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# ABSTRACT

## The Composition of Government Spending and the Real Exchange Rate*

We show that the composition of government spending influences the long-run behaviour of the real exchange rate. We develop a two-sector small open economy model in which an increase in government consumption is associated with real appreciation, while an increase in government investment may generate real depreciation. Our empirical work confirms that government consumption and government investment have differential effects on the real exchange rate and the relative price of nontradables.

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Keywords: government consumption, government investment and real exchange rate

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# 1. Introduction

In recent years, there has been a resurgence of interest in the long-run behavior of real exchange rates. Along one dimension, the role of an "undervalued" real exchange rate in accelerating development has been much debated (Rodrik 2007). A connected issue is the role of the real exchange rate in facilitating the emergence of large global imbalances, together with the implications of the accumulated net foreign asset position for the long-run value of the real exchange rate (Lane and Milesi-Ferretti 2002 and 2004, Galstyan 2007, Ricci et al 2008).

Within Europe, the long-run behavior of the real exchange rate has a special significance in the context of European Monetary Union (EMU). First, bilateral real exchange rate movements among the member countries take the form of inflation differentials, which cannot be properly interpreted without a view on the long-run drivers of the real exchange rate. Second, in relation to those countries that plan to join EMU, the projected path for the long-run real exchange rate matters in determining the correct entry rate for the nominal exchange rate and the timing of adopting the single currency.

In modelling the long-run behavior of the real exchange rate, the primary focus in the literature has been on factors such as productivity and the net foreign asset position. However, government spending has also been identified as a potential influence on the long-run real exchange rate. In the most comprehensive study, Ricci et al (2008) study the long-run determinants of the real effective exchange rate over 1980-2004 in a panel of 48 countries (combining advanced economies and emerging market economies) and find that government consumption is highly significant. Moreover, the estimated coefficient is economically large: a 1 percentage point increase in the ratio of government consumption to GDP is associated with a 3 percentage point appreciation of the real effective exchange rate.

The role of government consumption has previously been highlighted by Froot and Rogoff (1991), who postulate that increases in government consumption tend to increase the relative price of nontradables, since government consumption is concentrated on nontradables. Further empirical support is provided by De Gregorio et al (2004) and Chinn (1999), who also find that increases in government consumption are associated with real appreciation.[1]

Our goal in this paper is to expand the analysis of the relation between government

[1] There is also an active VAR literature on the short-run relation between fiscal shocks and the real exchange rate (Monacelli and Perotti 2006, Ravn, Schmitt-Grohe and Uribe 2007, Beetsma and Giuliodori 2007). Our focus here is on the long-run behaviour of the real exchange rate, which is not addressed in this literature.

spending and the long-run real exchange rate. In particular, the role of government investment has been neglected, with the literature cited above focusing on the role of government consumption. The distinction is important, since we wish to highlight that government consumption and government investment may be expected to have different effects on the evolution of relative price levels. While an increase in government consumption is typically modelled as increasing the relative demand for nontradables and thereby leading to real appreciation, a long-run increase in public investment has an ambiguous impact on the real exchange rate. While an increase in public investment that delivers a productivity gain in the tradables sector may generate real appreciation through the Balassa-Samuelson mechanism, if public investment disproportionately raises productivity in the nontradables sector, it may actually lead to real depreciation. Moreover, if productivity is increased symmetrically in both sectors, there is no long-run impact on the relative price of nontradables and the real exchange rate.

We illustrate these mechanisms by laying out a two-sector small open economy model that incorporates both government consumption and government investment as potential influences on the real exchange rate. In our empirical work, we examine trade-weighted real effective exchange rates and the relative price of nontradables for a panel of nineteen advanced economies over 1980-2004.[2] Our results confirm that an increase in government consumption appreciates the real exchange rate and increases the relative price of nontradables. Consistent with the model, the results for government investment are more ambiguous, with government investment leading to real depreciation for some country groups but with a zero effect for others.

The rest of the paper is organized as follows. Section 2 describes the theoretical framework, while Section 3 describes the data and reports the empirical results. Some conclusions are offered in Section 4.

## 2. Model

In this section, we lay out an adapted version of the standard two-sector small open economy model (Obstfeld and Rogoff 1996). The production functions for traded and nontraded goods are respectively

$$Y_T = A_T^* F(L_T, K_T) = (A_T Z^{\alpha_Z}) L_T^{\alpha_L} K_T^{\alpha_K} \tag{1}$$

[2]The set of advanced economies are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, United States.

$$Y_N = A_N^* G(L_N, K_N) = (A_N Z^{\beta_Z}) L_N^{\beta_L} K_N^{\beta_K} \tag{2}$$

where $L$ and $K$ stand for labor and capital, while $Z$ stands for the public capital stock. That is, we assume that total factor productivity in each sector is a composite of a sector-specific term ($A_T^*$, $A_N^*$) and the level of public capital.[3] Accordingly, productivity in both sectors is enhanced by a larger stock of public capital but we allow for the impact to be potentially different across sectors (if $\alpha_Z \neq \beta_Z$). We assume that $\alpha_L + \alpha_K = 1$, but $\beta_L + \beta_K < 1$. That is, we incorporate a fixed factor of production (normalized to 1) in the nontraded sector such that the production function in that sector exhibits diminishing returns to labor and capital.[4] The price of the traded good is equal to world price of the good and is normalized to 1, while the price of non-traded goods is $P_N$.

