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The Ageing, Longevity and Crowding Out Effects on Private and Public Savings: Evidence from Dynamic Panel Analysis

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JEL Classification: J10, C33, E21, D91, H62

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Abstract

Life-cycle theory predicts ageing exerting long-term macroeconomic impacts through the reduction of private savings. Ageing can be brought either through a fall in fertility rates or a rise in longevity. However, empirical research studying macroeconomic determinants of savings generally regard age dependency as the measure capturing the process of ageing, overlooking longevity exerting an opposite impact on private savings. Since longevity and dependency are correlated determinants of private savings, omitting either potentially causes omitted variable bias. This paper considers the joint effects age dependency and longevity have on savings. In contrast to the wider literature, not only private, but also public, savings was studied. Applying dynamic panel modelling techniques to a dataset of 55 countries from 1972-2004, age dependency is found to still exert a negative effect on private savings. However, it is found that some of these reductions can potentially be offset by increased longevity. The study also reveals some level of crowding out of private sector savings associated with changes in public sector savings and find that the Ricardian Equivalence Hypothesis cannot be entirely dismissed.

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[c] We would like to thank Michael Graff for his valuable comments on an earlier draft of the paper. Obviously all remaining errors are ours.

I. INTRODUCTION

Within a few decades, the demographic structures of most, if not all, economies will be vastly different from today. Advances in medical science will conceivably result in continual increases in life expectancy. This resulting rise in longevity will see a greater proportion of people making it into higher age brackets. Coupled with the falling fertility rates that have been observed for some time, demographic structure are expected to shift towards the aged.

The macroeconomic impact that ageing brings about cannot be understated. One of the channels where demographic structures can exert its influence is through aggregate savings. Ageing reducing savings has already been well established in the literature (see de Serres & Pelgrin 2003; Loayza, Schmidt-Hebbel & Serven 2000). Nonetheless, despite the stylised fact that ageing is largely a by-product of both higher life expectancy and falling fertility, the direct link between life expectancy and savings has only recently started to come forth within the literature through work such as Li, Zhang & Zhang (2007) and Kinugasa & Mason (2007). The impact of life expectancy on savings are very different from those of an older population structure, yet as life expectancy and aging dependency are highly correlated, analysis of the impact of one without due consideration paid to the other is likely to result in bias.

Using a large panel dataset covering 55 countries and data from 1972-2004, this paper sets forth to investigate the joint effect of higher age dependency and rising longevity on savings through the use of dynamic panel modelling with Generalised Methods of Moments (GMM) estimation. The contributions of this paper are threefold.

Firstly, our model jointly considers the effects of higher age dependency and greater life expectancy on savings, thus avoiding potential bias in previous studies that neglect one of the two factors. In terms of theoretical foundation, our model is similar to that of Li, Zhang & Zhang (2007) and Kinugasa & Mason (2007). What sets this paper apart is its empirical approach motivated by our attempt to model the dynamics of savings. The observation that savings exerting a fair degree of inertia makes it necessary to distinguish between the long and short run impacts. This paper makes this distinction through the use of dynamic panel models.

Secondly, most studies of demographic aged structures on savings tend to focus on either national savings or private savings, with public savings largely neglected. This lack of attention on public savings is rather curious considering their potential role in driving growth. Furthermore, the more theoretical literature starts to question the exogeneity of public savings (Alesina & Drazen 1991: Alesina & Tabellini 1990a and 1990b). Therefore, the other contribution of this paper is to include public savings in the analysis alongside private and national savings.

Lastly, theories like the substitutability between private and public expenditure and the Ricardian Equivalence Hypothesis suggest the potential for changes in public savings to crowd out private savings. The Ricardian Equivalence Hypothesis in the strictest sense predicts that any changes in public savings stemming from changes in tax revenues will be offset one for one by private savings, leaving national savings unchanged. If a crowding out effect exists, policies aimed at changing the national savings rate should look to alter the incentives to save within the private sector. This paper thus also sets forth to analyse to what extent any impact ageing has on public savings are offset by responses in private savings.

The rest of the paper is organised as follows. Section II gives an overview of the literature. Section III and IV offer a discussion of the data and methodology respectively. Section V presents and discusses the results. The final section concludes.

II. Literature Review

The Life-Cycle Hypothesis (LCH)[1] suggests that individuals save during their economically active years to finance their consumption during retirement (Modigliani & Brumberg 1954). Accordingly, increases in the dependency ratio, be it youth or age dependency, will lead to a decrease in average private savings. As national savings is largely made up of private savings, it is expected that, *ceteris paribus*, increases in dependency ratios will reduce national savings. The seminal work of Leff (1969) found that higher dependency ratios, whether be it youth, aged or total dependency, reduced national savings[2]. Despite early criticisms levelled by Gupta (1971), Goldberger (1973) and Ram (1982), among others, subsequent studies tend to support Leff's conclusions. As indicated in Table 1, there exists considerable consensus within the more recent literature that higher dependency acts as a drag on savings.

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[1] The Permanent Income Hypothesis gives essentially the same predictions as the LCH. For simplicity, we only refer to the LCH in the paper.

[2] While Leff used national savings, the theoretical underpinnings of his ideas were very much similar to the LCH. It was very likely he used national instead of private savings because of the lack of data.

[INSERT Table 1]

Previous work, however, has largely ignored the fact that ageing is brought about by, besides falling fertility rates, longer life expectancy. While it is true that higher age dependency would increase the number of non-savers relative to savers in the economy, thus bringing about a reduction in the private savings rates in aggregation, this idea largely rests upon the assumption that although saving rates vary amongst different age groups, the saving rate of individual age group remains largely unchanged over different cohorts. Closer examination of the LCH suggests that this might not necessarily be the case. Increases in longevity can serve as motivation for agents to save more, allowing the financing of a longer retirement. In fact, such increases in saving rates may not even be linear. The elderly may be encouraged to save even more aggressively, or at least to rundown their assets at a slower rate, since longevity brings about more uncertainty of future medical expenses and the risk of outliving one's assets (De Nardi, French & Jones 2009). Furthermore, there is no real reason to still expect the retirement age to stay constant if life expectancy increases. Ando et al. (1995), for example, found that the elderly in Japan had a high probability of maintaining employment, not dissaving as much as theoretical predictions. Work by Ehrlich & Lui (1991), Lee, Zhang & Zhang (2003) Lee, Mason & Miller (2003) and Sheshinski (2009) provide theoretical support for the positive impact longevity has on private savings. Empirical evidence provided by Bloom, Canning & Graham (2003) and Kinugasa & Mason (2007) reaffirms this theoretical prediction.

Since higher age dependency and rising longevity exert opposite effects on private savings, the impact of ageing with regards to private savings are therefore equivocal. This ambiguity motivated more recent work by Graff, Tang & Zhang (2008) and Li, Zhang & Zhang (2007) jointly considering both higher age dependency and rising longevity.

The link between demography and public savings, in comparison to private and national savings studies, is a much neglected field within the literature. In fact the study of public savings in general has never gathered much attention (Krieckhaus 2002). Edwards (1996) commented that until very recently, the notion of public savings being exogenous was a commonplace within the literature. This view has only started to change in the last 20 years, with the introduction of theoretical modelling of public savings from a political economy perspective (see Alesina & Drazen 1991; Alesina & Tabellini 1990a; Alesina & Tabellini 1990b for examples). Some recent theoretical studies of demographic change on public expenditure have been framed with such a political economy focus[3]. While looking at public expenditure, and therefore public savings, through the interaction of ageing and political factors is appealing, this would somewhat detract from the focus of the current paper, which is simply on how ageing, *per se*, affects public savings.

