account for cross-

[1] To generate imperfect mobility of labor, 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.

country differences in the responses of sectoral output shares to a fiscal shock. We thus calibrate the model to match data from the 16 OECD countries regarding dimensions such as the non tradable content of labor, consumption, investment, government spending, and the elasticity of labor supply across sectors capturing the degree of labor mobility. In line with the evidence, the decline in the output share of tradables and the rise in the output share of non tradables are more pronounced in countries with a higher degree of labor mobility. 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. Although the model tends to understate changes in the relative size of sectors, it is able to generate a cross-country relationship between the responses of sectoral output shares and the degree of labor mobility that is similar to that in the data.

We contribute to the vast literature investigating fiscal transmission both empirically and theoretically by focusing on the reallocation effect of government spending shock. Like Ramey and Shapiro [1998], we emphasize the importance of the composition of government spending for understanding both the aggregate and the sectoral effects of a fiscal shock. In contrast to the authors who consider a rise in defense spending during a military buildup, which is heavily concentrated in the manufacturing sector, we investigate a rise in government consumption in 'normal times' and find that such a government spending shock leads to a sharp increase in non traded output relative to traded output. This finding is in line with estimates documented by Monacelli and Perotti [2008] and Benetrix and Lane [2010] which reveal that an increase in government spending disproportionately benefits the non traded sector. In contrast to the authors who restrict their attention to sectoral output effects, we highlight the changes in sectoral shares in labor and real GDP. In this regard, one major finding is that the share of non tradables in employment and real GDP increases significantly while the share of tradables declines. These findings reveal that government spending shocks are strongly biased toward non tradables and produce a reallocation of labor across sectors that affect their relative size.[2] Like Perotti [2008], the sector which is relatively more intensive in the government spending shock experiences an increase in real wages. In contrast to Perotti who considers Ramey-Shapiro episodes (i.e., Vietnam War and the Carter-Reagan buildup) and finds empirically higher increases in the real wage in industries that are defense related, we detect empirically a significant increase in wages paid by non traded industries which are relatively more intensive in government spending shocks in 'normal times'. One additional key finding with respect to the papers mentioned above is that international differences in workers' costs of switching sectors can account for

[2] More precisely, all else being equal, for the share of non tradables in real GDP to increase, the fraction of the rise in government consumption spent on non tradables must be higher than the share of non tradables in real GDP.

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.

Our theoretical approach is at the cross-roads between two strands of the literature investigating the adjustment of open economies to sectoral demand shocks. First, it is closely related to the analysis by Morshed and Turnovsky [2004], Cardi and Restout [2015], Chatterjee and Mursagulov [2016] who develop variants of the neoclassical model and investigate the effects of a rise in government spending on non tradables.[3] All of these works have in common that they impose perfect mobility of labor across sectors and focus mainly on the real exchange rate dynamics by considering either intersectoral capital mobility costs, endogenous markups, or an increase in public investment, respectively. In contrast to these works, we document panel VAR evidence on fiscal transmission and show how a difficulty in reallocating labor across sectors can account for our evidence following a rise in government purchases biased toward non tradables. In this respect, our study can be viewed as complementary to the literature which investigates the quantitative implications of a sector-specific government spending shock in a model with labor market frictions. By developing a multi-sector model with search frictions in the labor market, Phelan and Trejos [2000] show that an adverse sectoral demand shock originating from a cut in military purchases can be greatly magnified as a result of the combined effect of labor shifts across sectors and a slow reallocation. Like the authors, we show that the combined effect of sectoral intensity in the government spending shock and imperfect mobility of labor across sectors matter for fiscal transmission. In contrast, we estimate the degree of labor mobility across sectors, quantify both empirically and numerically the changes in the relative sector size following a rise in government consumption and show that international differences in the degree of labor mobility across sectors can account for cross-country differences in the sectoral impact of fiscal policy. Furthermore, the authors abstract from physical capital while we find that both imperfect mobility of labor along capital adjustment costs are necessary to produce the responses of sectoral shares in real GDP that we document empirically.

The remainder of the paper is organized as follows. In section 2, we establish panel VAR evidence on aggregate and sectoral effects of a government spending shock and then document an empirical relationship between the responses of sectoral output shares and the degree of labor mobility. In section 3, we develop an open economy version of the neoclassical model with a difficulty in reallocating labor across sectors. In section 4, we abstract from physical capital accumulation in order to derive a number of analytical results and to build up intuition on fiscal transmission with imperfect mobility of labor. In section 5, we report the results of our numerical simulations and assess the ability of the model

[3] It is worth mentioning that we consider a rise in government consumption which is splits between non tradables and tradables in accordance with their respective share in government spending.

to account for the evidence. In section 6, we summarize our main results and present our conclusions.

2 Stylized Facts on Fiscal Transmission

In this section, we revisit the time-series evidence on fiscal transmission by differentiating the effects of fiscal policy between the traded and non traded sectors. Because the sectoral impact of an expansionary fiscal shock varies considerably across the countries in our sample, we also contrast the effects of government spending shocks in economies with low and high workers' mobility costs. We denote below the level of the variable in upper case and the logarithm in lower case.

2.1 VAR Model and Identification

In order to shed some light on fiscal transmission and guide our quantitative analysis, we estimate the VAR model in panel format on annual data. We consider a structural model with $k = 2$ lags in the following form:

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

where subscripts i and t denote the country and the year, respectively, $Z_{i,t}$ is the vector of endogenous variables, 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.

Because the VAR model cannot be estimated in its structural form, we pre-multiply (1) by A^{-1} which gives the reduced form of the VAR model:

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

where $A^{-1}B_k$ and $e_{it} = A^{-1}\epsilon_{it}$ are estimated by using a panel OLS regression with country fixed effects and country specific linear trends. 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 shown in eq. (1).

To identify fiscal shock, we follow Blanchard and Perotti [2002] and assume that government spending is predetermined relative to the other variables in the VAR model. We thus adopt a Cholesky decomposition in which government spending is ordered before the other variables so that the fiscal shock is exogenous. The identifying assumption holds as long as public spending does not react contemporaneously to the state of the economy due to delays between current output observation and the implementation of fiscal measures. The potential problem is that we use annual data and some adjustment could be possible within the year. To support our assumption, we estimated the same panel VAR model that includes aggregate variables which are available on a yearly and a quarterly basis. The responses of variables to an exogenous fiscal shock are similar whether we use annual or quarterly series as our estimates using quarterly data lie within the confidence interval of those obtained from yearly data.[4] 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. Moreover, as government spending does not include transfers (such as unemployment benefits), it is therefore much less likely to respond automatically to the other variables. 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.[5] First, we run Granger-causality tests and do not find that fiscal forecasts have any predictive power for our identified government spending shocks. Second, it turns out that differences are rather moderate when we control for the anticipation effects and that our main results are not altered by the inclusion of forecasts for government spending growth.[6]

2.2 Data Construction

Before presenting the VAR model, we briefly discuss the dataset we use. Our sample consists of a panel of 16 OECD countries: Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Ireland (IRL), Italy (ITA), Japan (JPN), the Netherlands (NLD), Norway (NOR), Spain (ESP), Sweden (SWE), the United Kingdom (GBR), and the United States (USA). Our sample covers the period 1970-2007 and contains annual observations.

As detailed in the next subsection, we consider a number of VAR specifications as we wish to shed some light on the reallocation of resources triggered by a fiscal shock that affects the relative size of sectors. Because their movements are strongly intertwined, we explore both the aggregate and sectoral effects of government spending shocks empirically. The former variables consist of government consumption (G_{it}), GDP (Y_{it}), private fixed investment (JE_{it}), current account (CA_{it}), labor (L_{it}), and real consumption wage ($W_{C,it}$).

[4]The results are included in a Technical Appendix available on request from the authors. An alternative to deal with the potential endogeneity problem is to identify exogenous changes in government spending directly from historical events or official documents. In a robustness exercise, we augment each VAR model with the 'spending-based' events variable constructed by Guajardo, Leigh, and Pescatori [2014] whose dataset contains 173 fiscal policy changes for 17 OECD countries over the period 1978-2009. Overall, our results show low sensitivity to the identifying assumption.

[5]We use an alternative dataset constructed by Fioramanti et al. [2016] which contains one year-ahead forecasts for the budget balance-GDP ratio performed by the European Commission and do not find any evidence of anticipation effects.

[6]Details about our empirical strategy and data construction can be found in a Technical Appendix.

All data are obtained from the OECD Economic outlook and OECD STAN database together with EU KLEMS database. For government final consumption expenditure, GDP, and private investment (excluding residential investment), we use the volumes reported by the OECD. Aggregates G_{it}, Y_{it}, JE_{it} are deflated with their own deflators. We use hours worked to measure labor. All quantities are scaled by the working age population and are measured in logs, except for the current account which is expressed as a fraction of GDP. The real consumption wage is the ratio of the nominal aggregate wage, W_{it}, to the consumption price index, $P_{C,it}$, and is measured in logs. The nominal wage is obtained by calculating the ratio of labor compensation to the number of hours worked. Details of data construction and the source of variables used in our estimate are given in Appendix A.

Because our primary objective is to investigate the sectoral effects of fiscal transmission, we describe below how we construct time series at a sectoral level. Our sample covers the period 1970-2007 (except for Japan: 1974-2007), for eleven 1-digit ISIC-rev.3 industries. We use the EU KLEMS [2011] and OECD STAN [2011] database which provide domestic currency series of value added in current and constant prices, labor compensation and employment (number of hours worked) at an industry level. To split these eleven industries into traded and non traded sectors, we follow the classification suggested by De Gregorio et al. [1994]. Agriculture, hunting, forestry and fishing; Mining and quarrying; Total manufacturing; Transport, storage and communication are classified as traded industries. Following Jensen and Kletzer [2006], we updated the classification by De Gregorio et al. [1994] by treating Financial intermediation as a traded industry. Electricity, gas and water supply; Construction; Wholesale and retail trade; Hotels and restaurants; Real estate, renting and business services; Community, social and personal services are classified as non traded industries.[7]

Once industries have been classified as traded or non traded, series for sectoral value added in current (constant) prices are constructed by adding value added in current (constant) prices for all sub-industries in sector $j = T, N$, from which we construct price indices, P_{it}^j, which correspond to sectoral value added deflators. The relative price of non tradables, P_{it}, is defined as the ratio of the non traded value added deflator to the traded value added deflator (i.e., $P_{it} = P_{it}^N / P_{it}^T$). The same logic applies to constructing series for hours worked and labor compensation in the traded and the non traded sectors which allow us to construct sectoral wages, W_{it}^j. The relative wage, Ω_{it}, is computed as the ratio of the

[7] In contrast to De Gregorio et al. [1994] who treat "Financial intermediation" as non tradable, we classify this industry as tradable, following Jensen and Kletzer [2006]; our sensitivity analysis reveals that our conclusions hold whether "Financial intermediation" is classified as tradable or non tradable. The classification of the "Wholesale and Retail Trade", "Hotels and Restaurants", "Transport, Storage and Communication", and "Real Estate, Renting and Business Services" items may also display some ambiguity. In order to address this issue, we re-estimated the various VAR specifications for different classifications in which one of the above industries initially marked as tradable (non tradable resp.) is classified as non tradable (tradable resp.), all others industries staying in their original sector. Because results are very similar, to save space we do not present them and they are therefore relegated to the Technical Appendix.

non traded wage to the traded wage (i.e., $\Omega_{it} = W^N_{it}/W^T_{it}$). The real consumption wage in sector j, $W^j_{C,it}$, is defined as the sectoral nominal wage, W^j_{it}, divided by the consumption price index, $P_{C,it}$.

2.3 VAR Specification

In order to investigate the distribution of the aggregate fiscal multiplier across sectors along with the contribution of the reallocation of resources to sectoral fiscal multiplier, we consider four specifications. The choice of variables is motivated in part by the variables discussed in the quantitative analysis.

- To explore the magnitude of the aggregate fiscal multiplier empirically, we consider a VAR model that includes in the baseline specification (log) government consumption, g_{it}, GDP, y_{it}, total hours worked, l_{it}, private fixed investment, je_{it}, and the real consumption wage denoted by $w_{C,it}$. Our vector of endogenous variables, is given by: $z_{it} = [g_{it}, y_{it}, l_{it}, je_{it}, w_{C,it}]$. In the second specification we replace private investment with the current account expressed in percentage of GDP, ca_{it}.

- To investigate the magnitude of the sectoral fiscal multiplier, we consider a VAR model that includes value added at constant prices in sector j, y^j_{it}, hours worked in sector j, l^j_{it}, and the real consumption wage in sector j, $w^j_{C,it}$. Our vector of endogenous variables, is given by: $z^j_{it} = \left[g_{it}, y^j_{it}, l^j_{it}, w^j_{C,it}\right]$ with $j = T, N$.

- To estimate the change in relative sector size defined as the excess of the sectoral fiscal multiplier over the aggregate fiscal multiplier, we consider a VAR model where we divide sectoral value added at constant prices (sectoral labor) by GDP (total labor) in order to filter the change in sectoral output (sectoral labor) arising from GDP (total labor) growth which allows us to isolate the 'pure' reallocation effect and thus gauge the importance of the shift of resources across sectors that affects their relative size. Denoting the output and labor share of sector j by $\nu^{Y,j}_{it} = y^j_{it} - y_{it}$ and $\nu^{L,j}_{it} = l^j_{it} - l_{it}$, respectively, our vector of endogenous variables, is given by: $z^{S,j}_{it} = \left[g_{it}, \nu^{Y,j}_{it}, \nu^{L,j}_{it}, w^j_{C,it}\right]$ with $j = T, N$.

- Finally, to investigate the relative price (p) and relative wage (ω) effects of a fiscal shock, we 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: $z^P_{it} = \left[g_{it}, y^T_{it} - y^N_{it}, p_{it}\right]$ and $z^W_{it} = \left[g_{it}, l^T_{it} - l^N_{it}, \omega_{it}\right]$, respectively.

2.4 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 percentage point of GDP. Fig. 1-2 displays the estimated effects of a fiscal shock for our four alternative sets of specifications. The horizontal axis measures time after the shock in years and the vertical axis measures percentage deviations from trend. GDP together with its demand components, sectoral output and sectoral output share are measured in percentage points of total output relative to trend. Sectoral labor and sectoral labor share are both measured in percentage deviations of total hours worked from trend. The remaining variables are measured in percentage deviations from trend. In each case, the solid line represents the point estimate, while the shaded area indicates the 90% confidence bounds obtained by bootstrap sampling. Point estimates are shown in Panel A of Table 1 at a one year-, two-year and four-year horizon.

2.4.1 Aggregate Effects

We start with the aggregate effects of a government spending shock. Fig. 1 shows results for the first VAR model. The top left panel of Fig. 1 displays the endogenous response of government spending to an exogenous fiscal shock. The response of government consumption is hump-shaped, as it peaks after one year and then gradually declines; it shows a high level of persistence over time as it is about 8 years before the shock dies out. The impact on GDP is fairly moderate as the fiscal multiplier is about 0.5 and averages 0.29 during the first four years after the shock.[8] As shown in the last row, the dynamic adjustment of real GDP seems to mimic the dynamic adjustment of hours worked which increase on impact by 0.53% and declines after one year. In addition, we detect a moderate increase in the real consumption wage followed by a rapid decline. Its cumulative response over a two-year horizon is 0.6% approximately, and subsequently becomes negative.

Turning to the response of investment and the current account as shown in the second column of Fig. 1, the top panel indicates that investment is fairly unresponsive on impact which suggests the presence of installation costs, while the middle panel reveals that the current account moves into deficit in the short-run. The government spending shock leads to a protracted decline in investment which remains below trend while the current account recovers after two years and moves into surplus after about 5 years. As shown in Table 1, after four years, the cumulative decline in investment amounts to -1.29 percent of GDP while the current account deficit is substantial at -3.35 GDP percentage points.[9]

< Please insert Figure 1 and Table 1 about here >

[8]Like Ilzetzki, Mendoza, and Vegh [2013], we calculate the (aggregate or sectoral) multiplier at a k-year horizon by computing the ratio of the present value of the cumulative change in output to the present value of the cumulative change in government consumption, setting the world interest rate set to 4% to be consistent with the model calibration.

[9]Overall, our panel VAR evidence for aggregate variables is well in line with that reported in earlier studies, see e.g., Corsetti et al. [2012] who use a panel of 17 OECD countries for the period 1975-2008, and Beetsma, Giuliodori and Klaassen [2008] who consider a panel of 11 Euro Area Members.

2.4.2 Sectoral Effects

We now discuss the sectoral effects of a government spending shock. In Fig. 2, we report results for the second, third and fourth VAR model.[10] The first column displays sectoral multiplier results. 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 percentage point of GDP, as reported in column 3 of Table 1, while its four-year horizon cumulative response is substantial at 1.88 percentage points of GDP. During the first four years after the shock, the non traded output multiplier of government spending averages at about 0.47 percentage point of GDP. In contrast, the traded sector displays a negative fiscal multiplier for the first four years as the government spending shock gives rise to a contraction in traded output which remains below trend.[11] For non traded output to increase relative to traded output, the fraction of the rise in government spending spent on non tradables, ω_{G^N}, must be higher than that on tradables, ω_{G^T}.[12] 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 at the expense of the traded sector. Furthermore, as shown in the second row 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 labor for the first five years.

