zero) shows the countries which have population growth or decline, depending on their position on the plan. Further, taking into account also the relative intensity of the components of population change, the countries can be classified by typology as in the Table 1.

Table 1: typology of population change

Change	*Category*	*Description*	*Conditions*
Population growth	1	Growth due **only** to natural change	N>0, M<0, (N)>(M)
	2	Growth due **more** to natural change	N>0, M>0, (N)>(M)
	3	Growth due **more** to net migration	N>0, M>0, (N)<(M)
	4	Growth due **only** to net migration	N<0, M>0, (N)<(M)
Population decline	5	Decline due **only** to natural change	N<0, M>0, (N)>(M)
	6	Decline due **more** to natural change	N<0, M<0, (N)>(M)
	7	Decline due **more** to net migration	N<0, M<0, (N)<(M)
	8	Decline due **only** to net migration	N>0, M<0, (N)<(M)

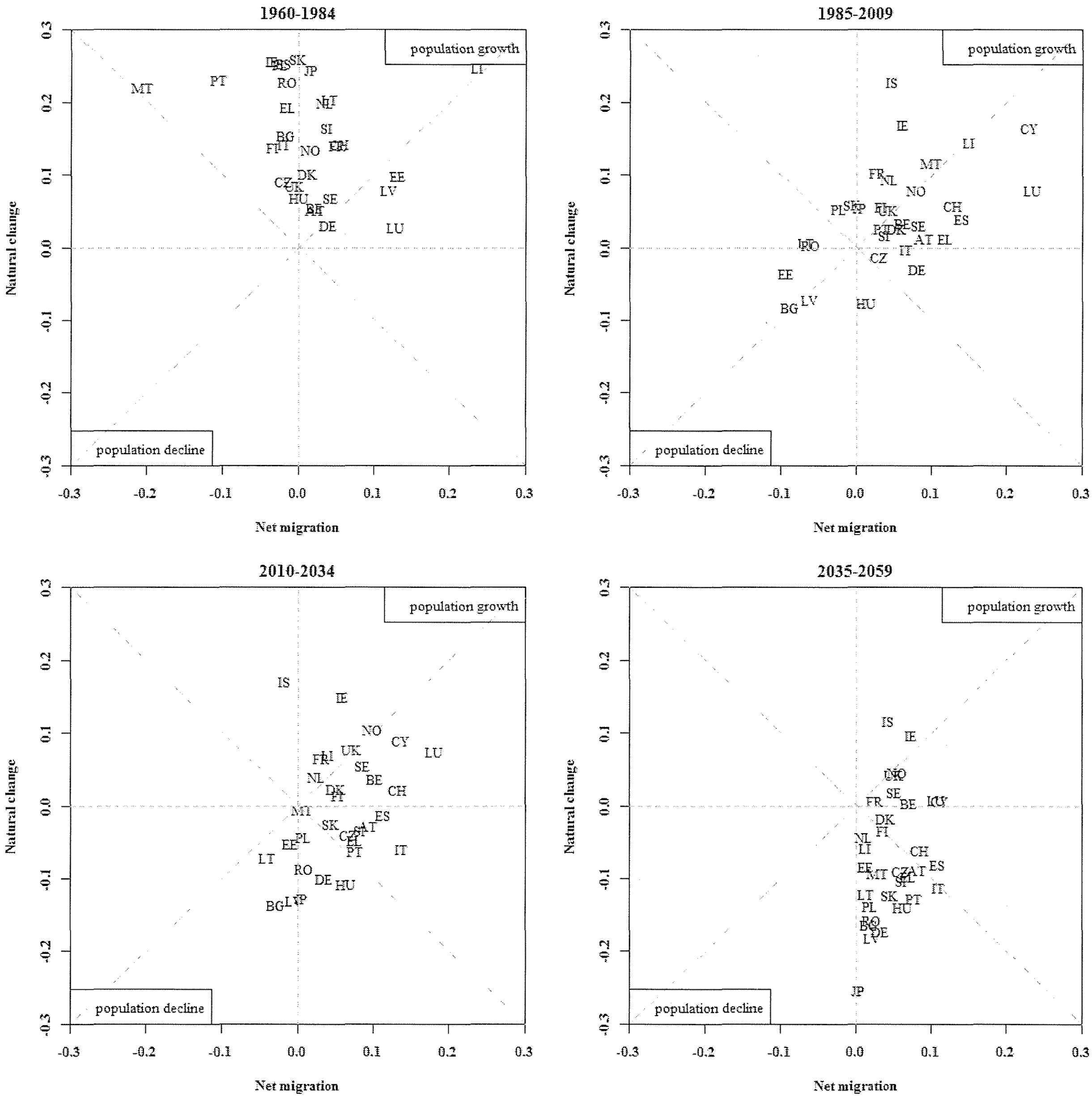
Note: N means natural change, M net migration and () the absolute value.

