Population Aging and the Possibility of a Middle Income Trap in Asia

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Abstract

We present three conditions for a demography-driven middle income trap and show that many economies in East, South, and South-East Asia satisfy all of them. The conditions are: (1) Support ratio – the ratio of workers to consumers – matters for economic growth; (2) Economic development accompanies more investment in human capital and lower fertility due to the quantity-quality tradeoff; (3) Current low level of fertility corresponds to too low support ratios for keeping up with the frontier economies in the long-run. The panel analyses for 178 countries among which 30 are ADB members show that (1) and (2) are satisfied for Asia with higher elasticity than others. As for (3), we set up a dynamic model for simulations, showing that about two thirds of ADB members have unsustainable level of support ratios, implying possibilities of a middle income trap due to demographic headwinds in the future.

Key words: middle income trap, demography, support ratio, fertility, NTA

JEL Classification: J11, O11, O53

Blurb: This paper presents the conditions for a demography-driven middle income trap and show that many economies in East, South, and South-East Asia satisfy all of them. Empirical analyses show that support ratio – the ratio of workers to consumers – matters for economic growth. However, Asia's economic development accompanies too low fertility, which, in turn, leads to too low support ratios for keeping up with the frontier economies in the long-run. This implies a possibility of a middle income trap due to demographic headwinds in the future.

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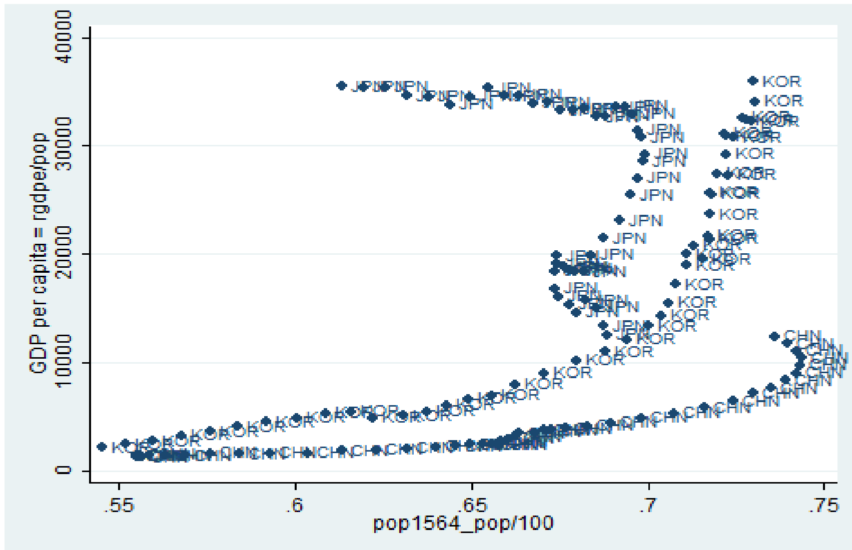
1. Introduction

Most Asian countries have been experiencing rapid demographic transitions for the last several decades, leading to huge changes in economic environment. As has been pointed out by many researches including Bloom, Canning, and Malaney (1999), Lee, Mason, and Park (2012), Ha and Lee (2016), this change in age structure has created large demographic dividends - increases in labor supply and savings due to faster increase in the number of workers compared with the number of consumers - for the Asian economies.

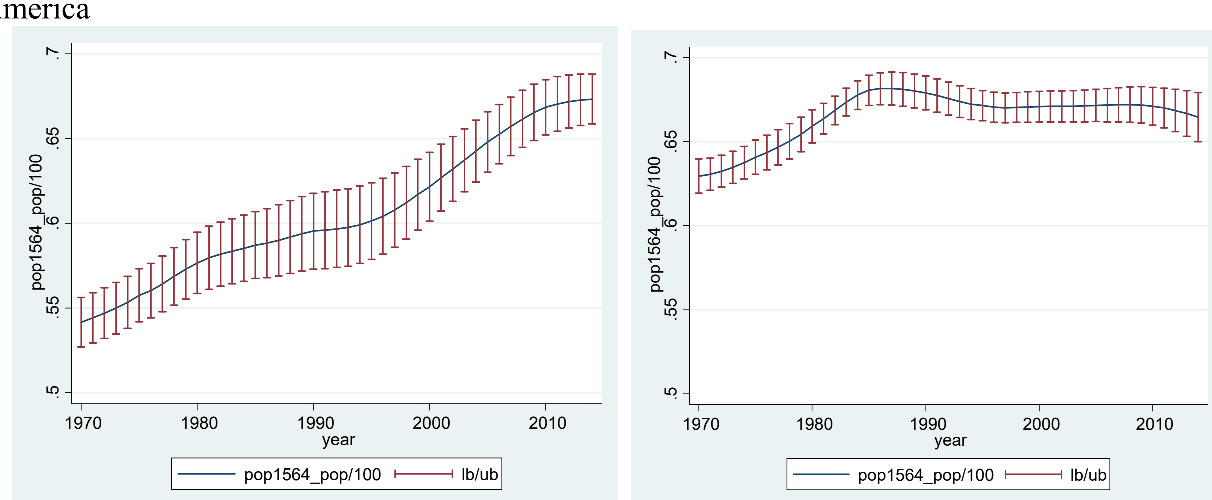
However, from the mid-2010s countries like the People's Republic of China (henceforth China) and the Republic of Korea (henceforth Korea) have begun to face totally different type of demographic changes – negative demographic dividends due to shrinking share of workers in population, which Japan has already experienced since the early 1990s. Moreover, a number of other Asian economies are also expected to face similar type of demographic headwinds in the 21st Century. Figure 1 shows that Japan, Korea, and China have all experienced rising GDP per capita but Japan has been more or less stagnating ever since the share of working age population (age 15-64) started to decline. Our concern here is what will happen to Korea and China where the age structure is going to follow the path of Japan.

Changes in the direction of demographic dividends in Asia are occurring much faster than any other continents in the world, meaning that Asia has already exploited the benefits of demographic transition almost up to the limit. Figure 2 shows that Asia's share of working population has reached the top level by the mid-2010s, reflecting rapid decline of fertility in this region (Figure 3).

<Figure 1> Share of population age 15-64 (x-axis) and GDP per capita for China, Japan, and Korea

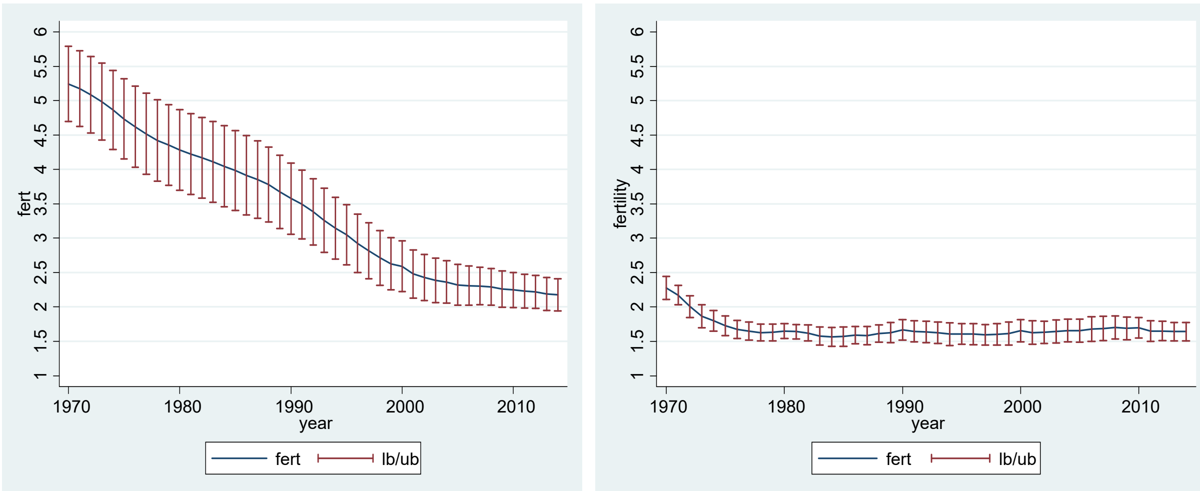


<Figure 2> Share of Population 15-64 for Asian economies (left) and West Europe & North America