Keeping everything equal, higher age dependency has the potential to reduce productivity, and thus the tax base, resulting in lower tax revenues. Higher age dependency also brings together the possibility of higher health and social security spending. Taken together, the view that higher age dependency will reduce public savings is quite plausible. The potential impact of longevity on public savings, however, is not as clear. Bloom et al (2007) showed theoretically that for individuals, the optimal response to an exogenous increase in longevity was to delay retirement. If this is indeed the case, increased longevity will serve to prop up the tax base. In reality, though, this has not been observed. Both Blöndal & Scarpetta (1998) and Duval (2003), studying retirement behaviour in the OECD, found that despite rises in life expectancy, social security schemes have actually created incentives for people to retire at the same age as a generation ago resulting in longer periods being dependent on the social security system.

Social security spending is not the only form of spending that is projected to rise with ageing. In term of health spending, as the elderly people consume more resources than the young, gains in life expectancy can be expected to put upward pressure on public expenditure, thus lowering public savings. However, the association between higher age dependency and longevity on the one side, and increasing public health spending on the other side is not definite. Firstly, there is contention whether rising longevity actually means people are spending more years in bad health. A study using New Zealand data by Bryant et al. (2004) found that it is the time distance to death rather than one's biological age that acted as a better predictor of public health expenditure. They found that while an ageing population can reasonably be expected to increase public health expenditure, the increases in health spending attributed to just the sheer number of elderly, or higher age dependency, is more modest when compared to that attributed to those disabled or requiring specialised aged care. Consistent with that view, Cutler & Sheiner (1998) argued that whether ageing increases public health expenditure, and so reduces public savings, crucially depended on disability rates in the economy, as well as sex and age distributions. These factors act as key

[3] See Razin, Sadka & Swagel (2002), Galasso & Profeta (2002) Sanz & Velazquez (2007) among others.

considerations when assessing the impact ageing has on public health expenditure. For example, living alone increases the likelihood of entering a long term aged care facilities, which can act as a drain on public finance. Regardless, projections of public health expenditure increasing, at least to some extent, with ageing were put forward by Cutler & Sheiner (1998) and Bryant et al.(2004). In contrast, Gouveia (1996) found that public health expenditure as a percentage of GDP fell with a higher proportion of aged, suggesting the notion that ageing necessarily brings about higher public health expenditure cannot be taken uncritically.

While empirical studies looking at the effect demography itself on public savings are few, they do exist. Edwards (1996) found that age dependency had no statistically significant effect on public savings in a sample of Latin American countries. However, his methodology was handicapped by the estimation procedures that predated the recent developments of dynamic panel modelling. Kim & Lee (2008), using a panel VAR approach with G7 countries data, found total dependency exerting a negative influence on public savings. The IMF (2004) also came to the same conclusion. Disney (2007) showed that the size of the welfare state within an OECD sample increases with higher dependency, though the degree of it depended on the design of the social security system itself. These studies, however, shared something in common; they neglected the role longevity can play in the determination of public savings. Untangling the respective impacts of age dependency and longevity on public saving could potentially be useful for the design of public policy in dealing with ageing. For example, if the dependency ratio is the main cause of the fall in public savings, policy regarding immigration and fertility in dealing with the dependency ratio should take priority. Alternatively, if longevity exerts a negative impact on public savings, then perhaps there should be evaluation of the age threshold for pension and other age-related welfare.

The preceding discussion focused only on the impact ageing has on private and public savings separately. However, is it possible that changes in public savings can crowd out private savings leaving national savings unchanged? The 19th century classical economist David Ricardo (1820) first posted a question of this kind in that whether there was a difference between funding a war with a one off tax hike, or with the issuance of government consols and paying off the interests through future taxation. Ricardo argued that households would be indifferent to both propositions if they were forward looking. The Ricardian Equivalence Hypothesis (REH) was later revisited and formalised by Barro (1974). The public policy implications of this theory are clear. If the theory holds true, any reduction (increase) in taxes, and by extension, public savings, would be perfectly offset by an increase (reduction) in private savings, leaving national savings unchanged. This view, however, does not gain universal currency. Objections to the REH have been raised by Feldstein (1976) and Buchanan (1976), among many, who criticised Barro of ignoring other factors, for example growth, in his analysis. The empirical evidence suggests that while there is a partial offsetting of taxes and private savings, this offset does not quite hold one for one (see Corbo & Schmidt-Hebbel 1991; Doménech, Taguas & Varela 2000; Holmes 2006 for examples).

The REH, however, is not the only theory that suggests substitutability between public and private savings. Specifically, the REH in the strictest form only considers changes in taxes entering into the household saving decision. It is possible that changes in the expenditure component of public savings can elicit a corresponding response in private savings through a separate channel that has nothing to do with the hypothesis. One such channel is the interest rate. In the spirit of intertemporal models allowing for substitution of consumption and savings between time periods, Blanchard (1985) and Auerbach & Kotlikoff (1987) found that increased government expenditure created incentives for households to save by pushing up interest rates. The relative magnitude of this response, though, depended on the time preferences for consumption of the household. Furthermore, Gouveia (1996) found that a $1 increase in public health expenditure reduced private health expenditure by 70 cents. While not a full crowding out, it suggests that there exist high levels of substitutability between at least some components of public and private expenditure. In short, there are various channels hinting public savings crowding out private sector savings and this will be considered in the following empirical analysis.

III. Data

For this empirical study, an unbalanced panel dataset of 55 countries with observations from year 1972-2004 was used. OPEC countries were excluded from the dataset, alluding to the fact that fluctuations in their savings are likely to be driven more by world demand and supply of crude oil than by factors like demography. In addition, countries with a population size of 1 million or less were excluded as their economies tend to compose mainly of a small group of, at times maybe as few as one or two, key industries. Demand or supply shocks to these industries can cause disproportionately large swings in their income and thus savings, introducing a large amount of noise into the dataset.

The variables used for this study and their respective sources are listed in Table 2.

[INSERT Table 2]

Panel ADF tests were conducted to check all the variables for stationarity. The results of these tests are presented in the appendix. GDP per capita was found to contain a unit root, so the first difference of the series, i.e. income growth rate, was used in the model. Furthermore, given that saving was expressed as a percentage of GDP, the effect of income on the level of saving had already been controlled for. The full description of countries with their respective year coverage and summary statistics of variables used in the dataset can be found in the appendix.

IV. Methodology

Model specification

Savings behaviour, whether private or public, is likely to exhibits some degree of inertia. To allow for the "time to change" property, the following dynamic models were estimated:

$$PUB_{i,t} = \rho PUB_{i,t-1} + \delta_1 GROWTH_{i,t-1} + \delta_2 AGED_{i,t} + \delta_3 LIFE_{i,t} + \theta_i + v_{i,t} \quad (1)$$

$$PRI_{i,t} = \zeta PRI_{i,t-1} + \pi_1 GROWTH_{i,t-1} + \pi_2 AGED_{i,t} + \pi_3 LIFE_{i,t} + \pi_4 PUB_{i,t} + \lambda_i + \eta_{i,t} \quad (2)$$

where PUB is public savings, PRI is private savings, GROWTH is real income growth per capita, AGED is age dependency ratio (defined as the ratio of population 65 and above to population 15-64), LIFE is life expectancy at birth, θ and λ are the country fixed effects, and v and η are the error terms. As will be discussed later, a two-step robust standard error correction for dynamic panel models was used, the distribution of the error terms is thus not crucial; correcting for standard errors in this manner allows for the weighing matrix to take into account both heteroskedasticity across individuals and autocorrelation within individuals.

