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by

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Abstract

This paper reports an empirical finding on the relation between the age structure of economies and their real exchange rate. The relation varies with the level of development. Among developed countries a 10 percentage point higher ratio of old people to the working age population is associated with a 12-15 percent higher price level. In middle income developing economies, a 10 percentage point increase in the ratio of children to the working age population is related to a 4 percent increase in the price level. The real exchange rate reflects the relative price of nontradables. A simple model attributes the findings to the effect of the age groups on the demand for nontradables. Its calibration indicates that the suggested explanation can account for a substantial part of the observed effect of the elderly. It is also consistent with the finding that the impact of children is much smaller. The fact that the significance of the elderly is limited to developed countries further supports the argument.

1. Introduction

The relative size of age groups differs substantially across countries. Important demographic changes also take place within countries over longer time horizons. In particular, the share of the elderly in the population is expected to rise sharply in developed countries over the coming decades.

The empirical finding of this paper is that variations in the age structure of economies are significant in accounting for differences in national price levels. The effect changes with the country's level of development. Among developed countries, an economy in which the ratio of old people to the working age population is 10 percentage points higher, will have a 12-15 percent higher price level. In middle income developing countries a 10 percentage point increase in the ratio of children to the working age population is associated with a 4 percent increase in the price level. Prices are not affected by either ratio in poor countries.

If the Purchasing Power Parity (PPP) holds for tradables, then the real exchange rate is determined only by the relative price of nontradables. I suggest that the positive correlation between the relative size of the age groups and the price level is due to their effect on aggregate demand for nontradables. This effect may operate through three channels, two of which are common to both groups. The third is unique to the elderly. The elderly and the young differ from the working age population in both the composition of their consumption and their saving rate. The consumption of children and old people is biased towards services which are nontradable: children require education while the elderly demand health care and related personal care services. An increase in their proportion in the population thus shifts aggregate demand towards nontradables. The young and the retired also have a negative effect on the aggregate saving rate. This means a higher level of demand (for all goods) at any given national income. The composition and saving channels both imply that any reallocation of resources from workers to children and the elderly will increase the total demand for nontradables. The third channel is related to the fact that beyond any transfer of resources from workers, the elderly have another source of income: their savings. A larger retired population may command more income from assets, therefore greater purchasing power in the economy. Even if the elderly saved at the same rate as workers did and had the same consumption patterns, unlike workers they add purchasing power without adding labor supply. This raises the demand for labor relative to its supply and thus the price of nontradables. In this respect the asset income of the elderly is reminiscent of the classic transfer problem. If that income were given to the workers (say as a unilateral transfer from abroad), the price level would rise as well. The differences in saving and consumption behavior only magnify this effect. A higher demand for nontradables, induced through any of the suggested channels, raises their price. The price of tradables is unaffected (if the country is small and open to trade). The result is a higher overall price level in the economy relative to other countries, in other words, an appreciation of the real exchange rate.

Should demand factors have any effect on relative national price levels, i.e., on the real exchange rate (RER)? The determinants of the RER have been explored extensively by the empirical literature. It has devoted much attention to testing the Balassa-Samuelson effect of differential productivity growth in tradables relative to nontradables. However, as Froot and Rogoff (1995) suggest in their survey, the evidence on this effect is mixed. Moreover, this supply side factor will be the sole determinant of the RER only in the presence of perfect capital markets. If these markets are imperfect then demand side factors should also matter. Several studies have looked at such factors. They typically use (any or all of) three variables as proxies for shifts in demand towards nontradables: government consumption, income per capita, and the terms of trade. Governments presumably spend more heavily on nontradables. The relative demand for services may grow with income if preferences are non-homothetic. Terms of trade shocks may work in a similar manner through their potential income and intertemporal implications. Bergstrand (1991), Froot and Rogoff (1991), De Gregorio and Wolf (1994), Chinn and Johnston (1996), and Giacomelli (1998) include some or all of these demand related variables in the regressions. They generally conclude that increased demand for nontradables is significantly correlated with an appreciation of the RER. De Gregorio et. al. (1994) find a similar effect of demand on inflation in nontradables. Garcia (1998) suggests using income inequality to test for demand effects, but concludes that it likely influences the RER through another channel.

The current paper contributes to the empirical literature on demand factors that affect the RER. Its innovation is in using new variables (age structure) as proxies for demand shocks. The variables that are typically used to capture such shocks have some disadvantages. Government's share in GDP may overstate the rise in demand for nontradables. Any increase in their price will raise the relative cost of government consumption, thus inflating its measured share in GDP. The relative size of the government may also have supply side implications (e.g., regulation, taxes). Terms of trade too have potential supply side effects such as changing the price of imported inputs or reallocating factors across sectors. GDP per capita reflects both differences in productivity and differences in income. Some papers, account for this by including direct measures of TFP differentials in addition to income per capita. Yet the variation in GDP per capita may also reflect an additional supply side effect: differences in relative factor endowments. If nontradables (services) are labor intensive relative to tradables then they should be more expensive in countries with a higher capital to labor ratio i.e., in richer countries. Bhagwati (1984) and Kravis and Lipsey (1983) discuss this point. Bergstrand (1991) includes the capital to labor ratio in the regressions and finds a significant effect on the RER. It reduces the significance of the income variable. Garcia (1998) also notes the importance of factor endowments.

I present a simple model that demonstrates the demand effects of the age structure on the price level through the various channels. A calibration of the model provides boundaries on the size of the effects that the proposed explanation may reasonably be expected to generate. Comparing these predictions with the regression results allows for an evaluation of the model's usefulness.

The data cover 98 countries for quinquennial years 1970-1990. Estimating the regressions for the full sample yields implausible coefficients in terms of the effect of the elderly dependency ratio on the RER. Inspection of the data reveals severe multicollinearity in the full sample among three explanatory variables: the elderly and child dependency rates and income per capita. However, when the sample is split into OECD, and middle-income NON-OECD countries the correlation among these variables is largely eliminated. Using these samples separately, the results are that in OECD countries the elderly dependency rate has a significant effect on the RER but the child dependency rate does not. The opposite holds for lower income countries. The estimated coefficients are somewhat larger, yet roughly within the order of magnitude of the values predicted by the calibration. Thus the proposed explanation can account for a sizable part of the effect. Furthermore, the regression results are consistent with the model's prediction that the impact of the elderly should be much larger than that of children.

The finding that the effect of the elderly is limited to developed economies supports the suggested explanation. The channels mentioned earlier will be operative only if the elderly have wide excess to advanced (and expensive) health care and nursing homes, if there is a well developed social security system that taxes workers and transfers the benefits to the elderly and if current retirees were able to save and accumulate assets (say through pension funds and other financial institutions) when they were workers. All of these mechanisms are clearly more relevant in the developed countries. In particular in many less-developed countries the extended family rather than formal institutions provides for the needs of the elderly.

