

# Demographic Change and the Current Account: Theory and Empirical Evidence

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**Abstract.** This paper examines the effects of population growth on national saving, investment, and the current account. An open-economy overlapping generations model with a pay-as-you-go social security system is used to derive the following theoretical predictions: (i) the investment rate is increasing in the population growth rate; (ii) the saving rate is ambiguously related to the population growth rate but negatively related to the social security tax rate; and, therefore, (iii) the current account is also ambiguously related to population growth and negatively related to the tax rate. The empirical evidence, using data from the 1970 to 2003 period for various subsets of 154 economies, supports the following: (i) both the investment and saving rates are negatively related to population growth and government size, but positively related to growth; and (ii) these effects on saving are stronger, and so the net foreign balance is also negatively related to both population growth and government size.

**JEL classification:** E21, F41, J10.

**Keywords:** Population growth, Current account, National savings.

## 1. Introduction

Two of the most far-reaching global economic developments of recent times are drastic demographic change and accelerating economic integration. The first has manifested itself in plummeting population growth rates, while the second has enabled unprecedented international capital mobility and current account imbalances. This paper investigates the relationship between population growth and the current account and tests it empirically for a sample of 154 economies.

The literature on the topic is extensive but full of mixed or inconclusive results. For example, Higgins and Williamson (1996) develop a model in which an increase in the population growth rate has ambiguous effects on savings, but raises

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investment sufficiently to guarantee a decrease in the current account balance. On the contrary, Krueger and Ludwig's (2007) theoretical model predicts that a higher population growth rate will raise both savings and investment, so that the effect on the current account is indeterminate.

Moreover, while many of the theoretical relationships are ambiguous, predictions are often based on simulations rather than econometric estimation. For example, Domeij and Floden (2006) and Ludwig, Krueger, and Boersch-Supan (2007) look at the relationship between population aging and international capital flows, while Heijdra and Romp (2007) focus on the effects of demographic change on consumption and savings.<sup>2</sup>

The goals of the present paper are, first, to illustrate some of the sources of the theoretical ambiguities, and second, to test empirically the effects of demographic change on national saving, investment, and the current account.

In the theoretical section, the paper uses an open-economy overlapping generations model with a pay-as-you-go social security system to derive the following theoretical predictions: (i) the investment rate is increasing in the population growth rate; (ii) the saving rate is ambiguously related to the population growth rate but negatively related to the social security tax rate; and, therefore, (iii) the current account, the difference between national saving and investment, is also ambiguously related to population growth and negatively related to the tax rate.

In the empirical section, the paper uses data from the 1970 to 2003 period for various subsets of 154 economies, in order to estimate these relationships econometrically. The cross-sectional econometric evidence supports the following: (i) both the investment and saving rates are negatively related to population growth and government size, but positively related to growth; and (ii) the effects on savings are stronger, and so the net foreign balance is also negatively related to both population growth and government size.

The rest of the paper is organized as follows. The empirical methodology is outlined in section 2, while section 3 discusses the data sources and definitions. The empirical results are presented and discussed in section 4. Section 5 concludes the paper.

## 2. Theoretical Framework

The methodology follows the overlapping generations (OLG) approach of Krueger and Ludwig (2007). People live for two periods: they are workers in the first period (when "young"), and they are retired in the second period (when "old"). The size of

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<sup>2</sup> See also Higgins (1998). For the effects of demographics on business cycle volatility, see Jaimovich and Siu (2008). Rose and Supaat (2007) investigate the relationship with the real exchange rate.

the cohort born at time  $t$  is denoted by  $N_t$  and its growth rate by  $n$ :  
 $N_t = (1 + n)N_{t-1}$ .

Using  $c_t^y$  to denote per capita consumption when young and  $c_t^o$  for per capita consumption when old, we assume the utility function takes the form

$$U = \ln(c_t^y) + \beta \ln(c_t^o), \quad (1)$$

where  $\beta$  is the discount factor.