The accumulation functions for the private capital stocks in the traded and nontraded sectors are given by

$$\Delta K_T = I_T^K - \delta K_T \tag{3}$$

$$\Delta K_N = I_N^K - \delta K_N \tag{4}$$

where $I$ denotes the level of gross investment and $\delta$ is the depreciation rate. The public capital stock evolves according to

$$\Delta Z = I^Z - \delta Z \tag{5}$$

We assume that private capital formation in the traded and nontraded sectors only requires the traded good as an input, while public capital formation uses only the nontraded good as an input.[5] The representative household has an instantaneous utility function over the goods defined as

$$C = \frac{C_T^{1-\gamma} C_N^{\gamma}}{(1-\gamma)^{1-\gamma}\gamma^{\gamma}} \tag{6}$$

with the implication that optimal household expenditure shares on traded and nontraded goods are fixed at $(1-\gamma)$ and $\gamma$ respectively, with a unit elasticity of the relative consumption of nontradables in relation to the relative price of nontradables.

[3] See also Barro (1990) on the inclusion of public capital in the production function.

[4] By incorporating a fixed factor, this allows demand-side factors to influence the structure of long-run relative prices. As is well known, demand-side factors are irrelevant for long-run relative prices if both sectors show constant returns to scale in mobile factors (Obstfeld and Rogoff 1996). The main results do not change if we also allow for a fixed factor in the traded sector.

[5] In fact, the details of the investment process are not important for our analysis. These polar assumptions just simplifies the presentation of the model.

The welfare-based price index consistent with equation (6) is

$$P = P_N^{\gamma} \tag{7}$$

We assume that that the price of the non-traded good in the rest of the world is fixed and normalized to $1$, such that changes in $P$ correspond to changes in the real exchange rate.

The government runs a balanced budget, levying lump-sum taxes equal to the value of total government consumption and government investment

$$T = G_T + P_N(G_N + I^Z) \tag{8}$$

where $G_T, G_N$ are the levels of public consumption of the traded and nontraded goods respectively and $I^Z$ is the level of public investment.

Households own the domestic stocks of capital in the traded and nontraded sectors. There are no inter-sectoral or international capital adjustment costs, so that the return on capital is equal to the exogenously-fixed world interest rate. In addition, households own the fixed factor in the nontraded sector and so receive the income accruing to that factor (the residual claimant on profits in the nontraded sector). Accordingly, households face the following budget constraint

$$\Delta B = rB + r(K_T + K_N) + w(L_T + L_N) - (I_N^K + I_T^K) - C_T - P_N C_N + \Pi_N - T \tag{9}$$

where $B$ is an international bond that pays the fixed real world interest rate $r$ (in terms of tradables), $\Pi_N = (1 - \beta_L - \beta_K)P_N Y_N$ is the aggregate profit in the nontraded sector and $T$ is the tax burden.

For simplicity, we assume an inelastic aggregate labor supply. Labor is perfectly inter-sectorally mobile, such that the equilibrium in the labor market is

$$L_N + L_T = L \tag{10}$$

The equilibrium in the non-traded goods sector is

$$Y_N = C_N + G_N + I^Z \tag{11}$$

while the trade balance is determined by

$$TB = Y_T - C_T - G_T - (I_N^K + I_T^K) \tag{12}$$

Equations (1) to (12) together with the first-order conditions for private consumption and private investment and the profits of the non-traded sector form the system.

Our primary interest is in the long-run behavior of the real exchange rate. Accordingly, we focus on the steady-state solution of the model. In order to obtain an analytical solution, we assume no depreciation.[6] We initially solve for a benchmark steady state in which the levels of net foreign assets and government consumption are zero (in order to obtain a closed-form solution). Then we log-linearize the system around this benchmark, in order to examine the sensitivity of the steady-state real exchange rate to shifts in the steady-state values of the exogenous variables.