Following the logic of the suggested explanation one indeed expects children not to affect prices in very poor countries. Saving is hardly feasible there and school attendance is minimal. The calibration predicts that the impact should at any rate be small. Yet the specific range of development in which it is detectable is an empirical issue. The finding that the effect of children is nonexistent in OECD countries and somewhat larger than predicted in middle income developing countries serves in qualifying the argument and bounding its applicability.

Dependency rates may also have supply side effects. A currently high ratio of retirees to workers is the result of either a relatively large cohort of workers in the previous period or enhanced longevity of that cohort. Either factor (longevity to the extent that it was anticipated) may have increased the total amount of savings in the earlier period. If capital is not internationally perfectly mobile, increased savings in the past could yield a larger capital stock per worker at present. Longevity and improved health might encourage workers to postpone retirement. The elderly may also help in taking care of their grandchildren, thus facilitating women's participation in the labor market. Lower fertility also promotes such participation. These possible effects will translate into higher GDP per capita. High dependency ratios may also reflect a skewed composition of the labor force. A large fraction of workers either at the beginning of their careers or approaching retirement, may have a negative effect on the overall productivity of the labor force and thus on GDP per capita. To the extent that this erodes total factor productivity in tradables more than in nontradables, the price of the latter will fall in line with the Balassa-Samuelson argument. Yet all these supply side forces will translate into higher or lower GDP per capita. Therefore, they cannot explain any effect of the dependency rates that remains after controlling for this variable.

In the OECD sample the impact of the elderly becomes insignificant when GDP per worker is included in the regressions instead of GDP per capita (the results are not affected by this change of variable in all other samples). Neither of the two variables is ideal. The per capita figure may fail to account for variations in the size of the labor force relative to the population. The per worker indicator potentially mismeasures the income effect. The interpretation of the impact of the elderly in developed countries should therefore be viewed with caution.

The paper proceeds as follows. Section 2 presents the model. Its calibration and sensitivity checks are reported in Section 3. The empirical evidence is discussed in Section 4. Section 5 concludes.

2. The Model

Consider an overlapping generations economy that consists of three types of individuals at any point in time t: children, workers (adults), and old people (retirees). Let μ_t be the number of children and ϕ_t the number of old people. The number of workers is normalized to 1. μ_t, ϕ_t are thus the child and elderly dependency rates respectively.

A worker at time t earns a wage w_t and his after-tax income is $w_t - \tau_t$. He allocates his income between current consumption for himself and his children and savings for his own future consumption after retirement. Two goods are used in consumption: tradables *(T)* and nontradables *(N)*. The worker's optimization problem is therefore to maximize the following utility function:

$$U_t = u\left(C_{NW_t}, C_{TW_t}\right) + \beta\mu_t u\left(C_{NC_t}, C_{TC_t}\right) + \rho u\left(C_{NO_{t+1}}, C_{TO_{t+1}}\right) \tag{1}$$

where:

$$u\left(C_{Ni_t}, C_{Ti_t}\right) = \alpha_i \log C_{Ni_t} + (1-\alpha_i)\log C_{Ti_t} \qquad i = w, c, o \tag{2}$$

subject to:

$$\begin{aligned} & P_{N_t}C_{NW_t} + P_{T_t}C_{TW_t} + \mu_t\left(P_{N_t}C_{NC_t} + P_{T_t}C_{TC_t}\right) \\ + & \frac{P_{N_{t+1}}C_{NO_{t+1}} + P_{T_{t+1}}C_{TO_{t+1}}}{1+r^*} = w_t - \tau_t + \frac{b}{1+r^*} \end{aligned} \tag{3}$$

C is consumption, subscripts *T, N* denote tradables and nontradables respectively and subscripts *W, C, O* denote workers, children, and old age respectively. α_i *(i=w,c,o)* characterizes the differences in preferences in the three stages of life. If $\alpha_c, \alpha_o > \alpha_w$ then consumption of children and old people is biased towards nontradables (relative to that of workers). μ_t, as noted, is the number of children the worker has. The consumption of each child is discounted by a factor β in the parent's utility. While consumption per child decreases with a rise in their number, total allocation to children's consumption grows. This shifts resources away from parents' own consumption and savings. ρ is the rate at which future (old age) consumption is valued. r^* is the world interest rate, which the small economy takes as given.

Current retirees have two sources of income: interest on their savings and government transfer payments. Let a_t be the (predetermined) amount of foreign assets that each retiree owns, yielding an interest rate of r^*.[1] Each retiree also gets a transfer payment of b from the government. The total income of the elderly population is thus $\phi_t\left(r^* a_t + b\right)$. They maximize their utility as defined by (2) subject to this budget constraint.

The government finances the transfer payments fully by a lump sum tax τ_t on each current worker.[2] Its budget constraint requires that:

[1] The assumption that the elderly own only foreign assets is simplifying but inessential. Given that the economy is open to capital flows and that domestic and foreign assets are ex-ante equivalent, savers may hold any combination of the two assets. The effects of demographic shocks discussed below may be somewhat weaker or stronger if the elderly own domestic capital. A flow of labor from the tradable sector to the nontradable one, induced by a demand shock, reduces the returns to capital in the first sector but raises them in the latter. The overall effect on the income of retirees that hold such capital is ambiguous.

[2] Labor supply is exogenous and does not respond to the level of income tax. An extension of the model could consider its endogeneity. The dependency ratio affects the tax rate, hence workers' disposable income. The potential impact on labor supply is ambiguous. The income

$$\tau_t = \phi_t b \quad (4)$$

The economy produces two goods: tradables and nontradables. The production function for tradables is given by:

$$Y_{T_t} = L_{T_t}^{\theta_T} K_{T_t}^{1-\theta_T} \quad (5)$$

and for nontradables:

$$Y_{N_t} = L_{N_t}^{\theta_N} K_{N_t}^{1-\theta_N} \quad (6)$$

where the total amount of capital in the economy and its allocation between the sectors (K_{T_t}, K_{N_t}), are exogenously given at time t. L_{T_t}, L_{N_t} are the number of workers in the respective sectors and full employment implies that $L_{T_t} + L_{N_t} = 1$. There is perfect competition in the economy.

The economy is small and open to trade, so the price of tradables is given by world markets. The price of nontradables however, is determined domestically. Equilibrium in the market for nontradables requires that demand equal supply. Aggregate demand for N includes its consumption by all children, workers, and old people. Thus:

$$C_{NW_t} + \mu_t C_{NC_t} + \phi_t C_{NO_t} = Y_{N_t} \quad (7)$$

A Change in the Child Dependency Rate

Solving the model and using the implicit function theorem it can be shown that $\partial P_{N_t}/\partial \mu_t > 0$ if:

$$(\alpha_c - \alpha_w) + \alpha_c \rho > 0 \quad (8)$$

A worker with more children allocates more of his disposable income to their consumption. This is done at the expense of his own consumption and his savings for retirement. Shifting consumption from workers to children raises the demand for nontradables if children's consumption is biased towards these goods, i.e., if $\alpha_c - \alpha_w > 0$. Reallocation from saving to consumption (captured by ρ) also increases the demand for nontradables provided that they have a positive weight in children's consumption. However the fact that $\alpha_c > \alpha_w$ magnifies the effect of the saving channel as reflected by the interaction term $\alpha_c \rho$.

effect may encourage workers to work more. The substitution effect creates an incentive to the contrary. Output, in particular that of nontradables, might increase or decrease. That in turn would reflect on prices. Prices could also respond to an effect of taxes on labor costs.