The second 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 and fourth rows show that the labor share of tradables declines by 0.27 percentage point of total labor while the reverse is true for non tradables. Since the response of sectoral labor share filters the change in sectoral labor arising from growth in total hours worked, our

[10] For reason of space, we omit the endogenous responses of government spending along with the dynamic adjustment of sectoral real consumption wages which can be found in a Technical Appendix. Because we consider alternative VAR models, one might be concerned by the fact that identified government spending shocks display substantial differences across VAR specifications. Reassuringly, the correlation between structural government spending shocks across VAR specifications averages 0.97. To further address this issue, we ran a number of robustness checks by augmenting each VAR model with the same identified spending shock, ordered first. Because in the quantitative analysis, we take $z_{it} = [g_{it}, y_{it}, l_{it}, je_{it}, w_{C,it}]$ as our benchmark model to calibrate the government spending shock, we augment each VAR model with the spending shock identified for this benchmark specification on annual or quarterly data. Results reveal that the discrepancy in the estimated effects is quite moderate whether the spending shock is identified on a yearly or a quarterly basis.

[11] Like us, Monacelli and Perotti [2008] who use U.S. quarterly data from 1954 to 2006 and Benetrix and Lane [2010] who consider of panel of 11 EU countries over 1970-2005, document a significant increase in non traded output following a government spending shock. While we find a protracted decline in traded output, Monacelli and Perotti [2008] detect a fall on impact only while traded output rises above trend after two years. Benetrix and Lane [2010] report an increase in traded output followed by a gradual decline. When we re-estimate the VAR model on U.S. annual data, we obtain similar sectoral output effects, at least qualitatively, to those reported by Monacelli and Perotti [2008]. Second, when we restrict our sample to EU countries over 1970-2005, we find that traded output increases instead of declining, in line with evidence reported by Benetrix and Lane [2010]. While the sample matters for the response of traded output, our main conclusions hold for the U.S. or a restricted set to EU countries: the relative size of the non traded sector increases significantly while the relative price along with the relative wage of non tradables appreciate.

[12] More specifically, keeping private sector's demand components fixed, the sectoral output growth differential in percentage points of GDP is determined by the sectoral intensity differential in the government spending shock, i.e., $\nu^{Y,N}\hat{Y}^N(t) - \nu^{Y,T}\hat{Y}^T(t) = (\omega_{G^N} - \omega_{G^T})\, dG(t)/Y$ where we denote the percentage deviation relative to initial steady-state by a hat.

estimates thus suggest that over the first year, a government spending shock causes 0.27% of workers to shift from the traded to the non traded sector. Since non traded hours worked increase by 0.55% of total employment, 50% of non traded employment growth is the result of labor reallocation. As shown in the first and the third row of the second column, a fiscal shock lowers the output share of tradables significantly and substantially increases that of non tradables. Because changes in output shares indicate how much sectoral output would increase if GDP remained constant, they provide us with valuable information on the shift of inputs across sectors and the resulting changes in their relative size. Quantitatively, since non traded output rises by 0.7 percentage point of GDP while the output share of non tradables rises by 0.35 percentage point of GDP, the shift of resources toward the non traded sector alone contributes to 50% of non traded output growth. Our second set of findings shown in Fig. 2 thus reveals that a government spending shock **generates a reallocation of labor that significantly affects the relative size of sectors**.

Inequality $\omega_{G^N} > \omega_{G^T}$ is a necessary but not sufficient condition for the share of non tradables in GDP to increase following a fiscal shock. The reason is that such a condition does not take into account that the share of non tradables in almost twice as large as that of tradables. A sufficient condition for the share of non tradables in GDP to increase is $\omega_{G^N} > \nu^{Y,N}$, i.e., the fraction of government spending spent on non traded goods must exceed the share of non tradables in GDP. We may consider inequality $\omega_{G^N} > \nu^{Y,N}$ as a stricter definition of a government spending shock biased toward non tradables. Obviously, for the increase in the GDP share of non tradables to materialize, resources must be reallocated away from the traded sector to the non traded sector.[13]

In order to check whether the government spending shock is strongly intensive in non tradables, we first split government final consumption 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.[14] The sample covers 13 OECD countries over the period 1995-2015. We choose 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.[15] Then, we estimate a VAR model in panel format on annual data that includes unanticipated government spending shocks, ϵ_{it}^G, or-

[13]Keeping private sector's demand components fixed, the growth differential in GDP units between sectoral value added at constant prices and real GDP is positive as long as the intensity of the non traded sector in the government spending shock is higher than its share in real GDP, i.e., $\nu^{Y,N}\left(\hat{Y}^N - \hat{Y}\right) = \left(\omega_{G^N} - \nu^{Y,N}\right) dG(t)/Y$.

[14]While there is some degree of arbitrariness in treating certain items as non tradable and the others as tradable, the content of items is such that there is little doubt in the breakdown. See Appendix B for details about the breakdown of g into g^N and g^T.

[15]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.

dered first, government consumption spending and sectoral government consumption on non tradables and tradables in panel format on annual data. 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. Fig. 3 displays the responses of government consumption of non tradables and tradables to an exogenous and unanticipated increase in government spending by 1% of GDP. 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%.[16] 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 1(a).[17]

The third column of Fig. 2 enables us to shed some light on fiscal transmission. The first two rows support the conjecture that an aggregate government spending shock triggers a sectoral demand shock in favor of non tradables. More specifically, the relative price of non tradables appreciates significantly in the short-run which signals an excess demand in the non traded goods market while the ratio of traded output relative to non traded output decreases substantially. The last two rows show that the sharp decline in hours worked in the traded sector relative to the non traded sector is associated with a significant increase in non traded wages relative to traded wages. The positive response of the relative wage to a government spending shock suggests **the presence of intersectoral labor mobility costs**.

< Please insert Figures 2-3 about here >

2.5 Cross-Country Differences in the Sectoral Impact and Imperfect Mobility of Labor

The presence of labor mobility costs preventing from wage equalization after a government spending shock square well with evidence documented by Artuç et al. [2010], Dix-Carneiro [2014], Lee and Wolpin [2006] who find substantial barriers to mobility and observe that wages are not equalized across sectors in the short run following both trade liberalization episodes and sector-biased technological change. Workers' costs of switching sectors, which can be interpreted as psychological or geographic mobility costs, or can be the result of sector-specific human capital, can rationalize the increase in non traded wages relative to traded wages. Intuitively, following a rise in public purchases that are heavily concentrated in non traded industries, establishments in the non traded sector wish to increase their production to meet this additional demand. To attract workers, non traded firms must pay

[16] See Table 3 in Appendix B.2 which displays the mean responses of the two components of government consumption.

[17] Interestingly, when we breakdown government consumption on non tradables into collective and individual expenditure, we find empirically that the latter component which includes in particular health and education services, accounts for 77% of increases in g^N.

higher wages in order to cover their mobility costs, and all the more so as the difficulty in reallocating hours worked across sectors is more pronounced. In countries where workers' mobility costs are higher, we thus expect the positive response of the relative wage to a fiscal shock to be greater as non traded firms must pay much higher wages to increase hours worked. As the labor demand shifts along a steeper labor supply schedule in countries with greater mobility costs, the decline in relative hours worked in tradables is expected to be less pronounced. Since the traded sector experiences a lower labor outflow, the fall in traded output relative to non traded output should also be less (in absolute terms).

To gauge the importance of workers' mobility costs for fiscal transmission, we thus ask whether the positive response of the relative wage to a fiscal shock is more pronounced whereas the reallocation of labor is lower in countries where mobility costs are higher. To explore our conjecture empirically, we draw on Horvath [2000] and estimate the elasticity of labor supply across sectors for each country.[18] This parameter measures the extent to which workers are willing to reallocate their hours worked toward the non traded sector following a 1% increase in the relative wage. When the elasticity of labor supply across sectors is greater, workers' mobility costs are thus lower which in turn implies a higher degree of labor mobility.

Building on our panel data estimates for the 16 OECD countries over the period 1970-2007, we split our sample into groups of 'high mobility' and 'low mobility' economies and re-estimate the sectoral effects for each of the two groups. The 'low mobility' economies are those for which the switching cost is above average for the sample. In order to provide some support for our measure of workers' mobility cost, we compute an intersectoral labor reallocation index in year t for each country i, denoted by $LR_{i,t}$, by calculating the average change between year t and $t-\tau$ in the amount of labor employed in sector j as a fraction of total employment:[19]

$$LR_{i,t}(\tau) = 0.5 \left[\sum_{j=T}^{N} \left| \frac{L_{i,t}^{j}}{\sum_{j=T}^{N} L_{i,t}^{j}} - \frac{L_{i,t-\tau}^{j}}{\sum_{j=T}^{N} L_{i,t-\tau}^{j}} \right| \right]. \tag{3}$$

We choose $\tau = 2$ to eschew year-to-year changes because of the low frequency changes in labor at that horizon and consider only differences over 2 years. As the values of the labor reallocation index, LR, increase, the fraction of workers who are working in a different sector in year t than in year $t-\tau$ is thus larger.[20]

In the following, we compare the cumulative responses of the labor reallocation index, hours worked in tradables relative to non tradables, and the relative wage for the 'low mobility' group with those for the 'high mobility' group. The last two columns of Panel B

[18] Details about the empirical strategy can be found in Appendix B while details of derivation of the testable equation are provided in a Technical Appendix.

[19] See e.g., Kambourov [2009] who computes the same labor reallocation index (3).

[20] When we estimate the response of the intersectoral labor reallocation index to a government spending shock, we replace hours worked in the traded sector in terms of hours worked in the non traded sector, $l_{it}^{T} - l_{it}^{N}$ with $LR(2)_{it}$ and thus consider the 'labor reallocation' specification that is given by: $z_{it}^{W} = [g_{it}, LR_{it}(2), \omega_{it}]$.

of Table 1 show the point estimates for both sub-samples for selected horizons. Contrasting point estimates reported in columns 5 and 6 of Table 1, we find that the magnitude of the shift of labor in the 'low mobility' group, as captured by the LR index (3), is about five times less in first year. This finding thus lends credence to our measure of mobility costs. Importantly, in accordance with our conjecture, we find that the magnitude of the responses of the relative wage and relative hours worked in tradables are different across the sub-samples. As can be seen in the last two columns of Table 1, non traded wages increase substantially relative to traded wages for the 'low mobility' economies while the relative wage response for 'high mobility' countries is not statistically different from zero. Columns 5 and 6 of Table 1 also show that the 'low mobility' economies experience a fall in relative hours worked of tradables which is less pronounced as labor supply is less elastic to the relative wage. Because the shift of labor toward the non traded sector is less, 'low mobility' economies also experience a smaller decline in output of tradables relative to non tradables as shown by point estimates reported in the last two columns of Table 1.

Overall, our results emphasize the importance of labor mobility for fiscal transmission. We now move a step further and explore the cross-country relationship between changes in the relative size of sectors and the magnitude of workers' costs of switching sectors. We estimate the same model as in eq. (2) but for a single country at a time.[21] Then in Fig. 4, we plot the impact responses of sectoral shares on the vertical axis against our measure of the degree of labor mobility, denoted ϵ, on the horizontal axis. This exercise may be viewed as tentative as the sectoral effect of a government spending shock varies considerably across countries and there is substantial uncertainty surrounding point estimates given the relatively small number of observations available per country.

< Please insert Figure 4 about here >

Fig. 4 plots sectoral labor and sectoral output shares against the degree of labor mobility across sectors. The cross-country analysis 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 government spending shock is strongly biased toward non tradables. Second, as can be seen in the top panels of Fig. 4, 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**

[21] When estimating the responses of sectoral labor and sectoral output shares to a government spending shock for each country, we omit $w^j_{C,it}$ in order to economize some degrees of freedom; the vector of endogenous variables is thus $z^{S,j}_{it} = \left[g_{it}, \nu^{Y,j}_{it}, \nu^{L,j}_{it}\right]$. 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.

sector size following a government spending shock increases with the degree of labor mobility across sectors.

In the following, we develop a dynamic general equilibrium model with imperfect mobility of labor and capital installation costs in order to account for our evidence on fiscal transmission. While these two features along with a high intensity of the government spending shock in non tradables are necessary to replicate the change in relative sector size for a representative OECD economy, we have to let the degree of labor mobility across sectors vary across countries to account for the cross-country dispersion in the sectoral output responses.

3 A Two-Sector Open Economy Model with Imperfect Mobility of Labor across Sectors

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, $r^{\star}$. 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.[22] 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:

$$C(t) = \left[\varphi^{\frac{1}{\phi}} \left(C^T(t)\right)^{\frac{\phi-1}{\phi}} + (1-\varphi)^{\frac{1}{\phi}} \left(C^N(t)\right)^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}, \tag{4}$$

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. To rationalize the rise in the non traded wage relative to the traded wage, we assume limited labor mobility across sectors. A shortcut to produce a difficulty in reallocating hours worked is to assume that workers experience a utility loss when shifting hours worked from one sector to another. We follow Horvath [2000] and consider that hours worked in the traded and the non traded sectors are aggregated by means of a CES function:

$$L(t) = \left[\vartheta^{-1/\epsilon} \left(L^T(t)\right)^{\frac{\epsilon+1}{\epsilon}} + (1-\vartheta)^{-1/\epsilon} \left(L^N(t)\right)^{\frac{\epsilon+1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon+1}}, \tag{5}$$

[22] The price of the traded good is determined on the world market and exogenously given for the small open economy.

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 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:[23]

$$U = \int_0^\infty \left\{ \ln C(t) - \frac{L(t)^{1+\frac{1}{\sigma_L}}}{1+\frac{1}{\sigma_L}} \right\} e^{-\beta t} \mathrm{d}t, \tag{6}$$

where β is the discount rate and $\sigma_L > 0$ is the Frisch elasticity of labor supply or intertemporal elasticity of substitution for (aggregate) 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, $P_J(t)J(t)$:

$$\dot{B}(t) + P_C(t)C(t) + P_J(t)J(t) = r^\star B(t) + R(t)K(t) + W(t)L(t) - T(t), \tag{7}$$

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 wage index, $W(t) = W\left(W^T(t), W^N(t)\right)$, associated with the labor index (5) is:

$$W(t) = \left[\vartheta\left(W^T(t)\right)^{\epsilon+1} + (1-\vartheta)\left(W^N(t)\right)^{\epsilon+1}\right]^{\frac{1}{\epsilon+1}}, \tag{8}$$

where $W^T(t)$ and $W^N(t)$ are wages paid in the traded and the non traded sectors, respectively.

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:[24]

$$J(t) = \left(\frac{J^N(t)}{\alpha_J}\right)^{\alpha_J} \left(\frac{J^T(t)}{1-\alpha_J}\right)^{1-\alpha_J}, \tag{9}$$

where α_J and $1-\alpha_J$ are investment expenditure shares 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, $I(t)$:

$$J(t) = I(t) + \frac{\kappa}{2}\left(\frac{I(t)}{K(t)} - \delta_K\right)^2 K(t), \tag{10}$$

[23] In a Technical Appendix, we show that relaxing the assumption of separability in preferences between consumption and labor merely affects the results.

[24] In accordance with the empirical findings documented by Bems [2008] for OECD countries, we choose an elasticity of substitution between J^N and J^T of 1.

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:

$$\dot{K}(t) = I(t) - \delta_K K(t). \tag{11}$$

Households choose consumption, worked hours and investment in physical capital by maximizing lifetime utility (6) subject to (7) and (11) together with (10). Denoting by λ and Q' the co-state variables associated with (7) and (11), the first-order conditions characterizing the representative household's optimal plans are:[25]

$$C(t) = \left(P_C(t)\lambda(t)\right)^{-1}, \tag{12a}$$

$$L(t) = \left(W(t)\lambda(t)\right)^{\sigma_L}, \tag{12b}$$

$$\frac{I(t)}{K(t)} = \frac{1}{\kappa}\left(\frac{Q(t)}{P_J(t)} - 1\right) + \delta_K, \tag{12c}$$

$$\dot{\lambda}(t) = \lambda(t)\left(\beta - r^\star\right), \tag{12d}$$

$$\dot{Q}(t) = \left(r^\star + \delta_K\right) Q(t) - \left\{R(t) + P_J(t)\frac{\kappa}{2}\left(\frac{I(t)}{K(t)} - \delta_K\right)\left(\frac{I(t)}{K(t)} + \delta_K\right)\right\}, \tag{12e}$$

and the transversality conditions $\lim_{t\to\infty} \lambda B(t) e^{-\beta t} = 0$, $\lim_{t\to\infty} Q(t)K(t)e^{-\beta t} = 0$. 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 (12d) yields $\lambda = \bar{\lambda}$.

Eq. (12c) can be solved for investment:

$$\frac{I(t)}{K(t)} = v\left(\frac{Q(t)}{P_J(t)}\right) + \delta_K, \quad v(.) = \frac{1}{\kappa}\left(\frac{Q(t)}{P_J(t)} - 1\right). \tag{13}$$

Equation (13) 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 replacement cost, $P_J(t)$. For the sake of clarity, we drop the time argument below provided 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:

$$C^T = \varphi\left(\frac{1}{P_C}\right)^{-\phi} C, \qquad C^N = (1-\varphi)\left(\frac{P}{P_C}\right)^{-\phi} C. \tag{14}$$

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 $C^T = (1-\alpha_C) P_C C$.[26]

Applying the same logic for labor, given the aggregate wage index (8), we can derive the allocation of aggregate labor supply to the traded and non traded sectors:

$$L^T = \vartheta\left(\frac{W^T}{W}\right)^{\epsilon} L, \qquad L^N = (1-\vartheta)\left(\frac{W^N}{W}\right)^{\epsilon} L, \tag{15}$$

[25] To derive (12c), we used the fact that $Q(t) = Q'(t)/\lambda$ which is the shadow value of capital in terms of foreign assets.

