Feminising the Workforce in Ageing East Asia?

The Potential of Skilled Female Labour in Four Advanced Economies

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Abstract

The populations of Hong Kong, Japan, South Korea, and Singapore are ageing rapidly, triggering fears of labour shortages. In spite of the widely acknowledged importance of worker's skill levels, traditional labour supply projections do not account for ongoing changes in populations' education composition and educational differentials in economic activity. By focusing on the role of educational expansion in general and female labour potential in particular, this study analyses past trends and projects future labour supply in four advanced Asian economies. We first offer an in-depth overview of developments of labour force participation, emphasising each country-specific context. We then provide selected scenarios of labour force projections up to 2050 which consider changing population compositions by education and differentials in labour participation patterns.

We find that due to continued improvements in education, post-secondary educated workers will make up at least two-thirds of the future labour force in each economy. If female labour force participation saw increases in line with the assumptions of our benchmark scenario, the share of post-secondary educated women could exceed 30% of the entire workforce by 2050. Hence, the pressing problem of labour shrinkage could partly be offset by particularly incorporating better-educated women. Our findings underscore the effects of different participation scenarios (especially of women) on the total size of the labour force and the importance of including the education dimension in considerations about future labour supply. While we are not the first to make the latter argument, we are the first to quantify this potential for the analysed four advanced Asian economies.

1. Introduction

Populations in Hong Kong, Japan, South Korea (referred to as Korea hereafter), and Singapore are ageing rapidly. Besides concerns about what a larger share of elderly means for public expenditures on health care and pensions, the accompanying shrinkage of working-age population is also a growing concern. Population age structures have been changing drastically during the last 50 years. The share of the young population (below age 15) has been decreasing, and the share of those above age 65 has been increasing. In Japan, the decline in the share of the *working-age population* (ages 15 to 64) has already begun in the mid-1990s, whereas in Hong Kong, Korea, and Singapore, the decline just started recently (United Nations 2015). However, as has been noted by many others before, the share of the working-age population is at best a rough indicator of labour supply. Due to stark differences across societies in gendered labour force participation patterns and the timing of labour market exit and retirement, the actual labour supply often differs greatly from the working-age population. Hence, what is crucial to investigate is the actual age-specific economic activity of individuals and how its changes affect the size and composition of the labour force.

Aside from labour force analyses, most ageing societies implement policies to prevent labour shortage. Increasing the exit age from the labour force is one measure to counter expected fiscal hardship of pension and social security systems. Another measure is the attempt to increase female labour force participation (FLFP) to compensate for a shrinking working-age population, particularly in societies with large gender gaps in labour force participation.[1] Due to differential historical and cultural backgrounds, FLFP varies quite a bit across the aforementioned four societies. Although selected policies towards this goal are being discussed and/or have already

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[1] The labour force is synonymous to the economically active population and to labour supply. It is made up of the employed and the unemployed population.

been implemented in each of the four societies, further progress toward higher FLFP is likely to be hampered by gender inequality and workplace discrimination to a varying extent. In addition to involving more women in the labour force, discussions related to improved skill levels in future workforce is crucial yet often lacking. This study will focus on labour projections by educational levels to fill the void.

There are two good reasons to do education-specific projections of labour supply: first, participation shows a strong education gradient. Higher education levels are associated with higher levels of economic activity for both sexes once a certain stage of economic development is attained. Second, including the education dimension allows not only estimations of the size and age-composition of the future labour forces but also inferences about their education composition, which is closely linked with productivity and economic growth (Lee and Mason 2010). As we will show below, the average level of female educational attainment is projected to increase in each of our four economies. This is a crucial aspect in economies that are expected to face shrinking labour force sizes, since smaller but more productive labour forces–due to higher human capital endowment—can have positive effects on economic growth (Fougere et al. 2009; R. Lee and Mason 2010; Ludwig, Schelkle, and Vogel 2012). Of our four societies, policy makers in Singapore seem to be the ones most aware of the value and need of having a highly educated labour force and also acting accordingly. The "Ministry of Manpower" has several agencies, initiatives and events under its umbrella that explicitly deal with the maintenance and increase in the human capital of the Singaporean labour force. As Chuan (2007) points out, changes in the education structure of the Singaporean workforce will increase productivity short to medium term, with the potential to work against the negative expected effect of reduced labour supply on GDP growth.

The decision to limit our analysis of female labour supply in Hong Kong, Japan, Singapore and Korea is based on the fact that these societies are rapidly ageing advanced economies in Asia.

Another commonality of these societies is their relatively low levels of FLFP, compared to men and to female participation in other advanced economies. While prior studies have explored FLFP in these societies in more detail than in other low- and middle-income Asian societies, comparative research on the commonalities and differences of women's economic activity is limited. Excluding China, the populations of Hong Kong, Japan, Singapore and Korea (a total of 185 millions) make up about 78% of the entire population in East Asia. Given that the East Asian region leads the trend in many socioeconomic and demographic indicators in Asia, knowing the future population and labour development of these societies are indicative of the larger Asian region.

This study aims to first offer an overview of age-specific developments of FLFP, contrasting it to male participation, and looking at differentials by education within each country-specific context. Then, we provide labour force projections up to 2050 to evaluate what potential patterns of FLFP could look like with the changing educational compositions of these ageing populations. The research questions we address in our study are:

(1) What are the patterns and trends of past and current female labour supply in Hong Kong, Japan, Singapore and Korea?

(2) What does future female labour supply by education level for these societies look like, based on selected participation scenarios?

2. Developments of FLFP: trends and context

The following sections provide country-specific portraits of the four Asian societies included in this study. Past trends of female labour force participation will be discussed, along with how they relate to educational expansion that are common features of these societies in the latter half of the twentieth century. While these societies all share a Confucian heritage, the socio-cultural context that influences further progression to higher FLFP varies and will also be addressed.

Past trend of FLFP

All four societies in this study experienced substantial increases in FLFP rates due largely to industrialization that took place in the 1960s and 1970s, even though Japan had been industrialized much earlier in the latter half of the nineteenth century. It should be noted that in rapidly ageing societies FLFP rates above age 15 are inevitably affected (in most cases suppressed) by shifting age structure, even if age-specific labour force participation patterns stay constant over time (Loichinger 2016). Hence, to properly interpret historical FLFP statistics within an ageing context, we will discuss FLFP trends from the angle of "changes in economically active population."

Japan quickly rose back to prosperity in the 1950s after the economy was hard-hit by World War II. In the following decades, remarkable economic growth was observed before other Asian societies became fully industrialized. Female labour force participation rates for women aged 15 and above grew in the 1960s due largely to part-time employment, because women were only secondary earners in the household (Yoon 2015). Since as early as the late 1960s, the share of economically active women above age 15 has been staying at around 48%-50% till the 2010s, with a periodic drop to 46%-47% in the mid-1970s and to 48% in the 2000s (Statistics Japan 2017). Even in the years of Japan's Economic Bubble, FLFP has not been substantially affected. Hence, female employment rates in Japan are higher than in Korea and Singapore. In fact, the levels of female labour force participation have actually increased substantially since the mid-1980s when changes in population age structure are considered (Loichinger 2016). However, the majority of Japanese women are non-regular workers with lower wages and less job protection (Kinoshita and Guo 2015).