Next, assume that the production function is Cobb-Douglas,  $Y_t = K_t^\alpha (\tilde{A}_t L_t)^{1-\alpha}$ , where  $Y$  is output,  $K$  is the capital stock,  $L$  is employment,  $\tilde{A}$  is labor-specific technology, and  $0 < \alpha < 1$ . Since only the young work,  $L_t = N_t$ , and thus the production function can be written as

$$Y_t = A_t K_t^\alpha N_t^{1-\alpha}, \quad (2)$$

where  $A_t = (\tilde{A}_t)^{1-\alpha}$  is total factor productivity.

Let  $g$  stand for the productivity growth rate:  $\tilde{A}_{t+1} = (1 + g)\tilde{A}_t$ , or:  
 $A_{t+1} = (1 + g)^{1-\alpha} A_t$ .

Assuming that this is a small open economy, the real interest rate will satisfy  $r_t = A_t k_t^{\alpha-1} = r^w$ , where  $k_t = K_t / N_t$  is the capital stock per capita, and  $r^w$  is the (exogenous) world real interest rate. It follows that the capital stock per capita will be given by:

$$k_t = \left( \frac{\alpha A_t}{r^w} \right)^{\frac{1}{1-\alpha}}. \quad (3)$$

Similarly, the real wage will be:

$$w_t = (1 - \alpha) A_t k_t^\alpha = (1 - \alpha) \frac{Y_t}{N_t}. \quad (4)$$

Next, suppose that there is a “pay as you go” social security system: the young pay a labour income tax which is used to finance social security benefits paid to the old.

Using  $\tau$  for the tax rate on first-period labor income,  $b$  for the second-period benefits, and  $s_t^y$  for first-period saving, we can derive the budget constraints. In particular, the constraint for the young is  $c_t^y + s_t^y = (1 - \tau)w_t$ , while for the old it is  $c_{t+1}^o = (1 + r)s_t^y + b_{t+1}$ . Combining the two constraints, we construct the consolidated constraint:

$$c_{t+1}^o = (1 + r)[(1 - \tau)w_t - c_t^y] + b_{t+1}. \quad (5)$$

The objective is to maximize (1) subject to (5). The first-order conditions, given  $b$ , imply that optimal consumption is given by:

$$c_t^y = \frac{(1 - \tau)}{1 + \beta} w_t + \frac{b_{t+1}}{(1 + \beta)(1 + r)}, \quad (6)$$

and optimal savings by:

$$s_t^y = \frac{\beta}{1 + \beta} (1 - \tau)w_t - \frac{b_{t+1}}{(1 + \beta)(1 + r)}. \quad (7)$$

The social-security budget constraint,

$$\overbrace{N_{t-1}b_t}^{\text{EXPENDITURE}} = \overbrace{N_t\tau w_t}^{\text{REVENUE}}, \quad (8)$$

can be used to determine  $b_t = \frac{N_t}{N_{t-1}}\tau w_t$ , and thus  $b_{t+1} = (1 + n)\tau w_{t+1}$ .<sup>3</sup> Using

(4), this becomes  $b_{t+1} = (1 + n)\tau(1 - \alpha)\frac{Y_{t+1}}{N_{t+1}}$ . Substituting in (7), optimal saving

for the young is given by:

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<sup>3</sup> Thus, this provides another way to think of equation (8): it determines the amount of benefits the old expect to receive conditional on the population growth rate, future wages, the tax rate, and government solvency.

$$s_t^y = \frac{\beta}{1+\beta}(1-\tau)(1-\alpha)\frac{Y_t}{N_t} - \frac{1+n}{(1+\beta)(1+r)}\tau(1-\alpha)\frac{Y_{t+1}}{N_{t+1}}. \quad (9)$$

We can now solve for aggregate private saving,  $S_t^P = N_t s_t^y + N_{t-1} s_t^o$ , where  $s_t^o$  denotes the optimal per capita saving of the old. Using (9), we obtain:

$$S_t^P = \frac{\beta}{1+\beta}(1-\tau)(1-\alpha)(Y_t - Y_{t-1}) - \frac{\tau(1-\alpha)}{(1+\beta)(1+r)}(Y_{t+1} - Y_t). \quad (10)$$

Because of the assumption that the government budget is balanced (equation (8)), government savings is zero, and thus national saving,  $S_t$ , equals  $S_t^P$ . It follows that  $S_t$  is also given by equation (10).

