The economics of population growth

THE BURDEN OF DURABLE ASSET ACQUISITION IN GROWING POPULATIONS

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While most analyses of economic impacts of population growth have been equivocal, this article describes a new perspective from which the effects are strongly negative. The economies and diseconomies of population size are largely circumstantial and empirically inconsistent, but those of growth rate are intrinsic and consistent. These impacts are not apparent on income and per capita GDP, but on costs. The article estimates these costs using the logic of calculus rather than marginal accounting. Specifically, the cost of maintaining per capita capacity of durable assets, including infrastructure, equipment and skilled personnel, is increased by population growth by a factor proportional to the working lifespan of the asset class.

Keywords: population economics, diseconomies of growth rate, infrastructure provision, skilled labour supply, demographic dividend, age dependency.

This article offers a new perspective for understanding the economic impact of population growth. It shifts focus from the relatively long-term impacts of population size to the near-term impacts of the population growth rate. It reveals how powerful diseconomies of the growth rate have been overlooked in contemporary economic analysis.

Economic discussion of population growth has usually focused on the economies and diseconomies of scale (Cocks, 1996). Yet the motivations for encouraging population growth have rarely been about scale. They are principally about growth rate, and its impact on age distribution, labour supply and demand for real estate and financial capital.

Missing from this discourse is any evaluation of the diseconomies of growth rate. It is this gap which the current discussion aims to fill. The analysis is developed in the context of the Australian population debate and draws on Australian examples, but is equally applicable to all nations, at any level of development.

The economic burden of durable asset acquisition

The ability of a society to meet its population's needs is largely dependent on its stock of durable assets. These include infrastructure, both public and private, as well as plant and equipment, and importantly its skilled personnel. A certain proportion of total economic capacity must be used for asset acquisition, to maintain services to the community.

Whether these assets are adequately represented by the term 'capital' may be disputed, but the latter may have broader meaning in economic accounting and discourse. In particular, this discussion is limited to man-made physical assets which deliver utility on an ongoing basis, not to financial or speculative assets or natural assets whose stocks are limited.

The thesis offered in this article is based on the simple observation that a society only acquires a fraction of its total stock of durable assets in any given year. The longer a class of assets lasts, the smaller the proportion that is replaced annually.

Considering infrastructure in the first instance, the annual needs of a stable population would include replacing worn-out facilities and modernising items whose technology or design has been superseded. The proportion replaced in any year is the inverse of its functional lifespan. Different items of infrastructure have differing lifespans, but a cost-weighted average is likely to be at least 50 years, once we remove growth as a reason for facilities being rendered

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obsolete. That would imply the need to replace no more than 2% of all infrastructure annually. The exact figure is not important here for the demonstration of the concept.

If population is growing at 1% per annum, the society needs to expand the capacity of its entire stock of infrastructure by 1% per annum, to avoid building up an infrastructure deficit, with negative impacts on access to and quality of services. The burden of infrastructure creation is thus increased by at least 50%, compared with a stable population: 2% replacement plus 1% in addition.

The same principle applies to the skilled workforce – to human capital formation. Professional or trade training is an up-front cost incurred before the working life begins. Australian graduates have a workforce participation rate of around 87%, and might average 43 years of post-graduation working age. This implies an average working life of 37 years. In a stable population with even age cohorts, annual retirements would be $100/37 = 2.7\%$ per year. Thus, the annual training requirement of a stable population with even age cohorts would be to graduate 2.7% of the workforce in any particular vocation.

Should the workforce be required to expand by 1% in the following year, graduations would need to equal 3.7% to cover retirements and growth, an increase of $(1 \times 100)/2.7 = 37\%$ over the stable population training requirement. As with the infrastructure example, the second ratio reverses the first, so the percentage increase in annual burden for each per cent growth is equal to the working lifespan in years. At 2% population growth rate, graduations would need to be 4.7% of the graduate workforce, an increase of 74% over the requirement of a stable population.

In this respect, skilled personnel are no different from hospitals, power stations, buses and trains, or furniture and white goods. Thus, in comparison with a stable population, for any class of durable asset:

Increase in acquisition burden (%) =

working life (*years*) *x population growth rate* (% *per annum*)

The above formula serves mainly as a statement of principle. It would apply where a previously stable population begins to grow. A number of factors may modify the effect in practice.