The Figure 6 shows the population changes in Japan and in the European countries over 100 years, split in four periods of 25 years each. The eight categories of population change as described in the Table 1 are identified in each panel by the portion of plan between the bisecting line and one of the axes, and sorted from the top-left part reading clockwise. The position of the countries on the plans is given by the annualized natural change and net migration crude rates in the period of reference.

In the first period, going from 1960 to 1984, the population growth is essentially sustained by the natural change. In Europe there are 15 countries whose population growth is ensured only by the natural change, plus other 11 where net migration also contribute, but to a less extent than the natural change. Just few European countries have a population growth sustained more by net migration and only one has a decline due only to net migration[3]. Japan also reports a relatively high natural change, accompanied by little net migration, being then quite similar, as for the population change, to Slovakia among the European countries.

[3] For this latter country (Cyprus, out of the range in the top-left panel of the Figure 6), it must be mentioned that the period includes the year (1974) in which the national authorities lost control of part of the territory. From 1974 onwards the population figures refer therefore only to the government-controlled area, and the drop of population size may enter artificially in the net migration figures as this is calculated as residual component from the demographic balance.

Figure 6: actual and projected population change in Japan and in the European countries by 25-year period



Note: CY and IS out of range in the top-left panel, respectively in the slices corresponding to category 8 and 1 of the Table 1.

In the following 25 years (1985-2009), migration enters into play in Europe. The bulk of countries move right- and downwards on the population change plan: only 2 European countries (Poland and Slovakia) have now a population growth sustained only by the natural change, while for 8 of them net migration is positive as well although less important than the natural change, and for 12 European countries it is actually the most important component of population growth. For a few European countries (the Czech Republic, Germany and Italy), net migration is the only driver of population growth, compensating the natural decline, while in Hungary the positive net migration is not sufficient to ensure population growth. Again, Slovakia is the European country closest to Japan, which has moved downwards along the vertical axis due to the reduction of its natural growth.

In the first part of the projections period (2010-2034), natural growth is slowing further down and migration remains the most important component of population change, although on reduced scale. The European countries, besides having moved slightly downward on the plan, are indeed less disperse and closer to the origin, and none presents anymore rates higher than 20 per thousand population. Only in Iceland the population growth is only due to natural change, 13 countries are still growing thanks to both components but now the number of those whose growth is only due to net migration increase to 8. The rest of European countries (9) are now on population decline, the Baltic countries and Bulgaria for both components, in the others despite of the positive net migration. Japan continues moving downward along the vertical axis, entering the area of population decline, and it gets close to Latvia.

In the last part of the projections period (2035-2060), positive net migration is not anymore sufficient to sustain the population growth, face to the scale of the natural decline. The European countries are projected to move downward on the plan, and most of them (18) are grouped into the area characterized by a natural decline stronger than the positive net migration. In 11 countries net migration is still the main engine of population growth, while Iceland and Ireland are the only two countries where the population growth is still due more to natural change. Japan continues its vertical fall and, although Latvia is still the closest European country, the distance between them has increased.

Further insights on the past natural change

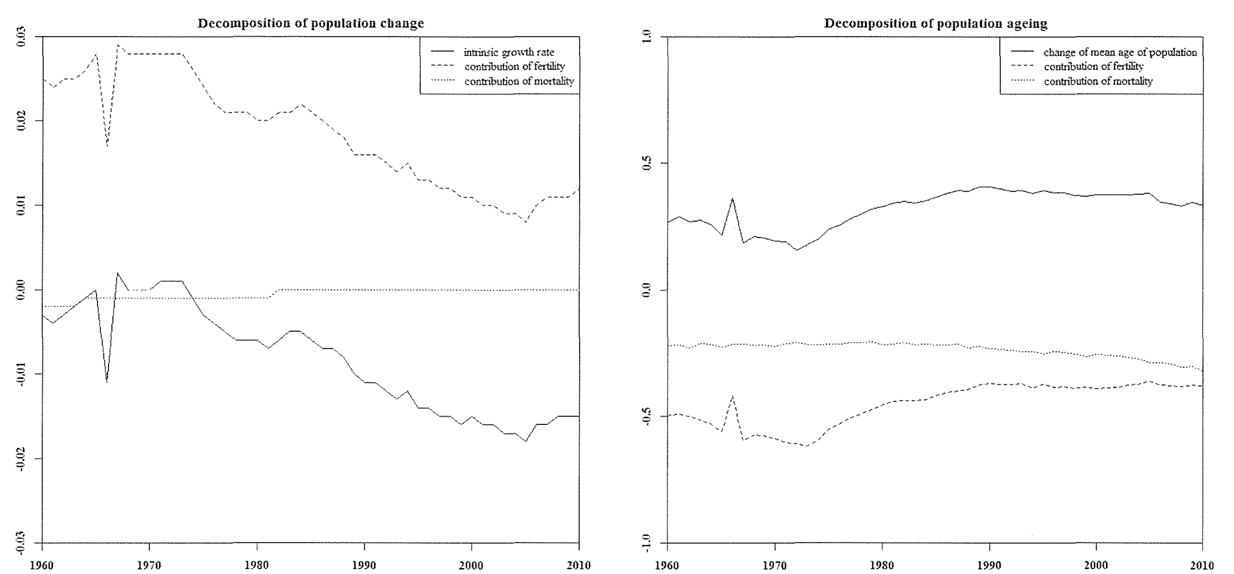
If natural change is the main factor behind the population change (growth/decline) of Japan, it may be interesting to look at which component between fertility and mortality has played the most important part. The first, most intuitive comparison would be between the respective crude rates. Looking again at the Figure 4 (the two panels have the same scale), it can there be noted how mortality start playing a more important role from the 1990s, while fertility has been declining all time long since the 1970s. The two cross each other during the past decade. However, those crude rates are influenced by the underlying age structure, which has been changing over time. From the theory of stable populations, it is known that if fertility and mortality rates are kept constant, any population would converge to an age structure independent from the original one and defined only by that fertility and mortality schedules, a property called (strong) ergodicity. The growth rate of this ultimate stable-equivalent population is called *intrinsic* growth rate. Preston and Guillot (1997) provides a simple formula to decompose the intrinsic growth rate r into fertility and mortality contributions:

$$r = \frac{\ln(TFR) + \ln(S) + \ln[p(A_M)]}{T} \qquad [1]$$

where S is the proportion of female births assumed constant across ages of the mothers, $p(A_M)$ is the probability of surviving from birth to the mean age at childbearing and T is the mean length of generation.

Assimilating Japan to a closed population, i.e. a population without in- or out-migration, the $\ln(TFR)$ and $\ln[p(A_M)]$ have been estimated for the period 1960-2010 and are shown in the left panel of the Figure 7, together with the approximated estimate of the intrinsic growth rate corresponding to the fertility and mortality schedules of each year. Fertility gives higher contribution to the *level* of the growth rate in the stable-equivalent populations, although its importance is decreasing over time; mortality instead has almost a null influence, at least from 1980 onwards. Due to the (constant) negative effect of the proportion of female births (not shown), the intrinsic growth rate decreases over time down to about -1.5 % in the past decade. Thus, if current fertility and mortality conditions were to stay for a long period, the ultimate stable-equivalent population of Japan would shrink to a rate such to half that population within half a century.

Figure 7: theoretical contribution of fertility and mortality to population change and ageing



Note: for sake of readability of the graph and given the minor importance for the current analysis, ln(S) from ***[1]*** *is not shown in the left panel.*

Taking two points in time and assuming that the proportions of female births as well as the mean length of generation do not change during that period, the contribution to the *change* of the intrinsic growth rate can be expressed as:

$$\Delta r = \frac{1}{T} \cdot \left[\ln\left(\frac{TFR^2}{TFR^1} \right) + \ln\left(\frac{p(A_M^2)}{p(A_M^1)} \right) \right] \qquad [2]$$

where the indexes 1 and 2 refer to the two successive points in time, respectively before and after the changes. By using [2], it can be estimated that the decline of the TFR from 1960 to 2009 has reduced the intrinsic growth rate by 0.014, while the improvements in mortality have increased it by 0.003, other conditions being equal. In summary, fertility has been playing the major role as for what concerns the influence on both levels and changes of long-term prospects of population growth/decline, i.e. once removed the effect of the contemporary age structure.

As for Europe as a whole, whose starting level is higher than in Japan in 1960, the relation above prove that the decline in the intrinsic growth rate, i.e. the annual growth rate that would prevail if fertility and mortality levels remained constant, depends on the proportional reduction of the TFR, and not from the absolute one. As the estimated change in the intrinsic growth rate for Europe as a whole due to the decline in fertility is about -0.017 (other conditions being equal), the fertility reduction occurred in the past 50 years would have had in Europe a largest (negative) impact on the intrinsic growth rate than in Japan.

Populations momentum

As discussed above, the decline of fertility combined with the age structure of the population has had large influence on the actual population trends in Japan, due to the shrinking of the number of women in reproductive ages. Intuitively, in order to oppose these ongoing population decline and ageing, one would then think to increase the size of these cohorts of women. This situation recalls the concept of *population momentum*, originally proposed by Keyfitz (1971), who defines it as the ratio of the size of an ultimate stationary population[4] to that of an initial stable population when fertility is immediately shifted to replacement level. In its original formulation, Keyfitz was referring to the case of (stable) population growth rather than decline, but the concept has been further elaborated and is now widespread, being applicable also for declining population.

Bongaarts and Bulatao (1999) report a simplified analytical expression to compute the population momentum, based on the ratio of the proportion of females under age 30 in the original population to the same proportion in the ultimate population which emerges in the long run with fertility at replacement, mortality fixed, and zero migration. By adopting their method, the population momentum have been computed for Japan as well as for all European countries, and reported in the Table 2.