Equation (10) can be used to derive the national saving rate:

$$\frac{S_t}{Y_t} = \frac{(1-\alpha)}{1+\beta} \left\{ \beta(1-\tau) \left[ 1 - \frac{1}{(1+n)(1+g)} \right] - \frac{\tau}{(1+r)} [(1+n)(1+g) - 1] \right\}. \quad (11)$$

To derive optimal investment, (1) and (3) can be combined to show:

$$\frac{K_t}{Y_t} = \frac{\alpha}{r}. \quad (12)$$

Next, define investment,  $I_t$ , simply as  $I_t = K_{t+1} - K_t$ . Making use of (12), the national investment rate is given by:

$$\frac{I_t}{Y_t} = [(1+n)(1+g) - 1] \frac{\alpha}{r}. \quad (13)$$

The implications for the optimal current account,  $CA_t$ , immediately follow

since  $\frac{CA_t}{Y_t} = \frac{S_t}{Y_t} - \frac{I_t}{Y_t}$ .

First, consider the effects of a demographic change without a social security system, i.e., when  $\tau = 0$ . Equations (12) and (13) make it clear that in this case an increase in the population growth rate,  $n$ , will raise both the saving rate and the investment rate. Therefore, the effects of a change in population growth on the current account will be ambiguous.

Now suppose that the social security plan is in place ( $\tau > 0$ ). An increase in the population growth rate,  $n$ , still raises the investment rate, but now has an ambiguous effect on the saving rate. A higher  $n$ , therefore, still has ambiguous effects on the current account, though the possibility of a negative effect is greater.

What are the effects of a change in the tax rate,  $\tau$ ? An increase in  $\tau$  does not affect the investment rate, but it does reduce the national savings rate, therefore unambiguously reducing the current account balance.<sup>4</sup>

### 3. The Data

All data are obtained from the Penn World Table (PWT, Mark 6.2), documented in Heston, Summers, and Aden (2006; see also Summers and Heston, 1991). Three data sets have been constructed, depending on the number of countries included, but the time period is 1970-2003 for all three data sets.

The first data set (*ALL*) consists of the 154 economies for which data on all series exist for each year of the 1970-2003 period. The second data set (*LARGE*) consists of the 109 economies for which 1970 population was greater than 1 million. The third data set (*OECD*) consists of the 26 OECD economies.

Figure 1 shows the growth rate of the total population of the first (*ALL*) and third (*OECD*) data sets.<sup>5</sup> As expected, the growth rate of the OECD population is consistently lower than the growth rate of “total” population. The dramatic nature of the current demographic change can be appreciated from the fact that the population growth rate has been steadily falling for both data sets. Whether that trend continues or not, it has been sustained for a sufficiently long time to have left a mark on the current account, if a strong relationship between the two variables exists.

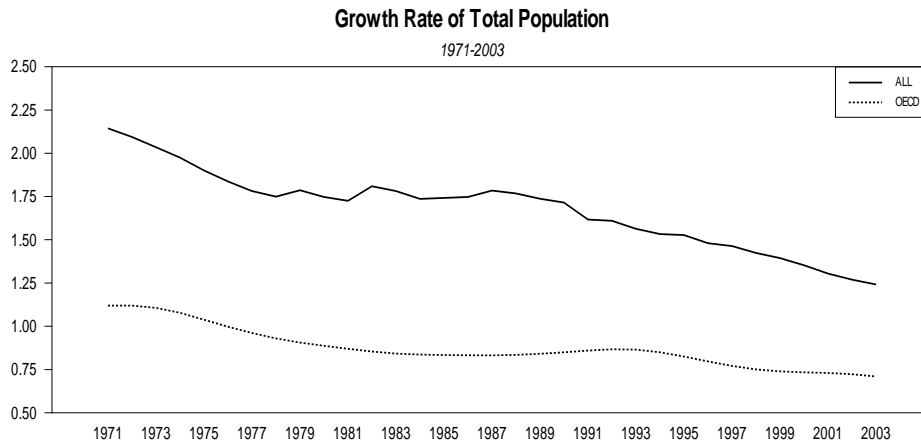
The current account balance has been constructed as the net foreign balance (*NFB*), equal to  $NFB = Y - C - I - G$ , where  $Y$  is real GDP,  $C$  is private consumption,  $I$  is investment, and  $G$  is government consumption. Note that national savings is given by  $S = Y - C - G$ , so that, by construction,  $NFB = S - I$ .