The most predictable factor is the impact of growth rate on the retirement rate of assets reaching the end of their life. In a population which has been growing at a steady rate for a period exceeding the lifespan of the asset class in question, the proportion of assets reaching the end of their life will be reduced because their cohort has been diluted by larger subsequent cohorts. This effect almost halves the increase in asset acquisition burden, over the range of growth rates and lifespans with which we are likely to be concerned. Figure 1 plots the increase in burden against asset lifespan, for populations growing steadily at 1%, 2% and 3% per annum. The case of a stable population moving to 1% population growth is also depicted, where the additional acquisition burden is equal to the working lifespan. Also plotted is the converse case, where a population with a historical growth rate of 1% moves to zero growth, where the burden is initially less than that of a historically stable population, due to its relatively youthful inventory of assets.

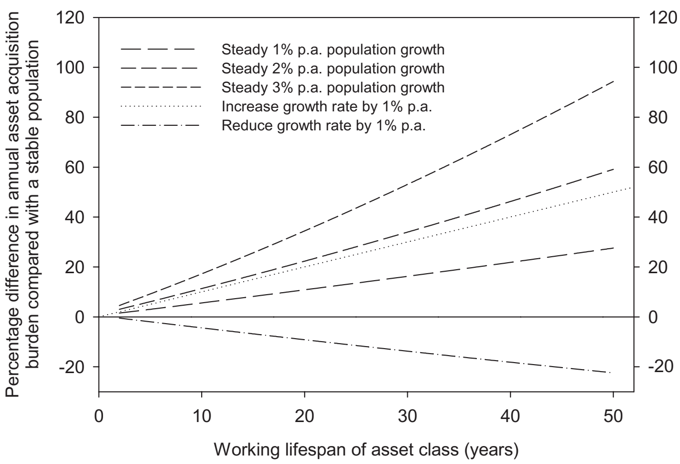

Figure 1: The annual burden of durable asset acquisition (turnover and growth) as a function of the lifespan of the asset class, for populations under various growth regimes, expressed as the percentage difference from the burden of asset maintenance in a stable population. (In populations growing steadily at 1%, 2% or 3% per annum, the burden of capacity expansion is partly offset by lower rates of retirement of existing assets due to relatively young asset stocks. In a historically stable population which moves to 1% per annum growth, the full impact of capacity expansion is carried. Conversely, when a steadily growing population moves to end population growth, the initial burden is less than that of a stable population, but will rise as the asset age cohorts even out.)

Working in the opposite direction is the effect of growth reducing the lifespan of assets. If the capacity of an existing installation cannot be easily expanded *in situ* or duplicated on another site, the structure may need to be removed to make way for a larger capacity version. Alternatively, growth may cause the land occupied by a facility to be reallocated. If the average effect were to reduce lifespan of infrastructure from 50 years to 40 years, this would add around 25% to the annual acquisition burden.

Likewise, diseconomies of scale and costs associated with retrofitting upgraded utilities in already built-up areas increase the costs of growth. Moving from locally dammed, largely gravity-fed water supply to regionally pumped, desalinated or recycled water greatly increases the unit cost, as does moving from simple road and rail structures to major freeways or subways. It is difficult to generalise on these costs, but it might be concluded that the effects shown in Figure 1 are very conservative.

For training, the time taken to train professionals further increases the training burden, as the number of students recruited must relate to the population at the time they graduate. The resulting burden for steady 1% population growth is between 21% and 24% above that of a stable population, depending on programme length, compared with the 20% burden considering the retirement rate effect alone. In any case, as long as population growth rate is constant and is mainly due to natural increase, the proportion of school leavers required to be enrolled in any particular vocation is similar to the proportion of that vocation in the working age population. However, where the population growth rate has been recently accelerated, the need to grow the whole workforce through new graduations means a

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Table 1: Estimates of Australian expenditure on major categories of durable assets in the 2010/11 financial year, the contribution of capacity expansion to accommodate population growth, and the cost in comparison to a long term stable population

Item	Assumed lifespan years	Annual expenditure A$ billion	Capacity expansion A$ billion	Cost in excess of stable population A$ billion
Infrastructure in GFCF	50	283	141.8	112.4
Household furnishings	15	24	4.5	2.8
Motor vehicles	10	20	2.6	1.6
Computer and audiovisual	5	9.5	0.6	0.4
Tertiary education	37	25	10.1	7.2
Total			159.6	124.4
Percent of GDP			12.2%	9.5%
Percent of GNI			14.8%	11.5%
Cost per person added			A$490,000	

Source: Expenditure components of Gross Fixed Capital Formation (GFCF) and Household Consumption from Australian Bureau of Statistics (2011) (Cat. 5206.0 and 6470.0).

significantly higher proportion of school leavers must be trained.