Lagged dependent variables were used in the model to capture the dynamic nature of both private and public savings. The life cycle variables, age dependency and life expectancy, were included to investigate the impact of ageing on savings. Standard growth models suggest that savings has the ability to drive income growth through capital accumulation. To mitigate reverse causality, the lagged of income growth is used. The theoretical argument of public savings crowding out private savings had been discussed earlier. On the contrary, there is no widely accepted theory of private savings driving public savings; private saving therefore does not enter (1). By the same logic, public saving can enter (2) contemporaneously as reverse causality is not an issue here. The public savings equation model is notably parsimonious. The literature hints that political and institutional variables are perhaps the most natural regressors for such a study. However, since institutional and political structures take many years or decades to evolve, the relative time invariant nature of such measures means that the country specific (i.e. fixed) effects should be sufficient to capture any such effect.

Endogeniety and Instrumental Variables

Nickell (1981) showed that estimating models presented by equation (1) and (2) as fixed effects panel data models introduces biasness and inconsistency of the estimator.[4] To circumvent this issue, instrumental variable (IV) techniques can be used. This technique starts off by taking the first differences to purge the fixed effects, following which appropriate instruments are chosen to account for endogeneity before finally estimating the coefficients.

Taking the first difference of equation (1) and (2) yields

$$\Delta PUB_{i,t} = \rho \Delta PUB_{i,t-1} + \delta_1 \Delta GROWTH_{i,t-1} + \delta_2 \Delta AGED_{i,t} + \delta_3 \Delta LIFE_{i,t} + \Delta v_{i,t} \quad (3)$$

$$\Delta PRI_{i,t} = \zeta \Delta PRI_{i,t-1} + \pi_1 \Delta GROWTH_{i,t-1} + \pi_2 \Delta AGED_{i,t} + \pi_3 \Delta LIFE_{i,t} + \pi_4 \Delta PUB_{i,t} + \Delta \eta_{i,t} \quad (4)$$

The terms $\Delta PUB_{i,t-1}$ and $\Delta PRI_{i,t-1}$ are correlated with the transformed error terms $\Delta v_{i,t}$ and $\Delta \eta_{i,t}$ respectively. Anderson & Hsiao (1982) suggested the second lag of the dependent variable (i.e. PUB_{t-2} and PRI_{t-2}) as candidate instruments to break this correlation with the transformed error term. Arellano & Bond (1991) went a step further and proposed the second and deeper lag of the dependant variables as valid instruments since these observations would also not be correlated with the error term either. This procedure is commonly known within the literature as difference GMM. More recently, as an extension to difference GMM, Arellano & Bover (1995) and Blundell & Bond (1998) proposed additional moment conditions that could be exploited as valid instruments in a method known as system GMM. This firstly uses the first and deeper lag *changes* in the dependent variable to instrument for the lag of the dependent variable in the levels equation like (1) and (2)[5]. Following which, using similar instruments as a difference GMM technique, the level and difference equations (similar to (3) and (4)) can be estimated as a system of two equations. In essence, difference GMM uses levels as instruments for differences while system GMM uses both differences and levels as

[4] Greene (2008) and Verbeek (2008) also provide a proof to this proposition

[5] For example, this would mean Pub_{t-1}in equation (1) can be instrumented by ΔPUB_{t-1}, ΔPUB_{t-2}, ΔPUB_{t-3} etc.

instruments in a system of equations. Besides efficiency, there are practical benefits to using system GMM. If the dependent variable has a data generating process that is close to a random walk or exhibits a high level of persistency, differences make better instruments than levels since they generate better forecasts.

Besides instrumenting the lagged dependent variable to remove the dynamic panel bias in the estimation process, instruments were also used to deal with endogeneity as in any regular IV or 2SLS framework. Age dependency ratios and life expectancy were taken to be exogenous in the models. It should be mentioned that while an exogenous and unmodelled shock can affect savings, age dependency and life expectancy, we chose to regard the latter two variables as exogenous in our model for two key reasons. Firstly, the most common exogenous shocks that can affect these variables simultaneously are events like pandemics, war, civil unrest etc. Since income growth was included in the model, most of these exogenous events had already been implicitly accounted for, thus reducing the chance that these exogenous events/shocks being captured by the error term. Secondly, the value of life expectancy at time t is constructed using mortality rates of different age groups in periods earlier[6]. Therefore, by construction, life expectancy is at least a weakly exogenous variable. Similarly, age dependency is also at least a weakly exogenous variable because its value depends on the fertility and mortality rates from the past up to the current period. In short, within our estimation framework, it is unlikely that $\Delta AGED_{i,t}$ and $\Delta LIFE_{i,t}$ are correlated with our transformed error terms, $\Delta v_{i,t}$ and $\Delta \eta_{i,t}$. At the same time, models estimated using instrumental variables by nature generate larger standard errors than ordinary least square estimates (Greene 2008), introducing needless imprecision. Therefore, it is paid in practice to 'restrict' the number of endogenous variables in the model whenever it is theoretically appropriate to do so.

Income growth was regarded as endogenous in our estimation due to its contemporaneous relationship between savings and income growth. A simple national account identity shows consumption, and by extension, savings, to be a function of income. Valid instruments for $\Delta GROWTH_{i,t-1}$ in equation (3) and (4) will be the second and deeper lags of growth (i.e. $GROWTH_{i,t-2}$, $GROWTH_{i,t-3}$ etc). In a system GMM framework, valid instruments for

[6] In theory the value of life expectancy at year t is constructed using mortality rates of different age groups at year t. However, due to either missing data or too few deaths in a particular year for robust estimates, mortality rates from earlier years are often used.

$Growth_{i,t-1}$ in equation (1) and (2) will correspondingly be the lag changes of income growth (i.e. $\Delta GROWTH_{i,t-1}$, $\Delta GROWTH_{i,t-2}$ etc).

Public savings in equation (2) and (4) were taken as "predetermined" in the estimation and also instrumented. The first and deeper lags of public savings are thus valid instruments for $\Delta PUB_{i,t}$ in equation (4) and the change and all lag changes of public savings (i.e. $\Delta PUB_{i,t}$, $\Delta PUB_{i,t-1}$ etc) are valid instruments for $PUB_{i,t}$ in equation (2). Implicitly, this implied that we regarded $PUB_{i,t}$ as being uncorrelated with $\eta_{i,t}$, proposing there exists no simultaneous determination of both the private and public saving levels once we controlled for income growth. Certainly, if public reacts instantly or even pre-emptively if they have forward looking expectations and information of a future change of public savings, this condition will no longer hold. Public savings will then be endogenous. We however, argue that using public savings as predetermined is valid. This mainly stems from the fact that private agents need time to learn about public saving rates before reacting and changing private savings accordingly. We take the view that private agents will rarely have such information of future changes in public savings since fiscal policy tends to be articulated through means like a budget announcement or an official government statement. Apart from that, it is unlikely that private agents can have any accurate idea of the true stance or state of fiscal policy. Furthermore, it must be noted that public expenditure and tax revenue are to a large extent determined by the fiscal policy stance of the government and therefore have a discretionary component. In any case, it was found *ex post* that even if we treated public savings as an endogenous variable, it did not change any of the conclusions found in this paper[7].

While the theoretical reasons for the validity of the instruments have been justifed in the preceding discussion, an econometric issue still arises if there exists correlation between the instrument set and the errors, rendering the instrument set invalid. Using equation (3) as an example, if $\Delta v_{i,t}$ is correlated with $\Delta v_{i,t-2}$, this means $PUB_{i,t-2}$ is invalid as an instrument since $PUB_{i,t-2}$ is correlated with $\Delta v_{i,t-2}$ through $v_{i,t-2}$. In this case, only the third and deeper lags of public savings are valid instruments assuming $\Delta v_{i,t}$ is not correlated with $\Delta v_{i,t-3}$. This underlines the simple idea behind Arellano & Bond's (1991) AR test. An AR(2) test will for example test whether $\Delta v_{i,t}$ is correlated with $\Delta v_{i,t-2}$. Deeper order AR tests can also be conducted.

[7] The point estimates only diverged at the 5th decimal place onwards and the standard errors only started differing at the 4th decimal place onwards.