In the benchmark steady state, the relative price of non-traded goods is[7] [8]

$$P_N = \left( \eta L_N^{\frac{1-\beta_L-\beta_K}{1-\beta_K}} Z^{\frac{\alpha_Z}{1-\alpha_K}-\frac{\beta_Z}{1-\beta_K}} \right)^{1-\beta_K} \tag{13}$$

In the next stage, we log-linearize around this steady state and solve the system. The equation of primary interest is the one governing the real exchange rate, $\hat{P} = \gamma \hat{P}_N$, with the relative price of non-traded goods given by

$$\hat{P}_N = -\hat{A}_N + \frac{1-\beta_K}{1-\alpha_K}\hat{A}_T + \mu_0(r\hat{B} + [G_N - G_T]) + \mu_1 \hat{Z} \tag{14}$$

where hatted variables denote percentage deviations from the steady-state values.[9] Equation (14) shows that an improvement in productivity in the nontraded sector generates real depreciation and a decline in the relative price of nontradables, while an increase in productivity in the traded sector generates real appreciation and an increase in the relative price of nontradables, where these forces operate according to the classic Balassa-Samuelson mechanism.[10] The other key coefficients are

$$\mu_0 = \frac{\alpha_L(1-\beta_L-\beta_K)(1-\gamma)}{\alpha_L(1-\gamma)+\beta_L\gamma} > 0 \tag{15}$$

and

$$\mu_1 = \frac{(1-\beta_K)\alpha_Z - (1-\alpha_K)\beta_Z}{\alpha_L} <=> 0 \tag{16}$$

[6] With depreciation the model has to be solved numerically.

[7] See Appendix A for the set of steady state equations.

[8] The parameter $\eta$ is a complex product of the underlying parameters: $\eta = \alpha_L \alpha_K^{\frac{\alpha_K}{1-\alpha_K}} r^{\frac{\alpha_K}{1-\alpha_K}-\frac{\beta_K}{1-\beta_K}} \beta_L^{-1} \beta_K^{-\frac{\beta_K}{1-\beta_K}}$.

[9] The equations governing sectoral output and consumptiond dynamics are given in Appendix B.

[10] A symmetric increase in productivity in both sectors generates real appreciation if the nontraded sector is less capital intensive than the traded sector ($\beta_K < \alpha_K$).

Since $\mu_0 > 0$, the level and composition of spending matters for the real exchange rate. In particular, a country that is a long-run creditor ($\hat{B} > 0$) experiences real appreciation, since the interest income on the creditor position enables an increase in the steady-state level of consumption.[11] In the traded sector, this translates into a long-run trade deficit ($TB = -r\hat{B}$), while the increase in demand for the nontraded good generates real appreciation due to the presence of the fixed factor in the nontraded sector.[12] Moreover, an increase in government consumption that is concentrated on nontraded goods ($[G_N - G_T] > 0$) also generates real appreciation by shifting the composition of aggregate consumption towards the nontraded sector.[13]

Finally, the effect of an increase in the public capital stock on the real exchange rate is given by the coefficient $\mu_1$, which has an ambiguous sign. If an increase in public capital has a symmetric impact on productivity in both sectors ($\alpha_Z = \beta_Z$) and both sectors have similar capital shares ($\alpha_K = \beta_K$), the real exchange rate is unaffected by the level of the public capital stock. If $\alpha_Z = \beta_Z$ but the nontraded sector is less capital intensive ($\alpha_K > \beta_K$), then an increase in public capital generates real appreciation, by the same logic as a symmetric improvement in the sector-specific productivity terms $A_T$ and $A_N$. However, even if $\alpha_K > \beta_K$, it is possible to construct scenarios in which an increase in the public capital stock generates real depreciation if productivity in the nontraded sector is more sensitive to the level of public capital than is productivity in the traded sector ($\alpha_Z < \beta_Z$). Accordingly, the sign of the relation between public investment and the real exchange rate is ultimately an empirical matter.

## 3. Data and Empirical Specification

### 3.1. Data

The data covers years 1980 to 2004. The relative price of non-traded goods is constructed using the ratio of the deflators of services sectors to manufacturing sectors from the EU *KLEMS* database (Timmer et al 2008).[14] The relative productivity differential variable is

[11]See also Lane and Milesi-Ferretti (2002, 2004) and Galstyan (2007).

[12]As noted earlier, if the share of the fixed factor in the non-traded sector were equal to zero, then $\mu_0 = 0$, and the demand side is redundant for the real exchange rate.

[13]A balanced increase in government consumption across the two sectors has no effect on the relative price of non-traded goods. Since the aggregate labour supply is inelastic, the level of production in each sector is unchanged by a shift in the mix between public and private consumption that leaves aggregate consumption in each sector unchanged (if $G_T$ and $G_N$ are simultaneously increased by one unit each, $C_T$ and $C_N$ each decline by one unit).

[14]The services sector is defined as the aggregate of 'Wholesale and Retail Trade', 'Hotels and Restaurants', 'Transport and Storage and Communication', 'Finance, Insurance, Real Estate and Business Services' and

constructed using relative labor productivities from the same *KLEMS* database. The real exchange rate is constructed using the consumer price index and the nominal period-average exchange rate from the International Monetary Fund's *International Financial Statistics* database, with the trade weights calculated by Bayoumi et al (2005). GDP per capita (measured in constant 2000 US dollars), is taken from the World Bank's *World Development Indicators* database. The balance on goods and services (in current USD) is from International Monetary Fund's *International Financial Statistics* database. The current-dollar value of GDP is from International Monetary Fund's *World Economic Outlook* database. Government consumption and government investment in current US dollars are taken from the OECD.