As for Korea, female labour force participation above age 15 has been steadily increasing from around 37% in the early 1960s (Myhie 1994) to almost 50% in the 2000s and 2010s, except a small drop around 1997 during the IMF financial crisis (OECD 2016a). Meanwhile, the labour force participation of men aged 15 or above dropped from around 78% in the early 1960s to about

73% in 1990 (Myhie 1994)[2]. Since then, despite some fluctuations, the rates have remained at around 72% all along to the 2010s[3] (The World Bank 2016; Trading Economics 2016). For both Japan and Korea, data on female labour force participation patterns by education in earlier decades are not available.

In the case of Hong Kong, the share of economically active women has also demonstrated a rapid increase since the 1960s, with that of women aged 15 and above rising from 36.8% in 1960 to 54.6% in 2014. On the other hand, the proportion of economically active men has dropped from 90% in 1961 to 69% in 2014 (Cheung 2002; Hong Kong Census and Statistics Department 2015). With regard to similar figures by educational attainment, an increase from 67.7% to 72.4% between 1986 and 2014 has been observed for those aged 15 and above with tertiary education, while the comparable figure for men with the same educational attainment dropped from 84.1% to 79.6%. The share of women with below secondary education have demonstrated a more significant decline in economic activity from 44.7% to 30.4% during the same period, and the figures for men of this educational level exhibited the most drastic decline from 81.5% to 44.2%[4] (Hong Kong Census and Statistics Department 2015).

In 1957, only about 22% of Singaporean women age 15 were economically active. This share has risen rapidly along with the industrialization in Singapore from 29.5% in 1970 to 44.3% in 1980 (Low et al. 1993). It further increased to 51.6% in 2001 and now stands at 60.4% in 2016, which is higher than most other advanced Asian economies (Ministry of Manpower 2017). Moreover, the share of economically active women aged 15 and above with tertiary education has

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[2] This can be referred to table 11-1 in Myhie (1994).

[3] The statistics shown by OECD for women aged 15 to 64 are 52 % in 2000 and 57% in 2014; and 77.1% in 2000 and 78.6% in 2014 for men.

[4] This can be referred to table 4.7 in Hong Kong Census and Statistics Department (2015). Statistics prior to 1986 are not found.

also been quite high—increasing from 75% in 1980 to 87% in 2000 and dropped slightly to 82% in 2010 (Lim 2015). Although Singaporean women have been fallen behind their male counterparts in terms of participation rates, the gender gap has narrowed since 1957.

These described developments have led to women making up 47% of the total labour force in Hong Kong, followed by Singapore (44%), Japan (43%) and Korea (42%) in 2016 (Worldbank 2016). Figure 1 depicts age-specific profiles of labour force participation for women and men in our four selected societies. As can be seen, patterns of female labour force attachment are distinct from each other. Women in Singapore and Hong Kong have very similar participation rates until around age 50, after which Singaporean rates remain higher. Participation rates of women in Japan and Korea show the typical M-shape and are significantly lower roughly between ages 25 and 39 than in Singapore and Hong Kong, but higher for older age-groups. These profiles reflect not only age-specific behaviour of economic activity but also differences across birth cohorts. The participation profiles for males also show some differences across societies, and the general shape is the typical inverse u-shape that is associated with male participation in general. The largest differences occur before age 30, where participation for Korean men is significantly lower than in the other three societies, and then again above age 55, where men in Hong Kong have consistently lower participation levels.

Figure 1 about here

Educational expansion and FLFP

Educational expansion in Japan has been relatively slower and more conservative than the other Asian advanced economies, largely because the Japanese government intended to control the quality of higher education (Nakata and Mosk 1987). Overall, an expanding share of tertiary-educated population has been linked to higher labour force participation levels, particularly among women.

Despite its slower growth, higher education in Japan went through substantial expansion since the 1960s (Brinton and Lee 2001), with women experiencing faster growth rates than men. While the expansion in men's higher education mostly concentrated at the university level, women have gained ground in both junior college and university education, with junior college credentials being more common than a university degree (Brinton and Lee 2001). This is largely due to the institutional context that fails to facilitate women's advancement in higher education (Yu 2009). In addition, a positive association between educational attainment and labour force participation rates often observed in other industrialized countries has not emerged in Japan (Raymo and Lim 2011) (cf. Figure 2). This is mainly because of sex discrimination in the labour market and the implementations of permanent employment systems.

For Korea, The growth of educational advancement for both men and women skyrocketed between 1970s and 2000s, due to the reforms on higher education in the 1980s (J.-K. Lee 2001). Prior to 1970, only around 12% of men and 4% of women aged 18-21 were enrolled in higher education, and yet by 2000, the enrolment rate had reached almost 80% for men and 50% for women[5] (Brinton and Lee 2001; S. Lee 2001). The gender gap in the share of men and women aged 25-34 with tertiary qualification has even reversed in 2012, with 72% of women and 64% of men (OECD 2015).

Although Korean women have been integrated into the labour market in a fast pace since the 1970s, with the overall labour force participation of working-age women reaching 57% in 2014 (OECD 2016a), still a large proportion of women with higher educational qualifications did not enter the labour market after leaving universities (Brinton and Lee 2001). Female university graduates in Korea demonstrated the lowest employment rate of 60%, and a widest gender gap in employment among OECD countries in 2010, with men of the same educational level showing 79% of employment rate (OECD 2011). In addition, the employment rate of highly-educated

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[5] See figure 8.1 in S. Lee (2001).

women aged 25-64 was 62% in 2011, only 4 percentages higher than those with below secondary education. The same figure of the OECD average however was a 31 percentage difference between the two groups (OECD 2011). Given the low returns in the workforce, university education does not necessarily provide Korean women with more advantages as a worker. Even for those who are employed, unequal gender treatment in the workplace significantly discourages women from staying in the workforce.

The expansion of secondary and tertiary education in Hong Kong mainly took place during the 1980s, when the government decided to implement policies to improve overall educational attainment (Lam and Liu 1995). Another wave of expansion for post-secondary education came after the mid-2000s, where more programs for associate degrees and other sub-degrees were established by private or self-financed higher education institutions under a new policy initiative (M. Lee 2014). In contrast to the limited opportunities for tertiary education in Hong Kong prior to the 1980s, where only about 3-4 % of the cohorts enrolled in degree programs, these two waves of expansion rapidly increased the share of tertiary-educated population ages 15+ to 24% in 2016 (Education Bureau 2017). Meanwhile, a general upward trend in the share of female enrolment at all educational levels has been observed, especially in tertiary education. In 1961, female accounted for only 26.5% of tertiary enrolment in both degree and non-degree programs (Choi 1995), and this figure rose to 54% in 2014, surpassing the enrolment rate of men (University Grants Committee Secretariat 2014).