Like any standard IV estimation, using more instruments than endogenous variables results in an overidentified system. Tests can be conducted to see if the additional moment conditions are valid to be exploited as instruments. Commonly used tests are the Hansen and Sargan tests, also known as the J and C tests respectively. Roodman (2006), however, cautions that these tests should not be relied on too faithfully. It is known that the Sargan test is not consistent, and the Hansen tests can be weakened by too many instruments to the point that even extremely reassuring evidence of the validity of the instruments can be rendered meaningless. This is especially an issue for system GMM as the instrument set has the potential to blow up rapidly. In addition, while excess instruments have the potential of allowing for greater precision, they are also known to bias estimators. While the literature is not helpful in providing a guide as to how many instruments is considered "too many", as a general thumb of rule, the number of instruments used should not exceed the number of observations (Roodman 2006). Even so, Windmeijer (2005) had shown that this limit can still be overly generous.

The practical benefits of a larger instrument set generating greater precision cannot be ignored for our empirical study. Mindful of the pitfalls of large instrument sets biasing our estimators, some practical strategies were undertaken to ensure this would not be the case. Firstly, the instrument set can be reduced when doing robustness checks since this will presumably increase the power of the Hansen Test. Our J test results revealed the validity of our instruments, with insufficient evidence to suggest the contrary. This was still the case even when the instrument set was reduced. Secondly, the AR(2) test did not reject the null of no autocorrelation at conventional significance levels for all the regressions in this paper, so providing no evidence to invalidate our instrument choices.

To recap, in the levels equation (i.e equation (1) and (2)), the first and deeper lag changes were used as instruments for the lagged dependent variable and lag income growth. All lag changes of public savings were used as instruments. For the difference equations (i.e. equation (3) and (4)), the second and deeper lags of the lagged dependent variable and income growth were used as instruments for the first lagged change income growth and the dependent variable. The first and deeper lags of public savings were used as instruments for $\Delta PUB_{i,t}$.

Finally, a two-step standard error correction method was used to allow for heteroskedasticity and autocorrelation. However, this method is known to cause a downward bias in the standard errors; they are thereby further adjusted using Windmeijer (2005) corrected standard errors.

V. Results and Discussion

Base Model Results

Equations (1) and (2) were estimated using system GMM. The results are presented in Table 3. The results confirm that private saving rate exhibits a high level of inertia, with the coefficient on its lag being equal to 0.74 and highly significant. The presence of this inertia suggests that changes in private savings would happen over a considerable period of time, hinting at a static model's inability to adequately capture the full impact of crowding out of private savings over the long-run, especially if the time dimension of the dataset is short. Income growth has a positive sign but is not significant.

[INSERT Table 3]

Age dependency is found to have a negative impact on private savings. In this respect, our findings support the LCH. We found that a one percentage point increase in the age dependency ratio decreases private savings as a percentage of GDP by 0.124 and 0.475 percentage points in the short and long-run respectively. Unfortunately, the vast majority of the literature cannot be directly compared to these results. Firstly, many previous studies used static models while ours was a dynamic model. Secondly, as ageing was our focus, we used age dependency. This meant that we could not compare with papers that used total dependency.[8] Thirdly, the sample coverage might be different. Notwithstanding these, our long-run coefficient is quite similar to those obtained by Serres & Pelgrin (2003), who found the long-run coefficient to be in the range of -0.5 to -0.6 in a variety of specifications.

Increases in life expectancy had a positive impact on private savings, confirming the theoretical validity of the LCH. For a 1 year increase in life expectancy, we expect private savings as a percentage of GDP to increase by 0.108 and 0.413 percentage points in the short and long-run respectively. Rising life expectancy, on the other hand, does not cause any significant decrease in public savings. Recall that there is a literature suggesting that most of the health expenditure is used for the last few years of life, so a longer lifespan does not necessary imply higher (public) health expenditure as suggested by the likes of Cutler &

[8] In later section we will report our results using youth and total dependency ratios respectively.

Sheiner (1998). In addition, countries may actually be reforming their social security system to increase the age where individuals can draw benefits from the system. Our results are also similar to those obtained by Bloom, Canning & Graham (2003). Once again though, we have to be careful with comparing the results between dynamic and static models. Nevertheless, these similarities provide some degree of reassurance of our results.

The short and long-run coefficients of public savings in the private savings equation are statistically significantly and negative. The point estimate of the long-run coefficient is equal to -0.87, no too far off from -1, which suggests a full crowding out effect of public savings on private savings. The 90% confidence interval for the long-run coefficient ranges from -1.62 to -0.13. Although the interval encompasses -1, it is nevertheless quite wide. The large confidence interval is due to the fact that it takes a combination of the standard errors of the short-run coefficients for both the lagged private savings and public savings to compute that that of the long-run coefficient on public savings. Therefore, whilst not entirely dismissing the possibility of a full crowding out, we acknowledge that the evidence is not overwhelming either. Nevertheless, the lower and upper bounds of the interval are both negative; this result being consistent with there being at least some level of crowding out. The uncovering of the possibility of full long-run crowding out effect might be attributed to the use of a dynamic model.

Turning to the results of the public saving equation in Table 3, the inertia of public savings is even stronger than that of private savings, with the coefficient on its lag being equal to 0.83 and is highly significant. This is probably because many public revenue and expenditure items are structural and cannot be changed quickly. Like that in the private saving regression, income growth is of the positive sign but not significant.

Age dependency had also been found to reduce public savings. This is broadly consistent with the results obtained by Kim & Lee (2008), though they used total dependency and different model specifications. Our estimates indicated that for a one percentage point increase in age dependency, public savings as a percentage of GDP falls by 0.035 and 0.209 percentage points in the short and long-run respectively. It is therefore clear that age dependency reduces both private and public savings.

Life expectancy also has a positive effect on public savings like that on private savings. However, compared to private savings results, the magnitude of the coefficient is far smaller and is not significant at all. This is hardly a surprise as private savings are probably more sensitive towards life-cycle determinants than public savings.

For completeness of the analysis, the overall impact of ageing on national savings was also examined with the following regression:

$$NAT_{i,t} = \alpha_i + \rho NAT_{i,t-1} + \beta_1 GROWTH_{i,t-1} + \beta_2 AGED_{i,t} + \beta_3 LIFE_{i,t} + v_{i,t} \quad (5)$$

where NAT is national savings. The equation is estimated in similar fashion to those of private and public savings equations using system GMM. Lagged income growth was regarded as endogenous, and age dependency and life expectancy treated as exogenous variables[9]. The results of this regression are also presented in Table 3.

The short-run coefficients for life expectancy and age dependency were both significant. In the long-run, private savings as a percentage of GDP will decrease by 0.52 percentage points in response to a one percentage point increase in age dependency and increase by 0.43 percentage points in response to a one year increase in life expectancy respectively. Owing perhaps to the imprecision of combining standard errors, the long-run coefficients are marginally insignificant at the 10% level of significance. Notwithstanding, the point estimates of the long-run coefficient did not deviate very much from those obtained in the private savings regression[10]. This is consistent with the possibility of full crowding out effect reported earlier, suggesting that changes in national savings may be almost entirely driven by changes in private savings; rendering changes in public saving rates irrelevant due to an endogenous response by the private sector. This can also be due to the size of public savings making up a very small component of national savings, and therefore, it is relative unimportance in the determination of national savings. Furthermore, the signs are correct, with at least the short-run coefficients being statistically significant, indicating that increases in both age dependency and life expectancy will, *ceteris paribus*, decrease and increase national savings respectively.

Developed versus Developing Countries

[9] In similar fashion, equation (5) was transformed with a first difference to get a difference equation. Thereafter, the first and deeper lagged change of income growth and national savings were used as instruments for lagged national savings and lagged income growth respectively in the levels equation presented in equation (5). In the difference equation, the second and deeper lag of national savings and income growth were used as instruments for ΔNati,t-1 and ΔGrowthi,t-1 respectively.