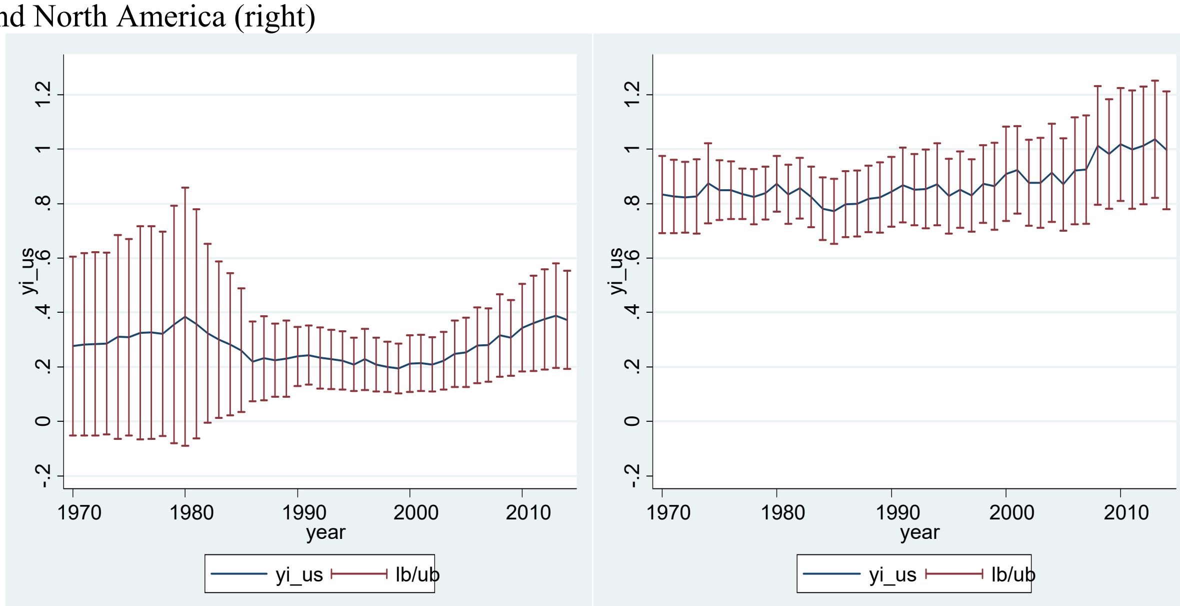
Source: World Development Indicators

<Figure 3> Total fertility of Asian economies (left) and West Europe & North America (right)



Source: World Development Indicators

<Figure 4> GDP per capita as a ratio of the US for Asian economies (left) and Western Europe and North America (right)



Source: Penn World Table 9

However, unlike Europe or North America, many of Asian economies are not fully developed yet (See Figure 4). This naturally raises the following question: what happens to Asia if it gets too old before getting rich? If being old means hardships in economic growth, then the answer to the above question could be that Asia is getting into a "middle income trap" due to demographic factors.

Here, we focus on the possibility of a demography-driven middle income trap of Asian countries. As for middle income trap, using a transition matrix analysis Han and Wei (2016) argue that a middle-income country that grows at the average or median rate of the middle-income group will clearly and surely become a high-income country, reaching and surpassing the living standard in today's US or France. Im and Rosenblatt (2013) also found no support for the notion of a middle income trap. However, from the viewpoint of demographic dynamics, the notion that middle income trap is not found reflects the data for the last several decades when demographic factors played a positive role for Asian countries. Indeed, Han and Wei (2016) point out that fast growing countries had a relatively large working age population, which we see as only temporary.

The possibility of a demography-driven middle income trap has been proposed by Ha and Lee (2016), where the role of support ratio – the number of workers as a ratio of the number of consumers - in the process of economic convergence has been analyzed using the panel data of more than 100 countries. They argue that the level of support ratio is closely related with the speed of convergence or growth rate of GDP per capita, and the level of economic development and average human capital has negative relationship with fertility. As economy grows fertility declines, ultimately leading to low support ratios and lower speed of convergence, which implies the possibility of a middle income trap.

In this research, we first present more extended analyses of Ha and Lee (2016) for different regions and income groups for Asia, then we add analyses on the link between fertility and support ratios for Asia. This additional work is important because fertility affects support ratios in different ways over time: in the short term, a decline in fertility always raises support ratio, however in the long-run it depends on current level of support ratio and other demographic variables. We model such dynamics to analyze long-run effects of fertility for each country to analyze if middle income trap is likely to come or not.

Moreover, we discuss what the National Transfer Accounts (henceforth NTA) data tells about the middle income trap. We show that the NTA data shows more vivid and clearer picture for intergenerational resource allocation and the dynamic relationship between fertility and support ratios.

The structure of this paper is as follows. Section 2 discusses related researches. Section 3 presents the structure of demography-driven middle income trap, including the dynamics of support ratios. Section 4 shows empirical results. Section 5 discusses what NTA tells about this issue, and Section 6 concludes.

2. The structure of demography-driven middle income trap

2.1 Related researches

According to Han and Wei (2016), who rejects unconditional notion of a 'middle income trap,' the term 'middle income trap' was invented by Gill and Kharas (2007). However, similar concepts, for example, a non-convergence trap, have been developed earlier in the 1990s modelling various sources of the trap. These theories are all based on the premise that developing countries could face stagnation if they fail to change 'gear' properly at the point where old growth regimes reach the limit during the convergence process.

In this type of models, success of the past becomes a hurdle for the future at certain point. Acemoglu, Aghion, and Zilibotti (2006) argue that growth strategy should change from investment-based one to innovation-based one to avoid this trap. Basu and Weil (1998), Aghion, Howitt, and Mayer-Foulkes (2005), respectively, emphasize that technologies and institutions should change appropriately following the level of economic development.

Unlike previous works on the 'trap', this paper focuses on demographic factors as - at least temporary – an important source of the middle income trap. It is well known that the role of demographic factors or demographic dividend has been significant in the development of Asia. Young (1995), Bloom and Williamson (1997), Bloom, Canning, and Malaney (1999), Mason and Kinugasa (2008), Deaton and Paxson (1997), Lee, Mason, and Miller (2003), Mason and Lee (2007), Lee and Mason (2010), Mason, Lee, and Lee (2010), Lee, Mason, Park (2012) all view that demographic transition accounts for significant parts of Asia's economic growth. This naturally leads to the possibility that Asia's growth could face adverse effects once demographic dividends turn negative, implying a stagnating force due to demographics.