A Change in the Elderly Dependency Rate

Similarly, it can be shown that an increase in the elderly dependency rate raises prices, i.e., $\partial P_{N_t}/\partial \phi_t > 0$ if:

$$\alpha_o (1 + \beta\mu_t + \rho)(1 + r^*) a_t + [(\alpha_o - \alpha_w) + (\alpha_o - \alpha_c)\beta\mu_t + \alpha_o\rho] b > 0 \quad (9)$$

A larger number of retirees raises the price level through their two sources of income: assets and transfer payments. Consider the first term in (9), which is multiplied by a_t. This is the effect of income from assets. It is always positive regardless of the bias in demand and even regardless of whether the elderly save less than the workers. The reason is simply that a larger retired population owns more assets, therefore its overall spending is higher. Retirees however, do not work. Thus unlike workers, they raise spending without increasing the supply of labor. The consequent increase in the demand for labor relative to its supply raises the price of nontradables. As noted earlier this effect of the elderly is similar to that of a transfer from abroad. If the same income were given to the workers, the price level would also rise, albeit by a smaller magnitude given the differences in saving and consumption behavior.

If the amount of assets held by the elderly does not rise with their number then the channel just described is not operative. This may happen if workers were too poor to save any of their income or lacked access to financial institutions as may be the case in poor countries. It might also occur in rich countries. One possibility is that a pay-as-you-go social security system discourages workers from saving for retirement. Alternatively, even if workers did save for retirement, a currently large number of retirees could reflect an unexpected increase in longevity for which workers failed to save sufficiently in the previous period.

The amount of assets owned by the retirees can also have supply side consequences. If capital is not fully mobile across countries, last period's saving affects the current domestic capital stock, and thus prices. However, for the purpose of empirical evaluation, this supply side effect of the elderly will be captured by the economy's income per capita.

Consider the second term in (9), which is multiplied by b. This is the effect of the elderly through the tax system that transfers income from workers to retirees. Such a transfer will affect prices only if the elderly differ from workers in their spending patterns: the elderly spend more heavily on nontradables than workers ($\alpha_o > \alpha_w$) and perhaps children ($\alpha_o > \alpha_c$)[3] and workers save while retirees do not ($\rho > 0$, which is again magnified by α_o).

[3] The tax reallocates to the elderly resources from all the components of the worker's spending. This includes expenditures on his children. "Generational conflict" models argue that elderly

3. Calibration

3.1. Parameters

This section presents a calibration of the model. The objective is to assess what magnitude of the regression coefficients would be compatible with the hypothesized explanation. Since the predictions depend on the choice of parameter values, I begin by explaining the construction of these values.

The parameter of preference between tradables (goods) and nontradables (services) for the different age groups is constructed as follows. The share of services in private consumption in the US in 1989 was 54 percent.[4] This serves as the benchmark for the working age population so $\alpha_w = 0.5$. The next stage is to find by how much is the share of services larger for children and the elderly. According to the US Consumer Expenditure Survey, in 1989 health care constituted 11 percent of total expenditures for households aged 65 and over compared with only 4 percent for younger households. However such data at the household level substantially underestimate old age spending on health care. Consumers pay only part of the bill, since much of it is paid for by the government. The public share in total expenditure on health care was 76 percent in OECD countries in 1990.[5] Direct patient payments account for only about one half of nursing home care expenditures in the US [Garber (1994)]. To account for that I add the Medicare expenditure per enrollee aged 65 and over[6] to the CES figures on the expenditures and income of the elderly. This yields that health care actually amounts to 26 percent of total spending by the elderly, i.e., 22 percentage points more than for younger households.[7] Thus $\alpha_o = 0.7$.

Education (primary and secondary in particular) is also largely funded by the government. This again suggests that household level data understate the actual expenditure on children's education. Using US data for 1995,[8] I add the average

voters will favor lower spending on education. Indeed, several empirical studies in the US [e.g., Button (1992), Poterba (1996), Poterba (1998)] find that an increase in the share of elderly in the population has a negative effect on public expenditure on education per child. However, as the consumption of both age groups is intensive in nontradables, the reallocation of resources between them may have only a small effect on P_{N_t}.

[4]US Statistical Abstract (1997).

[5]OECD Health Systems (1993).

[6]Obtained from Health, United States (1992).

[7]Assume that the share of health care in total expenditure is 4 percent for workers and 26 for the elderly, that the expenditure (including implicit transfers) of a retiree equals that of an average worker, and that the elderly dependency ratio is 0.2 (OECD average in 1990). Then the implied elasticity of total health expenditure with respect to the dependency ratio is 0.52. It is consistent with Hitiris and Posnett's (1992) finding that this elasticity in OECD countries (1960-1987) is 0.55.

[8]US Statistical Abstract (1997).

expenditure per child on elementary and secondary schools by all levels of government to the figures on expenditures per child by a medium income family. The result is that spending on services (education, child care, housing, transportation and health care) amounts to 76 percent of total spending per child. Hence $\alpha_c = 0.8$.

The same data (again taking into account public spending on education) also imply that the share of disposable income spent on each child is 0.25. Together with the saving rate it determines β and ρ. Aggregate saving was 14.4 percent of GDP in the US in 1985 but varies with time and across countries. A 15 percent saving rate serves as the benchmark.

The choice of a_t and b determines several ratios: the income of the elderly relative to that of workers, the size of the two sources of the retirees' income (assets, transfers) relative to each other and the tax rate on workers that is required to pay for the transfers. Since the results are sensitive to these ratios their values are reported for each calibration, so that its plausibility can be evaluated. As benchmark values consider the following figures. Payroll tax rates for old age Social Security programs in 1981 were 10.70 percent in the US but higher in many European countries (e.g., 13 in France, 18.50 in Germany, 24.46 in Italy).[9] The ratio of US elderly's asset to transfer income varied between 0.8 and 1.1 during the period 1976-1994 [Rubin and Nieswiadomy (1997)]. Combining data from the US Abstract, CES and Medicare statistics one can calculate for the US in 1989 that the average monthly social security plus Medicare benefits per retiree amounted to about one half of the monthly (pre-tax wage and salary) income per worker. Using the figure that asset income is roughly equal to that from social security it follows that the ratio of a retiree's income to that of a worker was about 0.9. Gokhale et. al. (1996) arrive at a similar estimate.

The OECD ISDB data for the US show that the labor share is about 60 percent in both the tradable (manufacturing, agriculture, mining) and nontradable (services) sectors. Therefore in the calibrations $\theta_T = \theta_N = 0.6$.

