**DECOMPOSING ECONOMIC SUPPORT RATIO FOR SINGAPORE BY EDUCATION AND AGE STRUCTURE**

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February 2023

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**Abstract**

This work looks at changes in Singapore’s economic support ratio (ESR) from 1970-2020. The ESR is evaluated by determining the number of net workers over the number of net consumers. Singapore’s rapid economic development historically had been attributed to favourable demographics – from large cohorts of the population entering the workforce for several decades. In this work, the contribution of education using data on highest qualification attained (HQA) is evaluated through the use of Das Gupta’s decomposition technique. We find that the demographic effect and education effect have both contributed to Singapore’s ESR, and that education effect had been significant in sustaining Singapore’s ESR. The contribution from education is expected to be important in the context of Singapore’s rapidly ageing population.

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# 1. INTRODUCTION

The National Transfer of Accounts (NTA) is a framework that accounts for the flow of resources across generations in society. The NTA accounts for how people have different flows of resources at different stages in their lives. For instance, people generate more financial resources in their active working years than they consume; people also tend to consume more financial resources than they generate in their early years of life, and in their advanced years in life. At the same time, there are transfers of financial resources from various institutions. Government is an important institution that transfers resources through taxation; within the family, there are also significant transfers from parents to their children.

Other than income, consumption, and transfers, there are other figures that are of interest. There is the Lifecycle Deficit, which is the difference between consumption and income. The difference between the two is total transfers, which can be separately accounted for as either coming from public or private sources.

The NTA is computed from accounting for the consumption and income at every age or age group. That is, individuals can be consuming and/or generating an income at every age. Children are usually not assigned an income as they are not earning.

We are interested in the effective economic support ratio, or sometimes shortened as the economic support ratio (ESR). The ESR is calculated as the number of effective workers over the number of effective consumers. The number of effective workers is defined as the number of people where income exceeds consumption. The number of effective consumers is defined as the number of people where consumption exceeds income. Effective workers are usually in the prime working age, while effective consumers are usually either very young and the retired persons.

The ESR has implications for public policy, particular in matters relating to redistribution. An ESR of more than 1 implies that there are more workers than consumption, and the society is likely to be generating fiscal surplus. An ESR of less than 1 implies that there are more consumers than workers, likely to be generating a fiscal deficit and requiring transfers.

We examine the ESR according to different levels of highest qualification attained (HQA). Using decomposition techniques, we identify the contributions of demographic and education effects.

# 2. LITERATURE REVIEW

The work in this paper is situated in the context of discussions about the importance and contribution of population dynamics to economic development. The rapid economic development in Europe and East Asia after the Second World War, together with new concepts of social development have refined our understanding of how population dynamics and education contribute to economic development.

What we are interested in is the contribution of demographics – the age structure of the population, and on the education profile of the population, on economic development. We will address these in turn.

The idea that the age structure of the population might have a bearing on economic development emerged from the empirical observation of the post-war phase of rapid development in Europe and in Asia, notably Japan, and later South Korea, Taiwan, Hong Kong and Singapore (Bloom & Williamson, 1998). It was observed that there was a baby boom in many of the countries, which led to the increase in working age populations.

The large increase in the working age populations in Asia and other countries in this period led to the phrase, “demographic gift” (ibid), later termed the “demographic dividend” to describe the large number of working age individuals in the population, relative to young and old dependents.

Decades on, countries around the world are experiencing dramatic changes in their demographics. Countries that experienced the large increase in working age populations were now experiencing a rapidly ageing population, with various policy issues arising.

In the context of these inquiries, Mason, Lee and others created the framework of National Transfer Accounts – a framework that adopts the pattern of the System of National Accounts to look at the generational life-cycle. Lee, Mason, and Miller looked at how demographic transitions might impact savings rate (Lee et al., 1998). As the number of young dependents decline, savings increase as people rely more on their labour income for retirement. (Lee et al., 2006). The National Transfer Accounts look at income and consumption throughout every year of life, with information coming from various national surveys, administrative data from government agencies, government budgetary documents, and other sources.

From the National Transfer Accounts, an alternative to the support ratio could be obtained by looking at the ratio of effective producers and effective consumers. This ratio, known as the economic support ratio (ESR) would be a better indicator for the economic potential of a country, given its demographic situation.

As mentioned, this work can be situated within the context of the discussion as to the sources of ESR changes in a country over time – whether education or age structure has an impact on growth or the ESR.