Ha and Lee (2016) provides a framework for the analysis of a demography-driven middle income trap. They focus on the key variable that effectively summarizes demographic structure: the support ratio - or the ratio of (effective) workers to (effective) consumers. They argue that in early stages of development, Asia's fast demographic transition raised support ratios that created huge demographic dividend, thereby encouraging Asia's fast convergence and economic development. However, in later stages, low fertility, which economic development brought about through the quantity-quality tradeoff, eventually leads to falling support ratios and negative demographic dividend.[1] If the support ratio falls to a level too low for catching up with the frontier, then the economy can get into a non-convergence trap.

Based on Ha and Lee (2016), we develop this concept by providing and analyzing the three conditions for the trap and the dynamic aspect of support ratios both theoretically and empirically. We also try to evaluate sustainability of high support ratio of Asia with some comparison between regions and income groups.

2.2 The three conditions for demography-driven middle income trap

We would like to suggest three conditions for a demography-driven middle income trap.

First, demographic factors should matter for economic growth and convergence. In this paper, we look at the relationship between support ratio and growth rates. We view that support ratios can affect saving and investment rates, and eventually growth rates of GDP per capita, which determines the speed of convergence to the frontier. From the viewpoint of the NTA, high support ratio means that more resources can be allocated within productive generations through saving and investment.

Second, there should be a negative relationship between the level of development and fertility. As economy develops, it needs more human capital for learning and adopting frontier technologies, leading to higher returns to education and more investment in education. More education accompanies lower fertility following the mechanism of quantity-quality tradeoff.

Third, fertility is low enough to eventually lead to low support ratio. This is more complicated than other conditions and creates more complex issues, since low fertility raises support ratio in

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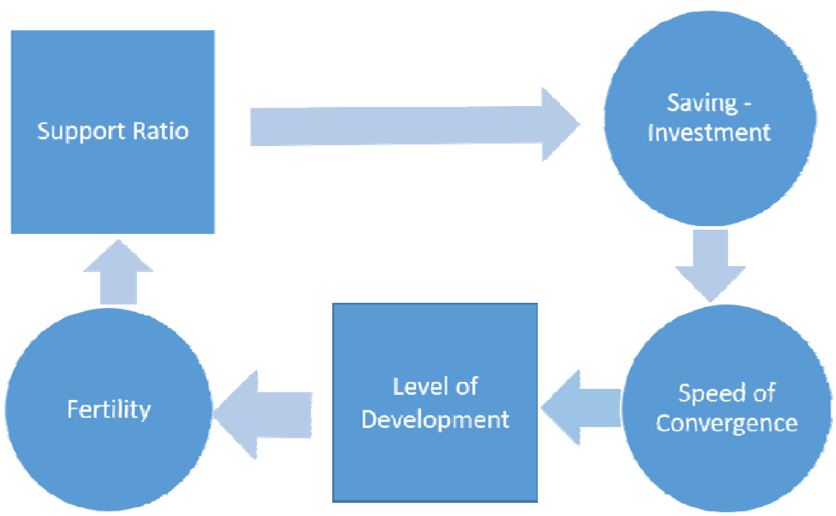
[1] As for the quality-quantity Tradeoff, refer to Becker (1960), Galor (2011), and Mason, Lee, and Lee (2010).

the short term, but could pull it down in the long run. Moreover, according to Lee-Mason, et al (2014) low fertility does not always lead to long-run low sub-optimal support ratios as there could be cases where the maximum steady state support ratios correspond to sub-replacement fertility – less than the fertility level of 2.1. We delve into this issue later in this paper.

Our previous research (Ha and Lee, 2016) analyzes the first and second conditions for Asia and the world, and this paper shows the three conditions for ADB economies and others, as well as for regions in Asia. In analyzing the third condition, we model the dynamics of support ratio and use the concept of steady state support ratios. The structure of the trap and the conditions can be summarized as Figure 5.

<Figure 5> Structure of demography-driven middle income trap



Note: Square refers to state variables, while circle refers to control variables

3. Testing for the conditions of demography-driven middle income trap

In order to test the conditions for middle income trap, we conduct panel analyses using the Penn World Table (PWT) 9.0 and World Development Indicators for 178 countries among which 30 are ADB members for the years from 1970 to 2014.[2] We present the results for both random effects models and fixed effects models as the Hausman test results are ambiguous for many cases. We use parsimonious models to see the relationship between major variables.

3.1 Condition (1): support ratio matters for economic growth

The first condition states that support ratios and economic growth should have positive relationships. In the panel analyses in this section, support ratio is defined as the population share of age 15-64, due to the coverage of data. The NTA data is more precise but time series and country coverage are quite limited.

<Table 1> Support ratio and growth rates

	GDP per capita growth – ADB		**GDP per capita growth - others**	
	Random effect	Fixed effect	Random effect	Fixed effect
Support ratio	0.1798***	0.2182***	0.0671***	0.1090***
	(0.0292)	(0.0334)	(0.0114)	(0.0212)
Constant	0.1192***	0.1408***	0.0550***	0.0774***
	(0.0152)	(0.0170)	(0.0062)	(0.0113)
# of observations	1160	1160	5850	5850
# of countries	30	30	141	141
R square	0.0280	0.0280	0.0071	0.0071

Note: All independent variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

2 See Feenstra, Inklaar, and Timmer (2015) for the details of PWT.

Table 1 shows the results. Here, the two variables are indeed closely related. The coefficients say that this relationship is much stronger for the ADB member countries than others, implying that Asian countries have been utilized demographic dividend more intensively for economic growth. This was possible due to the fast decline in fertility during the early stages of demographic transition.

We also looked at the relationship between support ratio and saving/investment rates as in Table 2 and 3. All of the results show that saving/investment rates are more closely tied to support ratio in Asia. This is consistent with the literature that shows large part of Asia's growth has been the realization of the first and second demographic dividends. The first dividend, which is the direct effect of increased labor supply among population, account for more than 10% of growth in many countries (Ha and Lee, 2016). But, it seems that the second dividend - increased saving and capital accumulation - is never smaller than the first dividend in Asia.

<Table 2> Support ratio and national saving

	National saving – ADB		**National saving - others**	
	Random effect	Fixed effect	Random effect	Fixed effect
Support ratio	2.5080***	2.5042***	0.6489***	0.4432***
	(0.2136)	(0.2151)	(0.1477)	(0.1533)
Constant	-0.5832***	-0.4556***	-1.6507***	-1.6037***
	(0.1727)	(0.1094)	(0.0979)	(0.0804)
# of observations	1111	1111	5146	5146
# of countries	30	30	140	140
R square	0.1325	0.1325	0.1147	0.1147

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

<Table 3> Support ratio and investment rate

	Investment rate – ADB		**Investment rate - others**	
	Random effect	Fixed effect	Random effect	Fixed effect
Support ratio	2.0773***	2.0739***	1.1984***	1.1039***
	(0.1419)	(0.1431)	(0.0857)	(0.0896)
Constant	-0.7262***	-0.6721***	-1.0699***	-1.1160***
	(0.1113)	(0.0730)	(0.0553)	(0.0480)
# of observations	1189	1189	5990	5990
# of countries	30	30	141	141
R square	0.1569	0.1569	0.1715	0.1715

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

We also looked at the difference between regions in Asia. As for the effect of support ratio on saving rate, there are no big differences among regions in Asia but the coefficients are a little high in Central Asia and a little low in South-East Asia. The coefficient of support ratio on investment rates are summarized as follows: Central Asia shows no significance, but other regions show significant correlations, with South and South-East Asia having high elasticity with respect to support ratios.