The economic boom from the 1960s to the 1980s has rendered substantial opportunities for women, which at the same time attenuated the labour market advantages of men. In particular, due to the increase in outward processing activities of Hong Kong manufacturers in China, the secondary manufacturing sector in the local economy had declined (Lam and Liu 1995). In contrast, the surge of service sectors since the late 1990s has opened up a great deal of employment opportunities for women, resulting in an increase in white-collar, well-paid middle-class jobs that

facilitated women's upward mobility (Leung 1995). This phenomenon has been accompanied by an occupational polarization of both high-paying and low-paying jobs. In addition, the labour force participation rate of women age 15+ with tertiary education was 73% in 2001, which is higher than 43.5% and 31.9% for those with lower-secondary and only primary education, respectively (Ngo and Pun 2009). Overall, it can be said that the pattern of educational gradient in female employment has been clear in Hong Kong, which indicates a closer link to women's educational attainment and their level of labour participation, compared to that in Japan and Korea.

In the case of Singapore, the share of the female population age 15 and above with tertiary education rose from less than 1% in the 1950s to nearly 4% in 1990. Since then, a rapid educational expansion took place, with the proportion of tertiary-educated women age 15 and above further increasing to 10% in 1995 and reaching 35% in 2010 (Barro and Lee 2016). The share of female students in tertiary education has also increased from about 30% in 1970 to nearly 50% in 2010 (Barro and Lee 2016). From the 1970s to 2010s, female labour force participation rates for the tertiary-educated have risen from 65% to over 80% with educational expansion, yet FLFP among those with primary and secondary education have declined slightly in the same period (Cheng 1977; Hwa 1980; Department of Statistics Singapore 2010). Over the years the latter has made up a much smaller share of the female population, from 90% of the female population aged 15+ in 1950 to about a quarter in 2010 (Barro and Lee 2016). Hence, the rapid increases in female labour force participation rates observed in Singapore have mostly been driven by changing educational compositions of female population, and only partially due to changes in education-specific FLFP rates.

These changes in the educational composition have had consequences for the composition of female labour supply in all four societies. In 1991, the female labour force in Korea was predominantly composed of women whose highest level of educational attainment was primary

education (57.4%) and where only 9.3% of working women possessed a tertiary credential (Table 1). Within two and a half decades, this changed drastically: by 2007, the share with at most primary education was cut in half (29.0%) and the share with tertiary education tripled (30.8%). Developments in the other three societies showed similar trends, however, the reduction in the share of the female labour force with at most primary education and the gender gap in the share with the highest level of education was more pronounced outside of Korea. In Singapore, the share of the female labour force with a tertiary education even surpassed that of their male counterparts.

Table 1 about here

Socio-cultural contexts shaping FLFP

The Confucian heritage that prevails in all four societies sets the contextual backdrop against which to interpret all major changes in labour force participation patterns.

The tendency of Japanese culture to invest in son's education over daughter's is further amplified by the institutional arrangements of university recruitment procedures. Along with sex discrimination practices at the work place and the permanent (lifetime) employment systems often observed in large Japanese companies (Yu 2009), women's further progression toward higher labour attachment is inevitably hindered. In addition, many companies use the two-tier tracking systems with permanent career-track positions mainly reserved for male workers and routine-work jobs for the majority of female workers (Kinoshita and Guo 2015). At the home front, childrearing hinders women's career because of a lack of quality childcare for preschool children and husband's low involvement in housework (Raymo and Lim 2011).

Many studies argue that the oversupply of highly-educated graduates together with the gender-biased practices in the Korean labour market is the reason behind the incredible gender gap in the workforce. The modest demand for non-manual labour is not capable of accommodating the oversupply of highly educated labour. Under this condition, the prevalent gender-biased assumption is that men are less likely to leave their jobs due to family responsibilities, and thus

are more committed to their job than women are (Brinton, Lee, and Parish 1995; Cooke 2010). The pervasiveness of patriarchal values not only affect women's motivations and attitudes toward family and paid work, but influence policymakers, employers and fellow employees who may determine the pay system and welfare, the hiring and training in the labour market (Brinton, Lee, and Parish 1995; Fagan, Rubery, and Smith 1999). Although the Equal Employment Opportunity Law (EEOL) passed in 1985 has prohibited employers from practicing gender-biased treatment toward employees and from setting "marriage bars," many employers sought to skirt around the regulations, using different excuses to lay off female workers who are married or pregnant (Brinton, Lee, and Parish 1995; Cooke 2010; Monk-Turner and Turner 2004). In turn, women have been facing substantial impediments in the labour market, including barriers to higher echelon, biased job assignment, differential wages, all of which put women on a disadvantageous status in the workforce (S. Lee 2001).

The Confucian culture plays a vital role in governing women's roles in and outside the family in Hong Kong. However, as the place of confluence of colonial officials, foreign merchants and missionaries, and Chinese migrants, Hong Kong also exhibits a mixed socio-cultural milieu characterized by both Confucian and Western values (E. W.-Y. Lee 2003a). Women's education and entrance into the public sphere were promoted by early missionary activities, which significantly improved women's status after the Second World War. Overall, the British colonial period westernized Hong Kong society, which gave rise to the coexistence of traditional Chinese familial ideologies and modern values emphasizing women's autonomy and independence. Hong Kong women, on the one hand, entered the labour market relatively earlier than women in other East Asian societies because of rising living standard resulting from rapid economic growth. On the other hand, an entrenched gendered division of labour in the domestic sphere still prevails that women still shoulder the bulk of housework and care work (E. W.-Y. Lee 2003b; Choi and Ting 2009).

For the case of Singapore, female labour force participation rates have long been higher than many of its Asian neighbours for two reasons: (1) despite the fact that Singapore is often considered a Confucian society, Confucianism has been utilized in this society for political and ideological purposes (Englehart 2000); (2) gender equality has been a major policy focus since 1961 when the Women's Charter was passed. In turn, women have been encouraged to join the workforce since the mid-1960s. During the industrialization period, labour shortage problems were resolved through policies designed to attract foreign investment in export-oriented industries that tend to increase the demand of female labourers (Pyle 1994). In addition, the Singaporean government also implement policies that encourage extended family living and raise the supply of childcare centres to help working women balance work and family (Huang and Yeoh 1994). These policies not only help women stay in the labour market but also promote filial piety within the family.

3. The future of labour force participation: labour force projections

As demonstrated in the previous sections, a significant share of women is not part of the labour force in all four societies. Meanwhile, these women are increasingly higher educated due to past and ongoing educational expansion. In order to be able to quantify this phenomenon, it is necessary to perform labour supply projections by education. Labour force projections for all four societies are regularly provided by the ILO (2013), and Kim (2012) provides projections for 12 Asian economies, among them also Hong Kong, Singapore, and Korea. In addition, there are country-level projections produced by national statistical offices or ministries, for example for Hong Kong (Census and Statistics Department 2015). Although none of these existing projections include any information about the educational structure of labour supply, they are useful for comparing our assumptions and results.