Barring capacity constraints, an increase in population tends to increase economic activity and tax revenue in proportion to population increase. A 1% increase in population would be expected to increase GDP and tax revenue by approximately 1%. A number of studies, some attempting to demonstrate economic benefit from population growth, have affirmed the conclusion that the effect on per capita GDP is small to absent (Productivity Commission, 2006; Collacott, 2003; Cocks, 1996; Turner, 2009a; House of Lords Economics Committee, 2007).

However, as we have seen, the cost of acquiring durable assets to maintain service levels increases at a very much greater rate, due to the durability factor. Clearly 1% more GDP or tax revenue cannot pay for 25–50% more public infrastructure creation, 50–100% more housing construction, 20–37% more training places, 5–15% more vehicles, 10–20% more appliances and fittings, and so on. Within the economy, activity is diverted to the task of capacity expansion, and consequently withdrawn from other provision of goods and services.

Magnitude of cost of population growth

While the durability factor suggests a significant increase in societal costs resulting from population growth, these costs are not easily quantified. Various estimates for the cost of adding a person or household suggest figures in the hundreds of thousands of dollars.

In 1986, MIT economist Lester Thurow published an opinion piece in which he estimated that it takes around 25% of GDP to sustain 2% population growth and that, because of this, no country is likely to progress economically with growth rates above 2% (Thurow, 1986). The cost of fully equipping extra people was thus estimated at 12.5% of GDP per 1% of population growth.

Pursuing the Australian example, in the year to December 2010 population grew 1.45% adding some 325,500 people. The average population growth rate of Australia over the past 40 years has been around 1.4% per annum. Hence, while growth rates in the three years previous to 2010 were higher, in terms of the expected retirement rate of assets a steady 1.4% growth rate may be assumed to apply. The average age of infrastructure of 21 years is consistent with an average infrastructure lifespan of approximately 50 years at this growth rate. Table 1 compiles a rough and incomplete list of expenditure on durable assets in Australia for the financial year 2010/11. It estimates capacity expansion at over 12% of GDP and almost 15% of GNI. This analysis assumes that infrastructure spending is keeping pace with societal needs, that asset retirements are based on the steady 1.4% growth model, and ignores inefficiencies of scale and shortened lifespan due to growth, which would increase the proportion of total expenditure attributable to capacity expansion. Compared with a long-term stable population, in which the asset retirement rate would be higher, the cost burden is estimated at 9.5% of GDP or 11.5% of GNI.

Thurow's calculation did not consider differences in asset retirement rate. In comparison with his estimate, this analysis estimates a capacity expansion cost of 10% of GNI per 1% population growth, or a burden of 8% of GNI per 1% population growth above the costs endured by a stable population. Given that these estimates are incomplete and conservative in a number of assumptions, the analysis is broadly consistent with Thurow's. It is widely accepted that infrastructure spending has not kept pace with Australia's recent population growth surge (Engineers Australia, 2010). Hence the actual expenditure in Table 1 may significantly underestimate the required asset acquisition burden to maintain quality of life.

Reconceptualising the costs of population growth

The above analysis suggests that population growth is a significant cost at a societal level. It may seem surprising, then, that population growth is not widely recognised as an economic burden. The following perspectives are offered to explain why the cost has remained elusive.

Capacity expansion is a recurrent cost of growing populations

Probably the largest contributing factor is the misconception that all spending on durable assets is 'investment'. For the purpose of this discussion, all the additional infrastructure, equipment and training needed to maintain the same level of service provision, utility or amenity to a larger population is

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termed capacity expansion. Capacity expansion is not an investment, in the sense of a current sacrifice for future gain, as the result is only stasis, not gain. If capacity expansion keeps pace with population growth, people who consistently obtain power when they turn on a switch or water through their tap continue to be able to do so. Those who expect to receive prompt and high quality medical care when they need it can continue to hold that expectation. Average commuting time would not increase and school classes would not expand. If capacity expansion fails to keep pace, any of these conditions already attained by a society may be eroded. Capacity expansion is therefore a recurrent cost.