Table 2: momentum multiplier in 2010 in Japan and in the European countries, sorted by ascending order

JP	0.815	LV	0.893	FI	0.952	LU	0.991
IT	0.823	PT	0.894	DK	0.961	MT	0.993
BG	0.824	ES	0.902	BE	0.962	UK	1.018
DE	0.835	RO	0.917	LI	0.967	FR	1.030
EL	0.851	AT	0.918	SK	0.972	NO	1.040
HU	0.860	LT	0.928	PL	0.979	CY	1.117
SI	0.865	EE	0.930	NL	0.980	IE	1.163
CZ	0.880	CH	0.933	SE	0.985	IS	1.190

It can there be noted that Japan has the lower momentum than any European country, implying that its population would have proportionally the biggest decrease due to its age

[4] A stationary population is a population whose growth rate is zero and resulting from births, age-specific death rates and age-specific net migration rates all constant over time. It is usually considered the case of net migration rates equal to zero at any age. The stationary population is a special case of the stable population (concept used in the previous paragraph).

structure before reaching the stationary state. On the contrary, in a bunch of European countries (the United Kingdom, France, Norway, Cyprus, Ireland and Iceland) the momentum is still positive and hence the population would continue to growth in case fertility is immediately set at replacement level and mortality would not improve anymore. Although the age structure of a population is essentially the outcome of past vital rates, the comparisons in Figure 2 and Figure 3 show that the declining path of Japanese fertility from above-replacement levels has not been that different from the European one, and in the previous paragraph it has been estimated that its impact on the intrinsic growth rate is less than for Europe. What made the difference is then probably the different contribution of migration to the population change in the most recent decades, which in Europe has modified the results of the action of the vital rates, especially in the childbearing ages.

Contribution of fertility and mortality to population ageing

The population momentum is closely linked to the population ageing, as proved by Kim and Schoen (1997) using three different measures of ageing. Both are in fact related to the changes in the vital rates, one looking at the consequences on population size, the other on its age structure. The analysis of the population momentum has already informed about the relevance of the current age structure (which is on its turn the outcome of past vital rates) on the ultimate population size. Once excluding migration, thus assuming Japan to be a closed population, the assessment of the relative importance of fertility and mortality for the population ageing can be done using a relation proposed by Preston *et al.* (1989). Starting from the consideration that ageing is a natural process which, in a theoretical closed population with no vital events, would take place at regular speed (one year more of the population mean age for each calendar year), Preston *et al.* (1989) prove that in a closed population it is the combined action of birth and death rates which opposes this process, as in the following equation:

$$dA_P/dt = 1 - d \cdot (A_D - A_P) - b \cdot A_P \qquad [3]$$

where dA_P/dt is the derivative of the mean age of population A_P with respect to time, A_D is the mean age at death, and b and d are respectively the crude birth and death rates. Therefore, the higher the (positive) difference between the mean age at death and the mean age of the population (multiplied by the death rate), the stronger the contribution of mortality to the opposition to the ageing process; more intuitively for fertility, the higher the birth rate (multiplied by the mean age of the population), the stronger the opposition as well.

Those quantities have been estimated for the period 1960-2010 for Japan and shown in the right panel of the Figure 7. The solid line is the annual change of the mean age of population. In absence of vital events, that change would be equal to one. That line is never equal to one in the Figure 7, but it is always in the upper positive half, meaning that the population in Japan has anyway aged over time. The two lines in the lower negative half are the contributions of fertility and mortality to the opposition to the ageing. Fertility is always more negative than mortality, meaning that the contribution of the former is more important of that of the latter, but none, either singularly or combined, reach levels such to stop (or even reverse) the population ageing. Looking at the relative contributions, the ageing has been "allowed" (i.e., less opposed) more by mortality than by fertility, and therefore, using an expression popular among demographers, the ageing in Japan has taken place more "from the top" of the (age) pyramid rather than from the "bottom". This outcome is against a probably common belief that fertility has been the main cause so far of the population ageing in Japan.

Projections assumptions and future population size

As shown above, the projected population developments for Japan can be resumed in a continuation of the natural decline not counterbalanced by positive net migration. It has also been stressed that this occurs regardless of assumptions about stability in fertility or improvements in mortality, essentially due to the current age structure of the Japanese population. However, what is the relative importance of these elements for the projected trends? To look at this matter, the method presented by Bongaarts and Bulatao (1999) for macro-regions of the world is here applied to Japan[5].

The approach consists of computing four sets of projections, each nested in the previous one, fixing progressively each component: in the *standard* projections all demographic components (fertility, mortality and migration) are taken into account and correspond to the official projections assumptions. Setting migration to zero and using the only fertility and mortality assumptions provides the *natural* variant. Next, fertility is set at the replacement level since the base year: the projections obtained from this level of fertility, improving mortality and no migration is called *replacement* variant. Finally, mortality is frozen at the last observed age and sex pattern, which gives the *momentum* variant of the projections. The characteristics of the various variants are summarized in the Table 3.