Data

Consistent past and current data on female labour force participation by age, sex and highest level of educational attainment is not provided in any international statistical database. We obtained some data directly from the national statistical offices, others from correspondence with the OECD Statistics Directorate (please see note below Figure 2 for exact information on data sources). Since the education categories and age intervals differed across societies, intensive data preparation and data validation was necessary to have comparable data for all four societies. It was not possible to obtain consistent time series data for economic activity by age, sex and education, so we abstained from analysing time trends and worked with the baseline information we had for each society. The year of baseline data is 2010 for Singapore and Korea, 2011 for Hong Kong, and 2015 for Japan.

Figure 2 illustrates the resulting age-specific patterns of labour force participation by education. The distinct differences between women with different levels of educational attainment are a strong argument in favour of performing education-specific labour force projections. The choice of the two education categories—at most secondary education versus post-secondary education— is the common denominator when we consider the educational composition of the population, the educational breakdown of the participation data, and the educational categorization of the population projection data.

Figure 2 about here

As far as future population data is concerned, we take advantage of a new projection dataset produced by the Wittgenstein Centre for Demography and Global Human Capital (2015)[6]. This dataset contains education-specific population data for the past (since 1970) and projections for the future (up to the year 2100) for 195 countries, including our four selected societies. Table 2

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[6] The complete data for 195 countries, including graphical representation like population pyramids by education, can be accessed under http://www.oeaw.ac.at/vid/dataexplorer/

summarizes the population structure by age and education in our four societies in 2010 and 2050, while Figure 3 focuses on the past and future development of women's educational attainment. The shown patterns of future attainment are from the medium scenario, whose assumptions about future education transitions are based on past global and country-specific developments of educational attainment (Lutz, Butz, and KC 2014). These education assumptions, in combination with the assumptions for developments of fertility, mortality and migration, can be interpreted as the most likely scenario for each country. Fertility and mortality assumptions are the result of expert opinions and statistical modelling (KC et al. 2013). In terms of fertility, this means that the total fertility rate (TFR) is assumed to be 1.4 children per woman in each of the four societies by 2050. This assumption implies a slight increase for all societies but Japan where rates are assumed to remain constant. Country-specific assumptions about differences in fertility by education are based on a negative gradient of education-specific TFRs. The overall assumptions for life-expectancy by country and sex are extended by positive education gradients. Migration assumptions during the projection period until 2050 represent a continuation of current trends and are based on probabilities of immigration and emigration (for details, see Sander et al. 2013).

Educational expansion happened at different points in time and at varying speed in all four societies, as explained earlier (section 2) but the outcome is the same: by now, the majority of women possess a degree equivalent to upper secondary or even post-secondary education. This trend is projected to continue, resulting in younger, more educated cohorts replacing older, less educated cohorts.

Figure 3 about here

Methods

The general approach to project the future labour force contains two steps: first, participation rates are projected, and in a second step, they are combined with future population data. We provide two scenarios for each society: one that constitutes the lower bound of future labour supply and

one that, as we will argue, represents the maximum labour supply that can be expected. Conceptually, there is a difference between projections and forecasts. What we perform are strictly projections: calculations of future developments of labour supply, based on clearly spelled out assumptions. The uncertainty of what will actually happen is dealt with by providing selected scenarios. Forecasts, on the other hand, usually imply that what is provided is the most likely path that future developments will take (Ahlburg and Lutz 1998).

The two scenarios of future labour force participation are:

1) **Constant scenario:** participation rates as they were observed in 2010 from age-group 15-19 to 75-79 are kept constant during the whole projection period until 2050. Any projected changes that are observed are solely due to changes in the age-, sex- and education-specific composition of the population. This scenario represents the low scenario: since female participation has been on the rise, as has the economic activity of older persons, future participation will be higher than current levels.

2) **Benchmark scenario**: Benchmark scenarios serve the purpose to demonstrate what it means for labour supply when deliberately selected participation patterns are set as targets. The selection of specific participation patterns is based on the argument that these patterns represent an ideal pattern. At the same time, they should not just be a theoretical construct but attainable patterns, given the right policies, economic climate and changes in attitudes and norms. As recent research has indicated, achieving Swedish participation patterns by age, sex and education that were observed in 2010 would substantially increase the participation levels of Taiwanese men and women (Cheng and Loichinger 2017). Sweden is a role model example when it comes to gender equality and economic activity levels of women and older workers. However, the situation is different in the four societies investigated here: Swedish participation rates have already been surpassed, particularly for workers above age 65, by males in all four societies. The rates of Japanese men are

higher than those of males in the other three societies for almost all age-sex-education combinations, and we set their observed rates as benchmark for male rates in all societies in 2050. For females, it is still well worth to use the Swedish participation patterns that can be considered to be representative for a society with low labour market barriers for women. For both sexes in every society, we keep a society's values in those few instances where current rates surpass the Japanese and Swedish rates, respectively. This condition only affects participation rates of women age 65 and above in Japan, Korea, and Singapore and those of men age 70 and above in Korea (cf. rates in Table 3). These assumptions do not violate the general observation that female rates are lower than male rates: Swedish female rates are lower than Japanese male rates.

Participation rates as observed in the starting year of the projections are shown in Table 3, as well as the values for women in Sweden in 2010. Values between 2010 and 2050 are obtained through linear interpolation.

Table 3 about here

4. Results

We compare the outcomes across the four societies and the two participation scenarios in terms of total labour force size and economic dependency ratios. In order to show the effect of changes in the educational composition of the labour force, we show developments of labour supply by education and point out differences in gender and age patterns.

Total labour force size

Labour supply in Japan is projected to decrease, irrespective of the participation scenario. The opposite holds true in the case of Singapore: here, labour supply is projected to increase throughout the projection horizon. If there was no change in participation rates (constant scenario), the size of the labour force in Korea would decline to less than 80% of its current size by 2050,

purely due to continued ageing of its population (constant scenario). Increases in female participation rates or patterns of participation as in the benchmark scenario would counter this development. Hong Kong is a special case in that constant participation patterns would lead to hardly any change in labour supply (Figure 4). In 2050, the additional labour potential under the assumptions of the benchmark scenario compared to the constant scenario is 9% in Japan, 16% in Singapore, 24% in Hong Kong, and 28% in Korea.

Figure 4 about here

Labour force dependency ratio

Developments of the total size of the labour force alone cannot tell much about what it means for a society when the labour force is projected to increase or decrease. In case the total population decreases commensurately, the economic and societal consequences will be very different compared to when the total population is increasing. We capture this development of economic dependency with a *labour force dependency ratio*, which is calculated as the ratio between the population that is not in the labour force and the population that is in the labour force. In 2010, the ratio is lower than 1 in Hong Kong, Japan, and Singapore, meaning that there are currently fewer inactive than active persons (Figure 5). In Hong Kong and Korea, the range of economic dependency in 2050 is significantly larger than for the other two societies, given the assumptions of the two participation scenarios. Yet, once we ignore the constant scenario, which is the least likely outcome in every society, it is clear that increases in female participation rates and/or in participation rates of older persons can keep the increase in dependency ratios at a moderate level (Hong Kong, Japan) or almost prevent it (Korea, Singapore).