It is recognised as unwise to fund recurrent costs by borrowing. If we take out a loan to buy this week's groceries, next week we have the same problem of funding the groceries and the additional burden of repaying the loan. Yet the major costs of capacity expansion, particularly for infrastructure, are regarded as investment simply because they add to the inventory of assets. Such an addition may indeed be a benefit, if not negated by adding to the requirement for such assets. No attempt is made to differentiate between those acquisitions which are adding to per capita utility (getting ahead), and those which are merely maintaining per capita utility (treading water). Both are regarded as 'investment', and hence are not conceptualised as 'cost' and not physically tallied in budgetary forward planning of recurrent costs. Figure 2 attempts to illustrate this distinction diagrammatically.

The label of 'inventory investment' is one of the main reasons that the costs of population growth have been rendered invisible. Others include

- GDPism, or a focus on economic metrics to the neglect of the goals for which they are surrogate. Clearly, if greater utility could be gained by avoiding the need for an expense than by responding to the need, then avoiding it is a better outcome even if GDP is lower as a result. Bushfires and tsunamis may boost GDP in the short-term, as the resulting rebuilding activity is measured as an economic stimulus. What is not recognised is that this activity diverts capacity from other activities which could add utility, only to replace utility that already existed. The diversion is not always obvious, because it may be drawn from the future, either through borrowing or drawing on insurance (inevitably increasing future premiums), or reduced capacity to save. Population growth creates the need for activity to regain a previously existing quality of life, in exactly the same way as natural disasters.
- 'Snapshot' modelling, of which the Australian Treasury's 2010 Intergenerational Report is a typical example. It compares 2009 with 2050, assuming the same levels of per capita infrastructure and service provision exist, but omitting to consider quantitatively how they are brought into existence. In this case, in which a 60% increase in population is anticipated over that period, almost twice as many of them must be brought into existence than under projections with achievable stabilisation at 24–26 million. Other dynamic factors are also ignored, such as the increasing personal debt levels, decreasing national savings, increasing dependence on foreign capital with concomitant foreign debt repayments and repatriation of profits to foreign investors, all implicit in the population growth projection and its anticipated maintenance of property appreciation.
- Costs are dispersed across various sectors and levels of government: school buildings are in the education budget, new hospitals in the health budget, prisons in the correctional services budget, etc. Telecommunications are funded federally, railways by states and waste handling facilities by local authorities. Electricity facilities, which were once publicly funded, now fall in the budgets of private corporations, but come from residents' pockets whether by taxes or service charges. Nowhere is there a comprehensive accounting of capacity expansion. In contrast, the cost of old age pensions or health care is easily cited.

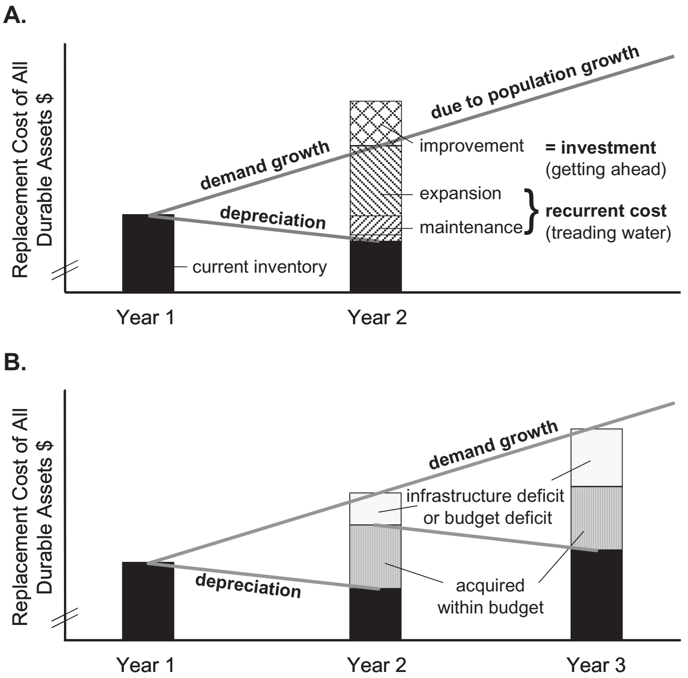

Figure 2: Conceptual illustration of: A. the components of durable asset acquisition as recurrent cost or investment, and B. the escalation of deficit if capacity expansion fails to keep pace with population growth