These analyses show that in general Asia have exploited demographic dividends more intensely than others, and high and rising support ratios have been important in catching up with the frontier. Therefore, the first condition of middle income trap is satisfied in Asia: support ratio matters more for growth in Asia.

<Table 4> Support ratio and national saving by region in Asia (1)

	National saving – Central Asia		**National saving – East Asia**	
	Random effect	Fixed effect	Random effect	Fixed effect
Support ratio	4.6038***	4.7468***	3.0057***	2.7649***
	(0.0607)	(1.0823)	(0.2624)	(0.2621)
Constant	-0.1480	0.0565	-0.0207	-0.1152
	(0.5795)	(0.5018)	(0.1299)	(0.1113)
# of observations	153	153	267	267
# of countries	8	8	6	6
R square	0.0444	0.0444	0.4966	0.4966

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

<Table 5> Support ratio and national saving by region in Asia (2)

	National saving – South Asia		**National saving –South East Asia**	
	Random effect	Fixed effect	Random effect	Fixed effect
Support ratio	2.8906***	2.9168***	2.1594***	2.1059***
	(0.4418)	(0.4434)	(0.3018)	(0.3025)
Constant	-0.2700	-0.2479	-0.5169**	-0.5044***
	(0.3644)	(0.5018)	(0.2573)	(0.1554)
# of observations	310	310	431	431
# of countries	7	7	10	10
R square	0.0198	0.0198	0.2373	0.2373

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

<Table 6> Support ratio and investment rate by region in Asia (1)

	Investment rate – Central Asia		**Investment rate – Eastern Asia**	
	Random effect	Fixed effect	Random effect	Fixed effect
Support ratio	0.4631	0.2756	0.6803***	0.7318***
	(0.5955)	(0.6098)	(0.2083)	(0.2122)
Constant	-1.9028***	-1.9911***	-1.0090***	-0.9874***
	(0.3174)	(0.2870)	(0.1089)	(0.0906)
# of observations	199	199	270	270
# of countries	8	8	6	6
R square	0.0731	0.0731	0.0079	0.0079

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

<Table 7> Support ratio and investment rate by region in Asia (2)

	Investment rate – South Asia		**Investment rate –South East Asia**	
	Random effect	Fixed effect	Random effect	Fixed effect
Support ratio	2.9056***	2.9064***	2.7087***	2.6933***
	(0.2963)	(0.2980)	(0.1959)	(0.1969)
Constant	-0.1606	-0.1602	-0.2974*	-0.3053***
	(0.2271)	(0.1676)	(0.1710)	(0.1018)
# of observations	315	315	450	450
# of countries	7	7	10	10
R square	0.1843	0.1843	0.3224	0.3224

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

3.2 Condition (2): development causing low fertility – quantity-quality tradeoff

The second condition is about the relationship between the level of development and fertility. This issue has been discussed widely within the framework of 'quantity-quality tradeoff' where increased investment in human capital accompanies lower fertility following households' optimization decision making. As an economy develops and moves closer to the frontier, more human capital is needed to learn and adopt the frontier technologies, and the return to human capital could rise. This makes households to put more weight on the quality rather than the number of children.

Table 8 shows that fertility is very sensitive to the level of economic development – measured by either GDP per capita or the level of average human capital *a la* PWT 9 - in Asia. If we look at the differences across regions in Asia, human capital accumulation has larger adverse effects on fertility especially in East and South-East Asia (Table 9 and 10). On the other hand, in Central Asia, fertility is not so sensitive to economic development. Table 11 shows that for all income groups human capital accumulation has a strongly negative effect on fertility.[3]

Fertility seems to be more sensitive to economic development in Asia than other continents. There may various reasons: Asia's education is much costlier due to factors like high cost of learning English language or tough competition due to education's role of screening better workers, etc. Moreover, despite the high cost, the massive increase in human capital needed during the process of economic catch-up has inevitably brought about the rapid decline in fertility in Asia.

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[3] We follow ADB's classification of income groups: in 2011 PPP, using PWT9.0, **Extremely low-income countries:** GDP per capita (2011 PPP) ≤ \$1096; **Low-income countries:** \$1096 < GDP per capita (2011 PPP) ≤ \$2585; **Lower-middle-income countries:** \$2585 < GDP per capita (2011 PPP) ≤ \$5351; **Upper-middle-income countries:** \$5351 < GDP per capita (2011 PPP) ≤ \$17600; **High-income countries:** GDP per capita (2011 PPP) > \$17600

<Table 8> GDP per capita, level of human capital, and fertility

	Model (1)				**Model (2)**			
	Fertility – ADB		Fertility - others		Fertility – ADB		Fertility - others	
	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect
GDP per capita	-0.4371***	-0.4475***	-0.2647***	-0.2571***				
	(0.0119)	(0.0121)	(0.0063)	(0.0065)				
Human capital					-1.7267***	-1.7532***	-1.3909***	-1.3876***
					(0.0368)	(0.0370)	(0.0130)	(0.0132)
Constant	4.7656***	4.8692***	3.4858***	3.4530***	2.3723***	2.3528***	2.1597***	2.1674***
	(0.1130)	(0.1014)	(0.0617)	(0.0568)	(0.0631)	(0.0260)	(0.0247)	(0.0095)
# observations	1189	1189	5993	5993	1044	1044	5064	5064
# of countries	30	30	145	145	25	25	118	118
R square	0.4042	0.4042	0.5746	0.5746	0.4959	0.4959	0.7730	0.7730

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

<Table 9> GDP per capita, level of human capital, and fertility by regions in Asia (1)

	Model (1)							
	Fertility – Central Asia		Fertility – East Asia		Fertility – South Asia		Fertility – S-E. Asia	
	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect
GDP per capita	0.0193	0.0221	-0.4465***	-0.4544***	-0.6216***	-0.6292***	-0.4271***	-0.4501***
	(0.0234)	(0.0236)	(0.0194)	(0.0199)	(0.0209)	(0.0207)	(0.0191)	(0.0194)
Constant	0.7473***	0.7231***	4.7871***	4.8599***	6.2283***	6.2876***	4.7880***	4.9819***
	(0.2217)	(0.2011)	(0.1948)	(0.1856)	(0.1832)	(0.1611)	(0.1842)	(0.1643)
# observations	200	200	270	270	315	315	449	449
# of countries	8	8	6	6	7	7	10	10
R square	0.0389	0.0389	0.7139	0.7139	0.3590	0.3590	0.3370	0.3370

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

<Table 10> GDP per capita, level of human capital, and fertility by regions in Asia (2)

	Model (2)							
	Fertility – Central Asia		Fertility – East Asia		Fertility – South Asia		Fertility – S-E. Asia	
	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect
Human capital	-0.5206**	-0.5211**	-2.2270***	-2.2348***	-1.4999***	-1.5962***	-1.6489***	-1.6539***
	(0.2526)	(0.2540)	(0.0639)	(0.0638)	(0.0952)	(0.1007)	(0.0432)	(0.0433)
Constant	1.5429	1.5434	2.6328***	2.6398***	2.1218***	2.1684***	2.2248***	2.2289***
	(0.3452)	(0.2817)	(0.1783)	(0.0578)	(0.0724)	(0.0508)	(0.0955)	(0.0283)
# observations	100	100	270	270	270	270	449	449
# countries	4	4	6	6	6	6	10	10
R square	0.0059	0.0059	0.3036	0.3036	0.4964	0.4964	0.5056	0.5056