Figure 5 about here

Educational composition of the labour force

As seen in the figures of Table 4, under the more progressive benchmark scenario the sizes of total labour force will expand for Hong Kong (17.3%) and Singapore (57.9%) but shrink for Japan (-22.4%) and Korea (-3.7%). The size of female workforce will grow in all societies except Japan. For all four societies, the declines in at-most-secondary-educated workforce are universal and similar for both sexes; yet the increases in post-secondary-educated female workforce are more noticeable than post-secondary-educated male workforce. When it comes to the educational composition of the future labour force, the driving force are the expected changes in the educational composition of the population, and to a much smaller extent differences in participation rates by education. The composition of the labour force is clearly projected to shift towards post-secondary educated workers, and by 2050, the great majority of workers will fall into this category. [7] The extent of this shift will vary across societies: While the share of the labour force with post-secondary education is projected to double between 2010 and 2050 in Hong Kong (from 30.9 to 62.0%) and to almost double in Korea (from 40.3 to 76.4%), the increase is less stark but still very noticeable in Japan (from 43.9 to 73.4%) and Singapore (from 57.5 to 86.6%) (Table 4). This variation is due to the different levels of educational expansion each society started out with in 2010: the larger the share of the adult population with higher education in 2010, the smaller the relative projected increase.

Table 4 about here

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[7] These figures are for the benchmark scenario. Detailed compositional results by education for both participation scenarios are available upon request from the authors. The difference in the share of the labour force with post-secondary education across the two scenarios ranges from 0 (Japan) to 1.5 (Hong Kong) percentage points for males and 1.1 (Japan) to 5.1 (Hong Kong) percentage points for females. Once the labour force is aggregated across sex, the difference between the two scenarios ranges only from 0.3 (Japan) to 3.1 (Hong Kong), with the share in the constant scenario being higher compared to the benchmark scenario.

The described expected changes in the educational composition of the labour force are happening for both sexes and irrespective of the participation scenario. In 2010, the share of the labour force with post-secondary education is almost identical for men and women in every society except Korea, where the share is about 7 percentage points larger for men. Projected increases in the education levels of Korean women entail that this discrepancy will disappear by 2050.

Figure 6 about here

The developments illustrated in Figure 6 clearly show the crucial role post-secondary educated women can and will play: by 2050, they could account for over 2/3 of the female labour supply and over 30% of the entire workforce in each society. Under the benchmark scenario, each of these societies could gain a significant additional workforce on top of the constant scenario, and the effect is not surprisingly larger for women than for men. The additional potential of female workers—of any education level—is 21% in Singapore and Japan, 35% in Hong Kong and 58% in Korea. In Korea, Singapore and Japan, the majority of this additional female labour force comes from post-secondary educated women (77% in Korea; 71% in Singapore and Japan) and in Hong Kong they account for about half of the potential (48%). Hence, the difference in the total size of the female labour force between the two scenarios matters not only for absolute head-counts but also because of the productivity potential of highly educated women. Of course, it will depend greatly on the circumstances of their integration into the labour market—above all whether they are working in positions commensurate to their levels and fields of education and whether their positions will be part- or full-time—in how far the four societies will benefit from their potential. Having said that, research has shown that female labour force participation is highest in advanced economies like the Northern European countries where both sexes enjoy a large degree of flexibility in working hours and where childrearing responsibilities are shared more equally (Kinoshita and Guo 2015). The fact that these societies also see relatively high levels of fertility

is proof that high female labour market engagement does not necessarily preclude higher levels of fertility than are currently observed in the four Asian economies.

5. Discussion and conclusion

Ongoing and projected changes in the education composition of the adult populations in the ageing societies of Japan, Hong Kong, Korea, and Singapore have critical implications for future labour supply. In this paper, we quantify these changes in the education structure of future labour supply, focusing on the role of women. Our main findings indicate that due to continued improvements in education, high-skill post-secondary educated workers will make up at least two-thirds of the future labour force in these economies. The shift in educational structure of labour supply takes place irrespective of changes in labour force participation patterns. If female labour force participation saw increases in line with the assumptions of our benchmark scenario, the share of post-secondary educated women could exceed 30% of the entire workforce across these four societies by 2050. This resonates with a recent study that shows the potential contribution of increasing women's labour force participation rates in rapidly ageing Taiwan (Cheng and Loichinger 2017). The gap between promoting more conservative versus more progressive labour policies in Taiwan is about two million workers by 2050, and this extra workforce consists mainly of well-educated women. Hence, the potential of integrating more women into the paid labour market lies not only in increasing the pure numbers of workers but also in making good use of a highly skilled labour pool. This aspect is often neglected in traditional labour force projections that do not consider educational attainment.

Although women will likely become a significant part of the workforce in these Asian societies, the actual availability of their labour will hinge on a continuation of changes in attitudes towards women in the paid labour market as well as perceptions of the role of women in the family. Ongoing efforts in each society to increase the economic activity of women by removing some of the barriers that women face when it comes to participation in the paid labour market have led to

some improvements, but the effects differ by society. For instance, due to the growth of "good" jobs in Japan, FLFP was positively affected by the combinations of the 1986 Equal Employment Opportunity Law and the 1992 Child Care Leave Law, particularly among highly-educated women (Raymo and Lim 2011). However, tax policy creates large incentive against female employment, and the design of the tax tends to favour the male-breadwinner-female-housekeeper type of labour division (Yoon 2015). For Korea, despite policy reforms on equal employment and an expansion on public childcare facilities (Hong 2008), female labour force participation remains the lowest among its OECD counterparts (OECD 2011). Hong Kong government has not been proactive in facilitating work-life balance for employees and childcare facilities are scarce and expensive (Kwok et al. 1997), which often lead to female workers suffering from cumbersome double burdens. In the face of labour shortage, studies have suggested that attracting skilled workers to boost the economy seems to be realistic strategies for Hong Kong right now (Shen and Dai 2006; Task Force on Population Policy 2003). Finally, women have been considered an important source of labour force for decades in Singapore. More progressive policies with stronger incentives to promote childbearing have been launched after 2000. These policies include income tax relief and tax rebates, childcare subsidies, maid levy subsidies, grandparent caregiver tax relief, and cash benefits (Sun 2012; Yoon 2015). Other non-monetary incentives have also been implemented to help balance work and family, such as flexible work schedule and childcare leave for civil servants, paid childcare leave, and paid maternity leave (Sun 2012).

Adopting progressive policies to incorporate more women into the labour force is necessary, as the differences in total labour supply between the constant (low) and benchmark (high) scenario range from 9% in Japan to 28% in Korea. The majority of these potential extra gains in workforce are skilled female labourers. Given that recent cohort fertility forecasts (Myrskylä, Goldstein, and Cheng 2013) up to the 1979 cohort in Korea and Singapore show no sign of fertility rebound and the reversal observed for Japan is considerably mild, a future rise in fertility is barely in sight in

any of these societies. This further underscores the importance of effectively incorporating working-age adults into the labour market, particularly when women have become much better-educated in these four advanced Asian economies.