It is important to measure variables in relative terms in order to capture the forces driving the structure of international relative prices. Accordingly, variables for each country are expressed relative to a weighted-average across the set of OECD trading partners in the database.[15]

### 3.2. Empirical Evidence

Next, we turn to more formal econometric evidence. Table 1 shows the statistics from panel unit root and cointegration tests. The tests do not reject the null of a unit root for the real exchange rate and the relative price of nontradables. In addition, the tests indicate non-stationarity for several of the explanatory variables (the productivity differential, relative GDP per capita and the trade balance). The evidence for the fiscal variables is mixed: while the PP-Fisher unit root test indicates non-stationarity, the other tests reject the unit root null. However, it is clear that the fiscal variables are highly persistent (a panel estimate of an AR(1) specification gives an estimated coefficient of 0.9), such that it is pragmatic to also treat the fiscal variables as non-stationary.[16] The Kao cointegration test clearly rejects the null of no cointegration among the variables for both the real exchange rate and relative price of nontradables equations.

Since non-stationarity is pervasive in the set of variables, we focus on the panel dy-

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'Community Social and Personal Services'. In this case the aggregate price index is the weighted average of sectoral price indices, where the weights are the value shares in the base year.

[15]For most members of the euro area (excluding Germany and Greece), the trade share with the set of 19 OECD countries is more than 70 percent. Among the other countries, Canada, Denmark, Norway, Sweden and the United Kingdom have a trade share of more than 70 percent. Only the United States and Japan have approximately 50 percent share, while Australia has a share of 60 percent. Accordingly, using the 19 OECD countries in the database to form trade-weighted averages is more or less representative.

[16]We also ran the dynamic OLS estimator on artificial data with three non-stationary variables and one persistent but stationary variable. Our simulation suggests that dynamic OLS is a good estimator for the scenario.

namic OLS (DOLS) estimator to establish the long-run relation between the explanatory variables and the real exchange rate and the relative price of nontradables. In general, our empirical specification is based on equation (14).

The specification for DOLS(-1,1) is

$$y_{it} = \alpha_i + \theta_t + \boldsymbol{\beta}'\mathbf{x}_{it} + \sum_{j=-1}^{j=1} \Delta\mathbf{x}_{it-j} + \epsilon_{it} \tag{17}$$

where $y_{it}$ is the dependent variable and $\mathbf{x}$ is the set of explanatory variables.[17] The $\beta$ coefficients in equation (17) capture the long-run impact on $y$ of long-run changes in the $\mathbf{x}$ variables. We are interested in explaining the long-run behavior of: (a) the real exchange rate; and (b) the relative price of nontradables.[18]

For the real exchange rate, we plausibly assume that the productivity differential between the traded and nontraded sectors is increasing in the level of GDP per capita.[19] Accordingly, we expect a positive long-run relation between the relative level of GDP per capita (measured relative to trading partners) and the real exchange rate. In relation to the positive impact of international investment income on the real exchange rate, we exploit the steady-state relation that the trade balance surplus should equal the international investment income deficit ($TB = -rB$) and thereby include the trade balance surplus as a regressor (the expected sign is negative).[20] Finally, government consumption and government investment (both measured relative to trading partners) are included, where the model suggests that an increase in government consumption should be associated with real appreciation but the sign on government investment is not tied down.[21] The specification is quite similar for the relative price of nontradables, with the exception that GDP per capita and the fiscal variables are measured in absolute terms, rather than relative to trading partners.[22]

[17] The choice of one lead and lag is dictated by the sample length.

[18] Although these two variables are isomorphic in the simplified model that was presented in Section 2, we recognize that various factors can generate substantial differences in the empirical behavior of these variables.

[19] Since government investment operates via a productivity channel, we do not want to directly include a productivity measure in the regression specification. Rather, we include GDP per capita as a general correlate of the level of productivity.

[20] See also Lane and Milesi-Ferretti (2002) and Galstyan (2007). An alternative is to include the level of net foreign assets (Lane and Milesi-Ferretti 2004 and Ricci et al 2008). However, the long-run relation between net foreign assets and the trade balance depends on the composition of the international balance sheet and the levels of returns earned on foreign assets and liabilities. Accordingly, the long-run trade balance is a better indicator of the long-run level of net international investment income.

[21] Although the model is written in terms of the level of public capital $Z$, we assume a close correspondence between the long-run level of public investment and the long-run level of public capital.

[22] The dependent variable is the relative price of nontradables, for which the value of domestic fiscal

Before turning to the panel DOLS estimates that focus on the time series dimension, we show graphically the relation between changes in government spending and changes in the real exchange rate along the cross-sectional dimension. Figure 1 shows the relation between the cross-country relation between changes in the fiscal variables and changes in the real exchange rate over 1980-2004.[23] The real exchange rate is positively correlated with government consumption (the correlation is $0.52$), while it is negatively correlated with government investment (the correlation is $-0.26$). Accordingly, the cross-country data supports the basic thrust of the theoretical model, by highlighting the real exchange rate is differentially sensitive to government consumption and government investment.