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

<Table 11> Elasticity of fertility with respect to the level of development by income groups

	GDP per capita & Fertility – ADB		Human capital & Fertility - ADB	
	Random effect	Fixed effect	Random effect	Fixed effect
Extremely low income	-0.7096***	-0.7285***	-1.5503***	-1.6297***
Low income	-0.8303***	-0.8340***	-2.0877***	-2.1770***
Lower middle income	-0.4689***	-0.4721***	-1.4598***	-1.4888***
Upper middle income	-0.3264***	-0.3254***	-1.1153***	-1.1694***
High income	0.0349	0.0320	-1.6825***	-1.6847***

Note: Right two columns and left two columns are the results of separate regressions. All variables are logged. *, **, *** refers to the significance level of 10%, 5%, and 1%, respectively.

3.3 Condition (3): low fertility leading to too low support ratio for catch-up

According to Lee-Mason et al (2014) low fertility does not necessarily mean low support ratio in the long-run. To put it simply, there can be a long-run optimal fertility that can maximize support ratio. One can easily conjecture that extremely high long-run fertility will lead to low support ratio due to too many children for each household, whereas extremely low long-run fertility will cause low support ratio due to ever shrinking size of workers compared with retired generations. Moreover, the optimal fertility that maximizes support ratio has nothing to do with replacement level of fertility, meaning that ever increasing or ever decreasing population size could be optimal to keep support ratio high and, hence, it is possible that relatively high or low fertility can last for quite long time. Recall that an average household can choose too low or too high fertility to maximize its within-household support ratio.

Considering these issues, the condition that low fertility leads to too low support ratio for catch-up is more complicated than it seems. Fertility affects support ratio with time lag and complex dynamics. To analyze this problem, we set up a model based on Ha and Lee (2015) and extend it to show the relationship between fertility and steady state support ratio. Then we put actual numbers to compare current support ratio with the steady state support ratio, which enables us to evaluate sustainability of high support ratio. This analysis is important because if high support ratios due to low fertility in recent years correspond to a very low support ratio in the long-run, then the high support ratio cannot be sustained in the future. In other words, if fertility decline raises support ratio in the short-run but lowers it in the long-run, then the speed of convergence or catch-up will erode, leading to a trap.

Therefore, we need to evaluate the sustainability of current support ratio for each country to see if it will face decline in support ratio or not. We do this by utilizing a model for the dynamics of support ratio presented by Ha and Lee (2016). In the model, the key state variables are the current support ratio (l), and the steady state support ratio (l_{ss}), the latter of which is the steady state value of support ratio that is implied by current birth-death rate combinations. The dynamics are as follows.

The support ratio l is:

$$l = L/N \tag{1}$$

where L is working age (age 15-64) population and N is total population.

The law of motion of support ratio is simply:

$$\frac{\dot{l}}{l} = \frac{\dot{L}}{L} - \frac{\dot{N}}{N} \tag{2}$$

And, the motion of working age population L is:

$$\dot{L} = zN - (m + d)L \tag{3}$$

where z is labor force inflow rate, which is the flow of population into the labor force as a ratio of population, m is retirement rate of L, and d is mortality rate of L.

Then, the motion of N is:

$$\dot{N} = nN \tag{4}$$

Putting (3) and (4) in (2), we have:

$$\frac{\dot{l}}{l} = \frac{\dot{L}}{L} - \frac{\dot{N}}{N} = \frac{zN}{L} - (m + d) - n = \frac{z}{l} - (m + d) - n \tag{5}$$

Letting (5) equal to zero, the steady state value of l is obtained as follows.

$$l_{ss} = \frac{z}{m+d+n} \tag{6}$$

This is consistent with the findings of Lee-Mason et al (2014) where l is constant but population growth rate is either positive or negative.

Now, we would like to apply this concept to Asian countries. In doing so, we introduce several simplifying assumptions: (1) Labor force inflow is the same as the number of people born 15 years ago; (2) L survives until 64 if life expectancy is greater than 64; (3) Labor force outflow is the number of people born 64 years ago if life expectancy is greater than 64. Otherwise, labor force outflow is mortality rate multiplied by population. Then, we have the following formula:

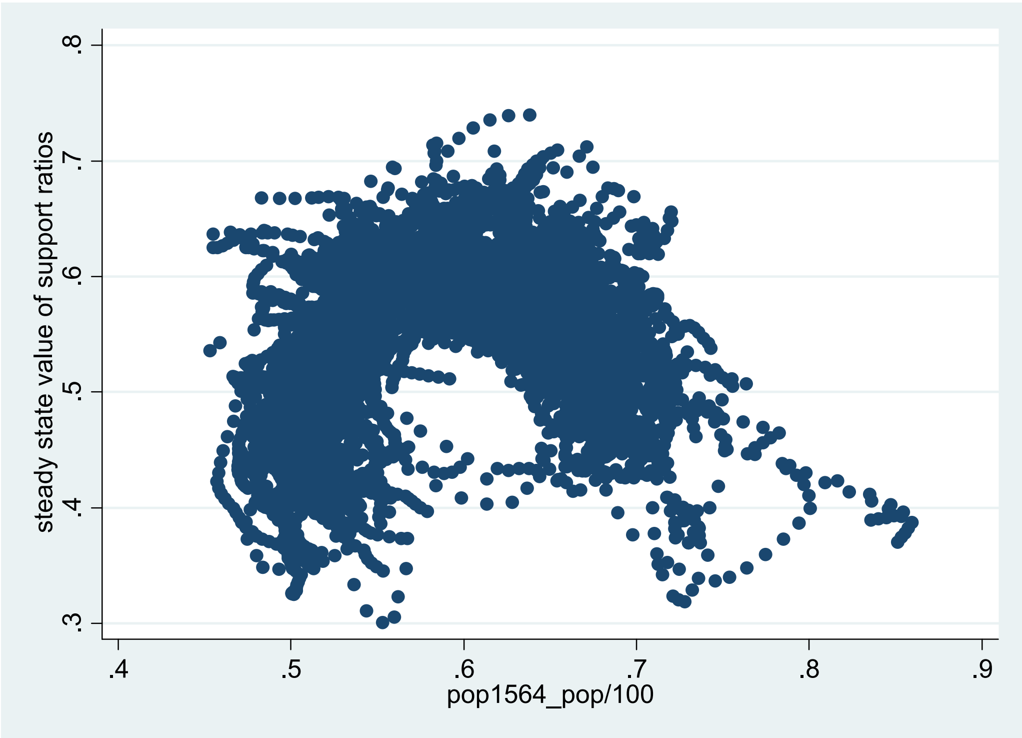
$$l_{ss} = \begin{cases} \frac{b\{(1+n)^{-15}-(1+n)^{-64}\}}{n}, \ if\ life\ expectancy > 64 \\ \frac{b(1+n)^{-15}-(b-n)}{n}, \ if\ life\ expectancy\ \leq 64 \end{cases} \tag{7}$$

We define $diffsr = l - l_{ss}$, which converges to zero in the long run. Then, we have the following proposition.