3.2. Results

Table 1 reports the percentage change in P_{N_t} in response to a 10 percentage point increase in the elderly dependency rate (from 20 to 30 percent), holding the capital stock in both sectors fixed. Hence it is the short run impact of a demand shock. Results are given for the benchmark case of a saving rate of $s = 0.15$ and $\alpha_o = 0.7$ and for the case of $s = 0.25, \alpha_o = 0.8$. To check for

[9] US Abstract (1997). In the present context one should add Medicare taxes to the US figures. In 1986 the Medicare tax rate (employer plus employee) was 2.90 percent up to a defined limit on income, see Medicare Statistics (1987).

Table 1: Calibration - The Elderly Dependency Rate Rises 10% Points

τ_t/w_t	$(r^*a_t)/b$	$(r^*a_t+b)/w_t$	s=0.15, $\alpha_o=0.7$ ΔP_N (%)	s=0.25, $\alpha_o=0.8$ ΔP_N (%)
0.10	0.5	0.75	2.58	3.52
	1	1.00	3.98	5.13
	1.5	1.25	5.34	6.62
0.15	0.5	1.13	3.53	4.77
	1	1.50	5.49	6.95
	1.5	1.88	7.39	9.04

sensitivity two tax rates ($\tau_t/w_t = 0.10, 0.15$) and three ratios of the elderly's income from assets relative to their income from transfers [$(r^*a_t/b) = 0.5, 1, 1.5$] are considered. The third column reports the endogenously determined ratio of an elderly's total income to that of a worker [$(r^*a_t + b)/w_t$]. The change in P_{N_t} varies from 2.58 to 9.04 percent. The latter number however is associated with an elderly's income being almost twice as large as that of a worker. Further note that the effect of the elderly rises as their asset income increases relative to that from transfers. Since transfers only reallocate income between workers and retirees, they affect the price level only by the extent of the difference in behavior between the generations. On the other hand, the asset income of the elderly raises the total purchasing power in the economy thereby driving up prices even in the absence of such a difference. A potential implication is that the effect of aging might be amplified by its interaction with the institutional form of providing for the elderly. If countries with a higher proportion of retirees find it harder to sustain a pay-as-you-go system and thus switch to a fully funded one, the effect of this age group on the price level will be magnified by the institutional change.

Table 2 presents the calibrated percentage change in P_{N_t} in response to a 10 percentage point increase in the child dependency rate.[10] Results are reported for several combinations of the saving rate and the share of disposable income allocated to each child.[11] Clearly the change in prices is very small, typically

[10] Calculations are for an increase in μ_t from 0.4 to 0.5. $\alpha_c = 0.8, \alpha_w = 0.5, \alpha_o = 0.7$, $\phi_t = 0.1, \tau_t/w_t = 0.05$, and the ratio of a retiree's income to that of a worker is 0.75. The elderly related parameters are set at low values as the empirical results indicate that children only have an effect in low income countries, where elderly dependency rates are low. The calibrated effects are marginally smaller when ϕ_t and the tax rate are higher.

[11] Note that the overall share of income allocated to children is the product of the per child share and the dependency ratio. Thus when $\mu_t = 0.5$ even with a high per child share of 0.35,

Table 2: Calibration - ΔP_{N_t} (%) when $\Delta\mu = 10\%$ Points

Child Share	Saving Rate 0.15	0.25	0.35
0.15	0.68	0.82	0.99
0.25	1.07	1.29	1.56
0.35	1.44	1.72	2.06

about 1 percent. It is notably smaller than the response to variations in the elderly dependency rate. The extreme case of a saving rate and child share of 0.35 provides an upper bound on the plausible magnitude. The actual effect may be even smaller if the substitution between the quality and quantity of children is stronger than implied by the parameters chosen here. The assumption that the consumption of children is biased towards nontradables may not be applicable to very poor countries where children receive little education. These issues are further discussed in the empirical section.

4. Empirical Evidence

4.1. Data, Definitions, and Specification

The dependent variable is the log of the real exchange rate measured as the price level of GDP (divided by the nominal exchange rate) relative to the US price level. An increase in this variable corresponds to an appreciation of the real exchange rate. All the dependent variables are also relative to the US, but not expressed in logs. In particular, the demographic variables are the respective dependency rates in a country minus the corresponding rate in the US in that year. The semi-log specification provides a convenient interpretation of the coefficients on the demographic variables: a coefficient of say, $\beta = 3$ means that a 1 percentage point increase in the dependency rate of a country is associated with a 3 percent increase in the price level (RER appreciation). Measuring all variables relative to the US is essential given the bilateral definition of the dependent variable. Furthermore, it has a desirable feature of detrending the data. It addresses the concern that prices, the elderly and the child dependency ratios may have a time trend (the first two upwards, the third downwards). The other explanatory variables are the conventional ones used in RER regressions. Opening to trade reduces the price of importables and should thus lead to a depreciation of the RER [Dornbusch

only 17.5 percent of workers' disposable income is allocated to children.

(1974)]. The hypothesized effects of the other variables were discussed in the introduction. I use the share in GDP of government consumption rather than total spending. Excluding explicit transfer payments such as old age social security from that share is particularly important as they constitute a substantial part of the retirees' income. Government consumption may still include implicit transfers to the elderly through the provision of publicly financed health care and other services. It also includes public spending on education which accounts for a large part of child-related expenditures. All of the regressions include year dummies to account for various time specific factors such as the oil shocks in the seventies and the appreciation of the dollar in the eighties.

Using a panel for countries $i = 1, .., I$ and years $t = 1, ..., T$ the estimated equation is of the form:

$$\begin{aligned} RER_{it} = \; & \alpha_i \; + \beta_1 CHILD_{it} + \beta_2 OLD_{it} + \beta_3 RGDP_{it} + \beta_4 TOT_{it} \\ + \; & \beta_5 OPEN_{it} + \beta_6 GOV_{it} + \epsilon_{it} \end{aligned}$$

where:

RER = log price level of GDP relative to the US

CHILD = child dependency rate (age 0-14 as % of population 15-64)

OLD = elderly dependency rate (age 65+ as % of population 15-64)

RGDP = real GDP per capita

TOT = terms of trade

OPEN = dummy = 1 if country is open

GOV = government consumption as % of GDP

The unbalanced panel covers 98 countries over the period 1970-1990. Availability of data by age group limits the sample to quinquennial years. An advantageous by-product of this constraint is the reduction of serial correlation and other problems related to the use of high frequency exchange rate data. The series for the relative price level, government share of GDP and real GDP per capita (in constant 1985 dollars) are obtained from the Penn World Tables (Version 5.6). The World Bank's World Development Indicators is the source of the demographic data.[12] The terms of trade index is from the World Bank's World Tables. Sachs and Warner's openness dummy equals 1 if the country is open to trade.