Table 3: characteristics of the projections variants

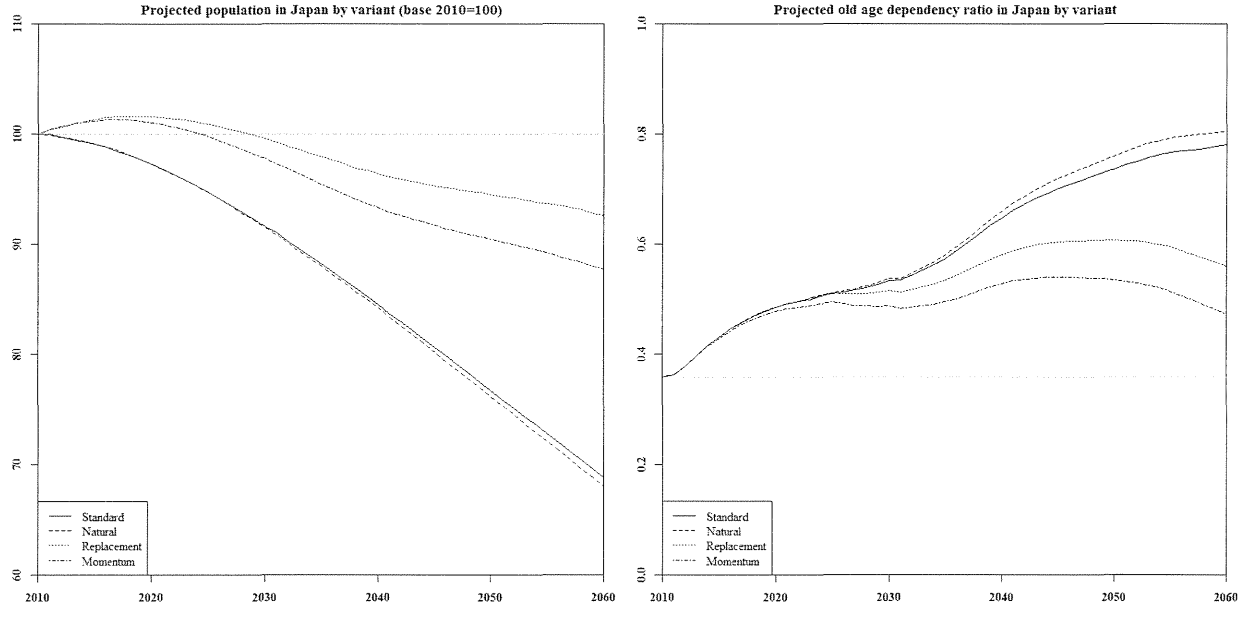
Variant	Fertility	Mortality	Migration
Standard	Changing	Improving	Yes
Natural	Changing	Improving	None (fixed at zero)
Replacement	Fixed at replacement level	Improving	None (fixed at zero)
Momentum	Fixed at replacement level	Fixed at last observed	None (fixed at zero)

By computing the ratios of the population size obtained with the various variants it is possible to estimate the effect (so-called multiplier) of each component. However, before the population gets to a stationary state in the momentum variant, it will pass through a transition period. Elegant analytical expressions have been developed in mathematical demography to estimate the population momentum including also the case of gradual fertility transitions to replacement level (e.g., Li and Tuljapurkar 1999, Goldstein 2002), but the use of comparative projections variants allows incorporating complex fertility assumptions and to provide additional information during the transition. The left panel of the Figure 8 shows the impact of the various components on the population size of Japan over a 50-year period. The solid line shows the population decline which would take place if every single assumption holds over that period, identifiable by the distance from the horizontal dotted gray line set at the level in 2010 (i.e., set to 100). As migration plays very little role in those projections, setting

[5] See Lanzieri (2010a) for an application to selected European countries.

it to zero does not change remarkably the outcome, as shown by the dashed line in the same graph representing the natural variant. Adding migration to the natural variant gives indeed a modest increase of 1 % of the population size by 2060. The significant difference comes with the fertility component: the distance between the natural and the replacement (the dotted line) projections gives a measure of the impact of the prospected below-replacement trends in fertility, which is estimated in about 27 % by the end of the period.

Figure 8: population size (left panel, 2010=100) and OADR (right panel) of Japan by projections variant



However, even if fertility were immediately to jump to the replacement level (a sudden *baby boom*), the population decline would not be avoided and would be about -7 % of the initial population size by 2060. About four decades of past below-replacement fertility have shaped the current age structure of Japan in a way that the population decline would start again within a couple of decades even with fertility at replacement level, a value which was in fact observed in Japan back at the end of the Sixties.