[26] Specifically, the non tradable content of consumption expenditure is given by $\alpha_C = \frac{(1-\varphi)P^{1-\phi}}{\varphi+(1-\varphi)P^{1-\phi}}$.

where ϵ is the elasticity of labor supply across sectors; it measures the extent to which agents are willing to increase their relative hours worked in sector j, L^j/L, following a 1% rise in the relative wage in sector j, W^j/W. As ϵ takes higher values, more labor shifts from one sector to another and thus the degree of labor mobility across sectors increases. When we let ϵ tend toward infinity, the special case of perfect labor mobility is obtained. Because workers are willing to devote their whole time to the sector that pays the highest wages, the sectors pay the same wage. Denoting by α_L the share of non tradable labor revenue in labor income, labor income from supplying hours worked in the non traded and the traded sectors are $W^N L^N = \alpha_L W L$ and $W^T L^T = (1-\alpha_L) W L$.[27]

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:

$$Y^j = Z^j \left(L^j\right)^{\theta^j} \left(K^j\right)^{1-\theta^j}, \tag{16}$$

where Z^j represents the TFP index which is introduced for calibration purposes only and θ^j corresponds to the labor income share 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:

$$Z^T \left(1-\theta^T\right) \left(k^T\right)^{-\theta^T} = P Z^N \left(1-\theta^N\right) \left(k^N\right)^{-\theta^N} \equiv R, \tag{17a}$$

$$Z^T \theta^T \left(k^T\right)^{1-\theta^T} \equiv W^T, \tag{17b}$$

$$P Z^N \theta^N \left(k^N\right)^{1-\theta^N} \equiv W^N, \tag{17c}$$

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:

$$K^T + K^N = K. \tag{18}$$

3.3 Government

The final agent in the economy is the government. Total government spending, G, falls 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

[27] Specifically, we have $\alpha_L = \frac{(1-\vartheta)\left(W^N\right)^{\epsilon+1}}{\left[\vartheta\left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]}$.

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:[28]

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

3.4 Model Closure and Equilibrium

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

$$Y^N = C^N + J^N + G^N. \tag{20}$$

Equality between non traded output and its demand counterpart is achieved through adjustments in the relative price of non tradables, P, which guarantee that eq. (20) holds at each point of time.

Regarding the allocation of government consumption in good $j = T, N$, we consider a rise in government consumption which is split between non tradables and tradables in accordance with their respective share in government expenditure which we denote by ω_{G^N} and $\omega_{G^T} \equiv 1 - \omega_{G^N}$, respectively;[29] more specifically, denoting the long-term values with a tilde, we have in linearized form:

$$\left(G(t) - \tilde{G}\right) = \omega_{G^N}\left(G(t) - \tilde{G}\right) + \omega_{G^T}\left(G(t) - \tilde{G}\right). \tag{21}$$

After inserting appropriate first-order conditions into the non traded good market clearing condition (20) and the no arbitrage condition (12e), it can be shown that the adjustment of the open economy towards the steady-state is described by a dynamic system which comprises two equations that form a separate subsystem in K and Q, i.e., $\dot{K} \equiv \Upsilon(K, Q, G)$ and $\dot{Q} \equiv \Sigma(K, Q, G)$. Linearizing these equations in the neighborhood of the steady-state and using (21), we get in a matrix form:

$$\begin{pmatrix} \dot{K}(t) \\ \dot{Q}(t) \end{pmatrix} = \begin{pmatrix} \Upsilon_K & \Upsilon_Q \\ \Sigma_K & \Sigma_Q \end{pmatrix} \begin{pmatrix} K(t) - \tilde{K} \\ Q(t) - \tilde{Q} \end{pmatrix} + \begin{pmatrix} \Upsilon_G \\ \Sigma_G \end{pmatrix} \begin{pmatrix} G(t) - \tilde{G} \\ G(t) - \tilde{G} \end{pmatrix}, \tag{22}$$

where 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.

To determine the solutions for physical capital and the shadow value of installed capital, we have to set the endogenous response of government spending to an exogenous fiscal

[28] In a Technical Appendix, we allow for distortionary labor taxation and consider a rise in government spending which is debt-financed. Denoting by $D(t)$ the stock of (traded) bonds issued by the government, the flow budget constraint reads as $\dot{D}(t) = r^\star D(t) + G(t) - T(t)$ with $T(t) = \tau(t)W(t)L(t)$ where τ is the wage tax levied on households' wage income. Our quantitative results show that the sectoral impact of fiscal policy is similar to that obtained when assuming a balanced-budget government spending shock; as expected, the rise in the labor tax in the short-run mitigates substantially the positive response of hours worked and thus the size of the aggregate fiscal multiplier.

[29] We provide more details on the non tradable content of the government spending shock in section 5.1 and Appendix B.2.

shock. In order to account for the non-monotonic pattern of the dynamic adjustment of government consumption in line with our evidence (see Figure 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 $g > 0$ 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 government consumption declines after reaching a peak at some time t.

Denoting the negative eigenvalue by ν_1 and the positive eigenvalue by ν_2, applying the standard method to solve systems of deterministic first-order linear differential equations and making use of (23), the general solutions for K and Q can be written in a compact form:[30]

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

where 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 physical capital and the shadow value of capital:

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

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

where K_0 is initial stock of physical capital, $\Gamma_i = -\frac{\Phi_i \tilde{Y}}{\nu_1 - \nu_2}\frac{1}{(\nu_i + \xi)}$, $\Phi_1 = (\Upsilon_K - \nu_2)\,\Upsilon_G + \Upsilon_Q \Sigma_G$, $\Phi_2 = (\Upsilon_K - \nu_1)\,\Upsilon_G + \Upsilon_Q \Sigma_G$, and $\Theta_i = (1-g)\,\frac{\nu_i + \xi}{\nu_i + \chi}$ (with $i = 1, 2$). When the shock is permanent, $X_2(t) = 0$ while $X_1(t)$ reduces to $e^{\nu_1 t}\left(K_0 - \tilde{K}\right)$. Because our objective is to account for VAR evidence, we restrict our attention to a temporary fiscal shock.

Using the fact that $RK + WL = Y^T + PY^N$ and inserting the market clearing condition for non tradables (20) into (7) gives the current account equation:

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

Substituting appropriate short-run solutions, eq. (26) can be written as a function of state and control variables, i.e., $\dot{B} \equiv r^\star B + \Xi\,(K, Q, G)$. Linearizing around the steady state, substituting the solutions for $K(t)$ and $Q(t)$ given by (24), solving and invoking the transversality condition, yields the solution for traded bonds:

$$\begin{aligned} B(t) - \tilde{B} \;&=\; \frac{\omega_B^1}{\nu_1 - r^\star} e^{\nu_1 t} - \frac{\Xi_G \tilde{Y}}{\xi + r^\star}\left(e^{-\xi t} - \Theta' e^{-\chi t}\right) - \frac{N_1 \Gamma_1}{\xi + r^\star}\left(e^{-\xi t} - \Theta_1' e^{-\chi t}\right) \\ &+\; \frac{N_2 \Gamma_2}{\xi + r^\star}\left(e^{-\xi t} - \Theta_2' e^{-\chi t}\right), \end{aligned} \tag{27}$$

[30] See e.g., Buiter [1984] who presents the continuous time adaptation of the method of Blanchard and Kahn.

where $\omega_B^1 = \left[\Xi_K + \Xi_Q \omega_2^1\right] \left[\left(K_0 - \tilde{K}\right) + \Gamma_2 (1 - \Theta_2) - \Gamma_1 (1 - \Theta_1)\right]$, with $\Xi_K = \frac{\partial \Xi}{\partial K}$, $\Xi_Q = \frac{\partial \Xi}{\partial Q}$, and $\Xi_G = \frac{\partial \Xi}{\partial G}$ evaluated at the steady-state, and $\Theta' = (1 - g) \frac{r^\star + \xi}{r^\star + \chi}$, and $\Theta_i' = \Theta_i \frac{r^\star + \xi}{r^\star + \chi}$ (with $i = 1, 2$). To ultimately remain solvent, the open economy must satisfy the following condition:

$$\tilde{B} - B_0 = -\frac{\omega_B^1}{\nu_1 - r^\star} + \frac{\omega_B^2}{\xi + r^\star}, \tag{28}$$

where B_0 is the initial stock of traded bonds and $\omega_B^2 = \Xi_G \tilde{Y} (1 - \Theta') + \left[\Xi_K + \Xi_Q \omega_2^1\right] \Gamma_1 (1 - \Theta_1') - \left[\Xi_K + \Xi_Q \omega_2^2\right] \Gamma_2 (1 - \Theta_2')$. The assumption $\beta = r^\star$ implies that temporary policies have permanent effects. In this regard, eq. (28) determines the steady-state change in the net foreign asset position following a temporary fiscal expansion.

4 Imperfect Mobility of Labor and the Transmission of Government Spending

In this section, we solve the model analytically by abstracting from physical capital. This enables us to derive a number of analytical results which show that a model assuming imperfect mobility of labor across sectors can account for the evidence on fiscal transmission documented in section 2, as long as the government spending shock is biased toward non tradables. To avoid unnecessary complications, we solve the model by assuming that the endogenous response to an exogenous fiscal shock is governed by the following dynamic equation:

$$dG(t)/Y = g e^{-\xi t}, \tag{29}$$

which amounts to setting $\xi = \chi$ into eq. (23). We consider a rise in G which is split between non tradables and tradables in accordance with their respective share in government spending, ω_{G^j}, as described by (21). Building on our evidence which reveals that a rise in government consumption is biased toward toward non tradables, we consider that ω_{G^N} is high enough to produce an appreciation in the relative price of non tradables, in line with our empirical findings.

Both sectors use labor as the sole input in a constant returns to scale technology, i.e., $Y^j = L^j$ with $j = T, N$. Because there is a difficulty in reallocating labor, sectoral wages do not equalize, i.e., $1 = W^T$ and $P = W^N$. The key equations characterizing optimal household behavior are given by first-order conditions described by (12a)-(12b) and (14)-(15). The market clearing conditions for non traded and traded goods read as $Y^N = C^N + G^N$ and $\dot{B} = r^\star B + Y^T - C^T - G^T$, respectively.

4.1 Solving the Model Analytically

Substituting first (12a) into (14), (12b) into (15), using $W^N = P$, totally differentiating the market clearing condition for the non traded good and denoting the percentage deviation relative to initial steady-state by a hat leads to the change in the relative price of non tradables:

$$\hat{P}(t) = \frac{-\left[\alpha_L \sigma_L + \alpha_C \omega_C\right]}{\Psi}\hat{\tilde{\lambda}} + \frac{\omega_{G^N}}{\Psi}\frac{dG(t)}{Y}, \tag{30}$$

where we set $\Psi = \alpha_L \left[\epsilon \left(1-\alpha_L\right) + \sigma_L \alpha_L\right] + \omega_C \alpha_C \left[\left(1-\alpha_C\right)\phi + \alpha_C\right] > 0$. In eq. (30), we denote by $\omega_C = \frac{P_C C}{Y}$ consumption expenditure as a share of GDP, α_C and α_L the non tradable content of consumption expenditure and labor compensation, respectively; in a model without capital, α_L also measures the share of non tradables in GDP, i.e., $\alpha_L = \frac{PY^N}{Y}$.

Inserting first the demand for tradables (14) and labor supply to the traded sector (15), linearizing in the neighborhood of the steady-state, substituting the law of motion of government spending (29), solving and invoking the transversality condition leads to the solution for traded bonds:

$$B(t) - \tilde{B} = \frac{\Upsilon_G \tilde{Y}}{\xi + r^\star} g e^{-\xi t}, \tag{31}$$

consistent with the intertemporal solvency condition

$$\left(\tilde{B} - B_0\right) = -\frac{\Upsilon_G \tilde{Y}}{\xi + r^\star} g, \tag{32}$$

where $\Upsilon_G = \Upsilon_G^N \omega_{G^N} + \omega_{G^T}$ with $\Upsilon_G^N = \frac{\left[(1-\alpha_L)\alpha_L(\epsilon-\sigma_L)+(1-\alpha_C)\omega_C\alpha_C(\phi-1)\right]}{\Psi}$. If the elasticity of labor supply across sectors, ϵ, is large enough with respect to aggregate labor supply, σ_L, then we have $\Upsilon_G^N > 0$, so that the current account unambiguously deteriorates following a temporary fiscal expansion, in line with our VAR evidence.[31]

To determine the change in the equilibrium value of the marginal utility of wealth, we have to differentiate the market clearing condition for the traded good evaluated at the steady-state (i.e., $\dot{B}(t) = 0$), using the fact that in the long-run, government spending is restored to its initial level (i.e., $dG = 0$); next, inserting (32) into the resulting expression leads to the change in the equilibrium value of the marginal utility of wealth:

$$\hat{\tilde{\lambda}} = \frac{\Psi \Upsilon_G}{\Gamma} \frac{r^\star}{\xi + r^\star} g > 0, \qquad \Upsilon_G = \Upsilon_G^N \omega_{G^N} + \omega_{G^T} > 0, \tag{33}$$

where $\Gamma = \Psi \left\{\left[\left(1-\alpha_L\right)\sigma_L + \omega_C\left(1-\alpha_C\right)\sigma_C\right] + \left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C\right]\Upsilon_G^N\right\} > 0$.

4.2 Implications of Imperfect Mobility of Labor

What are the implications of imperfect mobility for fiscal transmission? As in a model that imposes perfect mobility of labor, a rise in government consumption produces an increase in the shadow value of wealth as taxes must be raised to balance the budget which reduces households' disposable income. The negative wealth effect described by (33) encourages agents to work more and cut real expenditure. Because the decline in real expenditure is spread over the two goods, the rise in G^N more than offsets the fall in C^N if ω_{G^N} is

[31] Differentiating (31) with respect to time leads to the current account response in percentage of GDP which is unambiguously negative as long as $\Upsilon_G^N > 0$. Intuitively, non traded output must increase to meet higher demand for non tradables. At the same time, households wish to avoid a large reduction in consumption and/or a large increase in labor supply. Because traded goods can be imported, resources are reallocated toward the non traded sector so that a current account deficit shows up.

high enough. As long as there is a difficulty in reallocating labor, an excess demand arises in the non traded goods market, which in turn causes the relative price of non tradables to appreciate. To see this formally, we determine the initial response of the relative price of non tradables by evaluating (30) at time $t = 0$, inserting (33), and using the fact that $dG(0)/Y = g$:

$$\hat{P}(0) = \left\{ \omega_{G^N} - [\alpha_L \sigma_L + \alpha_C \omega_C] \frac{\Psi \left[\Upsilon_G^N \omega_{G^N} + \omega_{G^T} \right]}{\Gamma} \frac{r^\star}{\xi + r^\star} \right\} \frac{g}{\Psi} > 0. \tag{34}$$

Eq. (34) shows that both the composition of government spending along with the degree of labor mobility across sectors matter in determining the response of the relative price of non tradables. First, when the rise in government consumption is fully biased toward non tradables (i.e., $\omega_{G^N} = 1$), the relative price of non tradables unambiguously appreciates.[32] In contrast, if the government spending shock were fully biased toward tradables (i.e., $\omega_{G^T} = 1$), the relative price would depreciate, in contradiction with our evidence. Because $\hat{P}(0)$ is monotonically increasing with ω_{G^N}, there is a critical value $\bar{\omega}_{G^N}$ so that $\hat{P}(0) > 0$ for $\omega_{G^N} > \bar{\omega}_{G^N}$. Second, as the degree of labor mobility across sectors increases, a government spending shock leads to a lower appreciation in the relative price of non tradables. The reason is that the shadow value of wealth, $\bar{\lambda}$, increases further, which results in a larger increase in non traded output and a greater decline in C^N.[33] In a model imposing perfect mobility of labor across sectors (i.e., $\epsilon \to \infty$), the relative price of non tradables remains unaffected by a fiscal shock. Intuitively, the appropriate amount of labor moves instantaneously toward the non traded sector to eliminate any excess demand in the non traded goods market.

Conversely, as long as $\epsilon < \infty$ and $\omega_{G^N} > \bar{\omega}_{G^N}$, an excess demand shows up in the non traded goods market so that the relative price of non tradables appreciates on impact. Non traded firms are encouraged to produce and thus to hire more workers. To persuade workers who experience mobility costs to increase their hours worked in the non traded sector, non traded firms must pay higher wages, i.e., $\hat{W}^N(0) = \hat{P}(0) > 0$. The subsequent shift of labor toward the non traded sector unambiguously raises non traded output. It can be shown analytically that the response of traded output is ambiguous; more precisely, Y^T may fall if the degree of labor mobility, ϵ, is higher than σ_L.

We now turn to the initial response of the sectoral output share. As documented in section 2, we find that a government spending shock increases the share for non tradables in real GDP and all the more so in countries where the degree of labor mobility across sectors is higher. In the data, the response of the sectoral output share is calculated as the

[32] To see this formally, the sign of the term in braces is unambiguously positive since $0 < [\alpha_L \sigma_L + \omega_C \alpha_C] \frac{\Upsilon_G^N \Psi}{\Gamma} < 1$ and $0 < \frac{r^\star}{\xi + r^\star} < 1$.