Changes in the age structure over short periods of time within any country are small. They are further attenuated when measured as deviations from US figures. Most of the variation is in the cross sectional dimension i.e., differences among countries. A random effects (GLS) model that exploits both dimensions of the variation is thus desirable. However, if the country specific effects are correlated with the error term the estimated coefficients of this model are biased and inconsistent. Fixed effects estimation is not subject to this problem but uses only the within country variation. It is less efficient than the GLS estimation. The following tables include results of both procedures. The p-value for a Hausman specification test is also reported. Whenever it is larger than 0.05 the random effects (GLS) estimation is valid.

4.2. Regression Results

4.2.1. Full Sample Results

Table 3 presents the results for the full sample. The Hausman specification test indicates that the random effects estimates are valid. The coefficients on real GDP per capita, openness and terms of trade are all significant and of the expected sign. The coefficient on GOV is insignificant (and of an unexpected sign). An insignificant or negatively signed coefficient on government consumption is also reported by Giacomelli (1998) and Garcia (1998). The effect of children is insignificant.

The impact of the elderly is significant even in the fixed effects estimation, which makes no use of the cross-country variation. Yet, the very large coefficient on OLD is puzzling. In the random effects specification it implies that a 10 percentage point increase in the elderly dependency rate is associated with a 35-39 percent increase in the price level (the fixed effects coefficient is even larger). This order of magnitude seems unreasonably large. Greene (1997) notes that high multicollinearity may result in coefficients of an "implausible magnitude". Indeed, inspection of the data reveals a very high correlation among three explanatory variables in the full sample. Figure 4.1 plots real GDP per capita against the child and elderly dependency ratios in 1990 (the plotted data are not relative to the US). In the world as a whole, income per capita is clearly positively correlated with the fraction of old people and negatively so with the proportion of children. However this relation appears substantially weaker when one examines the subsets of the rich countries and the poor ones separately. In particular note the steeply

[12] Demographic data for West Germany are from its Statistical Yearbook (1992).

Table 3: Regression Results (All Countries)

	Random Effects (GLS)					
CHILD		-0.027		0.221	0.222	
		(-0.157)		(1.269)	(1.279)	
OLD			3.614	3.900	3.855	3.565
			(4.774)	(4.940)	(4.896)	(4.726)
RGDP	1.069	1.052	0.495	0.584	0.620	0.531
	(8.788)	(6.560)	(2.921)	(3.190)	(3.471)	(3.223)
TOT	0.204	0.204	0.210	0.213	0.210	0.207
	(4.329)	(4.314)	(4.548)	(4.614)	(4.568)	(4.501)
OPEN	-0.100	-0.102	-0.135	-0.122	-0.117	-0.131
	(-2.128)	(-2.099)	(-2.900)	(-2.542)	(-2.466)	(-2.826)
GOV	-0.170	-0.170	-0.248	-0.245		
	(-0.621)	(-0.621)	(-0.921)	(-0.913)		
R^2	0.440	0.440	0.458	0.464	0.460	0.455
Haus.	0.121	0.161	0.538	0.634	0.552	0.419

	Fixed Effects (Within)					
CHILD		0.141		0.122	0.124	
		(0.659)		(0.578)	(0.590)	
OLD			5.216	5.197	5.188	5.205
			(3.854)	(3.835)	(3.837)	(3.854)
RGDP	0.379	0.428	0.150	0.193	0.199	0.157
	(1.412)	(1.536)	(0.553)	(0.687)	(0.719)	(0.587)
TOT	0.196	0.199	0.198	0.200	0.200	0.197
	(4.073)	(4.113)	(4.185)	(4.217)	(4.223)	(4.190)
OPEN	-0.178	-0.174	-0.157	-0.153	-0.153	-0.156
	(-3.237)	(-3.136)	(-2.883)	(-2.797)	(-2.796)	(-2.882)
GOV	-0.008	0.007	-0.064	-0.051		
	(-0.023)	(0.021)	(-0.193)	(-0.154)		
R^2	0.396	0.396	0.419	0.419	0.419	0.419

t statistic in parentheses.

98 countries, 479 observations.

All regressions include year dummies.

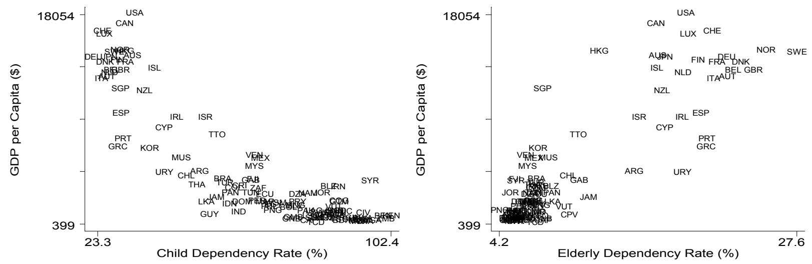

Figure 4.1: GDP per Capita and Dependency Rates

sloped range between these two groups. It contains a small number of countries that have intermediate levels of both income and dependency ratios. Within this range the correlation between the variables is very strong.

Table 4 lists the correlations between income per capita and the dependency ratios in the full sample and several of its subsets. The full sample has 98 countries. The OECD sample has 20 countries. NON OECD *all* includes the 78 remaining countries. NON OECD *no rich* excludes the 10 richest countries in that group. Dropping the 15 richest and 15 poorest countries in the NON OECD category, NON OECD *mid income* has only the 48 middle income countries of that sample. The countries included in each sample are listed in the Appendix. The more homogeneous the sample is in terms of income per capita, the weaker the correlation between that variable and the dependency ratios. For example, the correlation between RGDP and OLD drops from 0.83 in the full sample to 0.11 in the OECD sample. It falls from 0.51 in the entire NON OECD group to 0.29 in the group of middle income NON OECD countries. There is a similar decline in the correlation of the dependency ratios with each other (not reported in the table). The conclusion is that the multicollinearity problem is largely eliminated by estimating the regressions separately for the OECD sample and for the subsample of middle income NON OECD countries.

Before proceeding to subsample estimation it is worth noting the absence of another potential multicollinearity problem. One might expect government consumption to increase with the relative size of needy groups, such as children and

Table 4: Correlation between RGDP and the Dependency Ratios

	Full Sample	OECD	NON OECD *all*	NON OECD *no rich*	NON OECD *mid income*
CHILD	-0.83	-0.39	-0.59	-0.47	-0.34
OLD	0.83	0.11	0.51	0.44	0.29

the elderly. The government's share of GDP and the dependency ratios are weakly correlated in all of the samples. The correlation between GOV and OLD varies from 0.5 in the OECD sample to a negative correlation of -0.24 in the NON OECD samples. Its correlation with CHILD varies from 0.04 in the OECD group to 0.28 in the NON OECD sample.

4.2.2. OECD Results

Results for the sample of 20 OECD countries are presented in Table 5. The specification test indicates that the GLS estimates are valid, and the following discussion refers to them. Among the conventional regressors only the coefficient on real GDP per capita is significant. GOV is insignificant even when the demographic variables are excluded. With the exception of New Zealand all the countries in this group were classified as open throughout the period. The results do not change much when OPEN is omitted. RGDP squared (RGDP2) is included to capture a possible nonlinear relation between income and prices. This addresses the concern that the demographic effect might just reflect such a relation. RGDP2 enters significantly but the results discussed shortly are robust to its inclusion.