Removing the impact of mortality improvements from the replacement projections adds little to this picture. The dot-dashed line representing the momentum projections shows that fixing mortality at current conditions would reduce the population size of a further 5 % by 2060. As above highlighted, these are not yet the estimates of the multipliers, because by 2060 the population has not yet completed its transition to stationarity, but they give anyway a measure of the importance of the assumptions formulated for each component.

Therefore, with fertility at replacement level, current mortality pattern and no migration, the population size at the end of the period would be about 12 % less than the current one, reflecting the (negative) impact of the current age structure in Japan. Under those conditions, the generations of women in reproductive ages would continue to shrink down to about 20 % less than the initial size. Likewise, the number of births would continue to decrease for a while for then start to oscillate with reducing amplitude around the stationary level, and by 2060 the number of birth would be about 24 % less than the current level.

Projections assumptions and future population ageing

As the OADR is an important indicator of the impact of ageing on the economic system of a country (cf. Bongaarts 2004), it is interesting to see its values corresponding to the various variants during the transition to stationarity, as shown in the right panel of the Figure 8. Under the standard set of assumptions, by 2060 the OADR would reach a level of about 0.78. Given its already moderate levels, migration alleviates only little the weight of the elderly on the population in working age, and closing to migration implies an increase of less than 0.03 of the OADR. On the contrary, fertility on replacement level would reduce it to 0.56, a remarkable change downward, although after having exceeded the threshold of 0.60 for some years. If also mortality would not improve anymore, the OADR would end at a level just about 0.11 more than the current one, although passing through a period with higher values. However, in no variant the ageing would stop its increase by 2060, although its extent is obviously dependent on the assumptions.

Ageing: a "new" demographic transition?

The decline of fertility to below-replacement levels is then a major factor to explain the past and projected trends of the population size. However, long-lasting constant below-replacement fertility (and mortality) rates do not imply ageing, because after a while the proportionate age structure becomes stable. It is instead the *change* in the birth rates, either its acceleration or deceleration, which influences the age structure and therefore the population ageing. Therefore, from the point of view of formal demography, the so-called First Demographic Transition, defined by the change of birth and death rates from higher to lower levels, has temporarily consequences on population growth and ageing, but not necessarily "forever", because the lower levels on which those rates stabilize may be (still) such to counterbalance the natural ageing of the population (and of course the population could also be stationary, but this is of less interest here).

This seems not be the case for the countries under consideration. Over the past 50 years, Japan and the European countries have moved from higher to lower fertility, and those rates (together with mortality and migration) have not been (anymore) intense enough to counteract the population ageing. This latter process is expected to continue for a few decades more, to then perhaps stabilize afterwards on (much) higher levels, following a path which could be modeled by a logistic curve (Lanzieri 2011a). Such stabilization of the ageing is of course depending very much on the assumptions formulated for the very long term, and should then be taken with high caution. In particular, it is likely that the major force opposing the ageing in the future will be mortality.

In presenting his idea about a Third Demographic Transition triggered by immigration in low-fertility countries, Coleman (2006 p.419) lists the criteria that a population change should meet to be labeled as "transition": rapidity (in historical terms), unprecedented, irreversible and of high social, cultural and political relevance. It is quite straightforward to see there the characteristics of the process of ageing ongoing in Japan and Europe, at least the most of them. While the intention here is not to analyze the validity of the classification of the population ageing as "demographic transition", such a label could actually help to keep high the attention on the important challenges this process entails for the future societies. Looking at ageing as a transition – thus a permanent shift to a stable higher level and not a temporary one – would further stress the importance to be prepared for this new socio-economic framework. Demographic levers are not the only options; on the contrary, several policies could and should be thought to ensure a smooth transition and to be prepared to the new demographic regime. However, even confining ourselves to a “no-change” policy scenario, it may be useful to explore all possible demographic options. While fertility has definitely an important role on both population decline and ageing in Japan, even a sudden rise would not stop these ongoing processes. Further, according to the official projections, there are currently no signs of fertility recovery in Japan. This highlights the importance of looking at migration as a potential lever to counterbalance, or at least attenuate, the Japanese demographic trends.

And if…? - Thinking of different future scenarios

It has been shown above that, regardless of the assumptions on the vital rates, the population of Japan is expected to both decline and age due to its negative population momentum. However, the extent of these processes does depend on the future course of fertility, mortality and, last but not least, migration. Sensitivity variants are useful tools to assess the impact of changes in the assumptions on the population dynamics, but this is left to the official forecasters. The approach taken here is instead of thinking of different scenarios for the assumptions setting.