The findings underscore three key points: (1) the importance of including the education dimension in considerations about future labour supply, (2) the effects of different labour force participation scenarios (especially of women) on the total size of the labour force in general, and (3) the significance of the educational composition of the future labour force. Our findings indicate that the shift in labour composition toward mostly post-secondary-educated will take place irrespective of participation scenarios. The education profile of the labour force is crucial, because better educated individuals differ in important aspects from those with lower educational attainment: For example, they have longer life expectancy (Crimmins and Saito 2001), lower morbidity and mortality rates (Adler et al. 1994; Feldman et al. 1989), they remain on average longer in the labour force (Leinonen, Martikainen, and Myrskylä 2015), and have higher innovative capacity and economic output (Gintis 1971), aspects which are closely related to the question of how the economic impact of population ageing could be mitigated.

The constant scenario represents the lower bound of future labour supply, and will be surpassed in each society, due to anticipated further increases in retirement ages and ongoing increases in female labour force participation. As revealed in the review of past and existing labour force participation trends, FLFP patterns in these four societies are intricately shaped by country-specific gender-role values, cultural-historical factors, and labour practices. To what degree the benchmark scenario represents the future of economic activity in either society depends mostly on the degree to which women remain and/or return to the labour force after getting married and/or childbearing. The situation is in many ways similar across the four economies, but at the same time, differences in family norms and work culture lead to significantly disparate participation patterns for women along the educational ladder at different stages of their life course.

The found differences in the education gradients of economic activity of women in the four societies add another layer of complexity to this. Still, our projection horizon of 2050 would allow enough time to implement policies that have been deemed important for greater female engagement in paid work elsewhere—i.e. provision of affordable and adequate childcare options, flexible work hours, childcare leave, tax relief, measures to reduce gender discrimination, etc.— and to allow those women who would like to work to do so, and to do so not only in low quality part-time positions. In the case of Japan, Raymo and Lim (2011) found that women with higher education (junior college and university) are less likely to leave the labour force but also less likely to re-enter compared to women with at most high school education hints at strong tensions between these two transitions. The reasons for the low propensity to return cannot be fully explained by Raymo and Lim (2011), but are likely rooted in non-desirable work environments they would return to, lower level jobs than they had before their labour force exit and persisting traditional family ideals. Several policies have already been implemented to address this effect, many of which with the goal to change the work culture, but particularly the income tax system still supports the male breadwinner model.

Kim's (2012) projections of labour supply in 12 emerging Asian economies do include Hong Kong, Singapore and South Korea. His results for the total size of the labour force, based on regression analysis and subsequent extrapolation between 2010 and 2030, project a decline for Hong Kong after 2020, which is in line with the result we obtain under the constant scenario. His results for South Korea also show a decline that starts around 2020, which we obtain for the constant scenario as well. Under the other two scenarios, the decline starts to set in slightly later. For Singapore, our results contrast the ones by Kim (2012): whereas he projects a decline after 2025, our estimates indicate a continuous increase in labour supply throughout 2050 even under the constant scenario. The differences are presumably due to differences in the population projection results between the UN World Population Prospects 2004 that he uses and the

Wittgenstein projections we use. The latter projects significantly larger increases in the Singaporean population due to immigration than the former.

The education composition of adult men and women in our four societies can be projected with quite some certainty, due to the inertia in educational changes. Even if no further educational expansion would take place among 15-34-year-old women (and men), the overall education composition of women (and men) of working-age would still shift towards higher education levels, simply due to cohort replacement. Since this development is already built into current population dynamics, it can be projected with quite some certainty. To exemplify this development with numbers for Korea and Singapore: in 2010, 34.4% of Korean women age 20-24 had completed post-secondary education, compared to 7.5% of women age 60-64. For Singapore, the respective numbers are 75.5% and 13.6%. Also, in spite of our focus on post-secondary education, it should not be forgotten that skills can be acquired outside of formal education systems and at various stages of people's working lives. For example, high school graduates (i.e. those with upper secondary education) who receive extensive job training have the potential of becoming skilled workers.

The aspect in these projections with the most uncertainty comes from assumptions about future developments of migration, which is naturally least predictable. All four societies have very strict immigration policies but very different approaches when it comes to the number of migrants they allowed into their societies in the past (Ducanes and Abella 2008). The share of the foreign-born population is relatively small in Japan and Korea, whereas the foreign-born population in Hong Kong and Singapore represents a significant proportion of the population as well as the labour force.

A couple of limitations should be noted. First of all, data about economic activity by education for Singapore is only provided for citizens, which means permanent residents and non-residents are not included. In 2010, more than one third of the total population in Singapore was either a

permanent resident or a non-resident, and the share of this population group has been increasing constantly since the 1970s (Department of Statistics Singapore 2015). Hence, the presented statistics for age-, sex- and education-specific participation rates are based on only two thirds of the Singaporean population. Since we have no information about economic activity of non-residents and permanent residents, we applied the estimated participation patterns to the whole Singaporean population in our projections.

Second, the educational composition of persons age 50 and above in Hong Kong, Singapore and Korea is quite different from those in Sweden, where a larger share has already been post-secondary educated. This means that workers in higher age-groups in these societies that have higher education (ISCED 456 in our study) are a more selected group of people compared to highly educated Swedes. So, the fact that women in Hong Kong and Singapore age 65 and above currently have higher participation rates than their counterparts in Sweden might be related to this difference in educational distribution, which could have a significant effect on their labour market attachment. Even it was possible to quantify this effect for the present, it would be impossible to estimate it for the future. We deliberately kept participation rates at the country-specific age-sex-education-specific maximum in the benchmark scenario, but this might be an overestimation in case a reduction in selection will mean lower rates in the future. At the same time, it is easy to argue that participation rates of elderly will remain high, since they are at least partly the result of country-specific labour market and social policy characteristics and that future policies will work towards keeping them at a high level or even increase them further.

Finally, our study focuses on potential future labour supply and we do not incorporate any explicit assumptions on potential future labour demand. Depending on how labour demand develops, a situation could arise where there is a shortage of workers due to a mismatch between supply and demand by education level, in spite of a large potential labour force with post-secondary education. One should keep this point in mind in the interpretation of our results. If

current developments are any indication, labour shortages of low-skilled (and low-wage) workers will continue to be met by labour migrants, while demand for higher skills will mostly be met by local workers. Trying to estimate long-term future labour demand would have gone beyond the scope and the purpose of the present study.

In summary, this study emphasizes that education is a crucial aspect to consider when doing labour supply projections in rapidly ageing East Asia. The tremendous educational expansion that started during the latter half of the 20th century has transformed the skill level of the four analysed societies, which bears important implications for future labour supply. The pressing problem of labour shrinkage could be partly offset by incorporating better-educated women to a larger extent even if no immediate rise in fertility is foreseeable. While deep-rooted culture and norms could hamper the progress toward higher female participation rates, social changes and effective policies likely offer partial solutions against falling into a low-growth trap commonly foreseen for ageing societies.