Figure 2 plots the sum of the (absolute value of the) net foreign balance as a fraction of GDP, again for the first (*ALL*) and third (*OECD*) data sets. These graphs show the degree to which current account deficits in a subset of these countries are matched by surpluses in the rest. The steady increase in these series since the early

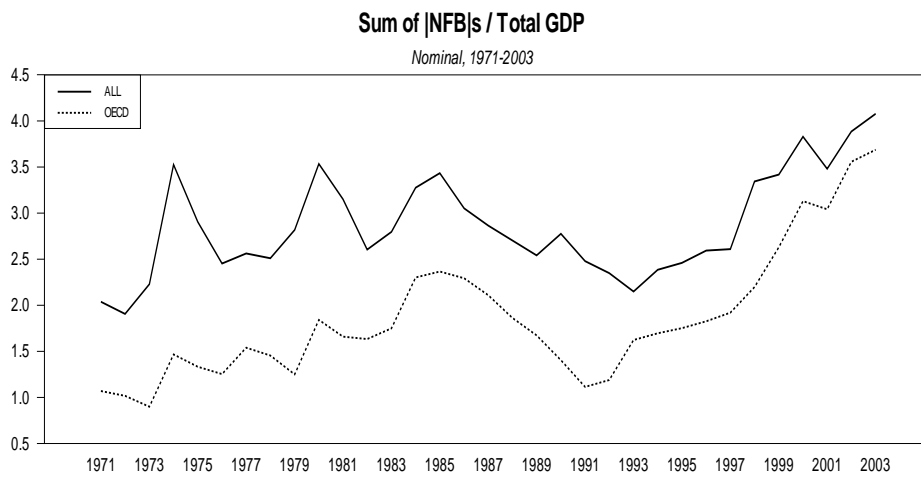
<sup>4</sup> For simulation-type experiments based on these relationships, see Domeij and Floden (2006), Ludwig, Krueger, and Boersch-Supan (2007), and Heijdra and Romp (2007). Here, by contrast, our focus will be on empirical estimation.

<sup>5</sup> Not surprisingly, the plot for the second data set is almost indistinguishable from that of the first data set, and so it is not included. This also applies to Figure 2 below.

1990's is evidence that increasing financial integration has enabled countries to have larger "imbalances" on their current accounts. Once again, this variability should help us identify the effects of population growth rates on the current account.



**Figure 1**



**Figure 2**

#### 4. Empirical Results

Table 1 reports several cross-sectional regressions in which the dependent variable is a country's saving rate averaged over the period 1970-2003. There are two specifications for each of the three data sets. The first specification simply regresses the average saving rate,  $\overline{S/Y}$ , against the average population growth rate,  $\overline{n}$ , while the second specification adds the average government size,  $\overline{G/Y}$  (a proxy for  $\tau$ ) and the average growth rate of GDP per capita,  $\overline{growth}$  (a proxy for  $g$ ) as explanatory variables.

Starting with the bivariate regressions,<sup>6</sup> the estimated coefficients of population growth are either negative and statistically significant ( $-6.89$  in data set *LARGE* and  $-3.81$  in *OECD*), or negative but statistically insignificant ( $-0.63$  in data set *ALL*). This seems to resolve the theoretical ambiguity that we noted above, in favour of the population growth rate having negative effects on saving rates: countries with more rapid population growth rates experience lower saving rates.