[33] As the degree of labor mobility across sectors increases, more labor shifts toward toward the non traded sector which results in a greater decline in traded labor and thus triggers a larger current account deficit. In the long-run, for the intertemporal solvency condition to hold, the open economy must run a trade surplus and consumption must thus be reduced more though a stronger negative wealth effect.

growth differential in GDP units between sectoral value added at constant prices and real GDP denoted by Y_R. Totally differentiating non traded output and real GDP, the latter being equal to overall labor compensation WL with $L = \left(\bar{\lambda}W\right)^{\sigma_L}$, and evaluating at time $t = 0$ leads to the impact response of the output share of non tradables in real terms:[34]

$$\alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right) = \alpha_L \left(1 - \alpha_L\right) \epsilon \hat{P}(0) > 0, \tag{35}$$

where $\hat{P}(0)$ is given by (34). According to (35), the appreciation in the relative price of non tradables and the subsequent increase in non traded wages leads to a shift of labor toward the non traded sector which increases its share in real GDP. A rise in the parameter ϵ exerts two opposite effects on the magnitude of the positive response of the output share of non tradables. On the one hand, as the parameter ϵ on the RHS of (35) takes higher values, more labor shifts toward the non traded sector, thus amplifying the positive response of the output share of non tradables. On the other hand, as mentioned above, the negative wealth effect turns out to be greater as labor becomes more mobile across sectors; as a result, increased labor mobility mitigates the excess demand in the non traded goods market and thus the appreciation in the relative price of non tradables as reflected in smaller values of $\hat{P}(0) > 0$. It can be shown analytically that the former effect predominates so that $\alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right)$ is increasing with ϵ since the elasticity of the relative price response with respect to the degree of labor mobility is smaller than one, i.e., $-\frac{\partial \hat{P}(0)}{\partial \epsilon} \frac{\epsilon}{\hat{P}(0)} < 1$. [35] Letting ϵ tend toward infinity into eq. (35) and applying l'Hôpital's rule leads to:[36]

$$\lim_{\epsilon \to \infty} \alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right) = \left[\omega_{G^N} - \left(\frac{\alpha_L \sigma_L + \alpha_C \omega_C}{\sigma_L + \omega_C} \frac{r^\star}{\xi + r^\star}\right)\right] g > 0. \tag{36}$$

The analytical expression of the response of the share of non tradables in real GDP described by (36) in the special case of perfect mobility of labor enables us to shed some light on the relationship between the non tradable content of the government spending shock, ω_{G^N}, and $\alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right)$. Keeping the responses of the private sector's demand components fixed, it is straightforward to show that the share of non tradables in real GDP increases

[34] Real GDP is the sum of value added at constant prices, i.e., $Y_R = Y^T + \tilde{P} Y^N$ where $\tilde{P}$ corresponds to the initial steady-state value for the relative price of non tradables. Using the fact that $Y_R = WL$, totally differentiating real GDP and inserting $\hat{L} = \sigma_L \hat{\bar{\lambda}} + \sigma_L \hat{W}$ with $\hat{W} = \alpha_L \hat{P}$, leads to $\hat{Y}_R = \sigma_L \hat{\bar{\lambda}} + \alpha_L \sigma_L \hat{P}$. Using the fact that $\hat{Y}^N = \left[\epsilon \left(1 - \alpha_L\right) + \alpha_L \sigma_L\right] \hat{P} + \sigma_L \hat{\bar{\lambda}}$, multiplying the growth differential between non traded output and real GDP (i.e., $\hat{Y}^N - \hat{Y}_R$) by α_L and evaluating at time $t = 0$ leads to (35).

[35] In a Technical Appendix, we are able to show that $\alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right) > 0$ is increasing with the degree of labor mobility across sectors, ϵ, by considering two polar cases: a weakly and a highly persistent fiscal shock. More specifically, we show that $\alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right)$ is increasing with ϵ as long as $-\frac{\partial \hat{P}(0)}{\partial \epsilon} \frac{\epsilon}{\hat{P}(0)} < 1$. Since the elasticity $-\frac{\partial \hat{P}(0)}{\partial \epsilon} \frac{\epsilon}{\hat{P}(0)}$ ranges from a low when the shock is weakly persistent to a high when the shock is highly persistent, i.e.,

$$-\frac{\partial \hat{P}(0)}{\partial \epsilon} \frac{\epsilon}{\hat{P}(0)} \in \left\{ \frac{\alpha_L \left(1 - \alpha_L\right) \epsilon}{\Psi}, \frac{\alpha_L \left(1 - \alpha_L\right) \epsilon}{\Psi} \left[1 + \frac{\left(\alpha_L \sigma_L + \omega_C \alpha_C\right)^2}{\Gamma}\right] \right\},$$

where both bounds of interval are smaller than 1, the initial reaction of the share of non tradables in GDP is unambiguously increasing with ϵ.

[36] First inserting (34) into eq. (35), letting ϵ tend toward infinity and applying l'Hôpital's rule that implies that $\lim_{\epsilon \to \infty} \frac{\Psi \Upsilon_G}{\Gamma} = \frac{1}{\sigma_L + \omega_C}$ together with $\lim_{\epsilon \to \infty} \frac{\alpha_L (1 - \alpha_L)}{\Psi} = 1$ gives eq. (36).

as long as $\omega_{G^N} > \alpha_L$.[37] In a general equilibrium model, demand components react to the government spending shock and thus slightly modify this condition. Adding and subtracting α_L in the RHS of (36) implies that the response $\alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right)$ is larger than $(\omega_{G^N} - \alpha_L)\, g$ since $\alpha_L > \left(\frac{\alpha_L \sigma_L + \alpha_C \omega_C}{\sigma_L + \omega_C} \frac{r^\star}{\xi + r^\star}\right)$. Intuitively, households smooth their consumption while non traded output must meet higher demand for non tradables. Because traded goods can be imported, net exports decline on impact which in turn further biases the spending shock toward non tradables. Because $0 < [\alpha_L \sigma_L + \alpha_C \omega_C] \frac{\Psi\left[\Upsilon_G^N \omega_{G^N} + \omega_{G^T}\right]}{\Gamma} < \frac{\alpha_L \sigma_L + \alpha_C \omega_C}{\sigma_L + \omega_C}$ (see the second term on the RHS of eq. (34)), this result also holds when assuming imperfect mobility of labor across sectors. Henceforth, the critical value $\bar{\omega}_{G^N}$ above which the relative price appreciates on impact, i.e., $\hat{P}(0) > 0$, and thus the share of non tradables in real GDP increases, is smaller than α_L but would reduce to α_L if the current account were unresponsive to the fiscal shock.

How do hours worked and the real consumption wage react to a fiscal shock? Higher non traded wages increase the aggregate wage W in proportion to the non tradable content of labor compensation, i.e., $\hat{W} = \alpha_L \hat{P}$. Differentiating $W_C = W/P_C$, using the fact that $\hat{P}_C = \alpha_C \hat{P}$, the initial response in the real consumption wage is given by:

$$\hat{W}_C(0) = (\alpha_L - \alpha_C)\, \hat{P}(0) > 0. \tag{37}$$

As long as the non tradable content of labor compensation α_L is higher than the non tradable content of consumption expenditure α_C, the rise in the aggregate wage index more than offsets the increase in the consumption price index so that a fiscal shock initially raises the real consumption wage W/P_C, in line with the evidence.

The initial reaction of hours worked to a temporary government spending shock is unambiguously positive as the result of the negative wealth and the rise in the aggregate wage:

$$\hat{L}(0) = \sigma_L \left(\hat{\bar{\lambda}} + \alpha_L \hat{P}(0)\right) > 0, \tag{38}$$

where $\hat{\bar{\lambda}} > 0$ and $\hat{P}(0) = \hat{W}^N(0) > 0$ are given by (33) and (34), respectively. It can be shown analytically that $\hat{L}(0)$ is decreasing with ϵ.[38] Intuitively, as the degree of labor mobility increases, the non traded wage and thus W increases less. As a result, hours worked rise by a smaller amount as ϵ takes higher values.[39]

[37] Totally differentiating the market clearing condition for non tradables while keeping C^N fixed leads to $\alpha_L \hat{Y}^N(t) = \omega_{G^N} dG(t)/Y$. Denoting net exports by NX, totally differentiating $Y_R = P_C C + G + NX$ while keeping NX and C fixed, leads to $\hat{Y}_R = dG(t)/Y$. Subtracting $\alpha_L \hat{Y}_R(t)$ from $\alpha_L \hat{Y}^N(t)$ leads to $(\omega_{G^N} - \alpha_L)\, dG(t)/Y$.

[38] The formal proof is contained in a Technical Appendix.

[39] As mentioned above, the marginal utility of wealth increases more as labor becomes more mobile across sectors. Yet, the smaller rise in $W(0)$ more than offsets the larger increase in $\bar{\lambda}$.

5 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 described in section 3 numerically.[40] First we discuss parameter values before turning to the short-term consequences of higher government consumption.

5.1 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. Our sample covers the sixteen OECD economies in our dataset. Our reference period for the calibration corresponds to the period 1990-2007.[41] Since we calibrate a two-sector model with tradables and non tradables, we pay particular attention to ensure that the non tradable content of the model matches the data. Table 5 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 the 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 5 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 5. 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 endogenously calibrated to fit a set of aggregate and sectoral ratios.[42] We choose the model period to be one year and therefore set the world interest rate, $r^\star$, which is equal to the subjective time discount rate, β, to 4%.

In light of our discussion above, ϵ plays a key role in fiscal transmission. 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 Table 5.[43] Our estimates display a sharp dispersion across countries and we therefore conduct a sensitivity analysis with respect to this parameter. Excluding

[40] Technically, the assumption $\beta = r^\star$ requires the joint determination of the transition and the steady state.

[41] The choice of this period was dictated by data availability for all countries in the sample.

[42] As detailed in a Technical Appendix, the steady-state can be reduced to four equations which jointly determine P (and thus α_C), Y^T/Y^N (and thus $\frac{L^N}{L}$), K/Y (and thus $\omega_J = \frac{P_J I}{Y}$) and $\upsilon_B = \frac{r^\star B}{Y^T}$ (and thus $\upsilon_{NX} = \frac{NX}{Y^T}$ where we denote net exports by NX). Among the 19 parameters that the model contains, 16 have empirical counterparts while the remaining 3, i.e., φ, ϑ, δ_K together with initial conditions (B_0, K_0) must be set in order to match $\alpha_C = \frac{PC^N}{P_C C}$, $\frac{L^N}{L}$, $\omega_J = \frac{P_J I}{Y}$, and $\upsilon_{NX} = \frac{NX}{Y^T}$ with $NX = Y^T - C^T - G^T - I^T$.

[43] Since estimates of ϵ for Denmark and Norway are not statistically significant at a standard threshold, the values are left blank and we set ϕ to 0.75 which corresponds to the average value. To estimate ϵ, we first derive a testable equation by combining first-order conditions for labor supply and labor demand. We next run the regression of the sectoral employment growth arising from labor reallocation across sectors on the percentage change in the relative share of sectoral value added accrued to labor, see Appendix B.

the estimates of ϵ for Denmark and Norway which are not statistically significant at 10%, estimates 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. Hence, we allow for ϵ to vary between 0.22 and 1.64 in the sensitivity analysis.

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 5.[44] The weight of consumption in non tradables $1 - \varphi$ is set to 0.51 to target a non-tradable content in total consumption expenditure (i.e., 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 intertemporal elasticity of substitution for labor supply σ_L to 0.4, in line with evidence reported by Fiorito and Zanella [2012], but conduct a sensitivity analysis with respect to this parameter. The weight of labor supply to the non traded sector, $1-\vartheta$, is set to 0.68 to target a non-tradable content of labor compensation of 66%, in line with the average of our estimates shown in the last line of column 6 of Table 5.

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 5). Labor income shares in the traded (θ^T) and the non traded sector (θ^N) are set to 0.58 and 0.68, respectively, which correspond roughly to the averages for countries with $k^T > k^N$.[45] Such values, i.e., $\theta^T = 0.58$ and $\theta^N = 0.68$, give an aggregate labor income share of 64%, in line with the average value shown in the last line of column 14 of Table 5. In line with our evidence shown in the last column of Table 5, 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 investment expenditure share on non-tradable goods, α_J, to 64%, in accordance with the evidence shown in column 3 of Table 5. 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.[46]

As shown in column 4 of Table 5, 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%.

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

[45] Table 5 gives the labor share of sector j θ^j (with $j = T, N$) for the sixteen OECD countries in our sample. While θ^T and θ^N are set to 0.58 and 0.68, respectively, in the baseline calibration, we use reverse but symmetric values, i.e., $\theta^T = 0.68$ and $\theta^N = 0.58$, when $k^N > k^T$. For reason of space, we do not show numerical results for this case which can be found in the Technical Appendix of a longer version of the paper. Overall, the quantitative analysis reveal that our results are similar whether $k^T > k^N$ or $k^N > k^T$ as long as we assume imperfect mobility of labor across sectors.

[46] Eberly, Rebelo, and Vincent [2008] run the regression $I/K = \alpha + \beta \,.\, \ln(q)$ and obtain a point estimate for β of 0.06. In our model, the steady-state elasticity of I/K with respect to Tobin's q is $1/\kappa$. Equating $1/\kappa$ to 0.06 gives a value for κ of 17.

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 $P_C C/Y = 59\%$.[47] It is worthwhile mentioning that the non tradable content of GDP is endogenously determined 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 (20) by Y leads to the non tradable content of GDP:

$$PY^N/Y = \omega_C \alpha_C + \omega_J \alpha_J + \omega_{G^N} \omega_G = 63\%, \tag{39}$$

where $\omega_C = 59\%$, $\alpha_C = 53\%$, $\omega_J = 21\%$, $\alpha_J = 64\%$, $\omega_{G^N} = 90\%$, and $\omega_G = 20\%$. According to (39), the ratios we target are consistent with a non tradable content of GDP of 63% found in the data, as reported in the last line of column 1 of Table 5.

In order to capture the endogenous response of government spending to 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 percentage point 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 follows.[48] Because $G(t)$ peaks after one year, we have $dG(1)/Y = \left[e^{-\xi} - (1-g)\, e^{-\chi}\right] = g' > g$ with $g' = 0.011265$ 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:

$$\omega_{G^j} \left(G(t) - \tilde{G}\right)/Y = \omega_{G^j} \left[e^{-\xi t} - (1-g)\, e^{-\chi t}\right], \tag{40}$$

where ω_{G^j} is the fraction of government consumption in good j.[49] To determine (40), 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 in good j. The right panel of Figure 9 in

[47] Remember that $J = I$ at the steady-state.

[48] Our calibration of the government consumption shock is based on estimates of the first VAR model $z_{it} = [g_{it}, y_{it}, l_{it}, je_{it}, w_{C,it}]$. Since we consider alternative VAR specifications and the endogenous response of government consumption may thus differ across VAR models, we ran a robustness check in which we compute numerically the responses of variables to an exogenous government spending consistent with the VAR specification used to estimate the empirical IRF of the corresponding variable. Reassuringly, as can be found in the Technical Appendix, we find that whether we consider a baseline or alternative spending shocks, the discrepancy in numerically-computed responses is insignificant.

[49] While one may be concerned by the fact that the methodology to break down total government spending into non tradables and tradables can be viewed as somewhat arbitrary, the computation of ω_{G^N} is consistent with eq. (39), i.e., the non tradable content of expenditure coincides exactly with the non tradable content of GDP.

Appendix B.2 contrasts empirical responses of sectoral government consumption to an exogenous fiscal shock with theoretical responses derived from eq. (40) by setting ω_{G^N} and ω_{G^T} to 0.9 and 0.1, respectively. Overall, the theoretical responses perform well in reproducing the evidence and thus the assumptions underlying the dynamic equation (40) which governs the adjustment of G^j are consistent with data.

As the baseline scenario, we take the model with imperfect mobility of labor across sectors and capital adjustments costs. In our baseline calibration we set $\epsilon = 0.75$, $\sigma_L = 0.4$, $\kappa = 17$, but we also conduct a sensitivity analysis with respect to these three parameters by setting alternatively: ϵ to 0.22 and 1.64, σ_L to 1, and κ to 0. In order to contrast our results with those obtained when imposing perfect mobility of labor across sectors, we let ϵ tend toward infinity.

5.2 Results

In this subsection, we analyze in detail the role of imperfect mobility of labor in shaping the dynamics of the open economy in response to a government spending shock. Our primary objective is to explain in what 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.

Table 2 shows the simulated impact effects of an exogenous and unanticipated increase in government consumption by 1 percentage point 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 perfect mobility of labor (i.e., we set $\epsilon \to \infty$) and abstract from capital installation costs (i.e., we set $\kappa = 0$) as well. Other columns give results for alternative scenarios discussed below. While in Table 2, we restrict our attention to impact responses, in Fig. 5 and 6 we show the dynamic adjustment to an increase in government consumption by 1% of GDP. Figures show 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 dotted blue lines indicating the 90% confidence bounds. The solid black line shows the transitional paths obtained in a model with imperfect mobility of labor and capital adjustment costs. To gauge the importance of labor mobility across sectors for fiscal transmission, we contrast our baseline case featuring imperfect mobility with the perfect mobility case shown by the dashed black line. It is worth mentioning that the endogenous response of government spending to an exogenous fiscal shock that we generate theoretically in Figure 5(a) by specifying the law of motion (23) reproduces the dynamic adjustment from the VAR model remarkably well as the black line and the blue line cannot be differentiated.

5.2.1 Aggregate Effects

We begin with the aggregate effects of a government spending shock shown in panels A and B of Table 2. Contrasting the numerical results reported in columns 2 and 7 with the evidence shown in column 1, whether we assume imperfect or perfect mobility of labor, both models tend to understate the responses of real GDP and hours worked. However, the model performance improves with imperfect mobility of labor as the rise in GDP by 0.19% lies within the confidence interval, as shown in Figure 5(c). The reason is that with imperfect mobility of labor, the existence of workers' costs of switching sectors puts upward pressure on non traded wages and thus on the aggregate wage. This then amplifies the positive response of hours worked which increases on impact by 0.30% instead of 0.11% when the mobility cost is absent. Because agents supply more labor, real GDP rises by a larger amount as long as there is a difficulty in reallocating labor. While the real consumption wage is unaffected on impact when we let ϵ tend toward infinity, a government spending shock generates a rise in the wage rate which more than offsets the increase in the consumption price index and thus pushes up the real consumption wage by 0.07% in the baseline model where $\epsilon = 0.75$.