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Table 1 Educational composition of the labour force (in %) for Hong Kong, Japan, South Korea, and Singapore (source: Worldbank 2015).

		Japan		Singapore		Korea		Hong Kong	
		1990	2008	1991	2013	1991	2007	2002	2013
Men	Primary educ.	29.9	58.3	51.4	21.0	38.3	18.7	37.3	26.6
	Secondary educ.	43.5		41.9	30.3	43.4	43.3	41.2	46.0
	Tertiary educ.	24.9	41.7	6.7	48.7	18.3	38.1	20.5	26.9
Women	Primary educ.	33.2	59.1	38.2	18.2	57.4	29.0	27.4	22.1
	Secondary educ.	47.1		55.1	30.3	33.3	40.2	49.2	51.2
	Tertiary educ.	17.8	40.9	6.8	51.5	9.4	30.8	21.7	26.0

Table 2 Population by broad age-groups and highest level of educational attainment, 2010 and 2050, for Hong Kong, Japan, South Korea, and Singapore (source: Wittgenstein Centre for Demography and Global Human Capital (2015)).

	Hong Kong		Japan		Korea		Singapore	
absolute numbers (in 1000s)								
age-groups	2010	2050	2010	2050	2010	2050	2010	2050
0-14	812	940	16,903	11,067	7,918	4,694	885	894
15-64	5,343	4,739	80,926	53,716	34,896	24,539	3,743	4,690
65+	899	2,982	28,707	42,699	5,369	17,158	458	2,048
Total	7,053	8,662	126,536	107,482	48,184	46,390	5,086	7,632
Education composition of population 15+ (in %)								
	2010	2050	2010	2050	2010	2050	2010	2050
less than upper secondary	45%	16%	21%	6%	29%	7%	32%	7%
upper secondary	33%	37%	46%	33%	39%	31%	22%	16%
post-secondary	22%	48%	33%	61%	32%	63%	46%	77%

Note: Differences to 100% are due to rounding.

Table 3 Baseline participation rates for Hong Kong, Japan, South Korea, and Singapore (year 2010, except Japan 2015) by age, sex, and education (source: for Hong Kong, Japan, South Korea, and Singapore, see note of Figure 2; Sweden is based on the EU Labour Force Survey 2010, own calculation).

women	Hong Kong		Japan		Korea		Singapore		Sweden	
Age	At most secondary	Post-secondary	At most secondary	Post-secondary	At most secondary	Post-secondary	At most secondary	Post-secondary	At most secondary	Post-secondary
15--19	0.08	0.12	0.12	0.18	0.07	0.00	0.11	0.00	0.40	0.53
20--24	0.54	0.79	0.50	0.89	0.41	0.78	0.45	0.69	0.72	0.60
25--29	0.82	0.94	0.76	0.85	0.59	0.74	0.72	0.90	0.77	0.84
30--34	0.75	0.86	0.66	0.74	0.47	0.59	0.71	0.89	0.84	0.91
35--39	0.68	0.84	0.72	0.72	0.55	0.57	0.67	0.84	0.85	0.94
40--44	0.66	0.81	0.75	0.75	0.68	0.62	0.67	0.81	0.87	0.95
45--49	0.64	0.83	0.77	0.79	0.67	0.61	0.65	0.80	0.84	0.95
50--54	0.55	0.72	0.75	0.78	0.63	0.52	0.60	0.80	0.83	0.94
55--59	0.40	0.58	0.68	0.71	0.54	0.51	0.48	0.70	0.82	0.92
60--64	0.20	0.29	0.50	0.52	0.43	0.26	0.35	0.42	0.60	0.76
65--69	0.08	0.11	0.30	0.46	0.33	0.20	0.19	0.23	0.14	0.24
70--74	0.03	0.04	0.17	0.27	0.26	0.16	0.11	0.14	0.03	0.11
75--79	0.01	0.02	0.05	0.08	0.11	0.07	0.03	0.03	0.01	0.04

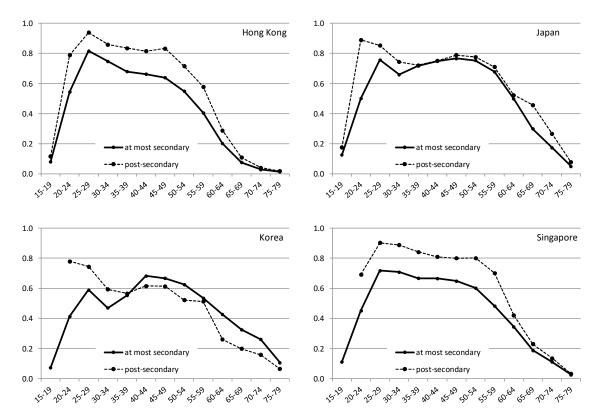| men	Hong Kong		Japan		Korea		Singapore	
Age	At most secondary	Post-secondary	At most secondary	Post-secondary	At most secondary	Post-secondary	At most secondary	Post-secondary
15--19	0.09	0.12	0.13	0.20	0.04	0.00	0.17	0.00
20--24	0.55	0.74	0.59	0.89	0.45	0.74	0.54	0.70
25--29	0.90	0.96	0.92	0.94	0.74	0.85	0.84	0.88
30--34	0.92	0.98	0.95	0.97	0.91	0.93	0.91	0.94
35--39	0.92	1.00	0.95	0.98	0.91	0.96	0.91	0.97
40--44	0.92	1.00	0.95	0.98	0.92	0.96	0.92	0.95
45--49	0.92	0.99	0.94	0.98	0.91	0.96	0.92	0.94
50--54	0.88	0.95	0.93	0.97	0.89	0.93	0.89	0.91
55--59	0.76	0.84	0.91	0.98	0.83	0.86	0.82	0.79
60--64	0.49	0.54	0.76	0.82	0.71	0.64	0.65	0.63
65--69	0.23	0.26	0.51	0.64	0.56	0.50	0.44	0.43
70--74	0.11	0.12	0.31	0.39	0.44	0.39	0.27	0.27
75--79	0.05	0.05	0.12	0.15	0.24	0.21	0.10	0.10

Table 4 Total sizes and changes in size of the labour force for Hong Kong, Japan, South Korea, and Singapore, by sex and education in 2010 and 2050 (benchmark scenario) (source: own calculations)

	Japan			Hong Kong		
	absolute numbers in 1000s (shares in %)		% changes in labour size	absolute numbers in 1000s (shares in %)		% changes in labour size
	2010	2050		2010	2050	
TOTAL	**66,365**	**51,509**	**-22.4**	**3,671**	**4,306**	**17.3**
At most sec.	37,214 (56.1)	13,678 (26.6)	-63.2	2,536 (69.1)	1,636 (38.0)	-35.5
Post-secondary	29,151 (43.9)	37,831 (73.4)	29.8	1,135 (30.9)	2,670 (62.0)	135.2
MALES	**37,611**	**27,123**	**-27.9**	**1,962**	**2,151**	**9.6**
At most sec.	21,176 (56.3)	7,705 (28.4)	-63.6	1,360 (69.3)	833 (38.7)	-38.8
Post-secondary	16,435 (43.7)	19,418 (71.6)	18.2	602 (30.7)	1,318 (61.3)	118.9
FEMALES	**28,753**	**24,386**	**-15.2**	**1,709**	**2,153**	**26.0**
At most sec.	16,038 (55.8)	5,973 (24.5)	-62.8	1,176 (68.8)	802 (37.3)	-31.8
Post-secondary	12,715 (44.2)	18,413 (75.5)	44.8	533 (31.2)	1,351 (62.7)	153.5