On fertility and mortality, the easiest way to compare structural differences of Japan with the European countries is to assume that the former behaves demographically like the latter ones, and to incorporate Japan in the European convergence framework. The main assumption on which EU projections are based is that socio-economic differences between countries are fading in the very long term. This may raise some skepticism about the incorporation of Japan in the (converging) mainstream, considering the cultural differences. However, whether in the future the socio-economic drivers of fertility and mortality would be the most important explaining factors, the convergence scenario may be an alternative way of thinking about future Japanese dynamics, also in consideration that the demographic convergence is never fully achieved (not even between European countries) and that this framework is used to control for the range of variation of fertility and mortality across countries, which may sound plausible. As a matter of fact, demographic convergence has occurred in the past decades (Wilson 2001), and although timing and pace for fertility may be debatable (Dorius 2008, Lanzieri 2010b), on mortality such convergence may concern also forerunner countries as Japan (Wilmoth 1998).

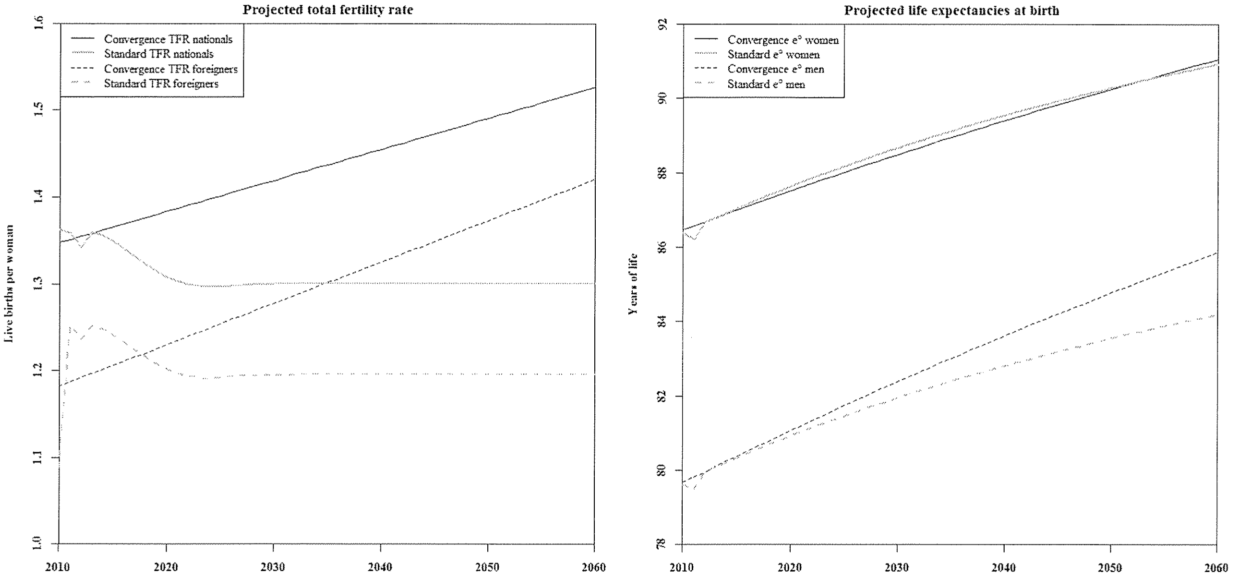
As the European experience shows, migration is typically a very volatile component, the most influenced by policies and economic cycles. It is probably the easiest lever on which policy-makers can rely for population policies of immediate impact, although in a global context the “migration market” is becoming progressively competitive, at least as for the skilled labor force. Not necessarily immigration is a controlled phenomenon, but considering the geographical characteristics of Japan, this is more likely to be the case than in Europe. Two theoretical cases are here considered: in the first, it is assumed that policy-makers opt for an action on immigration limited in time, like an injection of demographic rejuvenation to boost the population growth and avoid excessive decline and ageing in the future; in the second, future migration inflows are linked to the shrinking of the population in working age. As for historical comparisons, the former may be roughly thought as the Great Migration from Europe to USA at the beginning of last century, stopped by the Immigration Act of 1924, the latter as the labor migration occurring in Western Europe in the Sixties until the economic crisis of 1973 (cf. Fassmann and Münz 1992).

Therefore, three theoretical alternatives to the official scenario (here named "Standard") are hereinafter presented. The first, named "Convergence" scenario, only modifies the fertility and mortality assumptions. The latter two focus instead on the migration assumptions, as the real policy-makers' lever for driving the future population change in Japan, and migrants are assumed to settle permanently in the country. Although a policy aiming to attract temporary workers is more likely in Japan, the full demographic effect of migration cannot take place if those leave the country after a while. As Tsuda (1999) shows well for the case of the *nikkeijin*, the Brazilians of Japanese origin, not always the permanent settlement comes from a decision taken once forever at the beginning of the immigration, but it may well be the final outcome of a prolonged temporary stay.

Japan converging with the European countries

In order to isolate the impact of fertility and mortality assumptions, the migration assumptions are left unchanged, thus as from the official projections for Japan. The assumptions for fertility in the convergence scenario would point to a recovery of the TFR for both nationals and foreigners, as shown in the left panel of the Figure 9, and to decreasing differences in fertility behavior between these two population groups. As for mortality, there would not be much difference for the assumptions on female life expectancy at birth, but in the convergence scenario male mortality would be assumed to catch up with the improvements in female mortality, which gives an increasing difference for the male life expectancy at birth between the two scenarios.