Turning to the dynamic adjustment of investment and the current account displayed in Fig. 5(b) and 5(d), a model assuming perfect mobility and abstracting from capital installation costs dramatically overstates the decline in investment and predicts a current account surplus in the short-run, contrary to the evidence. Because capital-labor ratios are fixed, the return on domestic capital remains unchanged as well. The substantial decline in private savings generates such a physical capital decumulation that the current account moves into surplus. In contrast, as long as we relax the assumption of perfect mobility of labor, the neoclassical model is able to produce the crowding out of investment along with the current account deficit in the short-run, as shown in column 5 of Table 2 where we abstract from capital installation costs to isolate the role of limited labor mobility. Intuitively, as long as there is a difficulty in reallocating labor across sectors, the capital-labor ratio falls in the traded sector as the workers' mobility costs moderate the shift of labor. Thus, the return on domestic capital increases, which in turn mitigates the fall in investment and produces a current account deficit. However, the model tends to overstate the crowding-out of investment and to understate the decline in the current account. In contrast, as shown in column 2, when we allow for capital installation costs along with imperfect mobility of labor, the model predicts a current account deficit of 0.34% of GDP, which accords well with our estimate, by further mitigating the decline in investment. We then ask whether both capital adjustments costs and imperfect mobility of labor are essential to account for the evidence. To answer this, column 8 considers a scenario where we assume that physical capital accumulation is subject to installation costs while hours worked are perfect substitutes across sectors. The model predicts a rise in investment instead of a decline and considerably overstates the current account deficit found in the data: while the shadow price of investment, Q, increases as in a model assuming imperfect mobility of labor, the rise in the investment price index, P_J, is not large enough to drive down Tobin's q. As will become clear below, perfect mobility of labor implies that the relative price of non tradables merely appreciates, thus hampering the increase in P_J.

Contrasting the model's predictions with VAR evidence in Fig. 5, the simulated responses lie within the confidence interval along the transitional adjustment, with the exception of the real consumption wage. Although quite stylized, the model is able to account for the time-series evidence on the aggregate effects of a government spending shock as long as we allow for both capital installation costs and a difficulty in reallocating labor.

< Please insert Table 2 and Figures 5-6 about here >

5.2.2 Reallocation Effects across Sectors

Turning to the sectoral impact of a rise in government consumption, the baseline model can account reasonably well for the dynamic adjustment of the non traded sector and somewhat less well for the traded sector. Panels C and D of Table 2 show impact responses of labor and product market variables, respectively, while in Fig. 6, we report the model predictions together with the VAR evidence of selected sectoral variables.

Focusing first on impact responses, column 7 of Table 2, shows that a model assuming perfect mobility of labor fails to account for the evidence along a number of dimensions. More specifically, comparing the VAR evidence reported in column 1 with simulated impact effects, we find that a model abstracting from workers' mobility costs understates the expansionary effect of a government spending shock on non traded output, cannot generate an appreciation in the relative price of non tradables or a rise in the non traded wage relative to the traded wage, and substantially understates the changes in sectoral output shares.

In contrast, as displayed in column 2, the performance of the neoclassical model improves as long as we allow for imperfect mobility of labor. To begin with, the baseline model which considers costs of switching sectors can account for the rise in the relative wage. Intuitively, because government spending is biased toward non tradables, 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% as shown in the sixth line of panel C.

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 perfect labor mobility (see column 7). The reason is twofold. First, the capital-labor ratio in the non traded sector increases as workers are reluctant to shift their hours worked across sectors. Second, because the aggregate wage increases when we allow for imperfect mobility of labor, workers supply more labor which further raises output in the non traded sector since it is relatively more labor intensive. While the baseline model is able to account pretty well for impact responses of hours worked and output of non tradables, it tends to somewhat overstate the contraction in hours worked and output of tradables which are fairly muted according to VAR evidence.

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 the relative price triggers a reallocation of resources toward the non traded sector, raising its output share by 0.38% of GDP, while that of tradables falls by exactly the same amount. As we move from column 3 to column 4 of Table 2, the utility loss resulting from the shift from one sector to another is reduced. As shown analytically in section 4, a rise in the degree of labor mobility exerts two opposite effects on sectoral output shares: while workers are more willing to shift across sectors, the relative price of non tradables appreciates less which mitigates the incentive for labor reallocation. We find numerically that raising the elasticity of labor supply across sectors, 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 2.5. Thus, the former effect more than offsets the latter.[50]

Turning to the adjustment of sectoral variables following a government spending shock as shown in Fig. 6, the dynamics of the relative price and the relative wage are captured fairly well by the model. As government spending falls and is restored to its initial level, excess demand in the non traded goods market is reduced, which depreciates the relative price of non tradables along the transitional path, as shown in Fig. 6(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. 6(h) and 6(g). Because non traded wages fall relative to traded wages during the transitional adjustment, as shown in Fig. 6(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. 6(e) and 6(d), the model tends to somewhat understate the contraction of labor and the output of tradables in the medium run.[51]

In order to further highlight the performance of the baseline model with imperfect mobility of labor and capital installation costs, it is useful to analyze the dynamic adjustment

[50]However, the latter influence may predominate if the values of ϵ are higher because the relative price merely appreciates in this case. In the polar case where ϵ tends toward infinity, the output share of non tradables increases by only 0.24%, a value that is much smaller than the estimated response of 0.35% of GDP.

[51]The explanation is intuitive: the baseline model underpredicts the decumulation of physical capital along the transitional path while the traded sector is more capital intensive.

of sectoral variables when these two features are absent. The dotted line in Fig. 6 displays the model predictions if we let ϵ tend toward infinity, while the parameter governing the magnitude of adjustment cost, κ, is set to zero. First, a model assuming $\epsilon \to \infty$ and setting $\kappa = 0$ predicts a flat temporal path for the relative wage and the relative price which conflict with the evidence. Second, it substantially understates the impact responses of sectoral output shares while the simulated responses for the baseline model accord well with the evidence. Intuitively, the relative price of non tradables appreciates when ϵ takes intermediate values, which in turn amplifies the shift of capital toward the non traded sector. Third, the model imposing perfect mobility of labor considerably overstates the changes in sectoral output shares 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.

5.2.3 Sensitivity Analysis

To gauge the relative role of limited labor mobility and capital adjustment costs, we also report results from two restricted versions of the model where one of the two features is, respectively, shutdown. Column 8 of Table 2 shows the predictions of a model imposing perfect mobility of labor along with capital installation costs while column 5 reports impact responses from a model assuming imperfect mobility while setting $\kappa = 0$.[52] Both models fail to account for the responses of sectoral output shares to a government spending shock. While introducing capital installation costs restore transitional dynamics for the relative price of non tradables, the restricted model where labor is perfectly mobile across sectors considerably overstates the responses of sectoral output shares. Intuitively, workers no longer experience a mobility cost and are thus 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 relative price, thus leading to a change in the sectoral output share which is about twice what is estimated empirically, as can be seen in column 3. In contrast, as reported in column 7, a model assuming imperfect mobility of labor while abstracting from capital installation costs tends to substantially understate the responses of sectoral output shares. 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 the relative price appreciates less, resulting in smaller shifts of labor and capital toward the non traded sector.

Column 6 shows results when the elasticity of labor supply, σ_L, is set to 1. Raising σ_L from 0.4 to 1 amplifies the rise in hours worked triggered by the negative wealth effect and

[52] To save space we develop intuition regarding the implications of imperfect mobility of labor and capital adjustment costs by restricting attention to impact responses. In a Technical Appendix, we contrast the dynamic adjustment from baseline model with the responses from the restricted model where one of the two features is shut down.

the increase in the aggregate wage, which further raises real GDP. Because larger labor supply benefits both sectors, hours worked (and subsequently output) increase more in the non traded sector while employment (and subsequently output) falls less in the traded sector. Since the non traded sector is more labor intensive, the rise in non traded labor is somewhat more pronounced. However, the responses of sectoral output shares are almost unchanged compared with those obtained from the baseline model as the relative price of non tradables appreciates by a smaller amount, thus mitigating the shift of capital toward the non traded sector.

5.3 Cross-Country Differences in Sectoral Impact: Taking the Model to Data

We have shown above that the performance of the neoclassical model in replicating the evidence related to fiscal transmission improves as long as we allow for imperfect mobility of labor 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 key characteristics of the 16 OECD economies in our sample, including the share of non traded hours worked to total hours worked, the non tradable content of consumption, investment and public expenditure, investment- and government spending-to-GDP ratios, and the degree of labor mobility across sectors. Table 5 summarizes the country-specific data for non tradable and GDP component shares. The elasticity of labor supply across sectors, ϵ, which plays a pivotal role in fiscal transmission, is set in accordance with our estimates shown in the last column of Table 5. As mentioned in section 5.1, φ, φ_J, ϑ, δ_K together with initial conditions (B_0, K_0) need to be calibrated endogenously to target α_C, α_J, L^N/L, ω_J along with $\upsilon_{NX} = NX/Y^T$ where $NX = Y^T - C^T - G^T - J^T$ corresponds to net exports. The remaining parameters are set to their empirical counterparts. Some parameters, such as the elasticity of labor supply, σ_L, and κ governing the magnitude of adjustment costs to physical capital accumulation, along with the world interest rate, are kept constant however for all countries. While we explore the sectoral effects of a rise in government consumption by 1% of GDP (i.e., g is set to 0.01) for each country in our sample, to be consistent with the calibration to a representative OECD economy described in section 5.1, we assume that the increase in public purchases is split between non tradables and tradables in accordance with their respective shares in government spending, i.e., ω_{G^N} and $1-\omega_{G^N}$, respectively, where ω_{G^N} is set in accordance with its country-specific value shown in column 4 of Table 5, except for Australia and Ireland.[53]

[53]For Australia and Ireland, we find empirically that the output share of tradables increases on impact while the relative size of the non traded sector declines. To be consistent with empirical evidence, we

< Please insert Figures 7-8 about here >

To explore the cross-country relationship quantitatively, we first plot in Fig. 7 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.[54] Restricting our attention to countries where the rise in government consumption is biased toward non tradables, 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. 7(a) and 7(b) also show that these differences in the responses of sectoral output shares are correlated with the measure of the degree of labor mobility across sectors. As ϵ takes higher values, countries with a higher degree of labor mobility experience a larger decline in the relative size of the traded sector and a larger increase in the relative size of the non traded sector. These results thus reveal 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. 7(a), our model predicts that a country with a low degree of labor mobility as captured by a value of ϵ of 0.2 will experience a decline in the output share of tradables of 0.2% of GDP, while a country with a higher degree of labor mobility as captured by a value of ϵ of 1.2 will face a fall by 0.4% of GDP, a decline which is twice as strong. Hence, **cross-country differences in the degree of labor mobility generate a substantial dispersion in the sectoral impact of fiscal policy**.

In Fig. 8, we contrast the cross-country relationship from the calibrated baseline model shown by the solid blue line with the cross-country relationship from the VAR model shown by the solid black 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 -0.207 for tradables ($t - stat = -2.238$) and 0.207 for non tradables ($t - stat = 2.238$). 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.

6 Conclusion

While the literature analyzing fiscal transmission mainly focuses on the aggregate effects of a rise in government consumption, our empirical results reveal that the impact of fiscal policy varies significantly between sectors and across countries. Using a panel of 16 OECD countries over the period 1970-2007, we find empirically for the whole sample that a gov-

consider a rise in public purchases which is fully biased toward tradables. It is worthwhile mentioning that at the initial steady-state, we set the non tradable content of government spending, ω_{G^N}, to 88% and 90% for Australia and Ireland, respectively, in accordance with the shares reported in column 4 of Table 5.

[54] Because our panel data estimates are not statistically significant at 10% for Denmark and Norway, these two countries are removed from the cross-country analysis. If we include them, the conclusions are unaffected.

ernment spending shock has an expansionary effect on hours worked and output of non tradables, whereas it gives rise to contractions in hours worked and output of tradables. Such a finding along with the appreciation in the relative price of non tradables suggests that public purchases are biased toward non traded goods. Importantly, non traded output increases substantially relative to GDP (in real terms) while the reverse is true for the traded sector. This evidence thus highlights the fact that resources are shifted toward the non traded sector, with the reallocation of inputs contributing to 50% of non traded output growth. If labor were freely mobile across sectors, sectoral wages would equalize. However, we find empirically that non traded wages increase substantially relative to traded wages, thus suggesting the presence of labor mobility costs across sectors. Contrasting the sectoral impact across the economies in our sample, the output share of non tradables (in real terms) rises for the vast majority of the economies while its magnitude varies sharply across countries. Estimating the elasticity of labor supply across sectors for each country, we find that impact responses of output shares for tradables and non tradables are more pronounced in countries with lower mobility costs.

To rationalize our panel VAR evidence, we develop a two-sector open economy model with imperfect mobility of labor across sectors and adjustment costs to physical capital accumulation. 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 rise in government consumption biased toward non tradables, we find quantitatively that the open economy version of the neoclassical model with tradables and non tradables 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 imperfect mobility of labor across sectors. The first feature mitigates the decline in investment and thus guarantees that the excess demand and thus incentives to shift resources toward the non traded sector are high enough. By reducing the elasticity of labor supply across sectors, the second 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 to a government spending shock: changes in the relative size of sectors are twice as strong in the country with the highest degree of labor mobility than in the economy with the lowest labor mobility. Finally, we find quantitatively that the 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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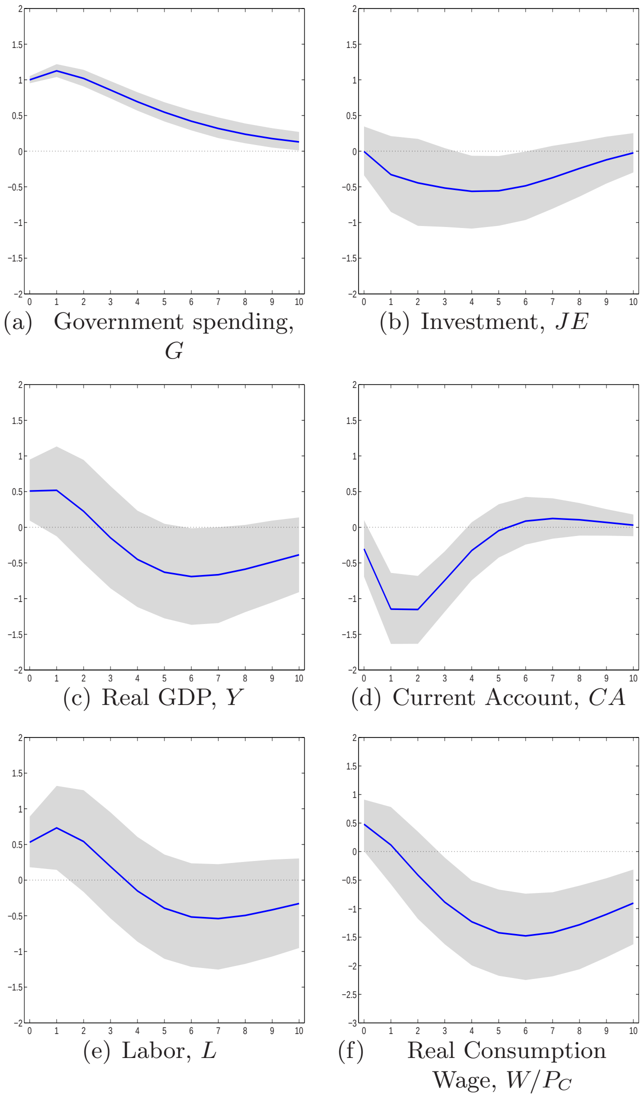


(a) Government spending, G (b) Investment, JE

(c) Real GDP, Y (d) Current Account, CA

(e) Labor, L (f) Real Consumption Wage, W/P_C

Figure 1: Effects of Unanticipated Government Spending Shock on Aggregate Variables.
Notes: Exogenous increase of government consumption by 1% of GDP. Aggregate variables include GDP (constant prices), total hours worked, private fixed investment, the current account and the real consumption wage. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in output units (government spending, GDP, investment, current account), percentage deviation from trend in labor units (total hours worked), percentage deviation from trend (real consumption wage). Solid blue lines: point estimates; shaded areas: bootstrapped 90% confidence intervals; sample: 16 OECD countries, 1970-2007, annual data.