[10] -0.52 compared to -0.48 for age dependency and 0.43 compared to 0.41 for life expectancy.

A natural question that arises from our results is whether our estimates are robust to different types of countries, considering that there is a mix of 31 developed and 24 developing countries in our dataset[11]. To test for this, we re-ran regressions (1) and (2), breaking the sample into developed and developing countries. A sample of OECD member nations was also taken. The OECD sample was taken to allow for countries that have similar institutional features. The results of these regressions are reported in Table 4 and Table 5. In terms of the long-run coefficient estimates, the results for the OECD and the developed countries sample are very similar for private savings. While the point estimates for public savings regression do differ in both samples, the same variables in both specifications are statistically significant. This is probably because 25 out of the 31 developed economies are OECD members.

[INSERT Table 4 and Table 5]

There is evidence that age dependency is a drag on public savings only in the developed and OECD economies, but not in developing economies. This could be due to the fact that developing countries often house less democratic institutions such that their governments are less pressed to respond to demographic changes. On the other hand, our findings for private savings are very robust to various subsamples. There was evidence across all three groups that age dependency and life expectancy reduces and increases private savings respectively. In fact, the long-run coefficients across all three samples are very similar for both drivers of ageing. This result also provides assurance that findings of high age dependency reducing private savings in the full sample are not solely being driven by developed countries alone. Another interesting result is that there was less than a full crowding out of private savings in the subsample of developed economies[12]. The developing economies sample had insufficient evidence against the hypothesis of a full offsetting effect. However, once again, this is mostly driven by the large standard errors blowing up the width of the confidence interval. It is worthwhile to note that the long-run coefficient of -2.1 is very large[13]. It is also worth noting that while increases in public savings will have a negative impact on private savings, only the developing subsample has evidence of a potential full crowding out effect.

[11] This is by the World Bank's definition of developed and developing countries.

[12] The upper bound for the 90% confidence interval for the long-run coefficient of public savings is even marginally positive, though at 10% level of significance, the point estimate is different from zero.

[13] This confidence interval is also very large, ranging from crowding out 3 times over to only a crowding out of about 30%. A contributing factor to this imprecision is the relatively small sample size of 302 observations for developing countries.

Finally, while not statistically significant in the findings presented in Table 3, income growth is a statistically significant driver of both private and public sector savings for developing countries. Growth theory tends to predict high savings driving higher growth. This result might hint at the possibility that developing countries can enter a virtuous cycle: higher savings driving higher growth, which in turns drives higher savings and even higher growth.

[INSERT Table 6]

Real Interest Rate

The real interest rate[14] was also considered as a determinant for private savings. There are two key reasons why this is incorporated in the analysis. Firstly, intertemporal models of consumption regard movement in the interest rate as a change in the relative price of consumption between time periods. Utility maximising agents respond to this relative change in prices by moving consumption, and thus savings, between periods. Theory thus demands that real interest rate be considered in the empirical model. However, due to limitations on the data coverage[15], this was not done in the original empirical analysis. Nonetheless, considering real interest rate as a determinant of private savings on a reduced sample will provide some comparisons with the base model. Secondly, in Barro's (1974) formalisation of the Ricardian Equivalence Hypothesis, it was shown that real interest rates remained unchanged and it was the changes in taxes that was driving agents to change their saving rates in response. Therefore, if the change in the real interest rate was a channel where changes in public savings affect public savings, we would expect to see both the real interest rate being statistically significant and the coefficient of public savings shrinking or perhaps even becoming statistically insignificant. The results of this regression can be found in Table 6. The sample covers 26 developed countries and 7 developing countries.

The long-run coefficient of age dependency and life expectancy are very similar to the base model, giving confidence to the robustness of the results[16]. Real interest rate is positively significant. The long run coefficient of public savings has reduced, though still statistically significant. This provides some support to the interest rate channel argument of the crowding

[14] We have constructed the real interest rate from taking the difference between nominal interest rates and inflation. The data sources for these variables are the IMF's International Finance Statistics series, Government Bond Yields and WDI respectively.
[15] The data coverage shrinks to 680 observation when real interest rate is considered, losing slightly under half of the data set.
[16] Inflation was also considered. Inflation was marginally negatively significant and the inclusion of inflation did not change the magnitude of all the other coefficients very much.

out effects. Nonetheless, since the coefficient of public savings is still negatively significant, this suggests that Barro's view of Ricardian Equivalence occurring though the tax channel cannot be dismissed.

Wealth

Consideration for wealth affecting the savings function was also considered in the empirical analysis. Permanent income hypothesis predicts that an increase in wealth, if translated into a permanent increase in income, will increase consumption, and so decreasing private savings. Therefore, we should theoretically expect a negative relationship between private savings and wealth.

In this paper, we have used the measurement of broad money (M2) as a percentage of GDP as a proxy for wealth. Our logic stems from the fact that higher wealth would increase the motivation for more financial instruments to smooth consumption. The measure of broad money thus acts as a proxy for the deepening in the financial system. The results are also presented in Table 6.

Two broad observations can be seen when our proxy of wealth was used, giving confidence to our earlier findings. First, the statistically significant negative sign gives the "correct" sign, providing some evidence that our measurement of wealth has a negative association with private savings. However, the size of the coefficient, -0.0002, is very small and can be considered economically insignificant. Second, the statistical significance of the demographic variables in the short run, while reduced, provides confidence of our previous results. The main reason driving the statistical insignificance of the long run coefficients for the demographic variables is probably mainly because the sample is heavily dominated by developing countries owing to data constraints. The results thus mirror the results derived for the sample of developing countries in Table 5. This measurement was thus not considered in the main empirical exercise owning to the fact that once again, too many observations dropped out of the sample due to data constraints and the sample was dominated by developing countries.

To this end, estimation of such a savings-wealth function presents a number of interesting challenges. Firstly, using permanent income hypothesis as a theoretical base, changes in wealth has to be perceived to be permanent for there to be any discernable changes in consumption and saving levels. Therefore, though not done in this paper, distinguishing of whether the change in wealth is permanent or transitory is by itself, an important theoretical consideration. It can also not be ruled out the small and economically insignificant magnitude of wealth might be due to not making the distinction between permanent and transitory changes. Secondly, measurement of wealth is by itself tricky. This is an especially thorny issue when macro aggregated data is used. Therefore, there are issues whether the measurement of wealth is accurately measured. Empirical analysis that can sufficiently address the two above mention issues can be considered for future research.

Omission Bias

A practical question that confronts researchers in this field is whether the study of the demographic effect on savings can be done without jointly considering both life expectancy and age dependency. The correlation coefficient of both variables in our dataset was -0.68, a figure considered moderately high. Thus, jointly considering both in the same regression potentially introduces a high level of collinearity. On the other hand, due to the theoretical underpinnings of age dependency and life expectancy exerting different influences in private savings, omitting either variable could bias the estimation to the extent that it alters the sign of the other variable. The papers listed in Table 1, while widely cited, all failed to take into account longevity in their models. In Table 7, we show the extent of the bias in omitting life expectancy and age dependency respectively from our base model for both private and public savings estimated in Table 3. Clearly, omitted life expectancy caused the coefficient on age dependency to be biased upwards from -0.124 to 0.062. The bias in our sample was particularly strong to the point that the coefficient on age dependency was no longer statistically significant and has the wrong sign. Likewise, omitting age dependency caused the coefficient on life expectancy to be biased downwards from 0.108 to 0.066. Though the coefficient remained statistically significant and correctly signed, it was now much smaller in magnitude. For public savings, if we omitted life expectancy, the coefficient of age dependency changed from -0.035 to -0.018. While the coefficient was still statistically significant, there is an upward bias that understates the magnitude of the negative impact age dependency had on public savings. However, if we dropped age dependency, life expectancy clearly becomes negative and significant with its coefficient changing from 0.005 to -0.003. Therefore, this omission can cause wrong conclusions to be made since it is age dependency—not longevity—that is driving this fall in public savings.