**Table 1: Dependent Variable: Saving Rate (  $S/Y$  )**

	ALL		LARGE		OECD	
CONS	11.7** (3.21)	28.4** (4.29)	24.8** (2.39)	32.9** (5.43)	28.1** (1.78)	35.7** (5.31)
$\overline{n}$	-0.63 (1.59)	0.14 (1.33)	-6.89** (1.15)	-4.35** (1.35)	-3.81* (1.94)	-5.80** (1.76)
$\overline{growth}_i$		4.80* (1.99)		4.40 (2.36)		5.43** (1.83)
$\overline{G/Y}$		-0.89** (0.14)		-0.71** (0.27)		-0.58** (0.24)
$R^2$	0.002	0.30	0.19	0.37	0.12	0.35
$N$	154	154	109	109	26	26

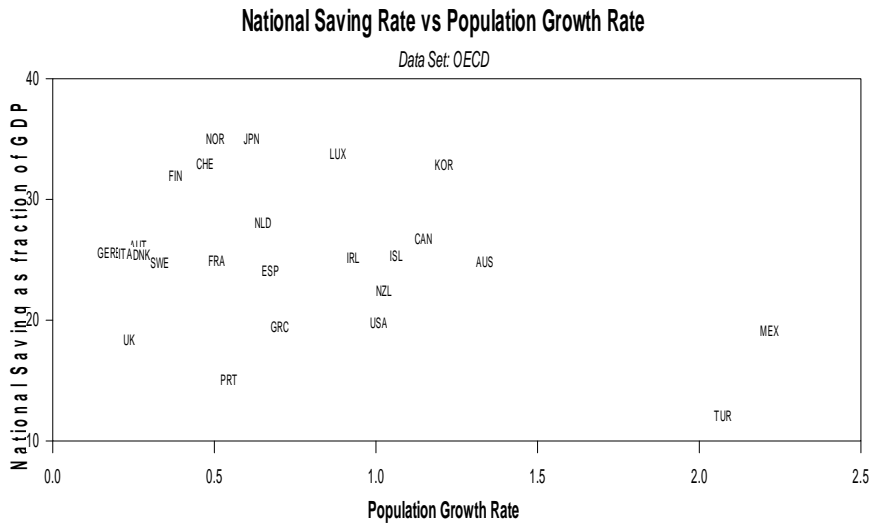
Notes: Variables are as defined in the text; averages are over the 1970-2003 period for each country. Estimated heteroskedasticity-consistent (White, 1980) standard errors in parentheses. \*\* and \* denote statistical significance at the 1% and 5% significance levels.

<sup>6</sup> The bivariate regressions are included to formalize the visual evidence of Figures 3, 4, and 5 presented below, and for the purpose of comparison with earlier papers in the literature.

Interestingly, the multivariate regressions confirm this finding. Again, the coefficients of population growth are estimated to be either negative and statistically significant ( $-4.35$  in data set *LARGE* and  $-5.8$  in *OECD*), or statistically insignificant ( $0.14$  in data set *ALL*). Even controlling for government size and growth, therefore, countries with faster growing populations have experienced lower saving rates.

It is also worth noting that the effects of growth on savings are positive and statistically significant, while those of the government size are negative and statistically significant. This is consistent with the theoretical predictions of the model we outlined above. Countries that are growing rapidly and/or have small government sectors tend to have higher rates of national saving.

Figure 3 presents a scatter plot of  $\bar{S}/\bar{Y}$  against  $\bar{n}$  for the *OECD* data set, showing clearly the negative relationship between the two variables.