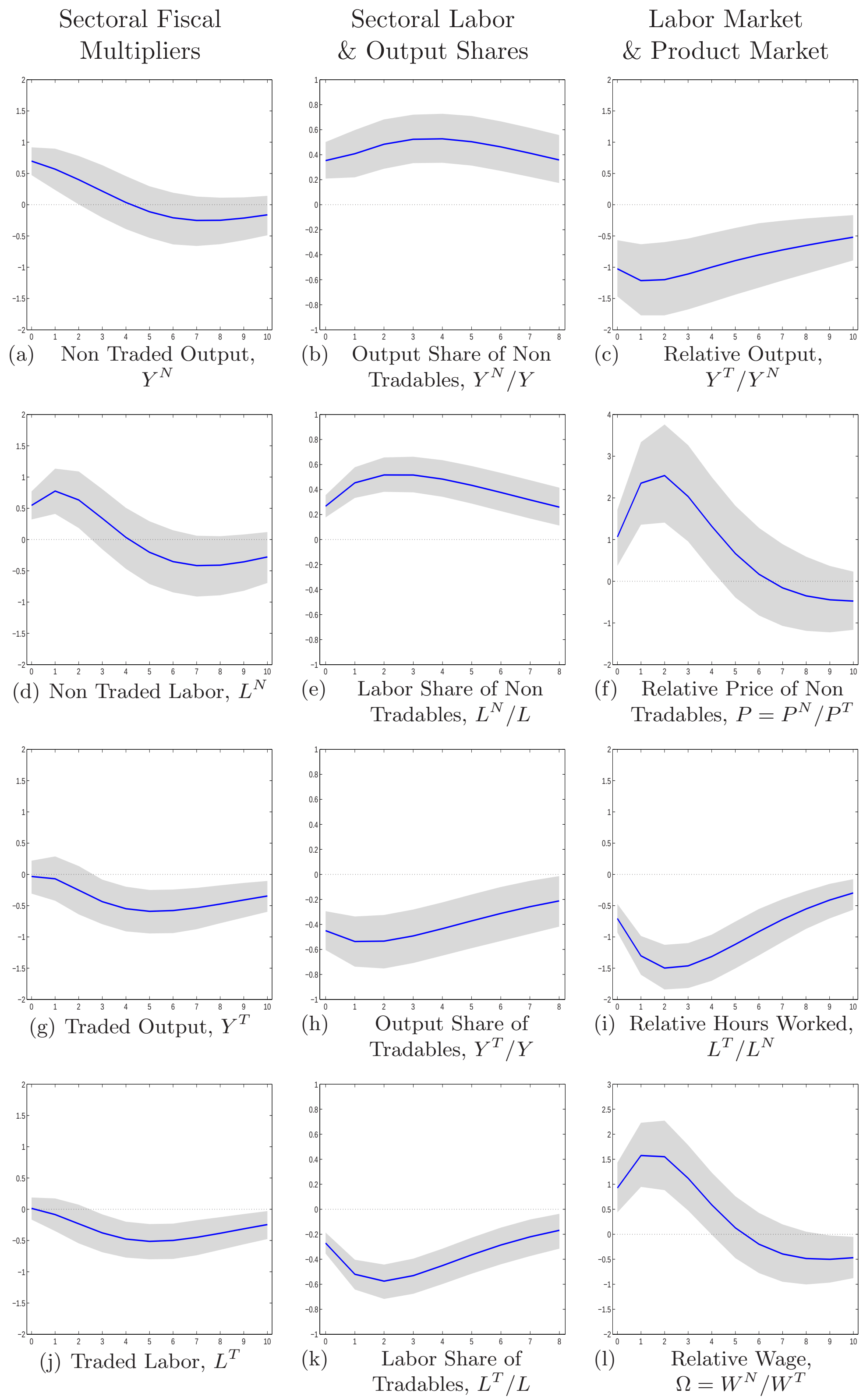
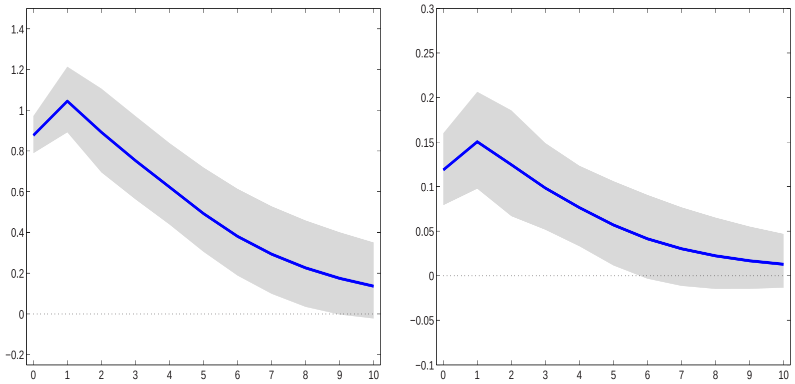


Figure 2: Effects of Unanticipated Government Spending Shock on Sectoral Variables. Notes: Exogenous increase of government consumption by 1% of GDP. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in output units (sectoral output, sectoral output shares), percentage 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). Solid blue lines: point estimates; shaded areas: bootstrapped 90% confidence intervals; sample: 16 OECD countries, 1970-2007, annual data.

Table 1: Responses to Government Spending Shock: Point Estimates

Variables	Horizon	A. Aggregate and Sectoral Effects			Variables	Horizon	B. Low Vs. High Labor Mobility		
		Aggregate (1)	Tradables (2)	Non Tradables (3)			All sample (4)	Low Mobility (5)	High Mobility (6)
Gov. spending	1	1.000*	1.000*	1.000*	Relative Labor	1	−0.705*	−0.346*	−1.770*
	2	2.127*	2.147*	2.134*	(L^T/L^N)	2	−2.007*	−1.303*	−3.972*
	4	4.004*	4.099*	4.044*		4	−4.968*	−3.950*	−7.299*
Output	1	0.508*	−0.033	0.697*	Relative Output	1	−1.025*	−0.674*	−1.936*
	2	1.026	−0.103	1.266*	(Y^T/Y^N)	2	−2.240*	−1.764*	−3.405*
	4	1.103	−0.792	1.882*		4	−4.547*	−4.293*	−5.389*
Labor	1	0.531*	0.014	0.547*	Mobility Indicator	1	0.304*	0.163*	0.851*
	2	1.263*	−0.071	1.323*	($LR(2)$)	2	0.754*	0.482*	1.772*
	4	1.994	−0.683	2.295*		4	1.110*	0.824*	2.191*
Real Wage	1	0.480*	0.215	0.835*	Relative Wage	1	0.939*	1.320*	−0.687
	2	0.595	0.080	1.569*	(W^N/W^T)	2	2.667*	3.603*	−1.307
	4	−0.703	−1.313	1.610		4	5.222*	7.683*	−5.248
Investment	1	−0.004							
	2	−0.332							
	4	−1.293							
Current Account	1	−0.303							
	2	−1.450*							
	4	−3.346*							

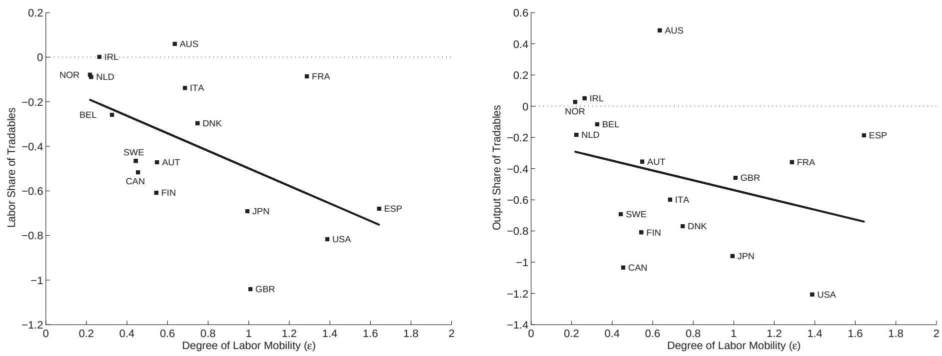
Notes: Horizon measured in year units. * denote significance at 10% level. Standard errors are bootstrapped with 10000 replications. The last three columns report, for selected horizons and samples, the cumulative responses of relative labor, relative output, the intersectoral labor reallocation index and relative wage to an increase in government spending by 1% of GDP. The response of relative labor (relative output resp.) is estimated from a 3-variable VAR that includes government spending, relative labor (relative output), L^T/L^N (Y^T/Y^N), and the relative wage of non tradables (relative price of non tradables), W^N/W^T (P^N/P^T). Finally, the response of labor reallocation (LR) is estimated from a 3-variable VAR that includes government spending, the intersectoral labor reallocation index, $LR(2)$, and the relative wage of non tradables, W^N/W^T.



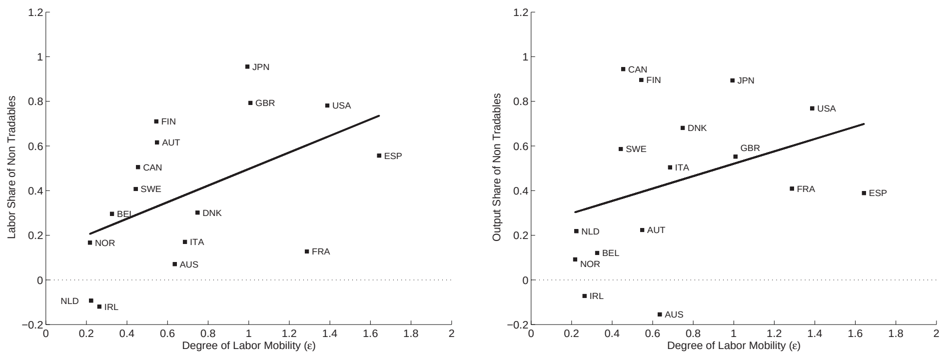
(a) Gov. Exp. on Non Tradables, G^N (b) Gov. Exp. on Tradables, G^T

Figure 3: Effects of Unanticipated Government Spending Shock on Government Final Consumption Expenditure on Non Tradables and Tradables. 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 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 are displayed by solid blue lines with shaded area indicating 90 percent confidence bounds obtained by bootstrap sampling; sample: 13 OECD countries, 1995-2015, annual data. Source: COFOG, OECD!.

Labor Shares Output Shares



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



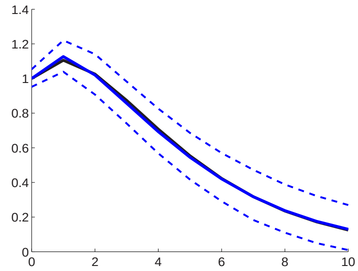
(c) Labor Share of Non Tradables (d) Output Share of Non Tradables

Figure 4: Effect of Government Spending Shocks on Sectoral Composition against the Degree of Labor Mobility across Sectors. Notes: Figure 4 plots impact responses of sectoral labor and sectoral output shares. 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 5.

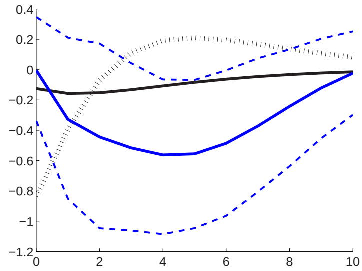
Table 2: Impact Responses of Aggregate and Sectoral Variables to of a Rise in Government Consumption (in %)

	Data	Imperfect Mobility					Perfect Mobility	
		Bench	Mobility		No Adj. Cost.	Lab. supply	No Adj. Cost.	With Adj. Cost
		($\epsilon = 0.75$)	($\epsilon = 0.22$)	($\epsilon = 1.64$)	($\kappa = 0$)	($\sigma_L = 1$)	($\kappa = 0$)	($\kappa = 17$)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A.Impact: GDP & Components								
Real GDP, $dY_R(0)$	0.51	0.19	0.22	0.16	0.15	0.34	0.07	0.09
Investment, $dI(0)$	-0.01	-0.13	-0.17	-0.08	-0.41	-0.14	-0.84	0.04
Current account, $dCA(0)$	-0.30	-0.34	-0.22	-0.46	-0.12	-0.29	0.06	-0.75
B.Impact: Labor & Real Wage								
Labor, $dL(0)$	0.53	0.30	0.34	0.25	0.24	0.53	0.11	0.15
Real consumption wage, $d\left(W/P_C\right)(0)$	0.48	0.07	0.08	0.06	0.05	-0.04	0.00	0.07
C.Impact: Sectoral Labor								
Traded labor, $dL^T(0)$	0.01	-0.14	0.02	-0.29	-0.09	-0.04	-0.20	-0.68
Non traded labor, $dL^N(0)$	0.54	0.44	0.32	0.55	0.33	0.57	0.30	0.83
Relative labor, $d\left(L^T/L^N\right)(0)$	-0.71	-0.52	-0.19	-0.86	-0.36	-0.50	-0.53	-1.86
Relative wage, $d\left(W^N/W^T\right)(0)$	0.93	1.44	1.87	1.03	1.02	1.33	0.00	0.00
Labor share of tradables, $d(L^T/L)(0)$	-0.27	-0.24	-0.09	-0.38	-0.17	-0.23	-0.23	-0.74
Labor share of non tradables, $d(L^N/L)(0)$	0.27	0.24	0.09	0.38	0.17	0.23	0.23	0.74
D.Impact: Sectoral Output								
Traded output, $dY^T(0)$	-0.03	-0.31	-0.19	-0.43	-0.21	-0.24	-0.22	-0.72
Non traded output, $dY^N(0)$	0.70	0.50	0.41	0.59	0.37	0.58	0.28	0.82
Relative output, $d\left(Y^T/Y^N\right)(0)$	-1.03	-0.97	-0.64	-1.30	-0.64	-0.97	-0.62	-3.16
Relative price, $dP(0)$	1.06	0.88	1.13	0.64	0.62	0.79	0.00	0.02
Output share of tradables, $d(Y^T/Y_R)(0)$	-0.45	-0.38	-0.26	-0.49	-0.27	-0.37	-0.24	-0.76
Output share of non tradables, $d(Y^N/Y_R)(0)$	0.35	0.38	0.26	0.49	0.27	0.37	0.24	0.76

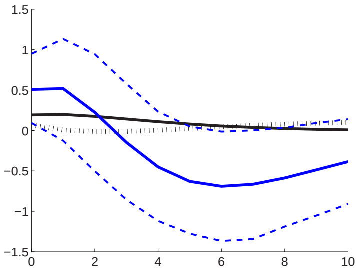
Notes: Effects of an unanticipated and temporary exogenous rise in government consumption by 1% of GDP. Panels A,B,C,D show the initial deviation in percentage relative to steady-state for aggregate and sectoral variables. Market product (aggregate and sectoral) quantities are expressed in percent of initial GDP while labor market (aggregate and sectoral) quantities are expressed in percent of initial total hours worked; θ^T and θ^N are the labor income share in the traded sector and non traded sector, respectively; ϵ measures the degree of substitutability in hours worked across sectors and captures the degree of labor mobility; σ_L is the Frisch elasticity of labor supply; κ governs the magnitude of adjustment costs to capital accumulation. In our baseline calibration (labelled 'Bench'), we set $\theta^T = 0.58$, $\theta^N = 0.68$, $\epsilon = 0.75$, $\phi = 0.77$, $\sigma_L = 0.4$, $\kappa = 17$.



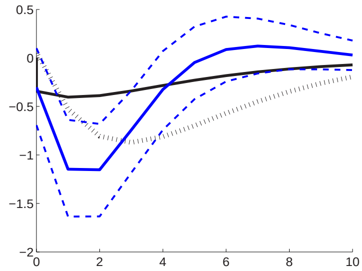
(a) Government Spending



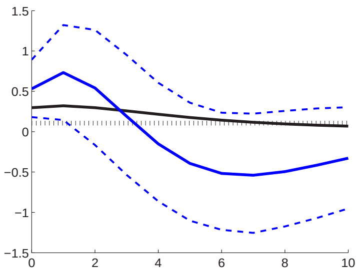
(b) Investment



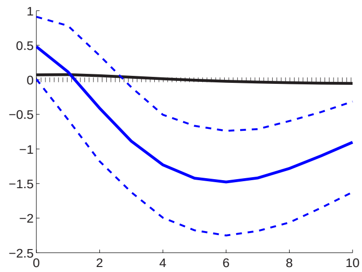
(c) Real GDP



(d) Current Account

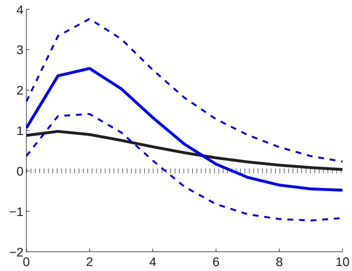


(e) Hours Worked

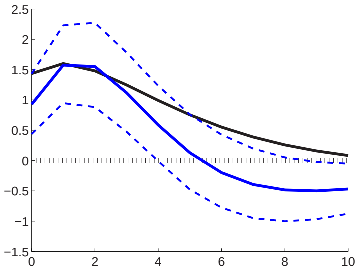


(f) Aggregate Real Wage

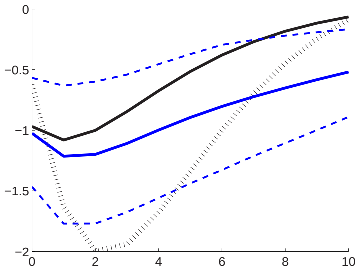
Figure 5: Dynamic Adjustment of Aggregate Variables to Unanticipated Government Spending Shock. Notes: Solid blue line displays point estimate of VAR model with dotted blue lines indicating 90% confidence bounds; the solid black line displays model predictions in the baseline scenario with imperfect mobility of labor across sectors ($\epsilon = 0.75$) and capital installation costs ($\kappa = 17$) while the dotted black line shows predictions of the model imposing perfect mobility of labor ($\epsilon \rightarrow \infty$) and abstracting from capital adjustment costs ($\kappa = 0$).