The DOLS results for the real exchange rate are presented in Table 2. We run the regressions for a variety of country groups. In addition to the full sample of OECD countries, we also differentiate between larger and smaller economies by running separate panel regressions for the G3 and non-G3 samples.[24] We also consider the sample of EMU member countries. This group is especially interesting, since real exchange rates for these countries have been much less volatile since the formation of European Monetary Union in 1999 – the elimination of bilateral nominal exchange rate shocks among the member countries may make it easier to capture the long-run patterns that are the focus of this paper. In turn, we allow for differences in country size within the EMU bloc by running separate panel regressions for the E4 group of the four largest countries (France, Germany, Italy and Spain) and the group of smaller member countries (non-E4 group).

Column (1) shows the estimates for the full sample. In relation to the fiscal variables, an 1 percentage point increase in relative government consumption is associated with a 1.2 percent appreciation in the real exchange rate and this estimate is significant at the 1 percent level. In contrast, relative government investment has a negative sign but is not significant. Accordingly, the general pattern is in line with predictions of the theoretical model, in that the composition of government spending matters: an increase in government consumption appreciates the real exchange rate in the long-run, but government investment does not. The control variables also are highly significant in the expected

variable is important. If the dependent variable were the difference in the relative price of nontradables acrosss countries, then the fiscal variables should be entered in relative terms. We have run this alternative specification - these results are available upon request.

[23]More precisely, Figure 1 plots the residual of the change in the real exchange rate against the residuals of the changes in government investment and government consumption, after each of these variables has been regressed on the set of controls: changes in the trade balance, relative GDP per capita and the omitted fiscal variable. Accordingly, the scatter plot captures the conditional comovement between these variables.

[24]The G3 is defined as Germany, Japan and the United States. See Lane and Milesi-Ferretti (2002, 2004) and Galstyan (2007) on the reasons why the sensitivity of relative prices to fundamentals should systemically vary with country size. In the simplified model in Section 2, the share of nontradables in consumption ($\gamma$) serves as a proxy for country size, in that we may expect larger economies to have relatively larger nontraded sectors.

manner, with an increase in relative GDP per capita and a long-run trade deficit both associated with real appreciation.

Columns (2) and (3) show the results when the sample is split between the G3 and non-G3 groups. In each group, the main fiscal results from the full sample carry over in qualitative terms. However, in line with the findings of Lane and Milesi-Ferretti (2002, 2004) and Galstyan (2007), the magnitudes of the coefficients are much larger for the G3 group. It is also noteworthy that the estimated semi-elasticity of the real exchange rate with respect to relative government consumption for the G3 group is quite similar to the estimate reported by Ricci et al (2008). Finally, we note that the control variables are significant for the non-G3 group but are individually insignificant for the G3 group.

We turn our attention to the EMU sample in columns (4)-(6). The results are broadly similar to the wider panel, with the exception that neither fiscal variable is individually significant for the E4 group of larger member countries.

The estimates for the relative price of nontradables are reported in Table 3. An increase in government consumption is significantly associated with an increase in the relative price of nontradables for the EMU and E4 samples. In contrast, it is striking that an increase in government investment is significantly associated with a decline in the relative price of nontradables for each sample, with the exception of the E4 group. For the non-G3 and non-E4 samples, the approximate coefficient estimate of $-3.4$ indicates that a 1 percentage point increase in the ratio of government investment to GDP (which corresponds to a one standard deviation increase in the panel data) is associated with a $3.4$ percent decline in the relative price of nontradables. In relation to the control variables, we note that the relative price of nontradables is increasing in the level of GDP per capita across all country groups.[25]

According to our model, government investment affects the structure of relative prices through its impact on relative sectoral productivity: it generates real appreciation if productivity is raised relatively more in the traded sector than the nontraded sector, and conversely it is associated with real depreciation if the productivity gains are concentrated in the nontraded sector. We directly examine this mechanism in Table 4, where we regress $(A_N^*/A_T^*)$ on GDP per capita and the level of government investment, using the same DOLS(1,1) estimator. The results in Table 4 are consistent with those in Table 3, in that there is evidence that an increase in government investment disproportionately raises productivity in the nontraded sector for most of the country groups. (As expected, an increase in GDP per capita is associated with an increased in traded-sector productivity relative to nontraded-sector productivity).

[25] In addition, the trade balance is positive and marginally significant for the non-E4 group.