The coefficient on CHILD is insignificant. This is consistent with the very small impact of children predicted by the calibration. A potential concern is that the insignificance is due to the inclusion of government consumption which captures the effect of children through public spending on education. However, their effect remains insignificant when GOV is dropped from the regression. Moreover, as just noted the correlation between GOV and CHILD in OECD countries is almost zero. The result is well supported by studies showing that in developed economies, total expenditure on education does not increase in response to a rise in the child dependency ratio. Instead, a larger cohort is offset by a decline in educational spending per child. Fernandez and Rogerson (1997) and Poterba (1996) report such findings using panel data for US states. Lindert (1996) makes the point for

Table 5: Regression Results (20 OECD Countries)

	Random Effects (GLS)						
CHILD		0.028			0.234		
		(0.064)			(0.561)		
OLD			1.474	1.411	1.477	1.402	1.258
			(2.022)	(2.210)	(2.002)	(1.982)	(1.983)
RGDP	0.792	0.783	0.757	0.724	2.553	2.461	2.334
	(5.566)	(4.934)	(5.532)	(5.191)	(3.392)	(3.404)	(3.112)
TOT	0.168	0.173	0.137	0.176	0.156	0.144	0.190
	(1.310)	(1.323)	(1.077)	(1.407)	(1.249)	(1.164)	(1.551)
OPEN	0.159	0.152	0.135		0.158	0.152	
	(1.639)	(1.481)	(1.414)		(1.607)	(1.635)	
GOV	0.390	0.371	-0.289		-0.518	-0.465	
	(0.642)	(0.591)	(-0.427)		(-0.763)	(-0.706)	
RGDP2					-1.394	-1.337	-1.262
					(-2.424)	(-2.393)	(-2.191)
R^2	0.778	0.775	0.801	0.781	0.811	0.814	0.789
Haus.	0.213	0.060	0.299	0.366	0.230	0.437	0.763

	Fixed Effects (Within)						
CHILD		1.376			1.229		
		(2.160)			(1.905)		
OLD			1.116	0.662	0.964	1.393	0.617
			(0.943)	(0.614)	(0.819)	(1.184)	(0.575)
RGDP	0.004	-0.002	-0.062	0.079	2.138	2.301	1.740
	(0.011)	(-0.005)	(-0.186)	(0.262)	(1.587)	(1.681)	(1.346)
TOT	0.210	0.322	0.196	0.197	0.307	0.203	0.214
	(1.497)	(2.202)	(1.392)	(1.449)	(2.089)	(1.457)	(1.576)
OPEN	-0.080	-0.074	-0.086		-0.067	-0.073	
	(-0.612)	(-0.579)	(-0.655)		(-0.525)	(-0.567)	
GOV	-0.623	-0.576	-1.062		-1.632	-1.899	
	(-0.590)	(-0.559)	(-0.919)		(-1.340)	(-1.541)	
RGDP2					-1.568	-1.699	-1.169
					(-1.666)	(-1.777)	(-1.321)
R^2	0.844	0.854	0.846	0.843	0.860	0.852	0.847

t statistic in parentheses.

20 countries, 100 observations. All regressions include year dummies.

19 OECD countries 1960-1981.

The coefficient on OLD is significant. A 10 percentage point increase in the elderly dependency rate in developed countries is associated with a 12-15 percent higher price level. This is about one third the magnitude suggested by the full sample regressions, so the extent of the multicollinearity problem in that sample is evident. The estimated effect in the OECD countries is still larger than the predictions of the calibrations which assumed conservative values for the saving rate, the ratio of the elderly's asset to transfer income, their income relative to that of workers and the weight of nontradables in their consumption. Nonetheless, the regression results are quite close to the calibrated ones when high values of these parameters were assumed. This suggests that such high values may actually be realistic. As discussed earlier, the micro data probably understate at least some of these parameters. A partial correction was made by augmenting the household level data with Medicare spending. Yet other implicit and explicit transfers and subsidies for the elderly are likely under-measured. Moreover a larger proportion of the elderly strengthens their political power and can therefore actually raise the benefits per retiree (up to a certain point). Studies that record the negative effect of elderly voters on educational spending were mentioned in an earlier footnote. Lindert (1996) provides further discussion. Gokhale et. al. (1996) calculate that the share of elderly Americans in total consumption increased by 67.9 percent between the 1960s and 1980s while the change in their relative number should have raised that share by 16.3 percent only. They provide more evidence on the negative effect of the elderly on US saving rates. Gruber and Wise (1997) report that workers in industrialized countries are taking advantage of early retirement benefits and leaving the labor force at younger ages. Variations in the effective ratio of retirees to workers might thus be larger than implied by changes in the elderly dependency rates in these countries. These arguments notwithstanding, the elderly may affect prices through additional channels, not captured by the hypothesis pursued here. Nonetheless, the explanation suggested by the model accounts for at least a substantial part of the effect of the old age population on prices.

A word of caution is in order. As noted earlier, real GDP per capita, while often used in the related literature, is not the perfect variable for the issue at hand. It fails to distinguish between two potential factors: the income effect and the relative productivity effect. Ideally, one would desire a separate variable for each of the two effects. Such data for the entire sample were not available. Instead, I examined the inclusion of real GDP per worker rather than per capita as a test of robustness. Real GDP per worker is closer to capturing the productivity effect though still imperfect because it does not measure the productivity in tradables relative to nontradbles, which the Balassa-Samuelson argument refers to. The per capita variable on the other, better accounts for the income effect. Thus it is not at all clear that the per worker figure is preferable to the per capita one. When real GDP per worker is used in the regressions, the results (not reported in the tables) regarding the age variables in both the full sample and the various NON-OECD samples (to be discussed shortly) are similar to the ones obtained when the per capita figures are included. However, in the OECD sample the effect of OLD becomes insignificant. This may cast some doubt on the demand side explanation. It might suggest that the significant coefficient on OLD, obtained when the GDP per capita variable is included, reflects a correction of the mismeasurement of labor productivity that is associated with that variable. The per capita figure could distort the measured effect of differences in labor productivity to the extent that the size of the labor force relative to that of the entire population changes over time and across countries.

Table 6 offers more direct evidence on the effect of the elderly that is due to the transfer of resources from workers to retirees. In these regressions, the elderly dependency rate is replaced by TRNSFR. This variable is the total amount of old age social security benefits as a percent of GDP (again, relative to the US figures).[13] The coefficient is significant. A 10 percentage point increase in the share of these payments in GDP is associated with a 13-17 percent higher price level. The sample correlation between TRNSFR and OLD is 0.6. RGDP2 is insignificant in this specification and not reported in the table. When GDP per capita is replaced by the per worker figure, the effect of TRNSFR becomes insignificant.