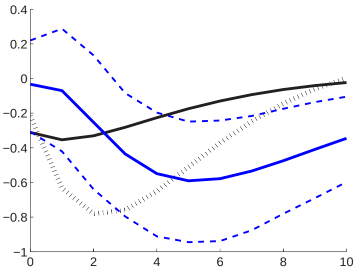
(a) Relative Price, P



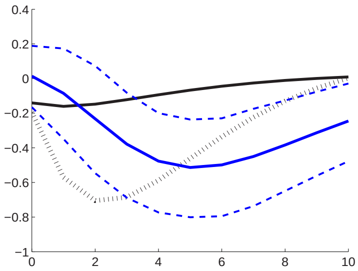
(b) Relative Wage, W^N/W^T



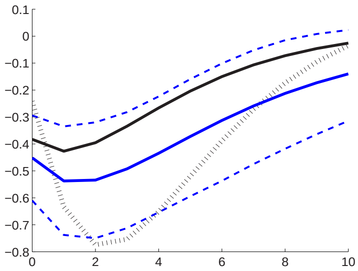
(c) Relative Output, Y^T/Y^N



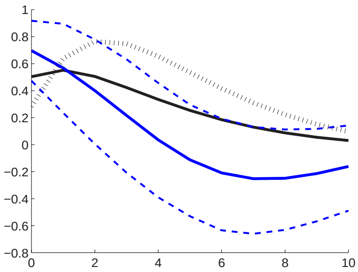
(d) Traded Output, Y^T



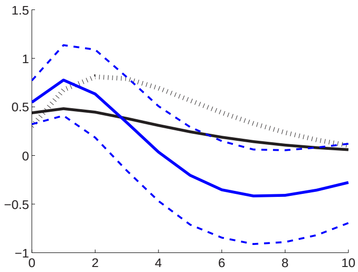
(e) Traded Labor, L^T



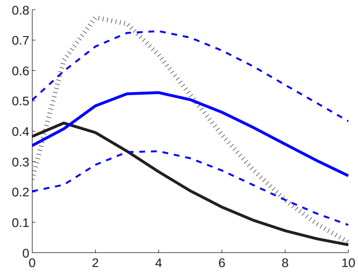
(f) Share of Tradables, $\nu^{Y,T}$



(g) Non Traded Output, Y^N

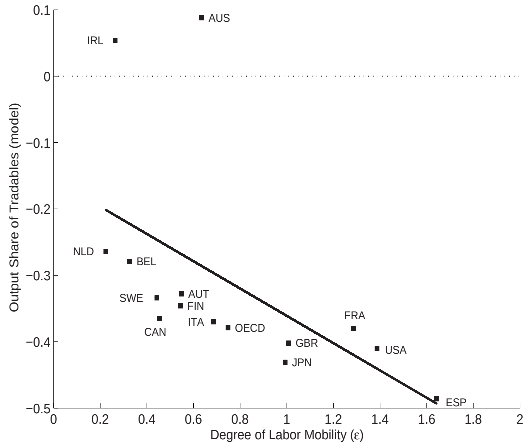


(h) Non Traded Labor, L^N

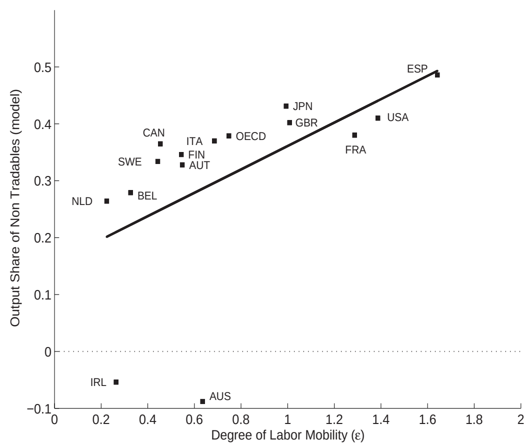


(i) Share of Non Tradables, $\nu^{Y,N}$

Figure 6: Dynamic Adjustment of Sectoral Variables to Unanticipated Government Spending Shock. Notes: Solid blue line displays point estimate of VAR with dotted blue lines indicating 90% confidence bounds; the solid black line displays model predictions in the baseline scenario with imperfect mobility of labor across sectors ($\epsilon = 0.75$) and capital installation costs ($\kappa = 17$) while the dotted black line shows predictions of the model imposing perfect mobility of labor ($\epsilon \to \infty$) and abstracting from capital adjustment costs ($\kappa = 0$).

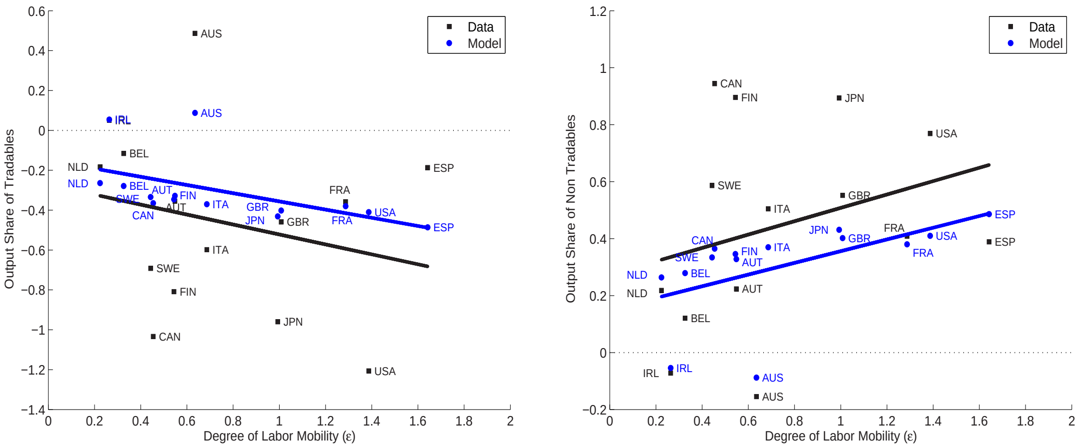


(a) Output Share of Tradables



(b) Output Share of Non Tradables

Figure 7: 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 5, which captures the degree of labor mobility across sectors. Vertical axes report simulated impact responses from the baseline model with imperfect mobility of labor across sectors and adjustments costs to capital accumulation.



(a) Output Share of Tradables

(b) Output Share of Non Tradables

Figure 8: Cross-Country Relationship from Simulated Responses vs. Cross-Country Relationship from VAR Estimates. Notes: Horizontal axes display panel data estimates of the elasticity of labor supply across sectors, ϵ, taken from the last column of Table 5, which captures the degree of labor mobility across sectors. Vertical axes report simulated responses from the baseline model (blue circles) and impact responses from the VAR model (black squares).

A Data Description for Empirical Analysis

Coverage: Our sample consists of a panel of 16 countries: Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Ireland (IRL), Italy (ITA), Japan (JPN), the Netherlands (NLD), Norway (NOR), Spain (ESP), Sweden (SWE), the United Kingdom (GBR) and the United States (USA). The period is running from 1970 to 2007, except for Japan (1974-2007).

Sources: Our primary sources for sectoral data are the OECD and EU KLEMS databases. We use the EU KLEMS [2011] sectoral database (the March 2011 data release, available at `http://www.euklems.net`) which provides annual data for eleven 1-digit ISIC-rev.3 industries for all countries of our sample with the exceptions of Canada and Norway. For Canada and Norway, sectoral data are taken from the Structural Analysis (STAN) database provided by the OECD [2011]. In addition, expenditure aggregates are obtained from the Economic Outlook Database provided by the OECD [2017].

The eleven 1-digit ISIC-rev.3 industries are classified as tradables or non tradables. To do so, we adopt the classification proposed by De Gregorio et al. [1994]. Following Jensen and Kletzer [2006], we have updated this classification by treating "Financial Intermediation" as a traded industry. We construct traded and non traded sectors as follows (EU KLEMS codes are given in parentheses):

- **Traded Sector**: "Agriculture, Hunting, Forestry and Fishing" (AtB), "Mining and Quarrying" (C), "Total Manufacturing" (D), "Transport, Storage and Communication" (I) and "Financial Intermediation" (J).
- **Non Traded Sector**: "Electricity, Gas and Water Supply" (E), "Construction" (F), "Wholesale and Retail Trade" (G), "Hotels and Restaurants" (H), "Real Estate, Renting and Business Services" (K) and "Community Social and Personal Services" (LtQ).

Once industries have been classified as traded or non traded, for any macroeconomic variable X, its sectoral counterpart X^j for $j = T, N$ is constructed by adding the X_k of all sub-industries k classified in sector $j = T, N$ as follows $X^j = \sum_{k \in j} X_k$.

Relevant to our work, the EU KLEMS and OECD STAN databases provide data, for each industry and year, on value added at current and constant prices, permitting the construction of sectoral deflators of value added, as well as details on labor compensation and employment data, allowing the construction of sectoral wage rates. In the VAR models, with the exception of the current account, all quantity variables are in log levels and scaled by the working age population (15-64 years old), while price deflators and wage rates are in natural logs. Source: OECD ALFS Database for the working age population. We describe below the construction for the sectoral data employed in Section 2 (mnemonics are given in parentheses):

- **Sectoral output**, Y^j: sectoral value added at constant prices in sector $j = T, N$ (VA_QI). Sources: EU KLEMS and OECD STAN databases.
- **Relative output**, Y^T/Y^N: ratio of traded value added at constant prices to non traded value added at constant prices.
- **Sectoral output share**, $\nu^{Y,j}$: ratio of value added at constant prices in sector j to GDP at constant prices, i.e., $Y^j/(Y^T + Y^N)$ for $j = T, N$.
- **Relative price of non tradables**, P: ratio of the non traded value added deflator to the traded value added deflator, i.e., $P = P^N/P^T$. The sectoral value added deflator P^j for sector $j = T, N$ is calculated by dividing value added at current prices (VA) by value added at constant prices (VA_QI) in sector j. Sources: EU KLEMS and OECD STAN databases.
- **Sectoral labor**, L^j: total hours worked by persons engaged in sector j (H_EMP). Sources: EU KLEMS and OECD STAN databases.
- **Relative labor**, L^T/L^N: ratio of hours worked in the traded sector to hours worked in the non traded sector.
- **Sectoral labor share**, $\nu^{L,j}$: ratio of hours worked in sector j to total hours worked, i.e., $L^j/(L^T + L^N)$ for $j = T, N$.
- **Sectoral real consumption wage**, W^j/CPI: nominal wage in sector j divided by the consumer price index (CPI). Source: OECD Prices and Purchasing Power Parities for the consumer price index. The sectoral nominal wage W^j for sector $j = T, N$ is calculated by dividing labor compensation in sector j (LAB) by total hours worked by persons engaged (H_EMP) in that sector. Sources: EU KLEMS and OECD STAN databases.
- **Relative wage**, Ω: ratio of the nominal wage in the non traded sector W^N to the nominal wage in the traded sector W^T, i.e., $\Omega = W^N/W^T$.

- **Labor reallocation index**, LR: measures the fraction of workers who are working in year t in a different sector than in year $t-2$ and is computed as:

$$LR_t(2) = 0.5 \sum_{j=T}^{N} \left| \frac{L_t^j}{\sum_{j=T}^{N} L_t^j} - \frac{L_{t-2}^j}{\sum_{j=T}^{N} L_{t-2}^j} \right|.$$

Data for labor (H_EMP), used to compute LR, are taken from EU KLEMS and OECD STAN databases.

In the following, we provide details on data construction for aggregate variables (mnemonics are in parentheses):

- **Government spending**, G: real government final consumption expenditure (CGV). Source: OECD Economic Outlook Database.
- **Gross domestic product**, Y: real gross domestic product (GDPV). Source: OECD Economic Outlook Database.
- **Private investment**, JE: real private non-residential gross fixed capital formation (IBV). Source: OECD Economic Outlook Database.
- **Current account**, CA: ratio of the current account to the gross domestic product at current prices (CBGDPR). Source: OECD Economic Outlook Database.
- **Labor**, L: total hours worked by persons engaged (H_EMP). Sources: EU KLEMS and OECD STAN databases.
- **Real consumption wage**, W/CPI: nominal wage divided by the consumer price index (CPI). Source: OECD Prices and Purchasing Power Parities for the consumer price index. The nominal wage is calculated by dividing labor compensation (LAB) by total hours worked by persons engaged (H_EMP). Sources: EU KLEMS and OECD STAN databases.

Government spending, investment and GDP variables are deflated with their own deflators.

B Data for Calibration

B.1 Non Tradable Content of GDP and its Components

Table 5 shows the non tradable content of GDP, consumption, investment, government spending, labor and labor compensation. In addition, it gives information about the share of government spending on the traded and non traded goods in the corresponding sectoral value added and the sectoral labor income shares. The column 11 shows the ratio of labor productivity of tradables to labor productivity of non tradables as we use labor productivity to approximate technological change. Columns 12 to 14 display the investment-to-GDP ratio and government spending in % of GDP and the labor income share, respectively, for the whole economy. Our sample covers the 16 OECD countries mentioned in Section A. Our reference period for the calibration corresponds to the period 1990-2007. The choice of this period has been dictated by data availability. Columns 15 and 16 report estimates for the elasticity of substitution in consumption between traded and non traded goods, ϕ, and the elasticity of labor supply across sectors, ϵ. In the following, statistics for the sample as a whole represent (unweighted) averages of the corresponding variables among the group.

To calculate the non tradable share of output, labor and labor compensation, we split the eleven industries into traded and non-traded sectors by adopting the classification proposed by De Gregorio et al. [1994] and updated by Jensen and Kletzer [2006]. Details about data construction for sectoral output and sectoral labor are provided in section A. We calculate the non-tradable share of labor compensation as the ratio of labor compensation in the non traded sector (i.e., $W^N L^N$) to overall labor compensation (i.e., WL). Sources: EU KLEMS [2011] and STAN databases. Data coverage: 1990-2007 for all countries. The non tradable content of GDP, labor and labor compensation, shown in columns 1, 5 and 6 of Table 5, average to 63%, 67% and 66% respectively.

To split consumption expenditure (at current prices) into consumption in traded and non traded goods, we made use of the Classification of Individual Consumption by Purpose (COICOP) published by the United Nations (Source: United Nations [2011]). Among the twelve items, the following ones are treated as consumption in traded goods: "Food and Non-Alcoholic Beverages", "Alcoholic Beverages Tobacco and Narcotics", "Clothing and Footwear", "Furnishings, Household Equipment" and "Transport". The remaining items are treated as consumption in non traded goods: "Housing, Water, Electricity, Gas and Fuels", "Health", "Communication", "Recreation and Culture", "Education", "Restaurants and Hotels". Because the item "Miscellaneous Goods and Services" is somewhat problematic, we decided to consider it as both tradable (50%) and non tradable (50%) in equal shares. Data coverage: 1990-2007 for AUS, AUT, CAN, DNK, FIN, FRA, GBR, ITA, JPN, NLD, NOR and USA, 1993-2007 for SWE and 1995-2007 for BEL, ESP and IRL. The non-tradable share of consumption shown in column 2 of Table 5 averages to 53%.

To calculate the non tradable share of investment expenditure, we follow the methodology proposed by Burstein et al. [2004] who treat "Housing", "Other Constructions" and "Other Products" as non-tradable investment and "Products of Agriculture, Forestry, Fisheries and Aquaculture", "Metal Products and Machinery", "Transport Equipment" as tradable investment expenditure. Source: OECD Input-Output database [2012]. Data coverage: 1990-2007 for AUT, CAN, ESP, FIN, GBR, IRL, JPN, NLD, and NOR, 1990-2006 for DNK, FRA, ITA and USA, and 1993-2007 for SWE. Data are not available for AUS and BEL. The non tradable share of investment shown in column 3 of Table 5 averages to 64%, in line with estimates provided by Burstein et al. [2004] and Bems [2008].

Sectoral government final consumption expenditure data (at current prices) were obtained from the OECD General Government Accounts database (Source: COFOG, OECD [2017]). "Economic Affairs" which includes "Fuel and Energy", "Agriculture, Forestry, Fishing, and Hunting", "Mining, Manufacturing, and Construction", "Transport and Communications" is classified as tradable. Items treated as non traded are: "General Public Services", "Defense", "Public Order and Safety", "Environment Protection", "Housing and Community Amenities", "Health", "Recreation, Culture and Religion", "Education", "Social Protection". Data coverage: 1995-2007 for AUT, BEL, DNK, ESP, FRA, GBR, IRL, ITA, NLD, NOR and SWE, 1998-2007 for AUS, 1990-2007 for FIN, 2005-2007 for JPN and 1970-2007 for the USA. Data are not available for CAN. The non tradable component of government spending shown in column 4 of Table 5 averages to 90% over the period 1990-2007. Government spending on traded and non traded goods in % of the corresponding sectoral output, i.e., G^T/Y^T and G^N/Y^N, respectively, is shown in columns 7 and 8 of Table 5. They average 5% and 30%, respectively.

The labor income share for sector j denoted by θ^j is calculated as the ratio of labor compensation of sector j to value added of sector j at current prices. Sources: EU KLEMS [2011] and STAN databases. Data coverage: 1990-2007 for all countries. As shown in columns 9 and 10 of Table 5, θ^T and θ^N average 0.60 and 0.67, respectively. When $k^T > k^N$, the shares of labor income average 0.58 and 0.67 for the traded and the non traded sector, respectively, while if $k^N > k^T$, θ^T and θ^N average 0.70 and 0.64, respectively. In addition, column 14 of Table 5 gives the aggregate labor income share which averages 0.64 in our sample.

We use sectoral labor productivities to approximate technological change. Column 11 of Table 5 displays the ratio of labor productivity in tradables to labor productivity in non tradables (Z^T/Z^N) averaged over the period 1990-2007. To measure labor productivity in sector $j = T, N$, we divide value added at constant prices in sector j (VA_QI) by total hours worked by persons engaged (H_EMP) in that sector. Sources: EU KLEMS [2011] and STAN databases. Data coverage: 1990-2007 for all countries. As shown in column 11, the traded sector is 28 percent more productive on average than the non traded sector for the whole sample.

Columns 12 and 13 of Table 5 display gross capital formation and final consumption expenditure of general government as a share of GDP, respectively. Source: OECD National Accounts Database. Data coverage: 1990-2007 for all countries.

B.2 Non Tradable Intensity of the Government Spending Shock

We turn to the calibration of the breakdown of the government spending shock between non tradables and tradables. In first approximation, the share of the government spending shock received by the non traded sector could be measured by the non tradable content of government spending we calculated above by using the COFOG dataset from the OECD. Denoting by ω_{G^j} the content of government spending in good j, we have:

$$G(t) = \omega_{G^N} G(t) + \omega_{G^T} G(t). \tag{41}$$

Assuming that ω_{G^j} is fixed over time and differentiating (41) leads to:

$$dG(t)/Y = \omega_{G^N} (dG(t)/Y) + \omega_{G^T} (dG(t)/Y). \tag{42}$$

Thus according to (42), the non tradable intensity of the government spending shock corresponds to the fraction of government consumption spent on non tradables. In order to reproduce the hump-shaped pattern of the endogenous response of government spending to an exogenous fiscal shock, we assume that the deviation of government spending relative to its initial value as a percentage of initial GDP is governed by the dynamic equation (23). Left-multiplying (23) by ω_{G^j} (with $j = N, T$) gives the dynamic adjustment of sectoral government consumption to an exogenous fiscal shock:

$$\omega_{G^j} \left(G(t) - \tilde{G} \right) / Y = \omega_{G^j} \left[e^{-\xi t} - (1 - g) e^{-\chi t} \right]. \tag{43}$$

We set g to 0.01 as we consider an exogenous increase in government spending by 1% of GDP and choose values of ξ and χ in order to reproduce the hump-shaped pattern of the endogenous response of government spending to the exogenous fiscal shock. To the extent that ω_{G^j} is considered as fixed over time, we set ω_{G^j} to the share of government consumption on good j in government final consumption expenditure, i.e., we set ω_{G^N} to 90% and ω_{G^T} to 10%.