The results derived from this exercise suggest that researchers have to be careful to jointly consider both age dependency and life expectancy when ascertaining the full and disaggregated impact of ageing.

[INSERT Table 7]

Youth and Total Dependency

To further test the robustness of our findings, we also attempted to allow youth dependency or total dependency to enter the model instead of age dependency. These are presented in Table 8.

[INSERT Table 8]

Youth dependency was never statistically significant for both private and public savings and even has the 'wrong' sign. Therefore, it was not surprising that when total dependency was used, it was no longer significant for public savings. For private savings, total dependency was still significant, but since youth dependency did not affect private savings, while age dependency did, this would indicate that this result is being driven solely by age dependency. Life expectancy was still significant in both private savings specification; therefore once again reaffirm the importance of jointly considering longevity. Finally, public savings was still a significant driver of private savings for both specifications, and the 90% confidence interval for the long-run coefficient still contained -1 in both cases.

Alternative Instruments

Finally, as presented in the appendix, the instrument set was reduced to see whether it altered the results derived in the base model. Two ways were used in the reduction of the instrument set. One method available was to "collapse" the instrument set matrix to reduce the instrument count[17]. Since, our models were estimated using the first and deeper valid lags as instruments, another method for reducing the instrument set was to use only the first valid lag as an instrument[18]. Reducing the instrument set through both methods changed neither the coefficient estimates very much nor the conclusions for private savings. For public savings,

[17] For technical details on the construction of the instrument matrix are described in graduate econometric textbooks like Greene (2008) and Verbeek (2008). Though "collapsing" is described as non-standard by Roodman (2006), he show how this instrument matrix can be "collapsed" and this is the procedure undertaken in this paper. Instruments set in an "uncollapsed" form generates instruments that are quadratic in T. "Collapsing" shrinks the instrument matrix and thus reduces the instruments generated.

[18] For example, instead of using the second and deeper lag of public savings to instrument for $\Delta PUB_{i,t-1}$ in equation (3), we will use only the second lag and no more.

though the coefficients estimates for age dependency started to deviate quite substantially from those derived earlier, the conclusions were still the same as in that the signs were unchanged and the same sets of coefficients were statistically significant. As described earlier, one could find issues with the validity of our J statistics in the Hansen test because as the instrument set is so large that it may make inferences from those J statistics useless. Reduction of the instrument set increases the power of the Hansen Test. It was also found that after doing so the instrument set still suggested there was insufficient evidence that the reduced set of moment conditions were invalid. Therefore, this can be taken to suggest the validity and the robustness of the key findings and results of the paper.

Policy Implications

The results from the various robustness tests, including using split samples, indicate that by and large the findings in Table 3 are very robust. This relieves us from sensitivity issues when drawing economic and policy implications from the results.

First of all, it is clear from our findings that both age dependency and life expectancy exert opposite effects on private savings, and in turn national savings. This implies that there is uncertainty in the overall impact of ageing on private savings, especially if an ageing society experiences both increases in age dependency and life expectancy.

The European Commission (2002 see section I.4) suggested increasing public savings before the onset of ageing to maintain fiscal sustainability. Floden (2003) also echoed the same view, asking for higher taxes and public expenditure cuts to reduce the welfare impact of debts. Our findings on crowding out cast doubts whether expenditure cuts or increased taxation by the public sector as a preparation for population ageing might only serve the purposes of improving public budget position, but irrelevant in terms of changing the national savings rates. If the focus of public policy is to increase national savings, perhaps effort should instead be targeted at influencing the level of private savings[19].

The finding that longevity can increase private and thus national savings potentially creates a development trap. Countries endowed with an unfavourable environment for health would have low savings, low growth and thus low income, which would in turn become a barrier to improve their life expectancy (Tang, Petrie & Rao 2009), ending up trapped in a vicious

[19] Policies that could influence private savings include, for instance, taxes on investment income or capital gain.

cycle. A corollary of this is that health aid could potentially play an important role in breaking the vicious cycle (Mishra & Newhouse 2009).

The positive relationship between longevity and (private and national) savings also present some interesting implications for countries with large longevity gaps. Within our dataset, the "best performing" country in terms of life expectancy was Japan at about 82 years in 2004. Emerging economies like India and Brazil, with life expectancy being around 70 years, have a longevity gap of over 10 years compared to Japan. Based on our estimates, closing this gap could increase Brazil's private and national savings by over 4 percentage points of GDP in the long-run, not an insignificant figure. Even advanced economies like the United Kingdom Belgium, and Austria could raise private savings by about 1.2 percentage points of GDP through closing their 3-year longevity gaps with Japan. The possibility exists that even best performing nations can still increase longevity further. Conservative projections made by Lee & Carter (1992) and Tuljapurkar, Li & Boe (2000) predict life expectancy to increase to 90 years by 2100. Taking this estimate, private savings would increase by over 3 percentage points for Japan. However, there are also opposite predictions that life expectancy in this generation may be regressing, mainly due to health issues associated with obesity and lifestyle choices (Olshansky et al. 2005). If the second scenario turns out to the case, this would give an even more pessimistic outlook compared to previous studies that only looked at age dependency, as the accompanying decrease in life expectancy creates a twin drag on national and private savings.

The preceding discussion about increases in life expectancy not depressing savings and growth outcomes of course implicitly assumed age dependency remaining constant. With higher age dependency acting as a drag on private and, in turn, national savings, policy influencing fertility rates will have to be implemented to allow a greater, or at least a constant, stream of people entering the 15-64 age bracket than those entering the 65+ age group. But is this possible? Within the literature, some have regarded falling fertility rates as an endogenous response towards higher life expectancy (Becker & Barro 1988). To allow rising longevity to take place without allowing for increases in age dependency will mean either more aggressive immigration policy targeted at those in the working age bracket, or policy to give incentives having children, or a mix of both. However, for the world as a whole, immigration policy that boosts the proportion of the working population in the destination country will inevitably lowers that in the source countries.

VI. Conclusion

Demographic change has the potential to alter macroeconomic outcomes. However, besides due consideration to the age structure, changes in longevity levels, which tends to accompany demographic change, can also exert their influence on savings behaviour at both private and public levels. This paper has found that age dependency exerts a drag on private and, in turn, national savings. Rising life expectancy can result in an increase in private savings. This is in contrast to the conventional view that ageing will only act as a drag on savings. The overall impact ageing has on savings is likely to depend on the relative pace of increases in longevity compared to the rise in age dependency.

The findings in this paper also indicate that in future demographic studies, age dependency should perhaps be jointly considered with life expectancy to avoid the potential of biased estimator. For many developed economies, despite the notion of a ceiling on life expectancy, there is still room to increase life expectancy by as much as 5 years in the United States for instance. Our calculations show that this can increase savings by a reasonably substantial magnitude in the long-run. This paper also found that there exists some degree of crowding out of private savings, with anecdotal evidence to suggest the possibility of a full crowding out. This hints that changes in public saving rates can be potentially irrelevant in terms of changing the national saving rate. In terms of policy implications, this suggests that countries that need to prop up national savings should design policy to simulate saving by the private sector.

Undoubtedly, solutions to deal with ageing populations will increasingly feature in the policy debate in the not so distant future. This paper looks at one channel where ageing can potentially exert a long term macroeconomic impact—savings. Ageing is primarily caused by higher age dependency and rising longevity. To this end, this paper finds that the impact ageing has on savings is at best ambiguous. Crucial consideration thus has to be paid to disentangle which of the two factors dominate in the determination of savings.