Even though some of these arguments are rooted in historical trends, they hold implications for population and education policy. If it was demonstrated that age structure effects were more dominant in influencing economic support ratio, it would mean that the period of rapid ageing that many advanced and developing countries were facing would inevitably lead to a decline in economic performance over time, and policies would ostensibly be designed to reduce the impact of such an outcome. If on the other hand, demographic factors were not dominant, and that other factors such as education/human capital was just as important, then it would lead policy makers towards other actions that might address the effects of an ageing population.

The idea that education or human capital might have some contribution to economic growth comes from the idea of total factor productivity – the residual after accounting for population growth and capital investments. Bloom and Williamson (1998) attributed the Asian economic “miracles” to favourable demographics. Benhabib and Spiegel (1994) found that although education levels had no direct correlation with economic growth, human capital did have contributions towards total factor productivity.

The relationship between economic growth, demography and education remains a contested one. Lutz et al. made suggestions about boosting primary and secondary levels of education for economic growth (2008) from models based on data from the International Institute for Applied Systems Analysis-Vienna Institute of Demography (IIASA-VID). They estimated that boosting the levels of education to secondary level and primary would increase growth more so than concentrating education policies at the tertiary level alone. Lutz and Samir (2011) argue for the importance of education in demography. They point out that high levels of education are correlated to lower mortality rates. Women with greater education also have lower rates of fertility. Crespo Cuaresma et. al. (2014) argued that the demographic dividend was mostly due to education. Lutz et al. ( 2019) argue that the demographic dividend in many advanced countries was due to education as well.

Although there have been efforts by researchers to make strong connections between the demographic dividend and education attainment, there are works that point in different directions, suggesting that there are interactions that are complex and not reducible to either education or demographics. Kotschy and Sunde (2018) instead argued that demographics and education interacted with each other, and Kotschy et. al. (2020) argued that the actual picture was more complex, and that countries with similar age structure and education could still diverge on macroeconomic performance.

The debate about the demography versus education/human capital is important for another related topic that also has a bearing on future economic performance, and that is on the issue of the second demographic dividend. The issue here is whether there might be a second demographic dividend for countries that had benefitted from the first demographic dividend.

The implications for the existence of a second demographic dividend would again influence policies in countries in addressing the issues arising from the ageing population. The existence of the possibility of the second demographic dividend would compel policies that would be different from the situation where the response to ageing would simply be that of adaptation.

The second demographic dividend can only emerge after the first demographic dividend. The second demographic dividend, unlike the first demographic dividend, is less reliant on a sudden influx of working age individuals in the population. It does however, rely on the surpluses from the first demographic dividend be saved.

One driver for the second demographic dividend would come from how individuals in a low-fertility context would be motivated to save for their own retirement due to lower family support – that is, parents would save more if they expect that they are going to have less or no children at all. The excess savings from the couple could then be invested in various ways, increasing the capital that would be available to the society. This would then go on to increase the capital available per worker, improving productivity in the economy. A second way in which the second demographic dividend could come about would be through the increase in spending on human capital, with education being an important channel. In this second way, increased education leads to greater productivity and more income for the individual. However, this would mean that the returns for from the first demographic dividend would have to be saved and invested in productive investments for the second demographic dividend to be realised. This involves a complex set of national policies that would have to be well-implemented for this to happen; for instance, it would involve continual policies to shift the industrial mix of a country to move towards more innovative sectors. This process was described in Lee et al., (2000).

Looking at country-level analyses, Islam (2019) found that age effects (demographic effects) were more important than education effects in Bangladesh, and that due to low levels of education, Bangladesh was not likely to experience a second demographic dividend. Across Asia, Wongboonsin and Wongboonsin (2014) acknowledged that many countries might not secure the second demographic dividend owing to the potential challenge to reform education and skills systems, improving the productivity of the workforce for capital accumulation and increase in standards of living. Rentería et al. (2016) found that education can offset some of the negative effects of ageing when comparing the income and consumption profiles and ESR for Mexico and Spain as the first demographic dividend is exhausted and the working age population ages with smaller succeeding cohort sizes.

Mason and Lee (2006) argue that reforms would have to be undertaken in several countries to be able to capture the gains from the second demographic dividend. It would require countries to undertake reforms that would enable the savings to be invested in global financial markets, for instance.

This second demographic dividend is important for Singapore as the effects from the first demographic dividend are “exhausted” as the prime working age population that created Singapore’s growth in previous decades would be exiting the labour force by the 2030s. The existence of a second demographic dividend would be an important factor as to whether the quality of life at present might be fiscally sustainable without incurring debt for future generations to address. Since this second demographic dividend comes ultimately from the first demographic dividend, the factors leading to the rise of the first dividend should then inform the nature of the second demographic dividend and how it might come about in Singapore.