The derivation of the dynamic equation (43) that governs the adjustment of sectoral government consumption following an exogenous fiscal shock relies on a number of assumptions. 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 in good j. To investigate whether our assumptions are consistent with the data, we contrast empirical with theoretical impulse response functions of sectoral government consumption. To estimate the dynamic effects on sectoral government consumption of an exogenous fiscal shock, we have to identify the government spending shock. We thus estimate the first VAR model that includes government final consumption expenditure, real GDP, total hours worked, private investment, and the real consumption wage. Then, we estimate a VAR model in panel format on annual data that includes unanticipated government spending shocks, ϵ^G_{it}, ordered first, government spending, g_{it}, government consumption on non tradables, g^N_{it}, and government consumption on tradables, g^T_{it}, i.e., $z^G_{i,t} = [\epsilon^G_{it}, g_{it}, g^N_{it}, g^T_{it}]$. All quantities are logged, expressed in real terms and scaled by the working age population.

Since time series for government consumption by function taken from the COFOG dataset are not available before 1995 for most of the countries in our sample, and because our objective is to estimate the non tradable content of the aggregate government spending shock, we consider a period running from 1995 to 2015 in order to have time series of a reasonable length. 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.

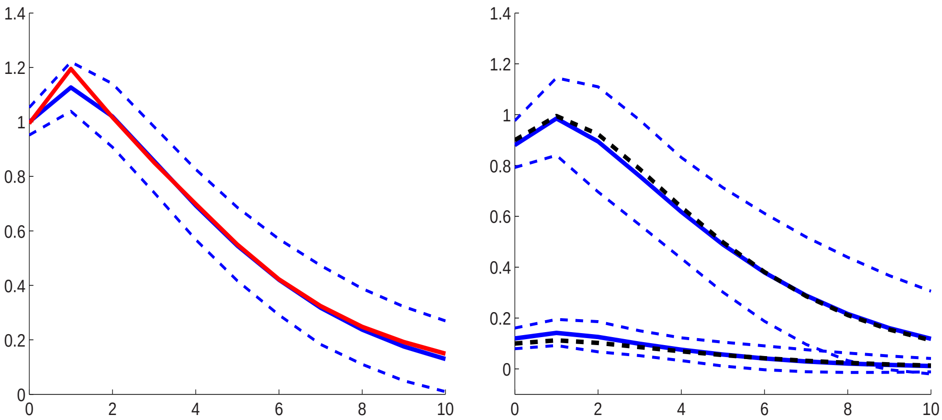
Table 3 reports, for various horizons, the responses of government consumption expenditure on non tradables and tradables to the identified government spending shock. We normalize the impulse responses so that government spending rises by one percentage point of GDP on impact. As can be seen in the first two columns of Table 3, a government spending shock leads to an increase in government consumption expenditure on non tradables by 0.88% on impact while the rise in public purchases of tradables accounts for the remaining share, i.e., 12%. The contribution of government consumption on non tradables to the government spending shock is displayed in the last column of Table 3. Its contribution is quite stable over time and varies between 88% and 91%. The contribution of government expenditure on non tradables averages 90% as can be seen in the last line of the table.

Empirical and theoretical impulse response functions are contrasted and displayed by solid blue lines in the right panel of Figure 9. Before discussing the results, we first focus on the response of government final consumption expenditure to the exogenous fiscal shock shown in the left panel of Figure 9. The endogenous response of government spending to an exogenous fiscal shock displayed in the solid blue line corresponds to the baseline government spending shock in the main text (see Figure 1(a)) we obtain from estimates of the first VAR model. The dynamic response of government final consumption expenditure which has been computed by summing mean responses of government consumption consumption on non tradables and tradables is displayed by the solid red line. While the solid blue line displays point estimate from a sample of 15 OECD countries over 1970-2007, the solid red line displays point estimate from a sample of 13 OECD countries over 1995-2015. Whereas the samples are different, the discrepancy is quite moderate. Since theoretical responses of sectoral government consumption are based on the response of government spending shown in the solid blue line in the left panel while the sum of mean responses of government consumption expenditure on non tradables and tradables gives a slightly different response of government spending as shown in the solid red line, we have to rescale empirical responses for G^j so that the sum of mean responses corresponds exactly to the point estimate displayed in the solid blue line. The rescaled empirical responses of sectoral government consumption are displayed by solid blue lines in the right panel of Figure 9 with dotted blue lines indicating the 90 percent confidence bounds obtained by bootstrap sampling. We contrast empirical with theoretical responses displayed by the dotted black lines. It turns out that differences are rather moderate. We may notice that whereas the theoretical response of government consumption of non tradables (tradables) slightly overstates (understates) the estimated response in the short-run, it lies within the confidence bounds for both goods. To conclude, the assumptions underlying the dynamic equation (43) which governs theoretical responses of G^j are reasonable and consistent with data.

Table 3: Responses of G^N and G^T to Identified Government Spending Shock: Point Estimates

Horizon	Responses G^N	G^T	Non tradable intensity of gov. spending shock
0	0.876	0.119	88%
1	1.045	0.150	87%
2	0.892	0.125	88%
3	0.753	0.098	88%
4	0.623	0.076	89%
5	0.493	0.057	90%
6	0.381	0.041	90%
7	0.294	0.030	91%
8	0.226	0.022	91%
9	0.175	0.017	91%
10	0.136	0.013	91%
Mean	-	-	90%

Notes: Horizon measured in year units. We generate impulse response functions by using a simple VAR, i.e., $z^G_{i,t} = [\epsilon^G_{i,t}, g_{i,t}, g^N_{i,t}, g^T_{i,t}]$, with 2 lags. To identify the government spending shock $\epsilon^G_{i,t}$ 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 Choleski decomposition. The last column of the table displays, for all horizons, the contribution of the response of non tradable component to the government spending shock. Data coverage: 1995-2015 for AUT, BEL, DNK, ESP, FIN, FRA, GBR, IRL, ITA, NLD, NOR, SWE and the USA. All variables are real and scaled by the working age population.



(a) Government Final Consumption Expenditure, G (b) Government Expenditure on Non Tradables, G^N, and Tradables, G^T

Figure 9: Effects of Unanticipated Government Spending Shock on Government Final Consumption Expenditure on Non Tradables and Tradables: 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 with dotted blue lines indicating the 90 percent confidence bounds; sample: 13 OECD countries, 1995-2015, annual data. The red line 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. Theoretical responses of g^N and g^T are displayed by dotted black lines in the right panel.

B.3 Estimates of ϵ and ϕ: Empirical strategy

Column 1 of Table 4 shows our estimates of the elasticity of labor supply across sectors, ϵ, while columns 2-3 show our estimates of the elasticity of substitution in consumption between traded and non traded goods, ϕ. We detail our empirical strategy to estimate these two parameters.

Along the lines of Horvath [2000], we derive a testable equation by combining optimal rules for labor supply and labor demand and estimate ϵ by running the regression of the worker inflow in sector $j = T, N$ of country i at time t arising from labor reallocation across sectors computed as $\hat{l}^j_{i,t} - \hat{l}_{i,t}$ on the relative labor's share percentage changes in sector j, $\hat{\beta}^j_{i,t}$:[55]

$$\hat{l}^j_{i,t} - \hat{l}_{i,t} = f_i + f_t + \gamma_i \hat{\beta}^j_{i,t} + \nu^j_{i,t}, \tag{44}$$

where we denote logarithm in lower case and the deviation from initial steady-state by a hat; $\nu^j_{i,t}$ is an i.i.d. error term; country fixed effects are captured by country dummies, f_i, and common macroeconomic shocks by year dummies, f_t. The LHS term of (44) is calculated as the difference between changes (in percentage) in hours worked in sector j, $\hat{l}^j_{i,t}$, and in total hours worked, $\hat{l}_{i,t}$. The RHS term β^j corresponds to the fraction of labor's share of output accumulating to labor in sector j. Denoting by $P^j_t Q^j_t$ output at current prices in sector $j = T, N$ at time t, β^j_t is computed as $\frac{\xi^j P^j_t Q^j_t}{\sum_{j=N}^{T} \xi^j P^j_t Q^j_t}$ where ξ^j is labor's share in output in sector $j = T, N$ defined as the ratio of the compensation of employees to output in the jth sector, averaged over the period 1971-2007.[56] Because hours worked are aggregated by means of a CES function, total hours percentage change $\hat{l}_{i,t}$ is calculated as a weighted average of sectoral employment percentage changes, i.e., $\hat{l}_t = \sum_{j=N}^{T} \beta^j_{t-1} \hat{l}^j_t$. The parameter we are interested in, the degree of substitutability of hours worked across sectors, is given by $\epsilon_i = \gamma_i/(1-\gamma_i)$. In the regressions that follow, the parameter γ_i is alternatively assumed to be identical across countries when estimating for the whole sample ($\gamma_i = \gamma_{i'} \equiv \gamma$ for $i \neq i'$) or to be different across countries when estimating ϵ for each economy ($\gamma_i \neq \gamma_{i'}$ for $i \neq i'$). Data are taken from the EU KLEMS [2011] and STAN databases, and the sample includes the 16 OECD countries mentioned above over the period 1971-2007 (except for Japan: 1975-2007). Table 4 reports empirical estimates that are consistent with $\epsilon > 0$. All values are statistically significant at 10%, except for Denmark and Norway.[57]

To estimate the elasticity of substitution in consumption, ϕ, between traded and non traded goods, we first derive a testable equation by inserting the optimal rule for intra-temporal allocation of consumption (14) into the goods market equilibrium which gives $\frac{C^T}{C^N} = \frac{Y^T - NX - G^T - I^T}{Y^N - G^N - I^N} = \left(\frac{\varphi}{1-\varphi}\right) P^\phi$ where $NX \equiv \dot{B} - r^\star B$ is net exports, I^j and G^j are investment in physical capital and government spending in sector j, respectively. Isolating $\left(Y^T - NX\right)/Y^N$ and taking logarithm yields $\ln\left(\frac{Y^T - NX}{Y^N}\right) = \alpha + \phi \ln P$. Adding an error term μ, we estimate ϕ by running the regression of the (logged) output of tradables adjusted with net exports at constant prices in terms of output of non tradables on the (logged) relative price of non tradables:

$$\ln\left(\frac{Y^T - NX}{Y^N}\right)_{i,t} = f_i + f_t + \alpha_i t + \phi_i \ln P_{i,t} + \mu_{i,t}, \tag{45}$$

where f_i and f_t are the country fixed effects and time dummies, respectively. Because the term $\alpha \equiv \ln \frac{\left(1-\upsilon_{G^N}-\upsilon_{I^N}\right)}{\left(1-\upsilon_{G^T}-\upsilon_{I^T}\right)} + \ln\left(\frac{\varphi}{1-\varphi}\right)$ is composed of ratios, denoted by υ_{G^j} and υ_{I^j}, of G^T (G^N) and I^T (I^N) to $Y^T - NX$ (Y^N) and hence may display a trend over time, we add country-specific linear trends, as captured by $\alpha_i t$.[58]

Instead of using time series for sectoral value added, we can alternatively make use of series for sectoral labor compensation by inserting the first-order condition equating the marginal revenue of labor and the sectoral wage, i.e., $\frac{\theta^j P^j Y^j}{L^j} = W^j$, into the goods market clearing condition. Eliminating Y^j, denoting by $\gamma^T = \left(W^T L^T - \theta^T P^T NX\right)$ and $\gamma^N = W^N L^N$, and taking logarithm yields

[55] Details of derivation of the equation we explore empirically can be found in a Technical Appendix.

[56] As Horvath [2000], we use time series for output instead of value added so that our estimates can be compared with those documented by the author.

[57] In a Technical Appendix, we address one potential econometric issue. While $\beta^j_{i,t}$ (i.e., the RHS term in eq. (44)) is constructed independently from the dependent variable (i.e., the LHS term in eq. (44)), if the labor's share is (almost) constant over time and thus is close from the average ξ^j, an endogeneity problem may potentially show up. Our empirical results reveal that for the majority of the countries in our sample, the dependent variable does not Granger-cause the explanatory variable.

[58] Because an endogeneity problem of relative prices may potentially affect our econometric results, we ran Granger causality tests. Our empirical results reveal that for the majority of the countries in our sample, the dependent variable does not Granger-cause the explanatory variable. Our results show that one can consider the regressor in eq. (45) as exogenous with respect to the dependent variable.

Table 4: Estimates of the Elasticity of Labor Supply across Sectors (ϵ) and the Elasticity of Substitution in Consumption between Tradables and Non Tradables (ϕ)

Country	Labor Mobility (ϵ)	Elasticity of Substitution (ϕ)	
	eq. (44)	eq. (45)	eq. (46)
	$\hat{\epsilon}_i$	$\hat{\phi}_i^{FMOLS}$	$\hat{\phi}_i^{FMOLS}$
AUS	0.635^a (3.55)	0.268^a (2.99)	0.409^b (2.52)
AUT	0.548^a (2.66)	0.986^a (3.09)	1.413^a (4.99)
BEL	0.326^b (2.51)	0.070 (0.41)	0.795^a (4.99)
CAN	0.454^a (3.41)	0.391^a (3.74)	0.582^a (5.53)
DNK	0.150 (1.46)	2.071^a (2.95)	1.323^a (2.93)
ESP	1.642^a (3.02)	0.783^a (4.96)	0.413^b (2.04)
FIN	0.544^a (3.62)	1.072^a (8.57)	1.421^a (8.12)
FRA	1.287^b (2.44)	0.937^a (6.22)	1.038^a (5.25)
GBR	1.008^a (3.79)	0.477^a (9.64)	1.164^a (14.07)
IRL	0.264^a (3.18)	0.374^c (1.71)	0.158 (0.35)
ITA	0.686^a (2.84)	−0.308 (−1.60)	−0.187 (−0.98)
JPN	0.993^a (2.87)	0.654^a (2.98)	0.676^a (4.33)
NLD	0.224^b (1.97)	0.709^b (2.33)	0.428 (1.18)
NOR	0.097 (1.49)	0.979^a (9.72)	2.056^a (13.66)
SWE	0.443^a (3.61)	0.356^a (4.02)	0.900^a (7.23)
USA	1.387^a (2.59)	0.668^a (2.81)	0.799^b (2.02)
Whole Sample	0.479^a (12.16)	0.656^a (16.13)	0.837^a (14.16)
Countries	16	16	16
Observations	1178	605	605
Data coverage	1971-2007	1970-2007	1970-2007
Country fixed effects	yes	yes	yes
Time dummies	yes	yes	yes
Time trend	no	yes	yes

Notes: [a], [b] and [c] denote significance at 1%, 5% and 10% levels; t-statistics are reported in parentheses.

$\ln\left(\frac{\gamma^T}{\gamma^N}\right) = \eta + \phi \ln P$ where η is a term composed of both preference (i.e., φ) and production (i.e., θ^j) parameters, and (logged) ratios of G^T (G^N) and I^T (I^N) to $W^T L^T - \theta^T P^T NX$ ($W^N L^N$). We estimate ϕ by exploring alternatively the following empirical relationship:

$$\ln\left(\gamma^T/\gamma^N\right)_{i,t} = g_i + g_t + \sigma_i t + \phi_i \ln P_{i,t} + \zeta_{i,t}, \quad (46)$$

where g_i and g_t are the country fixed effects and time dummies, respectively, and we add country-specific trends, as captured by $\sigma_i t$, because η is composed of ratios that may display a trend over time.

Time series for sectoral value added at constant prices, labor compensation, and the relative price of non tradables are taken from the EU KLEMS [2011] and STAN databases (see Section A). Net exports correspond to the external balance of goods and services at current prices taken from OECD Economic Outlook Database. To construct time series for net exports at constant prices, NX, data are deflated by the value added deflator of traded goods P_t^T.

Since LHS terms of (45) and (46) and the relative price of non tradables display trends, we ran unit root and then cointegration tests. Having verified that these two assumptions are empirically supported, we estimate the cointegrating relationships by using fully modified OLS (FMOLS) procedure for cointegrated panel proposed by Pedroni [2000], [2001]. FMOLS estimates of (45) and (46) are reported in the second and the third column of Table 4 respectively. As a reference model, we consider eq. (45) which gives an estimate for the whole sample of $\phi = 0.66$. This value is roughly halfway between estimates documented by cross-section studies, notably Stockman and Tesar [1995] who find a value for ϕ of 0.44 and Mendoza [1995] who reports an estimate of 0.74.

Table 5: Data to Calibrate the Two-Sector Model (1990-2007)

Countries	Non tradable Share						G^j/Y^j		Labor Share		Product.	Aggregate ratios			Elasticities	
	Output	Consump.	Inv.	Gov. Spending	Labor	Lab. comp.	G^T/Y^T	G^N/Y^N	θ^T	θ^N	Z^T/Z^N	I/Y	G/Y	Labor Share	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	-
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	-
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: 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 labor productivity of tradables to labor productivity of non tradables. I/Y is the investment-to-GDP ratio and G/Y is government spending as a share of GDP.

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