4.2.3. Results from the NON OECD Samples

The effects of the age structure on the RER in less developed countries differ from those in the developed ones. The NON OECD category is a heterogeneous one and the results are sensitive to the range of countries under consideration within that group. Yet examining this set of countries and comparing the results with those for the OECD countries illustrates how the demographic effects vary with the level of development. It is useful in qualifying the findings of this paper and in warning against generalizations that ignore large differences in income across countries.

Table 7 reports GLS results for all 78 NON OECD countries and for the sample that excludes the 10 richest among these countries. When all NON OECD countries are included the results are similar to those obtained in the full sample. The effect of children is insignificant, that of the elderly, while smaller than in the

[13] Calculated using International Labour Office (1992, 1996) data. Missing observations reduce the sample size. 1989 data substitute for 1990 social security figures.

Table 6: OECD - The Effect of Transfers (GLS Estimation)

CHILD		0.461		0.439		0.427
		(1.059)		(1.027)		(0.988)
TRNSFR	1.524	1.653	1.533	1.697	1.379	1.447
	(2.017)	(2.163)	(2.160)	(2.351)	(1.917)	(1.978)
RGDP	1.067	1.111	1.064	1.103	1.036	1.069
	(6.249)	(6.329)	(6.458)	(6.561)	(6.137)	(6.129)
TOT	0.199	0.225	0.195	0.216	0.240	0.275
	(1.869)	(2.061)	(1.842)	(1.984)	(2.407)	(2.653)
OPEN	0.095	0.112	0.098	0.119		
	(1.191)	(1.379)	(1.241)	(1.461)		
GOV	-0.027	0.032				
	(-0.038)	(0.044)				
R^2	0.812	0.803	0.812	0.806	0.786	0.770
Haus.	0.737	0.116	0.659	0.182	0.960	0.899

t statistic in parentheses. Year dummies included.
20 countries, 65 observations.

full sample, still seems uncomfortably large. The particular position of the richest NON OECD countries in which income per capita and dependency ratios are highly correlated was discussed earlier. When these countries are excluded (the *no rich* sample), the coefficients on both demographic variables become insignificant. The correlation between RGDP and the dependency ratios also declines as indicated in Table 4. In both the NON OECD and the *no rich* sample, replacing GDP per capita with GDP per worker does not change the results.

The insignificance of either demographic variable in the *no rich* sample that consists of the 68 poorest countries is hardly surprising. The model suggests that for the elderly to affect prices there must either be a reallocation of income from workers to retirees or retirees should have income from savings. Both mechanisms are clearly less relevant the less developed the country is. Reallocation of income requires a social security system that taxes workers and pays benefits to the elderly. Such systems are not very well developed in the poorest of countries. The same applies to asset income at the disposal of the elderly. Poverty constrains the ability to set aside income for saving. Development and accessibility of financial institutions in poor countries are limited. In such societies the elderly often live with the extended family which provides for their needs thus substituting for formal saving and asset accumulation. The bias in old age consumption towards health care is less applicable to these circumstances. Access to modern health

Table 7: NON OECD Countries (GLS Estimation)

	all			*no rich*		
CHILD		0.090	0.178		0.189	0.216
		(0.472)	(0.917)		(0.895)	(1.012)
OLD			2.685			1.557
			(2.035)			(0.863)
RGDP	0.440	0.488	0.342	-0.127	0.008	-0.081
	(2.045)	(2.036)	(1.374)	(-0.323)	(0.019)	(-0.188)
TOT	0.191	0.192	0.193	0.225	0.225	0.228
	(3.742)	(3.759)	(3.801)	(3.957)	(3.942)	(3.988)
OPEN	-0.105	-0.101	-0.099	-0.116	-0.110	-0.106
	(-1.974)	(-1.850)	(-1.832)	(-1.991)	(-1.876)	(-1.799)
GOV	-0.273	-0.268	-0.250	-0.414	-0.401	-0.399
	(-0.924)	(-0.903)	(-0.847)	(-1.297)	(-1.256)	(-1.249)
R^2	0.224	0.225	0.232	0.226	0.234	0.237
Haus.	0.588	0.683	0.662	0.181	0.271	0.438

t statistic in parentheses. Year dummies included.
all sample includes 78 countries, 379 observations.
no rich sample includes 68 countries, 331 observations.

care is limited and family support replaces formal arrangements of old age care such as nursing homes.

The negative effect of high child dependency rates on savings in developing countries has received much attention in the literature. Notably, Coale and Hoover (1958) have argued that households and economies with many children must devote substantial resources to provide for their consumption and are therefore able to save less. Their argument has gained considerable empirical support. Using data for 7 Asian countries (1962-1972) Fry and Mason (1982) estimate that a rise in the child dependency ratio from 0 to 3 percent reduces the saving rate by 14-20 percentage points. Based on panel data for 88 countries Kelley and Schmidt (1996) calculate that the elasticity of the aggregate saving rate with respect to the child dependency ratio is around -2. Lewis (1983) attributes a large part of the increase in US saving rates in the nineteenth century to falling fertility. Higgins and Williamson (1997) make the point for Asian countries since the 1960s. Mason (1988) surveys additional evidence. The argument that an increase in the relative number of children inhibits savings at least at low levels of economic development is thus well supported.

In very poor countries the decline in the saving rate induced by high fertility need not raise the price level. The increased spending is likely to fall on basic goods such as food and clothing which are tradable, rather than on nontradable services such as education. In these countries many children do not attend schools or do so for only a few years. Infant mortality rates are still high so the child dependency ratio may overstate the relative size of the school age population. The fact that children there often start working at an early age further blurs the distinction between them and their parents in terms of consumption patterns and saving rates. Additionally, Schultz (1996) argues that in poor countries the price of teachers declines as the school age population increases because of economies of scale in the training of teachers which is done by the same educational system. Schultz (1987) further suggests that the fall in educational expenditure per child will be disproportionately sharper when the relative size of the school-age population is growing rapidly. The fall will be particularly mild when fertility is declining rapidly. In the first situation there is a temporary shortage in teachers and structures and in the second a temporary surplus. In view of the coming discussion note that this distinction likely applies to very poor versus middle income developing countries.