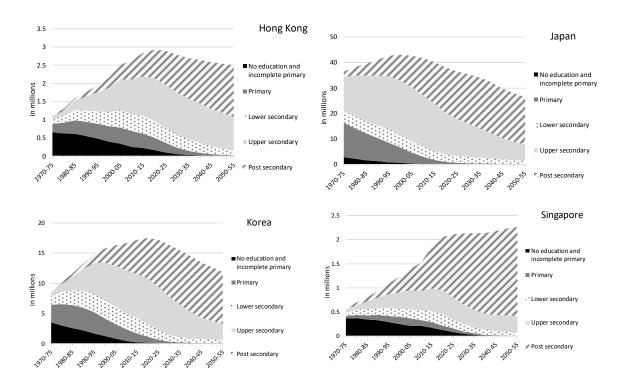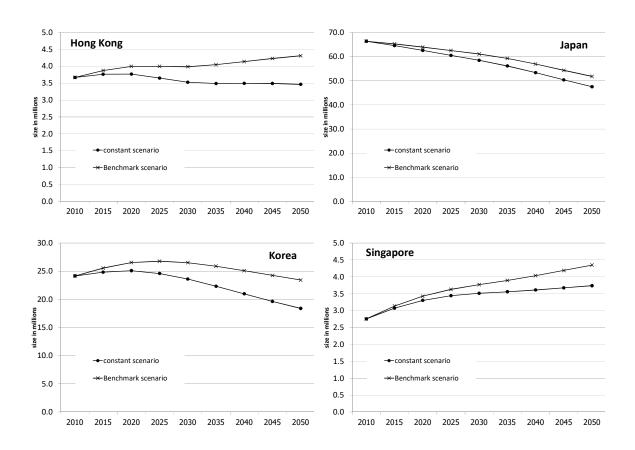|	Korea			Singapore		
	absolute numbers in 1000s (shares in %)		% changes in labour size	absolute numbers in 1000s (shares in %)		% changes in labour size
	2010	2050		2010	2050	
TOTAL	**24,152**	**23,264**	**-3.7**	**2,755**	**4,349**	**57.9**
At most sec.	14,408 (59.7)	5,487 (23.6)	-61.9	1,172 (42.5)	581 (13.4)	-50.4
Post-secondary	9,744 (40.3)	17,777 (76.4)	82.4	1,583 (57.5)	3,768 (86.6)	138.0
MALES	**14,225**	**12,630**	**-11.2**	**1,551**	**2,357**	**52.0**
At most sec.	8,080 (56.8)	2,964 (23.5)	-63.3	659 (42.5)	301 (12.8)	-54.3
Post-secondary	6,145 (43.2)	9,666 (76.5)	57.3	892 (57.5)	2,056 (87.2)	130.5
FEMALES	**9,927**	**10,634**	**7.1**	**1,204**	**1,992**	**65.4**
At most sec.	6,328 (63.7)	2,523 (23.7)	-60.1	513 (42.6)	280 (14.1)	-45.4
Post-secondary	3,599 (36.3)	8,111 (76.3)	125.4	691 (57.4)	1,712 (85.9)	147.8

Fig. 1 Male (left) and female (right) labour force participation rates by age for Hong Kong, Japan, South Korea, and Singapore in 2010 (source: ILO 2016).
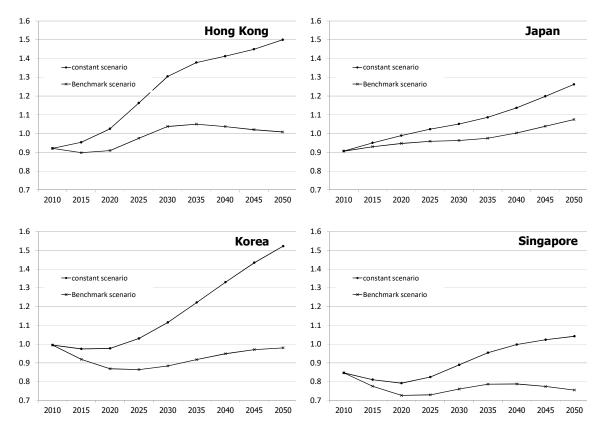
Fig. 2 Female labour force participation rates by age-group and highest level of educational attainment, for Hong Kong (2011), Japan (2015), South Korea (2010), and Singapore (2010). (source: Hong Kong: own estimates based on Census and Statistics Department (2015, 2013b, 2013a). Japan: own estimates based on National Statistics Centre (2016b, 2016a). South Korea: own estimates based on OECD (2016b) and data from personal correspondence with the OECD Statistical Office. Singapore: own estimates based on Manpower Research and Statistics Department and Singapore Department of Statistics (2011) and Ministry of Manpower and Singapore Department of Statistics (2016))
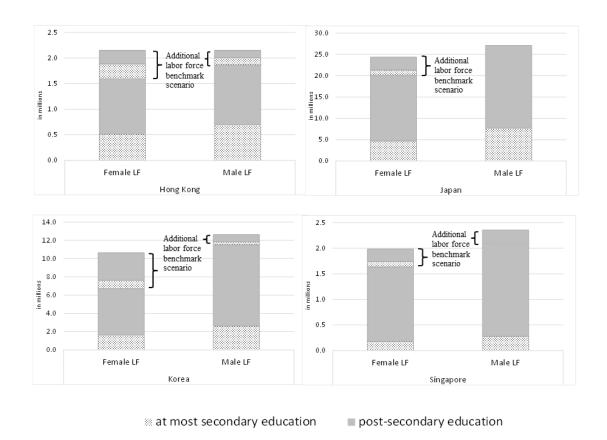
Fig. 3 Female population composition ages 15 to 64 by highest level of educational attainment for Hong Kong, Japan, South Korea, and Singapore between 1970 and 2050. Base year for the projections is 2010 (source: Wittgenstein Centre for Demography and Global Human Capital (2015))

Fig. 4 Total sizes of labour force (age 15+) for Hong Kong, Japan, South Korea, and Singapore by participation scenario from 2010 to 2050 (source: own calculations).

Fig. 5 Labour force dependency ratios for Hong Kong, Japan, South Korea, and Singapore, from 2010 to 2050. (Labour force dependency ratio = (population not in the labour force)/(population in the labour force)) (source: own calculations).

Fig. 6 Composition of the labour force (15+) for Hong Kong, Japan, South Korea, and Singapore by sex, educational attainment and participation scenario in 2050 (source: own calculations).