## 4. Conclusion

The main goal of this paper has been to show that the composition of government spending matters for the long-run dynamics of the real exchange rate. In our theoretical model, we have shown that government consumption typically leads to real appreciation but that the sensitivity of the real exchange rate to government investment depends on how an increase in the public capital stock differentially affects sectoral productivity levels in the traded and nontraded sectors. Our empirical estimates confirmed that government consumption indeed generates real appreciation for the full sample, while showing that government investment has no significant long-run impact on the real exchange rate for the set of EMU member countries.

Next, we checked whether the fiscal variables operate through the relative price of nontradables in the manner embedded in the theoretical analysis. We found that an increase in government consumption raises the relative price of nontradables for the EMU sample and sub-samples, while government investment is associated with a decline in the relative price of nontradables for most country groups. In turn, we found that the productivity gains from an increase in government investment are concentrated in the nontraded sector, which is consistent with the relative price evidence and the mechanism specified in our theoretical model.

## Appendix A: Benchmark Steady State

In the benchmark steady state, labor is distributed between the sectors according to

$$L_T = \frac{\alpha_L(1-\gamma)}{\alpha_L(1-\gamma)+\beta_L\gamma}L \tag{A.1}$$

$$L_N = \frac{\beta_L\gamma}{\alpha_L(1-\gamma)+\beta_L\gamma}L \tag{A.2}$$

The relative price of non-traded goods is

$$P_N = \left(\eta L_N^{\frac{1-\beta_L-\beta_K}{1-\beta_K}} Z^{\frac{\alpha_Z}{1-\alpha_K}-\frac{\beta_Z}{1-\beta_K}}\right)^{1-\beta_K} \tag{A.3}$$

where $\eta = \alpha_L \alpha_K^{\frac{\alpha_K}{1-\alpha_K}} r^{\frac{\alpha_K}{1-\alpha_K}-\frac{\beta_K}{1-\beta_K}} \beta_L^{-1} \beta_K^{-\frac{\beta_K}{1-\beta_K}}$

Capital is distributed between the sectors as follows

$$K_T = \left(\frac{\alpha_K L_T^{\alpha_L} Z^{\alpha_Z}}{r}\right)^{-\frac{1}{\alpha_K-1}} \tag{A.4}$$

$$K_N = P_N^{-\frac{1}{\beta_K-1}} \left(\frac{\beta_K L_N^{\beta_L} Z^{\beta_Z}}{r}\right)^{-\frac{1}{\beta_K-1}} \tag{A.5}$$

In the benchmark steady state, the levels of consumption of traded and nontraded goods are equal to the respective outputs and are given by

$$C_T = Y_T = Z^{\alpha_Z} L_T^{\alpha_L} K_T^{\alpha_K} \tag{A.6}$$

$$C_N = Y_N = Z^{\beta_Z} L_N^{\beta_L} K_N^{\beta_K} \tag{A.7}$$

where we normalise $A_T = A_N = 1$ and we assume a zero depreciation rate such that the steady state levels of private and public investment are zero.

## Appendix B: Sectoral Equations of Motion

The equations governing sectoral output and consumption behaviour are given by

$$\hat{Y}_T = \frac{1}{\alpha_L}\hat{A}_T - \frac{\beta_L\gamma}{\alpha_L(1-\gamma)+\beta_L\gamma}\left(r\hat{B} + [\hat{G}_N - \hat{G}_T]\right) + \frac{\alpha_Z}{\alpha_L}\hat{Z} \tag{B.1}$$

$$\hat{Y}_N = \hat{A}_N + \frac{\beta_K}{\alpha_L}\hat{A}_T + \frac{\alpha_L(\beta_K+\beta_L)(1-\gamma)}{\alpha_L(1-\gamma)+\beta_L\gamma}\left(r\hat{B} + [\hat{G}_N - \hat{G}_T]\right) + \frac{\alpha_Z\beta_K + \alpha_L\beta_Z}{\alpha_L}\hat{Z} \tag{B.2}$$

$$\hat{C}_T = \frac{1}{\alpha_L}\hat{A}_T + \frac{\alpha_L(1-\gamma)}{\alpha_L(1-\gamma)+\beta_L\gamma}\left(r\hat{B} - [\hat{G}_T + \frac{\beta_L\gamma}{\alpha_L(1-\gamma)}\hat{G}_T]\right) + \frac{\alpha_Z}{\alpha_L}\hat{Z} \tag{B.3}$$

$$\begin{aligned}\hat{C}_N \quad = \quad & \frac{\alpha_L(\beta_K+\beta_L)(1-\gamma)}{\alpha_L(1-\gamma)+\beta_L\gamma}\left(r\hat{B} - [\hat{G}_T + \frac{\alpha_L(1-\beta_K-\beta_L)(1-\gamma)+\beta_L\gamma}{\alpha_L(\beta_L+\beta_K)(1-\gamma)}\hat{G}_N]\right) \\ & + \hat{A}_N + \frac{\beta_K}{\alpha_L}\hat{A}_T + \frac{\alpha_Z\beta_K + \alpha_L\beta_Z}{\alpha_L}\hat{Z}\end{aligned} \tag{B.4}$$

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Figure 1: Cross-Country Relation Between Fiscal Variables and Real Exchange Rate, 1980-2004.