**Figure 3**

**Table 2: Dependent Variable: Investment Rate ( $I/Y$ )**

	ALL		LARGE		OECD	
CONS	19.1** (1.23)	17.8** (1.82)	23.5** (1.16)	19.7** (1.99)	24.9** (1.22)	29.40** (3.03)
$\bar{n}$	-2.36** (0.61)	-1.51** (0.53)	-4.35** (0.54)	-2.78** (0.69)	-2.31 (1.53)	-3.79** (1.20)
$\overline{growth}_i$		4.18** (0.93)		5.07** (1.16)		5.20** (1.94)
$\overline{G/Y}$		-0.10* (0.05)		-0.06 (0.09)		-0.42** (0.13)
$R^2$	0.15	0.28	0.28	0.41	0.10	0.44
$N$	154	154	109	109	26	26

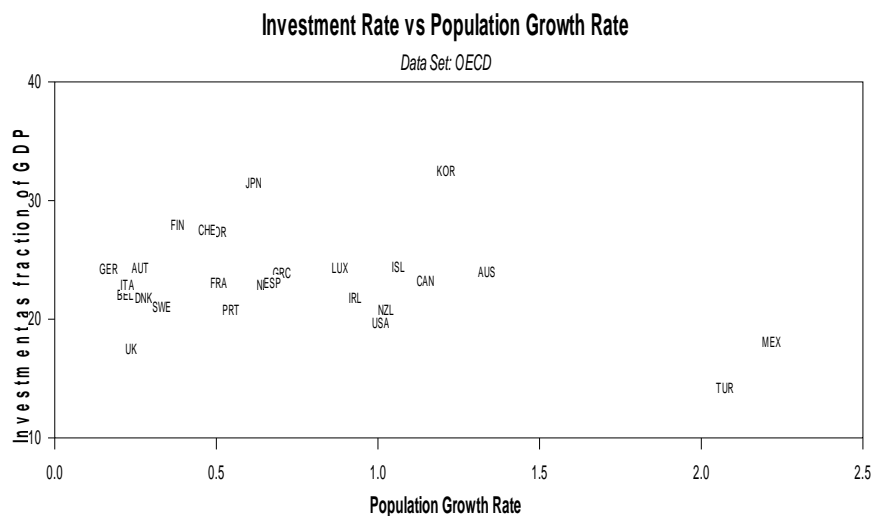
Notes: See Table 1

Table 2 repeats the exercise of the previous table but using as the dependent variable the investment rate averaged over the period 1970-2003. Table 2 is organized just like Table 1, so that again there are two specifications for each of the three data sets. The first specification simply regresses the average investment rate,  $\overline{I/Y}$ , against the average population growth rate,  $\bar{n}$ ; while the second specification again adds the average government size,  $\overline{G/Y}$  (the proxy for  $\tau$ ) and the average growth rate of GDP per capita,  $\overline{growth}$  (the proxy for  $g$ ) as explanatory variables.

Starting with the bivariate regressions, the estimated coefficients of population growth are negative and, except in the *OECD*, highly statistically significant. This implies that countries with more rapid population growth rates experience lower investment rates, a fact that is at odds with the overlapping generations theoretical model of section 2.

Once again, the multivariate regressions also support this finding. Indeed, the coefficients of population growth are now estimated to be negative and strongly statistically significant in all three data sets, including the *OECD*. Even controlling for government size and growth, therefore, countries with faster-growing populations have experienced lower investment rates.

Consistent with the theoretical predictions, the effects of growth on the investment rate are positive and statistically significant. At the same time, however, the effects of the government size are negative (though statistically significant only in *ALL* and the *OECD*), an effect that is missing from the theoretical model. In summary, countries that are growing rapidly and/or have small government sectors appear to have higher rates of investment.



**Figure 4**

Figure 4 visualizes the relationship between  $\overline{I/Y}$  and  $\overline{n}$  for the *OECD* data set, showing another negative correlation.

Table 3 follows the same pattern with the last two tables, but the dependent variable now is the net foreign balance as a fraction of GDP. Once again, the first set of specifications simply regresses the net foreign balance rate,  $\overline{NFB/Y}$ , against the average population growth rate,  $\overline{n}$ , while the second set adds again the average government size,  $\overline{G/Y}$ , and the average growth rate of GDP per capita,  $\overline{growth}$ , as explanatory variables.