Real per capita GDP or GNI is only what is left after capacity expansion

The metric 'GDP per capita' or the arguably more pertinent 'GNI per capita' are assumed to reflect the average utility rendered to each citizen as a result of aggregate economic activity. That is, it slices the whole pie into an equal portion for each. But capacity expansion does not provide any additional utility to the existing population. It may indeed reduce utility, in a number of monetary and non-monetary ways. It is a cost incurred only on behalf of future population.

Since capacity expansion is usually playing catch-up, it is seen to be for the sake of existing residents. It should be seen as delayed expenditure, on behalf of people who were not yet added at the time the additional capacity was actually needed. If people stopped being added, service capacity would catch up and then the cost would disappear.

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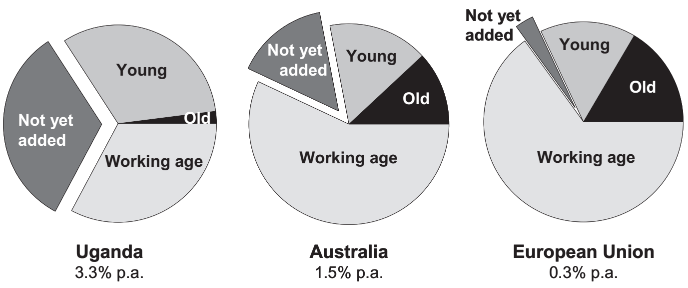

Figure 3: The pie of gross national income divided among demographic categories, on a notional 'per capita' basis. (Capacity expansion (the cost attributed to the 'not yet added') is provisionally assumed to have a cost of 10% of GNI per percentage of population growth. Current population growth rates and percentage under 15 and over 65 are from Population Reference Bureau 2011.)

It can be useful to look at capacity expansion as attributable to a third class of dependents, the 'not-yet-added'. There has been much discussion about demographic ageing and the cost burden of 'dependent' aged people. This discourse rarely acknowledges concurrent reduction in young dependants, nor the relative costs and contributions of young and old. More pertinently, the argument that population growth can be used to diminish the burden of ageing completely ignores the costs of the not-yet-added, who currently produce nothing and pay no tax but require substantial current expenditure.

For instance, Australian Treasury (2010) anticipates additional health and welfare costs attributable to ageing expanding gradually to 2.4% of GDP by 2050, under a population projection that anticipates 1.2% per annum growth. This ageing burden is presented as an imperative for population growth. However, population stabilisation would only increase the cost of ageing by an additional 0.8% of GDP by 2050. To avoid, or rather, to defer this cost, an amount probably exceeding 10% of GDP is needed immediately and continuously for capacity expansion of 1.2% per annum.

The pie charts in Figure 3 graphically illustrate this burden, using the conservative estimate of capacity expansion cost of 10% of GNI per percent of population growth. While these charts could do with much refinement, to reflect the relative costs and workforce participation of age classes, they provide a clearer picture of the 'demographic dividend' which reducing population growth provides. Not only does it shift the balance from young to working age people, but it greatly diminishes the burden of capacity expansion, increasing the proportion of total economic activity available to serve current people – less 'treading water' and more 'getting ahead'.

This model depicts capacity expansion as a much greater impact on 'total dependency' than demographic ageing. By comparison, increasing the proportion of people aged over 65 has relatively little effect. Australia currently has 4.8 people of working age per retiree, while Japan has only 2.8. Yet the cost of capacity expansion would need to be no more than 3% of GNI per percent population growth for Australia's working age slice of the pie to be as large as Japan's. The cost is clearly much greater than this, making population growth a far greater burden than the extent of ageing it may offset.

Incidence of costs

The costs of accommodating added people are spread broadly over the existing population, to the extent that it is difficult for individuals to trace the source of their financial stress to population growth.