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Table 1 Summary of Selected Studies on the Demographic Effect on Private Savings

Study	Empirical focus	Data coverage	Empirical findings
Edwards (1996)	Determinants of public and private savings	36 countries, 1970-1992	Total Dependency(-)
Bailliu & Reisen (1998)	Does increase in funded pension wealth increase aggregate savings?	10 countries, 1982-1993	Total Dependency (Nil)
Masson, Bayoumi & Samiei (1998)	International determinants of private savings	61 countries, 1971-1993	Total Dependency (-)
Haque, Pesaran & Sharma (1999)	Are studies of savings behaviour robust to considerations of dynamics and heterogeneity?	61 countries, 1971-1993, Same dataset as Masson, Bayoumi & Samiei (1998)	Total Dependency (Nil)
Loayza, Schmidt-Hebbel & Serven (2000)	Determinants of private savings	150 countries, 1965-1994	Youth Dependency (-) Age dependency (-)
Serres & Pelgrin (2003)	Determinants of the OECD private savings	15 OECD countries, 1970-2000	Age dependency (-)

(-) Variable was statistically negatively significant. (Nil) Variable was not statistically significant

Table 2 Variables and Sources

VARIABLE	SOURCE
GDP Per Capita PPP, Base Year 2000	Penn World Tables 6.2
Public Savings (as a % of GDP)	IMF World Economic Outlook, IMF Government Financial Statistics
Private Savings (as a % of GDP)	Constructed as the difference between National Savings in World Development Indicators (WDI) and Public Savings
Age dependency Ratio (ratio of population 65 and above to population 15-64	WDI
Life Expectancy at Birth	WDI

Table 3 Estimation Results Using System GMM

	(1)		(2)		(3)	
	Private savings		Public savings		National savings	
		Long-run coefficient		Long-run coefficient		Long-run coefficient
Lagged private savings	0.738*** (0.0744)					
Lagged public savings			0.832*** (0.0552)			
Lagged national savings					0.846*** (0.0679)	
Lagged income growth	0.042 (0.0331)	0.160 (0.132)	0.014 (0.0301)	0.082 (0.197)	0.024 (0.0350)	0.158 (0.236)
Public savings	-0.229*** (0.0615)	-0.874** (0.451)				
Age dependency	-0.124*** (0.0373)	-0.475** (0.253)	-0.035** (0.0176)	-0.209 (0.158)	-0.080** (0.0366)	-0.518 (0.438)
Life expectancy	0.108*** (0.0301)	0.413** (0.230)	0.005 (0.0037)	0.028 (0.025)	0.066** (0.0285)	0.426 (0.369)
90% confidence interval for long-run coefficient for public savings	[-1.617, -0.131]					
J statistic H_0: Surplus moment conditions are valid	46.46		54.63		51.10	
AR(2) test p value H_0: No 2^{nd} order autocorrelation	0.336		0.127		0.184	
No. of observations	1046		1046		1046	
No. of instruments	1030		935		935	

Standard errors in parenthesis.

***Significant at 1% level of significance. **Significant at 5% level of significance. *Significant at 10% level of significance.

Table 4 Public Savings by Group

	(1)		(2)		(3)	
	Developed countries		Developing countries		OECD	
		Long-run coefficient				Long-run coefficient
Lagged public savings	0.870*** (0.0836)		0.614*** (0.1507)		0.795*** (0.1159)	
Lagged income growth	-0.018 (0.0463)	-0.142 (0.341)	0.063* (0.0339)	0.162* (0.120)	0.022 (0.0483)	0.109 (0.271)
Age dependency	-0.040* (0.0241)	-0.305 (0.352)	-0.012 (0.0329)	-0.031 (0.094)	-0.018* (0.0134)	-0.086* (0.087)
Life expectancy	0.008 (0.0060)	0.064 (0.068)	0.003 (0.0073)	0.009 (0.021)	-0.003 (0.0074)	-0.016 (0.043)
J statistic H_0: Surplus moment conditions are valid	29.93		19.12		23.74	
AR(2) test p value H_0: No 2^{nd} order autocorrelation	0.128		0.310		0.346	
No. of observations	744		302		667	
No. of instruments	715		302		643	

Standard errors in parenthesis.

***Significant at 1% level of significance. **Significant at 5% level of significance. *Significant at 10% level of significance.

Table 5 Private Savings by Group

	(1)		(2)		(3)	
	Developed countries		**Developing countries**		**OECD**	
		Long-run coefficient		**Long-run coefficient**		**Long-run coefficient**
Lagged private savings	0.487*** (0.1709)		0.651*** (0.2109)		0.472*** (0.1467)	
Lagged income growth	-0.011 (0.0386)	-0.021 (0.080)	0.151*** (0.0509)	0.431* (0.222)	0.072 (0.0550)	0.136 (0.117)
Public savings	-0.156** (0.0850)	-0.305* (0.235)	-0.733** (0.1619)	-2.100** (1.077)	-0.254** (0.1044)	-0.481** (0.290)
Age dependency	-0.325*** (0.1243)	-0.634* (0.446)	-0.227** (0.1186)	-0.651 (0.725)	-0.215*** (0.0711)	-0.408** (0.238)
Life expectancy	0.256*** (0.0899)	0.499* (0.341)	0.136** (0.0789)	0.391 (0.461)	0.221*** (0.0634)	0.419** (0.235)
Real Interest Rate						
90% confidence interval for long-run coefficient for public savings	[-0.693, 0.083]		[-3.876, -0.323]		[-0.958, -0.003]	
J statistic H_0: Surplus moment conditions are valid	19.29		12.55		15.68	
AR(2) test p value H_0: No 2^{nd} order autocorrelation	0.426		0.499		0.390	
No. of observations	744		302		667	
No. of instruments	734		302		660	

Standard errors in parenthesis.

*****Significant at 1% level of significance. **Significant at 5% level of significance. *Significant at 10% level of significance.**

Table 6 Private Savings Specifications Using Real Interest Rate and Wealth Measure

	(1)		(2)	
	26 Developed and 7 developing countries		19 Developed and 24 developing countries	
		Long-run coefficient		**Long-run coefficient**
Lagged private savings	0.686*** (0.1098)		0.866*** (0.0795)	
Lagged income growth	0.066 (0.0849)	0.209 (0.291)	0.070 (0.0535)	0.518 (0.359)
Public savings	-0.155** (0.0845)	-0.494 (0.321)	-0.213** (0.0901)	-1.589 (1.402)
Age dependency	-0.157*** (0.0465)	-0.501* (0.305)	-0.073* (0.0489)	-0.541 (0.602)
Life expectancy	0.137*** (0.0478)	0.437* (0.303)	0.054* (0.0340)	0.403 (0.488)
Real Interest Rate	0.010*** (0.0027)	0.033* (0.041)		
M2 percentage of GDP			-0.000** (0.0001)	-0.002 (0.001)
90% confidence interval for long-run coefficient for public savings	[-1.023,0.035]		[-3.897,0.719]	
J statistic H_0: Surplus moment conditions are valid	26.67		39.84	
AR(2) test p value H_0: No 2^{nd} order autocorrelation	0.390		0.104	
No. of observations	680		686	
No. of instruments	678		686	

Standard errors in parenthesis.