Proposition: *As the absolute value of diffsr becomes larger, the speed and magnitude of support ratio adjustment becomes larger during the process of convergence to the steady state, as long as the current values of birth-death rates persist.*

This is because diffsr measures the amount of transitional factors, and therefore, the need for adjustment in the future. Figure 6 shows the relationship between current support ratio and the steady state support ratio. What is interesting here is that the two variables have an inverse U relationship, implying that too low or too high support ratios are not sustainable. Also, it seems that high support ratios that exceed 0.65 cannot be sustained if current birth-death rates do not change drastically. In the case of Asia, many middle income countries now already reached 0.7 or above.

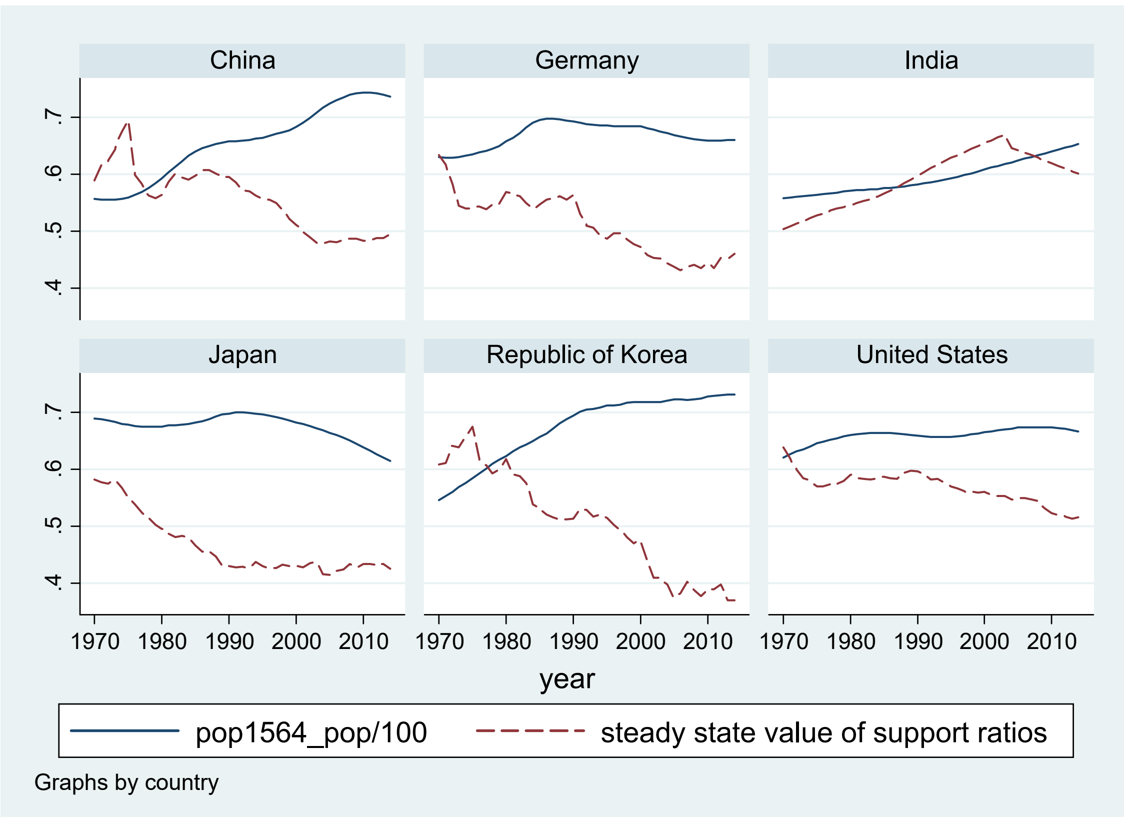
<Figure 6> Current support ratio and the steady state support ratio



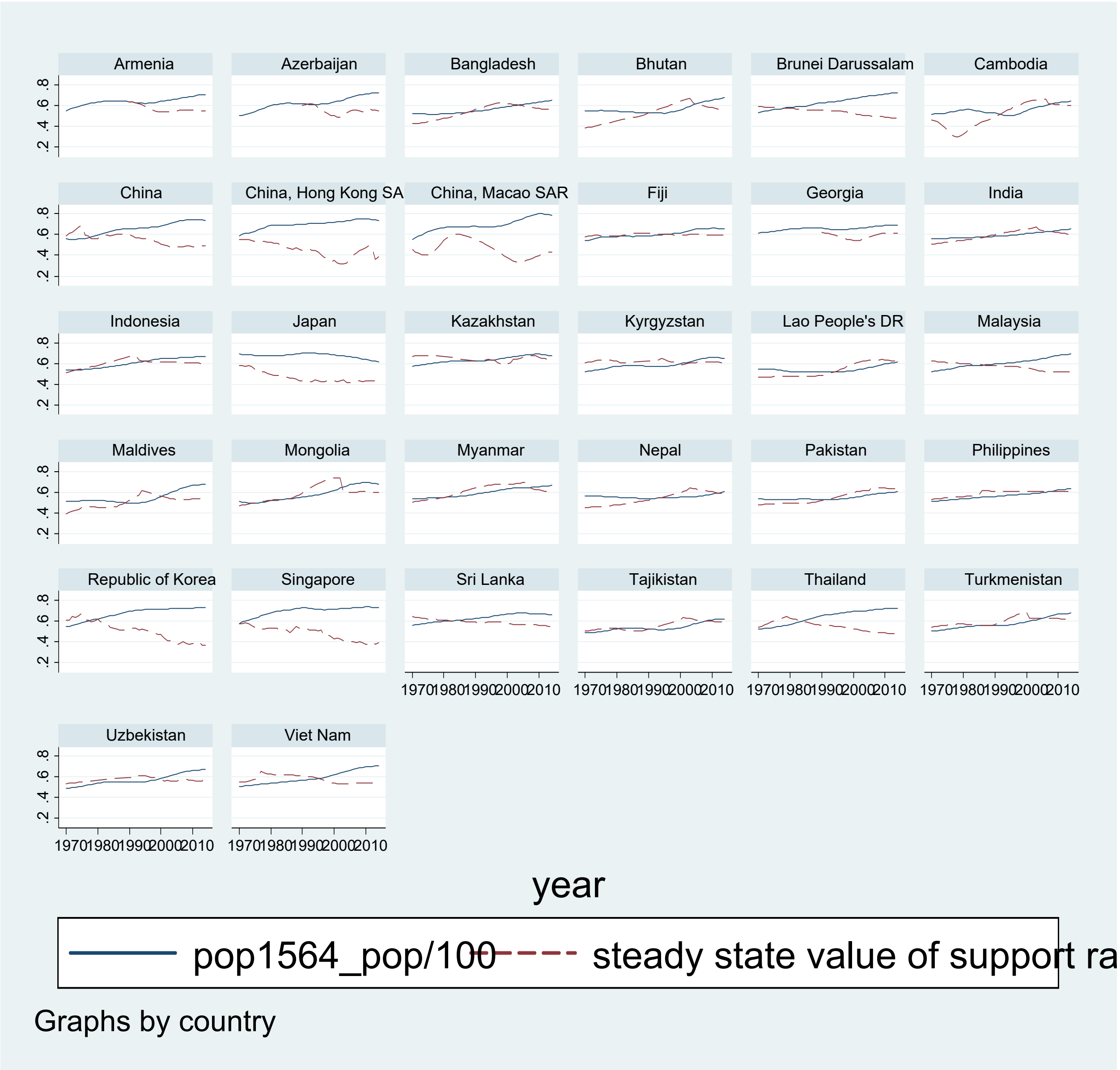
In Figure 7, we present the trends in the two support ratios for selected countries, where the gaps are quite large. Korea and China have exceptionally large gaps, predicting large long-run adjustments of support ratios. Japan and Germany seem to show a little bit of adjustment, while the US and India show relatively smaller gaps and the possibility of less drastic adjustments. However, except for India, the size of the gap – more than 10% - is substantial in every aspect, and requires close attention when predicting future growth paths.