The recent sudden increase in population growth in Australia provides a salient example. From 2004 to 2009, population growth rate surged from 1.1% p.a. to 2.1% p.a., fuelled by expansion of the skilled immigration programme and pro-natalist government rhetoric and policies including a 'baby bonus' payment. The anticipated impacts of population ageing, expressed in the Treasury's First Intergenerational Report in 2003, were the primary justification for these policy changes. A proportion of this surge was due to increased numbers of foreign students on temporary visas, but their expectation of permanent residency clearly caused this increase. When residence entitlements were wound back in 2009, enrolments dropped dramatically, accounting for much of the growth reduction in 2010. However, in response to special pleading by university vice chancellors, entitlement to remain in Australia has been partly restored.

The past decade has seen a dramatic increase in the cost of living in Australia, together with a rapid expansion of both public and private debt. Utility and rates charges have approximately doubled, and are anticipated to rise steeply in coming years as capacity shortfalls are addressed. Congestion of roads, public transport, ports and hospitals have become dominant issues in public discourse, testifying to these capacity shortfalls. Road tolls are starting to become a significant expense for capital city residents. Demand for capital has kept interest rates high, impacting on small businesses and magnifying the effect of escalating property values on first home buyers and tenants. (The impact of population growth on property values is a separate effect to that of durable asset acquisition, which will not be explored in this article.)

New South Wales State investment in public infrastructure more than doubled from 2004/05 to 2011/12 (Engineers Australia, 2010), with the spend in both those years corresponding to over A$170,000 per resident added in the previous year, and rising from 2% to 4% of Gross State Product (GSP). Spending by local government authorities is estimated to be of a similar magnitude (QCIA, 2009). Over this time, Engineers Australia (2010) reported a slight decline in the standard of infrastructure provision. Public perception of gross neglect of infrastructure provision was instrumental in the landslide election defeat of the NSW Government in 2011. Queensland, growing faster than NSW, doubled public sector gross capital formation from 4.2% of GSP in 2004 to 8.2% in 2008, and QCIA (2009) advised five years at this level was required to clear the backlog, with an ongoing rate of 7% of GSP to keep pace with growth. The current Queensland State budget for capital expenditure is similar to the NSW figure of over $170,000 per added resident, after removing the A$1.75 billion for reconstruction following last summer's floods and cyclones. Despite the sale of substantial public assets in the past year and an unprecedented mining boom, 80% of this capital expenditure is anticipated to be borrowed (Queensland Treasury, 2011). The alternative, a significant increase in taxation, has been resisted to date.

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Discussion

Asset acquisition burden has some overlap with the theory of capital shallowing (Coale and Hoover, 1958), but explains some of the empirical weakness of the latter. Capital shallowing regards capital as an element of economic productivity, affecting income. Like almost all literature on economic impacts of population growth, it compares outcomes based on measures of income or aggregate economic activity as an indicator of wealth. While per capita GDP is acknowledged as an imperfect measure of wealth, it is generally considered unbiased in international comparisons. *Ceteris paribus*, greater GDP per capita suggests greater wealth.

The current thesis focuses on the impact of population growth on the cost side of the ledger. If the cost structure of growing populations differs from that of stable populations, *ceteris paribus* does not hold. The utility gained by a growing population as a result of its aggregate economic activity may not be similar to the utility gained by a stable population with the same GDP per capita.

Population growth may indeed increase gross fixed capital formation, but without increasing productivity per capita. A higher effective savings rate may even ensue, as the cost of capital formation reduces other consumption. The extent to which this happens by lowering wages, as muted by Kelly (1988), or by increasing cost of living by incorporating the cost of capacity expansion into service charges, has little effect on the outcome. Certainly the lower capital inheritance rate component of capital shallowing (Turner, 2009a; 2009b) is a major source of the increased cost of living in growing populations.

Although generally omitted from discussion of capital shallowing, the dilution of fixed natural or environmental capital by population growth may become the dominant constraint on economic prospects and living standards as nations, and indeed the planet, exceed their natural carrying capacity. The focus on savings rate (Kelly, 1988), assuming that capital can be infinitely created through saving, ignores the unfungible character of these natural assets and the services they provide.

While this article does not deal with issues of carrying capacity, its focus potentially has greater relevance to public policy because of the shorter time frame in which impacts are anticipated to have effect.