*****Significant at 1% level of significance. **Significant at 5% level of significance. *Significant at 10% level of significance.**

Table 7 Estimation Results with Omission of Age dependency or Life Expectancy

	(1)		(2)		(3)		(4)	
	Private savings		**Private savings**		**Public savings**		**Public savings**	
		Long-run coefficient		**Long-run coefficient**		**Long-run coefficient**		**Long-run coefficient**
Lagged private savings	0.920*** (0.0424)		0.772*** (0.0502)					
Lagged public savings					0.843*** (0.0429)		0.846*** (0.0425)	
Lagged income growth	0.089** (0.0397)	1.112 (0.825)	0.062* (0.0323)	0.273* (0.150)	0.019 (0.0194)	0.121 (0.125)	0.010 (0.0171)	0.066 (0.115)
Public savings	-0.141** (0.0605)	-1.764 (1.391)	-0.225*** (0.0610)	-0.987*** (0.443)				
Age dependency	0.062 (0.0491)	0.775 (1.012)			-0.018** (0.0075)	-0.114 (0.149)		
Life expectancy			0.066*** (0.0155)	0.291*** (0.131)			-0.003* (0.0017)	-0.021* (0.015)
90% confidence interval for long-run coefficient for public savings	[-4.054, 0.525]		[-1.716, -0.259]					
J statistic H_0: Surplus moment conditions are valid	49.68		44.35		54.01		53.58	
AR(2) test p value H_0: No 2^{nd} order autocorrelation	0.359		0.337		0.129		0.126	
No. of observations	1046		1046		1046		1046	
No. of instruments	1029		1029		934		934	

Standard errors in parenthesis.

***Significant at 1% level of significance. **Significant at 5% level of significance. *Significant at 10% level of significance.

Table 8 Estimation Allowing for Alternative Measures of Economic Dependency

	(1)		(2)		(3)		(4)	
	Private savings		Public savings		Private savings		Public savings	
		Long-run coefficient		Long-run coefficient		Long-run coefficient		Long-run coefficient
Lagged private savings	0.815*** (0.0543)				0.808*** (0.0490)			
Lagged public savings			0.838*** (0.0554)				0.847*** (0.0451)	
Lagged income growth	0.055 (0.0396)	0.299 (0.216)	0.016 (0.0345)	0.101 (0.238)	0.055 (0.0398)	0.285 (0.207)	0.013 (0.0234)	0.088 (0.167)
Public savings	-0.190** (0.0805)	-1.025* (0.651)			-0.182*** (0.0631)	-0.945** (0.485)		
Youth dependency	0.001 (0.0059)	0.006 (0.032)	0.002 (0.0029)	0.012 (0.019)				
Total dependency					-0.010* (0.0073)	-0.054* (0.042)	0.000 (0.0040)	-0.003 (0.026)
Life expectancy	0.053*** (0.0171)	0.288** (0.173)	-0.005 (0.0036)	-0.029 (0.031)	0.063*** (0.0172)	0.329** (0.168)	-0.003 (0.0038)	-0.019 (0.028)
90% confidence interval for long-run coefficient for public savings	[-2.096, 0.047]				[-1.743, -0.146]			
J statistic H_0: Surplus moment conditions are valid	46.88		52.57		43.18		53.59	
AR(2) test p value H_0: No 2^{nd} order autocorrelation	0.346		0.128		0.348		0.128	
No. of observations	1046		1046		1046		1046	
No. of instruments	1030		935		1030		935	

Standard errors in parenthesis.

***Significant at 1% level of significance. **Significant at 5% level of significance. *Significant at 10% level of significance.

APPENDIX

Table A1 Data Coverage

Country	Year coverage	Number of time periods
Australia	1972-2004	33
Austria	1972-2004	33
Azerbaijan	1994-1999	6
Belarus	1995-2003	9
Belgium	1978-2004	27
Bolivia	1986-2003	18
Brazil	1980-1994	15
Bulgaria	1991-2004	14
Canada	1979-2004	26
Chile	1974-1988, 1992-2004	28
Colombia	1974-198	13
Croatia	1994-2004	11
Czech Republic	1993-2004	12
Denmark	1972-2004	33
Egypt, Arab Rep.	1975-1979, 1981-1997	22
Estonia	2000-2004	5
Finland	1972-2004	33
France	1978-2004	27
Georgia	1997-2001	5
Germany	1974-2004	31
Greece	1980-2004	25
Hong Kong, China	1980-2004	25
Hungary	1981-1999	19
Ireland	1972-2004	33
Israel	1976-2004	29
Italy	1980-2004	25
Japan	1980-2004	25
Kazakhstan	1997-2003	7
Korea, Rep.	1980-2004	25
Latvia	1994-2003	10
Lithuania	1993-2004	12
Malaysia	1996-2003	8
Mexico	1972-2000	29
Moldova	1997-2001	5
Mongolia	1992-2002	11
Netherlands	1975-2004	30
New Zealand	1980-2004	25
Norway	1980-2004	25
Panama	1990-1994	5
Peru	1990-2003	14

Poland	1994-2000	7
Portugal	1980-2004	25
Romania	1990-2004	15
Singapore	1972-2004	33
Slovak Republic	1996-2004	9
Slovenia	1990-2004	15
South Africa	1977-2004	28
Spain	1980-2004	25
Sweden	1978-2004	27
Switzerland	1977-2004	28
Thailand	1972-2002	31
Ukraine	1999-2003	5
United Kingdom	1973-2004	32
United States	1980-2004	25
Zimbabwe	1977-1991	15

Table A2 Summary Statistics

Variable	No. of observations	Mean	Standard deviation	Min	Max
Age dependency	1108	16.76074	6.508216	5.48	29.33
Real Income Growth per Capita	1108	5.579003	4.605773	-30.99	23.52
Life Expectancy at Birth	1108	72.88641	5.846744	44.61	82.03
Private Savings (% of GDP)	1108	23.71485	7.419446	-6.50	50.78
Public Savings (% of GDP)	1108	-0.94044	4.607695	-19.83	15.37

Table A3 Panel ADF Test

Variable	Exogenous Variable(s) Used in Test	Fisher Chi Square Test Statistic	p value
Age dependency	Intercept, Trend	233.674	0.000
GDP Per Capita, PPP	Intercept, Trend	106.102	0.587
Growth	Intercept	316.608	0.000
Life Expectancy	Intercept, Trend	268.396	0.000
Private Savings	Intercept	181.263	0.000
Public Savings	Intercept	227.424	0.000

Null Hypothesis: Unit Root. Growth is first difference of GDP Per Capita, PPP

Table A4 Estimation Results with Reduction of the Instrument Set

	(1)		(2)		(3)		(4)	
	Private savings "collapsed"		Public savings "collapsed"		Private savings		Public savings	
		Long-run coefficient		Long-run coefficient		Long-run coefficient		Long-run coefficient
Lagged private savings	0.358*** (0.0871)				0.642*** (0.1085)			
Lagged public savings			0.765*** (0.0430)				0.787*** (0.0413)	
Lagged income growth	-0.015*** (0.0489)	-0.023 (0.078)	0.030 (0.0206)	0.127 (0.094)	0.027 (0.0407)	0.076 (0.116)	0.003 (0.0259)	0.013 (0.122)
Public savings	-0.671*** (0.0998)	-1.045*** (0.270)			-0.440*** (0.0887)	-1.228** (0.564)		
Age dependency	-0.315*** (0.1218)	-0.491** (0.214)	-0.047*** (0.0183)	-0.202** (0.095)	-0.196*** (0.0765)	-0.548** (0.319)	-0.044** (0.0191)	-0.209** (0.109)
Life expectancy	0.275*** (0.0466)	0.428*** (0.121)	0.005 (0.0046)	0.023 (0.021)	0.154*** (0.0448)	0.431** (0.250)	0.007 (0.0045)	0.034 (0.023)
90% confidence interval for long-run coefficient for public savings	[-1.490, -0.601]				[-2.157, -0.298]			
J statistic H_0: Surplus moment conditions are valid	50.32		52.64		51.90		52.43	
AR(2) test p value H_0: No 2^{nd} order autocorrelation	0.225		0.126		0.279		0.118	
No. of observations	1046		1046		1046		1046	
No. of instruments	99		66		189		126	

Standard errors in parenthesis.

***Significant at 1% level of significance. **Significant at 5% level of significance. *Significant at 10% level of significance.