Likewise, Figure 8 shows the trends in the size of needs for adjustment for the ADB member countries. In a number of countries, the gap is quite small, but countries like Armenia, Azerbaijan, Brunei Darussalam, Bhutan, China, Hong Kong,China, Korea, Sri Lanka, Maldives, Malaysia, Singapore, Thailand, and Viet Nam have the support ratio gap greater than 10 percent point. This is 13 countries out of 30. Moreover, Bangladesh, Georgia, Indonesia, Mongolia, and Uzbekistan have the gap higher than 7 percent point. This means about two thirds of Asian economies are facing serious headwinds of declining support ratio in the near future.

<Figure 7> Gap between actual and steady state support ratios for selected countries



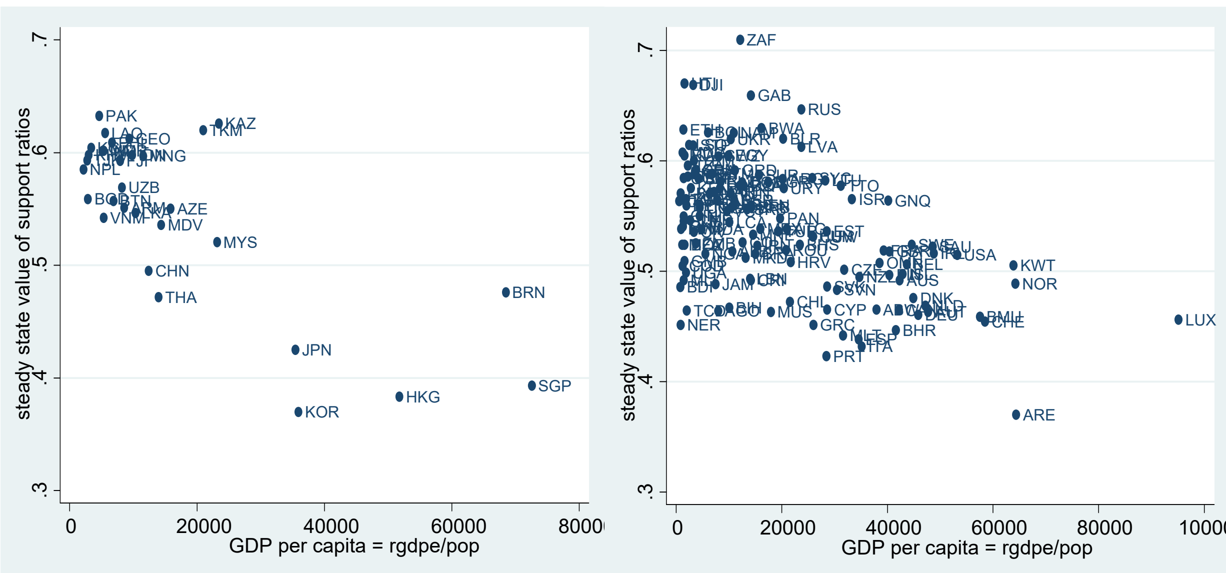
<Figure 8> Support ratio and its steady state value – ADB members plus Japan and Macao,China



3.4 Evaluating the possibility of a middle income trap in Asia

As we have seen in this section, most countries in East, South, and South-East Asia meet the three conditions of the middle income trap driven by demographic factors. Specifically, countries with low steady state support ratios and middle income are quite likely to get into the trap if they do not get into the high income group quickly or fail to raise fertility. It seems that China and Thailand are facing this possibility. Japan, Korea, Hong Kong,China, and Singapore are also facing similar trap although they are classified into the high income category. .

<Figure 9> GDP per capita and steady state support ratio for Asian economies (left) and others (right)



Note: Numbers are for year 2014.

3.5 Effects of extending retirement age

So far, steady state support ratios have been entirely determined by birth-death dynamics given fixed retirement age, 65. However, one can consider extending this retirement age to make the size of working age population larger and the size of retirees smaller. This can be analyzed by modifying Equation (7) as follows:

$$l_{ss} = \begin{cases} \frac{b\{(1+n)^{-15}-(1+n)^{-69}\}}{n}, \ if\ life\ expectancy > 69 \\ \frac{b(1+n)^{-15}-(b-n)}{n}, \ if\ life\ expectancy\ \leq 69 \end{cases} \tag{8}$$

Here, the only difference is that retirement age is now 70 instead of 65, and Equation (8) gives us the new steady state support ratios for given birth-death rates. In most cases, this change raises steady state support ratios substantially. <Table 12> shows that if the retirement age is extended to 70, steady state support ratios increase by 3.45%p in Korea, 4.38%p in China, and 4.45%p in Thailand. This narrow the gap between actual and steady state support ratios by 10-18% for these countries.

Therefore, an extended retirement age could certainly relieve the aging problems in Asia. However, one should keep in mind that this has only partial effect and cannot change the whole direction of aging dynamics as long as there exists retirement itself.[4]

[4] This means that if there is no retirement in the first place, age structure would not matter that much.

<Table 12> Steady state support ratios for retirement age 65 and 70 for Asia

Country	Support ratios			(A)-(B)	(C)-(A)
	Actual (2014) (A)	Steady-state (retirement age=65)(B)	Steady-state (retirement age=70)(C)		
Armenia	70.76%	55.11%	60.16%	15.64%	5.05%
Azerbaijan	72.40%	55.00%	59.00%	17.40%	4.00%
Bangladesh	65.07%	55.89%	59.69%	9.18%	3.80%
Brunei Darussalam	72.30%	47.59%	50.95%	24.71%	3.37%
Bhutan	67.61%	55.71%	59.83%	11.90%	4.12%
China	73.61%	49.51%	53.89%	24.10%	4.38%
Fiji	65.57%	59.26%	63.44%	6.30%	4.18%
Georgia	68.67%	61.20%	67.11%	7.47%	5.91%
Hong Kong,China	73.58%	38.31%	41.97%	35.27%	3.66%
Indonesia	66.91%	59.76%	72.92%	7.15%	13.16%
India	65.30%	60.15%	72.89%	5.15%	12.74%
Japan	61.36%	42.49%	47.06%	18.87%	4.57%
Kazakhstan	67.14%	62.58%	66.69%	4.55%	4.11%
Kyrgyzstan	64.72%	60.41%	63.72%	4.31%	3.31%
Cambodia	64.18%	59.77%	68.54%	4.41%	8.77%
Republic of Korea	73.01%	36.98%	40.43%	36.03%	3.45%
Lao People's DR	61.12%	61.75%	65.71%	-0.62%	3.96%
Sri Lanka	66.30%	54.65%	58.97%	11.66%	4.32%
Macao,China	78.67%	43.36%	47.04%	35.31%	3.68%
Maldives	67.69%	53.59%	56.92%	14.11%	3.33%
Myanmar	66.70%	60.14%	75.27%	6.56%	15.13%
Mongolia	68.12%	59.68%	63.35%	8.43%	3.66%
Malaysia	68.96%	52.06%	55.87%	16.89%	3.81%
Nepal	61.10%	58.50%	62.51%	2.60%	4.01%
Pakistan	60.32%	63.25%	62.93%	-2.93%	-0.32%
Philippines	63.28%	60.89%	69.00%	2.39%	8.12%
Singapore	73.07%	39.28%	42.77%	33.79%	3.48%
Thailand	71.95%	47.15%	51.59%	24.80%	4.45%
Tajikistan	62.02%	59.33%	62.26%	2.69%	2.93%
Turkmenistan	67.49%	61.97%	71.48%	5.52%	9.51%
Uzbekistan	66.85%	56.91%	69.70%	9.94%	12.79%
Viet Nam	70.27%	54.23%	58.26%	16.04%	4.03%