Effects of population size are slow, with significant change in the relatively uncertain future. It is easy to have faith that technological innovation will take care of them. It is also easy to dismiss the urgency of population policy measures, as their effects are deemed to be too slow to address near-term problems. However, effects of population growth rate are much more immediate, as Australia's recent population surge illustrates. Infrastructure and skills deficits quickly erode productivity and services, while costs escalate. Conversely, a slowing population growth rate immediately allows existing capacity for capital formation to 'get ahead', improving service access and quality. There can be snowball effects on productivity and poverty alleviation, particularly when this applies to educational capacity. This is largely the story of East Asia's economic rise, as described by Bloom *et al*. (2000).

The 'demographic dividend' of slowing population growth has long been recognised, giving societies a period of low dependency ratio as the proportion of youth declines before the proportion of the aged increases (Bongaarts, 2009). Increased workforce participation of women is an additional bonus, which comes into effect more quickly after a lowering of the fertility rate (Sinding, 2009). What has not been previously acknowledged is that a similar dividend applies to inventories of fixed capital. A growing population will have a relatively young stock of assets, and after slowing population growth will enjoy a period of low turnover of this stock, increasing capacity to raise per capita capital accumulation.

The argument that technological innovation will avoid resource limits overlooks the opportunity cost of absorbing such improvements with population growth. There is no doubt that technology has increased the human carrying capacity of the planet several fold in the past two centuries, particularly by increasing the productivity of land, and by substituting some of the products of land (particularly fuel, fibre and reduced nitrogen) with mined materials. However, in the absence of population growth, these same innovations may have delivered a high quality of life in all nations while limiting the human footprint to a level compatible with healthy biodiversity and a stable climate. The difference between the United Nation's low population projection and its high projection (on which we have lately been tracking, according to Population Reference Bureau data) may be similarly measured as the extent of development or avoided deprivation our future innovations may achieve. Even ignoring, for the moment, the unsustainability of several threads of the technological fabric on which our expanded population now depends, the opportunity cost of population growth would seem very high, unless one takes the view that the quantity of human lives is a greater goal than their quality.

Economic discourse can ultimately only inform the ethical basis for population policy. Some believe any discussion of the pros or cons of population growth is predicated on an unacceptable intention to meddle with an inalienable right or sacred project of procreation. Others despair at the plight of women whose health, economic security and social autonomy are threatened by unwanted fertility which could be alleviated for the want of a small investment in contraception. Some see contraception and acceptance of small family size as a necessary ecological counterbalance for the advances in medicine and hygiene that have reduced human mortality. While some see migration as a right, others see it as an inadequate response to the underlying causes of human displacement, ultimately sustaining and transplanting those causes. The rights of other species and the rights of children to inherit sufficient means for sustenance probably deserve more attention than they have been given.

At some point, public policy should articulate a position in these moral conflicts, rather than allowing complacency or misconception to dictate society's fate. Policy makers may do well to observe that, with the exception of a few oil-rich nations, no country has lifted itself out of poverty without first reducing its fertility rate (APPG-PDRH, 2007). The oil-rich states have reduced fertility to a much smaller extent, consistent with their less wealthy neighbours, arguing against the claim of development as the best contraception (cited in

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Keyfitz, 1991). It is questionable whether they will be able to maintain their development path as oil revenue drops and they seek to enter the increasingly crowded niche of nations selling their services for food.

Conversely, nations which chose to prioritise population stabilisation demonstrated that rapid fertility reduction can be achieved without coercive or punitive measures, and has been followed by economic progress more rapid than explained by population size effects, and only partly explained by the demographic dividend. I suggest that the burden of durable asset acquisition is central to understanding the extent of economic stimulus observed. The stimulus may be magnified by a virtuous cycle, of personal optimism contributing to investment, entrepreneurship, educational effort, lawfulness and political stability.

To many observers on the ground, the negative impact of population growth in least-developed countries is obvious. They describe the burden of expanding capacity of schools and health services, as 'running hard to stand still' (APPG-PDRH, 2007). To date, economic theorists have failed to articulate a basis for these observations. I believe this has been due to their focus on metrics of aggregate economic activity, neglecting the difference in cost structure imposed by population growth. I hope the conceptual models offered in this paper help to refocus the impacts of population growth.

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