# 3. SINGAPORE’S CONTEXT

Singapore is undergoing a rapid demographic transition. Singapore experienced a baby boom in the period after the Second World War. The baby boomer generation entered their working years in the period of 1970s through to about the 2000s. Over this period, they have contributed to Singapore’s economic development. This is also what is termed the first Demographic Dividend – the payoff to a society comprising largely working age residents with low numbers of young and old dependents.

Accompanying this rise was the increase in the number of polytechnics – a diploma-awarding education institution, and the number of universities recognised by the Ministry of Education with the “autonomous” status.

**Table 1: List of Polytechnics**

|  |  |
| --- | --- |
| Polytechnic | Year of Founding |
| Singapore Polytechnic | 1954[[1]](#footnote-1) |
| Ngee Ann Polytechnic | 1963 (as the Ngee Ann College)[[2]](#footnote-2) |
| Temasek Polytechnic | 1990[[3]](#footnote-3) |
| Nanyang Polytechnic | 1992[[4]](#footnote-4) |
| Republic Polytechnic | 2002[[5]](#footnote-5) |

At Singapore’s independence in 1965, Singapore had two polytechnics – education institutions that focused on career-relevant skills. In the 1990s the number of polytechnics increased to four, and were geographically dispersed across Singapore. The current number of polytechnics is 5, with Republic Polytechnic in the north of Singapore.

**Table 2: List of Universities**

|  |  |
| --- | --- |
| Universities | Year of Founding |
| National University of Singapore | 1905 (as the Straits Settlements and Federated Malay States Government Medical School)[[6]](#footnote-6) |
| Nanyang Technological University | 1981 (as the Nanyang Technological Institute)[[7]](#footnote-7) |
| Singapore Management University | 2000[[8]](#footnote-8) |
| Singapore University of Social Sciences | 2005 (as UniSIM), autonomous university status in 2017[[9]](#footnote-9) |
| Singapore University of Technology and Design | 2009[[10]](#footnote-10) |
| Singapore Institute of Technology | 2009[[11]](#footnote-11) |
| University of the Arts Singapore | 2024[[12]](#footnote-12) (1938, NAFA[[13]](#footnote-13); 1984, LASALLE College[[14]](#footnote-14)) |

Similarly, the number of universities had increased. At independence, there was only the predecessor institution of the National University of Singapore; 2024 will see the launch of the University of the Arts Singapore, itself an amalgamation of two arts education institutions.



These changes in the 2000s and 2010s were part of an overall shift in economic development towards an economy requiring higher levels of skills and education, with an emphasis on “innovation” – creating new industrial niches where Singapore could create value and be distinct in a global economy characterised by competition.

The change in the skill level of the population can also be seen through the changing HQA proportion in the population. In 1970, residents with university-level and higher qualifications only constituted 1% of the resident population;[[15]](#footnote-15) this dramatically increased with HQA-university at 10% in 2000, and at 27% in 2020. The effect is also seen in the reverse, with primary and primary and below qualification proportions falling from 93% in 1970 to 25% in 2020.[[16]](#footnote-16) This indicates that the stock of human capital in Singapore had increased in the time period.

# 4. AN AGEING SOCIETY

Singapore’s FDD was facilitated by a declining total fertility rate (TFR), with TFR declining from a 4.66 in 1965 to about 1.12 in 2020. The TFR had dipped below replacement rate of 2.1 by about 1976 (Singapore Department of Statistics & Immigration and Checkpoints Authority, 2022). The falling fertility rate indicates a smaller number of both young and old dependents, as the large size of the working age population had not grown old yet.

The proportion of the population aged 70 and over had increased from about 2% in 1970 to 10% in 2020. At the same time, life expectancy had increased from 64.5 years at birth to 83.9 years at birth in 2020 (Singapore Department of Statistics, 2021).

As a result of both the low TFR and the increase in life expectancy, the proportion of Singapore residents aged 70 years had increased drastically, from less than two percent in 1970, to about 9.5% in 2020.[[17]](#footnote-17)

This would mean that the number of effective consumers would also be increasing as a proportion of the population. As this figure rises, the ESR can drop below 1, requiring greater transfers from both private households and from the state as health consumption increases for the age group.

However, this shift towards an aged society and with a sub-one ESR situation is ameliorated by the rise in HQA of the population. Over time, residents in Singapore have had the opportunity to advance in education, climbing up higher rungs in education progression. People are advancing in education either with post-secondary qualifications or university qualifications. As they become more educated, they obtain more skills that are provide higher incomes in the market. As the proportion of residents acquire higher levels of HQA, they can also provide more income, compensating for the increase in the elderly dependents in the population, up to a point.