Note: The steady state numbers are computed using birth-death rates of 2014.

4. What NTA tells about Demography-Driven Middle Income Trap

In this section, we will consider what NTA tells about demography-driven middle income trap. It is obvious that the NTA data are much more precise for the analyses in this paper. However, the NTA data are not yet accumulated enough for panel analyses, and only 15 Asian economies are covered in the NTA data sheet of 2016. But, it still tells us something.

First, NTA shows more detailed and clearer picture for quantity-quality tradeoff. NTA shows that intergenerational resource allocation affects fertility and future course of economic development. One can see a stronger and clearer relationship between human capital investment and fertility through the lens of NTA. In particular, "human capital spending" and "consumption by age group 0-24" have strong negative correlations with fertility. In Figure 10, human capital spending and transfer to young generation data from NTA have much clearer negative relationship with fertility than PWT 9 data. Table 12 also shows this with the NTA human capital investment data having stronger correlation with fertility.

Second, NTA shows the transitional path of support ratios more accurately. The adverse effect of declining support ratios can last for decades, implying the possibility of a middle income trap for several decades. Future changes in support ratios imply that transitional effects can last for decades, leading to a 'temporary' trap. Figure 11 shows that for the years between 2015-35, some countries have positive growth rates of support ratio meaning positive support ratios, while others have negative rates.[5] But, for 2015-55 more countries fall into the area of negative demographic

[5] The prediction of support ratios in the NTA data sheet 2016 uses the UN fertility forecast and the current intergenerational resource allocation structure.

dividends. The calculation of the model shows that in the long-run with the current birth-death rates, most countries except for Laos face demographic headwinds.

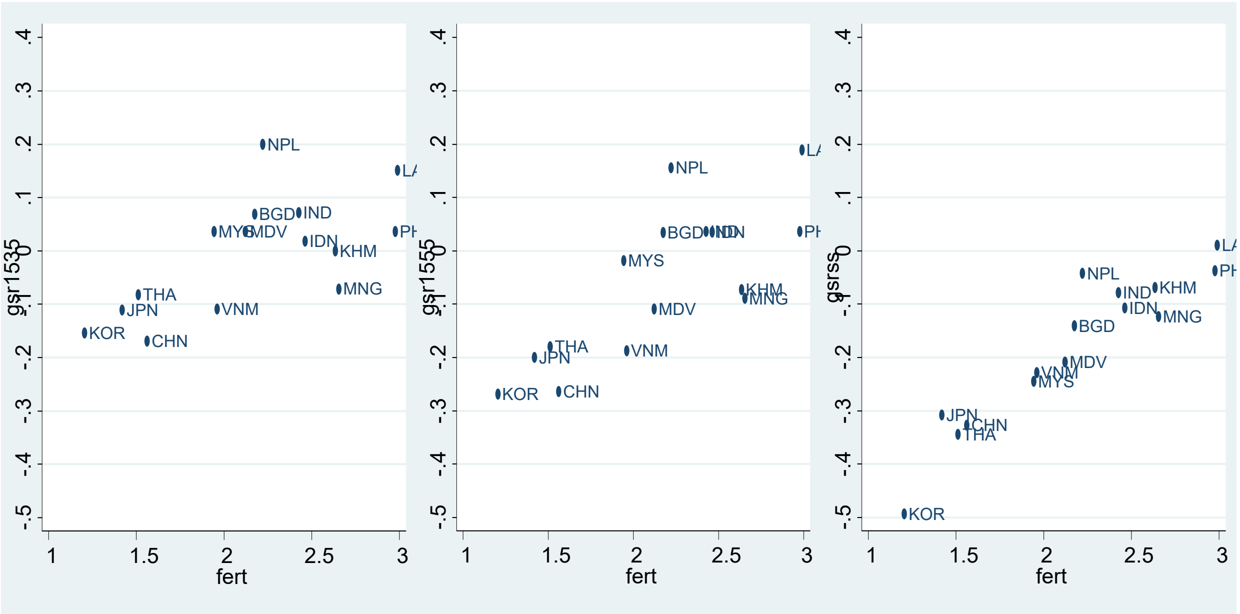
<Figure 10> Fertility and human capital (left; PWT9), human capital spending (middle; NTA), and consumption by age 0-24 (right; NTA)

<Table 13> Correlation between major variables from NTA and others

	Fertility	**Support ratio 2015 (NTA)**	**Support ratio 2035 (NTA)**	**Support ratio 2055 (NTA)**	**Steady state support ratio**
Human capital (PWT9)	-0.5979	-0.2599	-0.7369	-0.7162	-0.7494
Human capital spending (NTA)	-0.7284	-0.0725	-0.5453	-0.6664	-0.8076
Consumption of age 0-24 (NTA)	-0.7732	-0.3625	-0.7563	-0.8219	-0.7296

Note: Number of observations is 15. Human capital, fertility are for 2014, while others are for various years as measured in NTA data sheet 2016.

<Figure 11> Fertility and change rate of support ratio for 2015-35 (left; NTA), 2015-55 (middle; NTA), 2014 to steady-state (right; the model)



5. Conclusion

We have shown that there are three conditions for a demography-driven middle income trap, and our main finding is that Asian countries generally meet those conditions, especially in East and South-East Asia. So far, low fertility caused rapid increase in support ratios and more demographic dividends in Asia, leading to faster catch-up with the frontier. But, for many countries in this region, this positive effect cannot be sustained for many decades to come.

Declining support ratios are a strong headwind for growth, leading to at least a 'temporary' or 'transitional' middle income trap. So, we would like to emphasize that the 'transition' may take decades not years.

Policy implications for our analysis is straightforward. First, fertility decline should not be that fast and shocking to the economy. Second, fertility should come back to more sustainable levels in many Asian countries. Transfers to younger generations due to human capital investment is needed for continuing catch-up, but it may be too costly for some countries as too much 'quantity-quality tradeoff' leading to too low fertility, eroding the basis of catch-up itself. For example, it is well known that in East Asian countries, households spend substantial amount of income in English language education. This may be to prepare their kids for the catch-up development, but this, at the same time, makes the cost of having kids too high.

Therefore, as economies develop, the cost of human capital investment relative to income should become significantly cheaper to avoid the trap that may wait in the future. In the meantime, however, extending retirement age, for example to 70, will certainly help alleviate the problems to some degree.

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