The preceding discussion suggests that if any effects of demographic factors on prices in NON OECD countries are to be detected, one should look only at those with an intermediate level of income. In the poorest ones, the distinction among the age groups is not relevant. The richest ones introduce a strong multicollinearity problem, which yields unreliable estimates. I explore this possibility

Table 8: Regression Results (48 Middle Income NON OECD Countries)

			Random Effects (GLS)			
CHILD		0.429		0.431	0.433	0.431
		(1.993)		(1.993)	(2.024)	(2.023)
OLD			0.538	0.782	0.788	
			(0.244)	(0.359)	(0.362)	
RGDP	0.093	0.339	0.072	0.308	0.450	0.483
	(0.213)	(0.759)	(0.162)	(0.680)	(1.022)	(1.109)
TOT	0.231	0.231	0.230	0.231	0.225	0.225
	(3.947)	(3.962)	(3.937)	(3.951)	(3.862)	(3.872)
OPEN	-0.025	-0.009	-0.024	-0.009		
	(-0.453)	(-0.166)	(-0.445)	(-0.156)		
GOV	-0.464	-0.477	-0.462	-0.474		
	(-1.452)	(-1.508)	(-1.443)	(-1.494)		
R^2	0.237	0.282	0.236	0.281	0.262	0.262
Haus.	0.283	0.166	0.340	0.253	0.133	0.075

			Fixed Effects (Within)			
CHILD		0.223		0.221	0.228	0.230
		(0.912)		(0.900)	(0.938)	(0.951)
OLD			0.820	0.708	0.583	
			(0.265)	(0.229)	(0.191)	
RGDP	-0.657	-0.555	-0.658	-0.557	-0.523	-0.523
	(-1.240)	(-1.025)	(-1.239)	(-1.025)	(-0.974)	(-0.976)
TOT	0.209	0.209	0.209	0.209	0.208	0.208
	(3.587)	(3.584)	(3.575)	(3.572)	(3.591)	(3.607)
OPEN	-0.019	-0.013	-0.017	-0.012		
	(-0.328)	(-0.226)	(-0.302)	(-0.205)		
GOV	-0.189	-0.186	-0.200	-0.196		
	(-0.504)	(-0.496)	(-0.529)	(-0.517)		
R^2	0.443	0.445	0.443	0.446	0.445	0.445

t statistic in parentheses. Year dummies included.
48 countries, 236 observations

by excluding from the NON OECD sample the 15 countries with the highest income per capita in 1980 and the 15 countries with the lowest income. Results for the sample of the remaining 48 middle income NON OECD countries are presented in Table 8.

The specification test validates the GLS estimation. The coefficient on OLD is insignificant, as expected in light of the previous discussion. Note in particular the low correlation between income and the dependency ratios in this sample (see Table 4, *mid income* sample). While RGDP enters with the right sign it is insignificant. This is plausible given that the sample is constructed by excluding the high and low income countries, which reduces the variation of this variable among the remaining observations. Neither is squared RGDP significant (not reported). The terms of trade however are highly significant and correctly signed.

The GLS results indicate that in this set of countries the child dependency ratio has a significant effect on the price level. A 10 percentage point increase in that ratio is associated with a 4 percent appreciation of the RER. The effect is much smaller than that of the elderly dependency ratio (in developed countries), which is consistent with the predictions of the calibrations, and the proposed demand side explanation. However, the coefficient on CHILD is somewhat larger than predicted by those calibrations. Similar results are obtained when GDP per worker is used instead of GDP per capita. It was shown that even under relatively extreme assumptions on the parameters, the model predicts only about a 1-2 percent increase in prices in response to a 10 percent increase in the child dependency ratio. This suggests that children may be affecting prices through additional channels. Comparing the results of the last three NON OECD samples (Tables 7, 8), we note that as the sample is limited to a more homogeneous set of countries in terms of income per capita, the coefficient on CHILD and its significance increase. Thus while the estimates are sensitive to the sample chosen, the pattern seems systematic.

5. Conclusion

This paper reports an empirical finding on the relation between the age structure of economies and their real exchange rate, which under PPP is determined only by the relative price of nontradables. Among developed countries a higher ratio of old people to the working age population is associated with substantially higher prices. A 10 percentage point increase in this ratio effects a 12-15 percent higher price level. Among middle income developing countries the RER is related to the child dependency ratio. A 10 percentage point increase in this ratio corresponds to a 4 percent increase in the price level.

I have suggested that the findings can be explained by the effects of these age groups on the demand for nontradables. Both children and the elderly have a negative impact on the saving rate and their consumption, compared with that of the working age population, is biased towards nontradable services. Any reallocation of income from workers to these groups thus increases aggregate demand for nontradables. The elderly further affect demand by drawing on their savings, which provide them with a source of income independent of transfers from workers.

The model was calibrated to study the order of magnitude of changes in prices that the proposed explanation can be expected to generate under reasonable parameters.

The empirical investigation reveals that results based on the full sample are unreliable given a strong correlation in the data between the dependency ratios and income per capita. However, by splitting the sample into groups of countries that are more homogeneous in their level of income, the multicollinearity problem is largely eliminated. Estimation within these subsamples shows that the effects of the demographic variables vary with the level of economic development. The estimated coefficients are somewhat larger than predicted by the calibrations. Yet they indicate that the proposed explanation can account for a sizable portion of the effect, particularly in regards to the elderly dependency ratio. This explanation is further supported by the finding that the effect of the elderly is detected only in developed economies. The findings are also consistent with the predictions that the impact of the elderly should be much larger than that of children. On the other hand, the results obtained for the OECD countries when GDP per worker, rather than per capita, is included in the regressions, are unfavorable to the demand side explanation.

The findings expand the set of variables to be considered as affecting the RER. Their consistency with the proposed explanation suggests that they should mainly be viewed as additional demand-side determinants of the RER. Dependency ratios also have several advantages over other variables commonly used in the literature to identify the effects of demand shocks.

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Countries Included in the Samples

OECD	NON OECD *middle income*		Richest & Poorest	10 Richest
(1)	(2)	(3)	(4)	(5)
Australia	Algeria	Morocco	Argentina	Argentina
Austria	Bangladesh	Nepal	Barbados	Barbados
Belgium	Benin	Nicaragua	Brazil	Cyprus
Canada	Bolivia	Nigeria	Burkina Faso	Hong Kong
Denmark	Cameroon	Pakistan	Burundi	Iraq
Finland	Chile	Papua N. Guin.	Central Afr. Rep.	Israel
France	Colombia	Paraguay	Chad	Mexico
Greece	Congo	Peru	Congo Dem. Rep.	Singapore
Ireland	Costa Rica	Philippines	Cyprus	Tri. & Tob.
Italy	Cote d'Ivoire	Senegal	Ethiopia	Venezuela
Japan	Domonican Rep.	Sierra Leone	Gabon	
Netherlands	Ecuador	South Africa	Guinea	
New Zealand	Egypt	Sri Lanka	Guinea-Bissau	
Norway	El Salvador	Thailand	Hong Kong	
Portugal	Gambia	Tunisia	Iraq	
Spain	Ghana	Turkey	Israel	
Sweden	Guatemala	Zambia	Malawi	
Switzerland	Guyana	Zimbabwe	Mali	
United Kingdom	Haiti		Mauritius	
W. Germany	Honduras		Mexico	
	India		Niger	
	Indonesia		Singapore	
	Iran		Somalia	
	Jamaica		Syria	
	Jordan		Tanzania	
	Kenya		Togo	
	Korea		Tri. & Tob.	
	Madagascar		Uganda	
	Malaysia		Uruguay	
	Mauritania		Venezuela	

Full sample includes the countries in columns (1)-(4).
OECD sample is column (1).
NON OECD sample includes columns (2)-(4).
NON OECD *midincome* sample includes columns (2) and (3).
NON OECD *norich* sample excludes column (5) from the NON OECD sample.