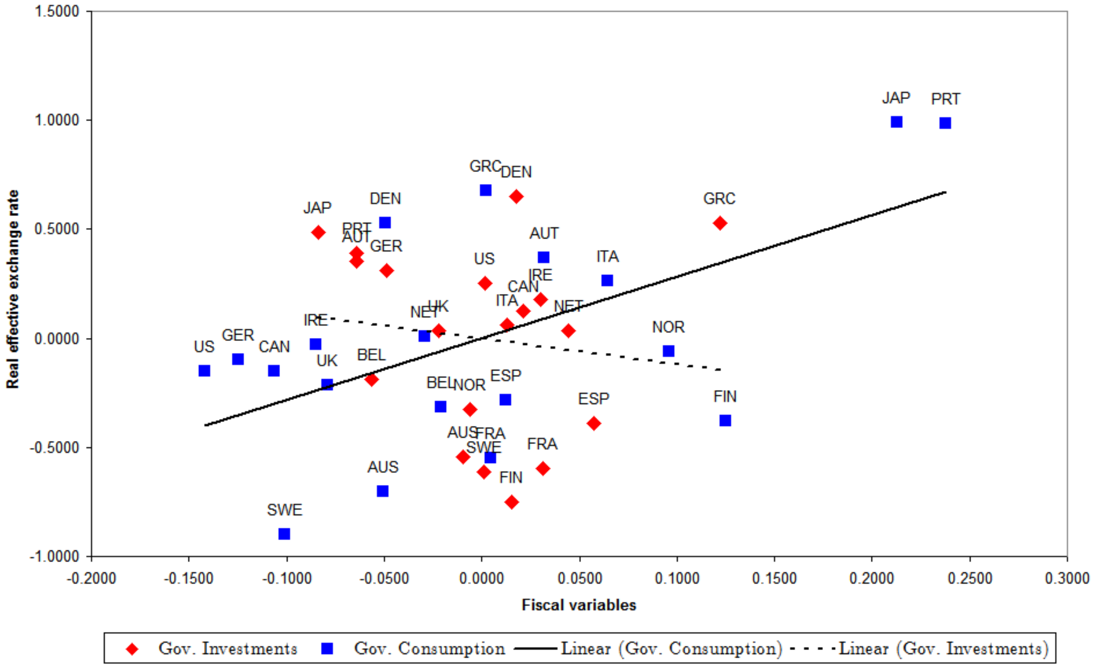

Table 1: Panel Unit Root and Cointegration Tests

| **Panel A: Unit Root Test** | Levin, Lin and Chu | Im, Pesaran and Shin | PP-Fisher Chi-Square |
|---|---|---|---|
| ln(REER) | 0.33 | 0.04 | 0.07 |
| ln(RNP) | 0.79 | 1.00 | 0.99 |
| ln(Prod. Diff.) | 0.18 | 1.00 | 0.31 |
| Trade Balance | 0.00 | 0.00 | 0.00 |
| ln(Rel. GDP per capita) | 0.30 | 0.41 | 0.78 |
| Rel. Govt. Consumption | 0.04 | 0.03 | 0.59 |
| Rel. Govt. Investment | 0.00 | 0.00 | 0.05 |
| Govt. Consumption | 0.06 | 0.02 | 0.47 |
| Govt. Investment | 0.00 | 0.03 | 0.01 |
| ln(GDP per capita) | 0.22 | 1.00 | 1.00 |
| **Panel B: Kao Cointegration Test** | | | |
| ln(REER) Trade Balance ln(Rel. GDP per capita) Rel. Govt. Consumption Rel. Govt. Investment | | | -6.12<br>(0.00) |
| ln(RNP) Trade Balance ln(GDP per capita) Govt. Consumption Govt. Investment | | | -1.67<br>(0.05) |
| ln(Prod. Diff.) ln(GDP per capita) Govt. Investment | | | -2.14<br>(0.02) |

*Note:* ln stands for natural logarithm; REER indicates the real effective exchange rate computed by the authors using trade shares provided by Bayoumi et al (2005) using the set of countries listed in Appendix A; RNP is the unit value of services relative to manufacturing; Prod. Diff. is the ratio of labor productivity of services to manufacturing sector; Trade Balance is the trade balance as a share of GDP; Rel. GDP per capita is real relative GDP per capita; Rel. Govt. Consumption is relative government consumption as a share of GDP; Rel. Govt. Investment is government investments as a share of GDP; Govt. Consumption is the government consumption as a share of GDP; Govt. Investment is government investment as a share of GDP; GDP per capita is real GDP per capita.