We are therefore interested in the contributions of the age structure and the HQA of different segments of the population throughout the period of Singapore’s history to the economic support ratio.

# 5. METHODOLOGY

The technique used to determine the contributions come from the Das Gupta decomposition technique (1993), a way to understand how changes of the different factors change a distribution. This technique has been used in different papers.

The implementation of the decomposition follows similar efforts from Renteria and Islam. This paper, similar to Islam (2019) and Renteria et al. (2016). In this procedure, $a\_{ij}$ and $e\_{ij} $(below) represent the variation in the population due to age structure and education characteristics respectively. To do so we obtain the income and consumption profiles at various ages and educations status of the population from the different census years.

As a guide to the equations:

* The subscript $i$ refers to age;
* The subscript $j$ refers to the HQA level;
* $N\_{i}\left(t\right)$ refers to the number of people of age $i$ at time t; $N\_{j}\left(t\right)$ refers to the number of people at HQA level $j$ at time t; $N\_{ij}\left(t\right)$ refers to the number of people at age $i$ and HQA level $j$ at time t;
* $esr\_{j}\left(t\right)$ refers to the ESR at HQA level $j$ at time t, derived from the income and consumption profiles.

$a\_{ij}=\left(\frac{N\_{ij}\left(t\right)}{N\_{j}\left(t\right)}⋅\frac{N\_{i}\left(t\right)}{N\left(t\right)}\right)^{0⋅5}$ … (1)

$e\_{ij}=\left(\frac{N\_{ij}\left(t\right)}{N\_{i}\left(t\right)}⋅\frac{N\_{j}\left(t\right)}{N\left(t\right)}\right)^{0.5}$ … (2)

$A\left(t\right)=∑\_{i}∑\_{j}\frac{ⅇsr\_{j}\left(t\right)+ⅇsr\_{j}\left(t-1\right)}{2}⋅\frac{e\_{ij}\left(t\right)+e\_{ij}\left(t-1\right)}{2}⋅a\_{ij}(t)$ … (3)

$E\left(t\right)=∑\_{i}∑\_{j}\frac{ⅇsr\_{j}\left(t\right)+ⅇsr\_{j}\left(t-1\right)}{2}⋅\frac{a\_{ij}\left(t\right)+a\_{ij}\left(t-1\right)}{2}⋅e\_{ij}(t)$ … (4)

$A\left(t\right) $captures the rate and age standardisation at time (t); similarly, $E\left(t\right)$ captures the rate and educations standardisation at time (t). These figures will enable us to compare the contribution of age and education effects respectively.

# 6. DATA

The figures come from the census for the respective decades. The income and consumption at the various age profiles and for the various education levels comes from calculations from IPS. Similarly, figures for total resident and total citizen income and consumption profiles were also calculated by IPS. Income and consumption profiles for ages are done based on 2013 levels. Using the 2013 levels for other decades, while imperfect, allows for income levels to be controlled for to estimate age and HQA effects.

# 7. RESULTS

The overall ESR for the decades are as follows:

**Table 3: Economic Support Ratio by Decade**

|  |  |
| --- | --- |
| Year | Overall ESR |
| 1970 | 0.45376 |
| 1980 | 0.61754 |
| 1990 | 1.10331 |
| 2000 | 1.41409 |
| 2010 | 1.56694 |
| 2020 | 1.44401 |

These figures are based on 2013 income and consumption figures. ESR in 1970 was 0.454, rises above 1 by 1990, and rises to a peak of 1.57 in 2010 and ends at 1.44 in 2020.

This is at the overall level, consisting of the various HQA together. Disaggregating the overall figures by HQA shows the divergence and to some extent, the education premium.

**Table 4: Economic Support Ratio by Highest Qualification Attained and Decade**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Decade | Primary | Secondary | Post-Secondary | Tertiary |  |
| 1970 | 0.391 | 0.852 | 8.782 | 43.542 |  |
| 1980 | 0.539 | 0.434 | 2.765 | 23.474 |  |
| 1990 | 0.489 | 1.959 | 2.438 | 40.821 |  |
| 2000 | 0.324 | 2.254 | 4.320 | 101.211 |  |
| 2010 | 0.168 | 1.360 | 3.509 | 56.644 |  |
| 2020 | 0.0583 | 0.592 | 2.776 | 27.752 |  |

The table shows the ESR for all levels of HQA in the paper. The ESR for the primary (and below) HQA level starts off at 0.391 in 1970, rises to 0.539 in 1980 and declines thereafter, ending at 0.058. The ESR for Secondary HQA level starts off at 0.852, rises to 2.254 in 2000 and ends at 0.592 in 2020. The ESR for Post-Secondary HQA level starts off at 8.782 and ends at 2.776. The University HQA level starts off at 43.642 in 1970, rises to 101.214 in 2000 and declines to 28.71 in 2020.