**Table 3: Dependent Variable: Net Foreign Balance (  $NFB / Y$  )**

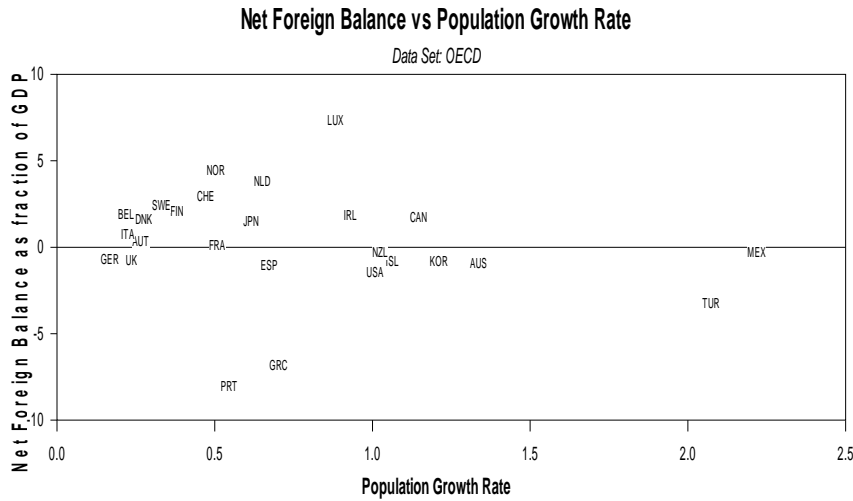
	ALL		LARGE		OECD	
CONS	-8.73** (2.28)	9.05* (3.74)	-0.68 (1.90)	11.09* (5.11)	1.09 (0.83)	3.27 (3.95)
$\bar{n}$	1.79 (1.10)	1.62 (0.95)	-2.12* (0.95)	-1.30 (1.79)	-1.15 (0.62)	-1.56* (0.69)
$\overline{growth}_i$		0.05 (1.63)		-1.04 (1.79)		0.45 (1.52)
$\overline{G/Y}$		-0.76** (0.15)		-0.62* (0.27)		-0.13 (0.20)
$R^2$	0.02	0.28	0.03	0.26	0.04	0.06
$N$	154	154	109	109	26	26

Notes: See Table 1.

For both the bivariate and multivariate regressions of Table 3, the estimated coefficients of population growth are less sizable and less statistically significant than those of Tables 1 and 2. Clearly, the estimated effect of population growth on the current account is weaker than the effect on saving or investment rates. In particular, increases in population growth are shown to statistically significantly reduce the current account surplus only in the bivariate *LARGE* and the multivariate *OECD* specifications.

Similarly weaker are the effects of growth on the current account: none of the estimated coefficients are statistically significant. Only the current account effects of the government size are consistently negative, and statistically significant for *ALL* and *LARGE* (but not for the *OECD*).

Figure 5 shows the (lack of a) relationship between  $\overline{NFB/Y}$  and  $\bar{n}$  for the *OECD* data set.



**Figure 5**

**5. Conclusions**

This paper has investigated the relationship between population growth and the current account.

Theoretically, the paper shows that an open-economy overlapping generations model with a pay-as-you-go social security system makes the following predictions: (i) the investment rate is increasing in the population growth rate; (ii) the saving rate is ambiguously related to the population growth rate but negatively related to the social security tax rate; and, therefore, (iii) the current account, the difference between national saving and investment, is also ambiguously related to population growth and negatively related to the tax rate.

Empirically, the paper has used data from the 1970 to 2003 period for various subsets of 154 economies, in order to estimate these relationships econometrically. The cross-sectional econometric evidence supports the following:

- (i) both the investment and saving rates are negatively affected by population growth;
- (ii) both the investment and saving rates are negatively affected by government size;
- (iii) both the investment and saving rates are positively affected by growth;

(iv) these effects are stronger on savings, and so the net foreign balance is generally negatively affected by population growth (weakly) and government size (more strongly).

Future research should focus on two possible extensions. First, it will be worthwhile to consider the relationship of the current account to other demographic variables, such as age composition and dependency ratios. It would also be interesting to exploit the time dimension of the data more fully using panel estimation techniques that combine cross section and time series.

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