Table 2: Real Exchange Rates: Long-Run Behavior

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Rel. Govt. Consumption | 1.64 | 2.70 | 1.64 | 1.77 | 2.17 | 1.63 |
| | (.47)*** | (1.34)** | (.40)*** | (.40)*** | (1.52) | (.46)*** |
| Rel. Govt. Investment | -0.64 | -8.02 | -1.06 | -0.99 | 1.13 | -1.28 |
| | (1.23) | (4.85) | (1.14) | (1.12) | (2.53) | (1.37) |
| Rel. GDP per capita | 0.31 | 0.48 | 0.28 | 0.23 | 0.40 | 0.19 |
| | (.09)*** | (.80) | (.08)*** | (.09)*** | (.26) | (.10)* |
| Trade Balance | -1.15 | -0.50 | -0.99 | -1.26 | -1.54 | -1.24 |
| | (.20)*** | (1.11) | (.21)*** | (.24)*** | (.54)*** | (.30)*** |
| $R^2$ | 0.61 | 0.62 | 0.55 | 0.53 | 0.29 | 0.59 |
| Marginal $R^2$ | 0.14 | 0.29 | 0.15 | 0.23 | 0.26 | 0.24 |
| Observations | 418 | 66 | 352 | 242 | 88 | 154 |
| Sample | All | G3 | Non-G3 | EMU | E4 | Non-E4 |

*Note:* Real effective exchange rate is computed by the authors using trade shares provided by Bayoumi et al (2005) using the set of countries listed in Appendix A; ln stands for natural logarithm; Rel. Govt. Consumption is relative government consumption as a share of GDP; Rel. Govt. Investment is relative government investments as a share of GDP; Rel. GDP per capita is the log of real relative GDP per capita; Trade Balance is the trade balance as a share of GDP.
Marginal $R^2$ is constructed by subtracting the ratio of the residual sum of squares of fixed effects regression with the set of control variables over the residual sum of square of the regression on the fixed effects only from one.
***,**,* significant at 1,5 and 10 percent respectively.

Table 3: Relative Price of Nontradables: Long-Run Estimates

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Govt. Consumption | 0.89 | 0.36 | 0.96 | 1.70 | 6.73 | 1.26 |
| | (.70) | (1.39) | (.79) | (.90)* | (1.32)*** | (.88) |
| Govt. Investment | -2.25 | 8.41 | -3.54 | -1.86 | 0.15 | -3.36 |
| | (.95)** | (3.79)** | (1.07)*** | (1.09)* | (1.76) | (.92)*** |
| GDP per capita | 0.63 | 1.05 | 0.59 | 0.63 | 0.79 | 0.54 |
| | (.04)*** | (.12)*** | (.05)*** | (.05)*** | (.07)*** | (.05)*** |
| Trade Balance | -0.44 | 0.58 | -0.40 | 0.59 | 0.99 | 0.67 |
| | (.40) | (1.05) | (.44) | (.36) | (.50)* | (.43) |
| $R^2$ | 0.71 | 0.86 | 0.69 | 0.74 | 0.92 | 0.70 |
| Marginal $R^2$ | 0.58 | 0.80 | 0.56 | 0.71 | 0.89 | 0.68 |
| Observations | 418 | 66 | 352 | 242 | 88 | 154 |
| Sample | All | G3 | Non-G3 | EMU | E4 | Non-E4 |

*Note:* Relative Price of Nontradables is the unit value of services relative to manufacturing; ln stands for natural logarithm; Govt. Consumption is government consumption as a share of GDP; Govt. Investment is government investments as a share of GDP; GDP per capita is the log of real GDP per capita; Trade Balance is the trade balance as a share of GDP.
Marginal $R^2$ is constructed by subtracting the ratio of the residual sum of squares of fixed effects regression with the set of control variables over the residual sum of square of the regression on the fixed effects only from one.
***,**,* significant at 1,5 and 10 percent respectively.

Table 4: Relative Sectoral Productivity Levels

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| GDP per capita | -0.92 | -1.21 | -0.89 | -1.02 | -0.97 | -1.05 |
| | (.06)*** | (.13)*** | (.07)*** | (.07)*** | (.11)*** | (.08)*** |
| Govt. Investment | 3.38 | -2.31 | 3.94 | 3.26 | -1.15 | 5.44 |
| | (1.39)** | (2.76) | (1.64)** | (1.31)** | (2.25) | (1.40)*** |
| $R^2$ | 0.87 | 0.87 | 0.88 | 0.89 | 0.85 | 0.91 |
| Marginal $R^2$ | 0.72 | 0.81 | 0.70 | 0.79 | 0.79 | 0.80 |
| Observations | 418 | 66 | 352 | 242 | 88 | 154 |
| Sample | All | G3 | Non-G3 | EMU | E4 | Non-E4 |

*Note:* GDP per capita is the log of real GDP per capita; Govt. Investment is government investments as a share of GDP.
Marginal $R^2$ is constructed by subtracting the ratio of the residual sum of squares of fixed effects regression with the set of control variables over the residual sum of square of the regression on the fixed effects only from one.
***,**,* significant at 1,5 and 10 percent respectively.