With these findings alone, the contribution of the education to the overall lifecycle deficit on a historical basis is clear. Despite an ageing population, Singapore’s ESR remained above 1 owing to the proportion of resident population with higher qualifications.

Following the Das Gupta decomposition, we arrive at the results below:

**Table 5: Age and Education Contribution over Time**

|  |  |  |
| --- | --- | --- |
| Decade | Age Effect | Education Effect |
| 1980 | 0.460 | 0.540 |
| 1990 | 0.485 | 0.515 |
| 2000 | 0.392 | 0.608 |
| 2010 | 0.450 | 0.550 |
| 2020 | 0.452 | 0.548 |

**Table 10: Contribution to Education Effect by Highest Qualification Attained and Decade**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Decade | Primary | Secondary | Post-Secondary | Tertiary |
| 1980 | 28.39% | 7.88% | 19.26% | 44.47% |
| 1990 | 11.98% | 17.21% | 11.29% | 59.51% |
| 2000 | 1.80% | 15.29% | 6.58% | 76.34% |
| 2010 | 0.45% | 3.45% | 5.47% | 90.64% |
| 2020 | 0.21% | 2.16% | 6.07% | 91.56% |

This chart indicates the strength of the tertiary HQA and the contribution to the education effect. As observed, the contribution of tertiary education to the education effect has likely plateaued. This would mean that much of the contribution of the education effect comes from elevating the HQA. As the population ages and as HQA becomes saturated, it is less likely that education can continue to contribute at the same level, given the growing demographic headwinds.

# DISCUSSION

The results suggest that education and age structure had a roughly equal role in contributing to the ESR at the beginning, with education having a larger role in later decades. This is suggestive of the effect of how higher HQA at higher levels did contribute to Singapore’s ESR. At the same time, while changes in the age structure had been disadvantageous to ESR, the changing higher attainment of the HQA and the associated higher incomes contributed to the maintenance of the ESR. However, as most of the population continues to age, the boost from incomes becomes less effective, as seen in the 2020 result. According to the United Nations World Population Prospects 2022 (United Nations department of Economic and Social Affairs, 2022), the medium variant projection for Singapore’s population sees those over aged 70 to increase from 669,000 in 2025 to 1.94 million by 2070 – an increase of more than two times, before declining. Their proportion in the population will also increase, from about eleven percent in 2025 to 32.7 per cent in 2070, and then declining.

In this analysis, the income and consumption profiles from 2013 are used throughout all the decades. This is one limitation of this analysis, allowing the age and education effects to be apparent.

This analysis adds to the perspective that Singapore’s historical economic performance was not just due to favourable demographics; a population that was also actively rising in HQA also contributed to the rapid growth experienced in the period. At the same time, the continuation of growth from the 2010s to the present cannot be attributed to demographics alone given the rapidly ageing population.

# 9. CONCLUSION AND FURTHER WORK

Together, the results suggest that rising HQA remains an important way to maintain the ESR despite the demographic headwinds. At the same time, there ought to be an ongoing effort to boost the incomes from HQA beyond 2013 levels, lower consumption especially for health in the later ages of life, among other measures.

The work also points to other strategies to shift consumption and income over time, so to reduce the need for transfers, including public transfers. One such way is to reduce the consumption of education in the first 25 or so years of life. Rather than the one-time large public subsidy of education, education could instead be broken down into smaller chunks throughout life with a smaller (but still substantial) public subsidy component. Smaller, more regular chunks of education and training throughout one’s career also has the effect of providing more relevant skills, rather than relying on education that might become less relevant as time passes. This is already in line with the SkillsFuture movement advocating for lifelong learning through various policy incentives (Government of Singapore, 2022).

In health, efforts such as Healthier SG announced by Minister of Health Mr Ong Ye Kung (2022) towards greater importance of preventive health rather than acute care might gradually drive down health care costs. Promoting healthier lifestyles among Singaporeans and early healthcare measures reduces the costs of acute care.

These efforts, if successful, can lower consumption and boost incomes, allowing Singaporeans to maintain current standards of living even as greater proportion of Singaporeans become older.

The National Transfer Accounts methodology will remain important as a way to track the effectiveness of the various policies discussed.

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