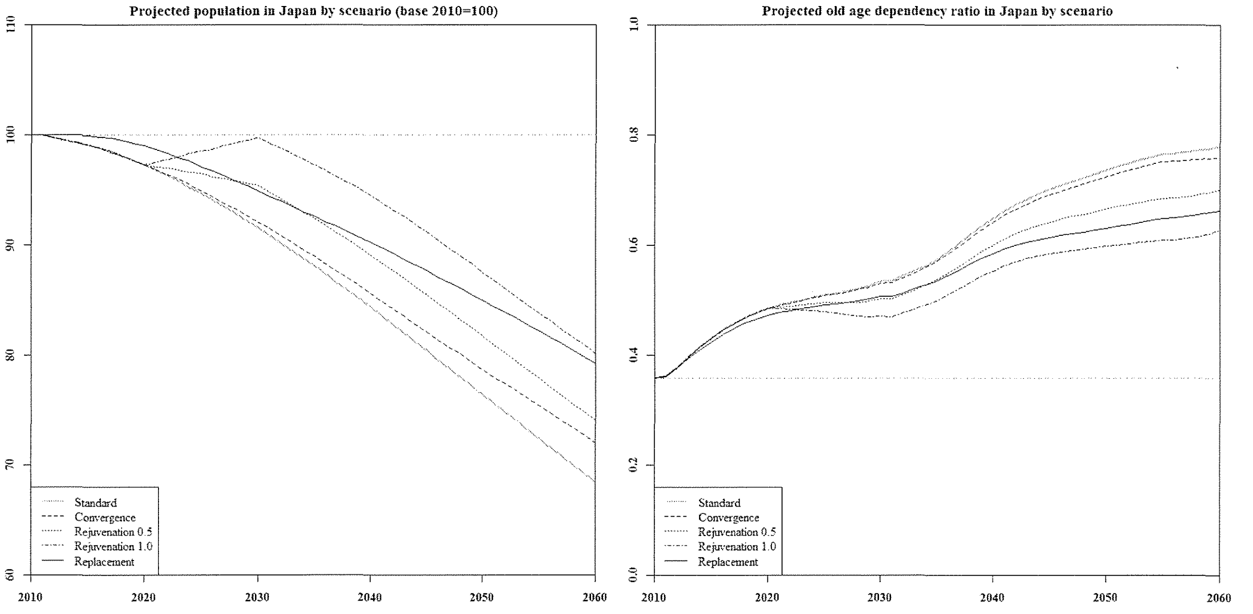
Figure 9: fertility and mortality assumptions for Japan in the Standard and in the Convergence scenarios



The left panel of the Figure 10 shows the projected populations according to the various scenarios in base 2010 up to 2060. As expected, the higher fertility as well as male mortality assumptions of the Convergence scenario (in dashed line) reduces the projected population decline to 18 % of the original size, a difference of about 4 p.p. from the official projections (in solid gray line).

As for the ageing, showed in the right panel of the Figure 10, the benefit of the more "generous" assumptions of the Convergence scenario is little visible and can be quantified in a reduction of the OADR of about 0.02 by 2060, which would still place Japan 0.08 points above the European country with the highest projected OADR (Latvia by that time). This should not come as a surprise, as it has been explained above that the current age structure of Japan would not stop the population ageing even for a much more significant recovery of fertility than that assumed in the Convergence scenario, and moreover there is an higher male life expectancy which may partially offset the downsizing effect of fertility on the OADR. From this point of view, fertility assumptions for Japan are "robust" as for what concerns the impact on population decline and ageing for the next five decades, in the sense that variations – to an extent foreseeable as of today - from the current official set of assumptions would not radically modify the main messages.

Figure 10: projected population size and OADR in Japan by scenario



A short-term rejuvenation input

The case of a temporary opening to immigration to offset the negative population trends in Japan, here named "Rejuvenation" scenario, is here presented in two variants to highlight the relevance of the inflow size. In both variants, this exceptional migration inflow is assumed to take place in the period 2020-2029, when the effects of ageing may start to be more acute (see Figure 5) and in consideration of the time necessary to implement such a policy.

Assuming a net inflow of half million foreigners each year per 10 years, equally split by sex, corresponds to a crude rate of about 4 person each 1000 inhabitant (not taking into account the migration of the Japanese nationals), a proportion below that projected for several European countries in the same period[6]. A more extreme hypothesis would be to consider a net inflow of 1 million foreigners each year over the same period, which would instead be a bit above the rates assumed for European countries[7]. For all years before and after the "opening" period, net migration of foreigners is set to the same level of the Standard scenario. Likewise, all the other assumptions (including migration of Japanese nationals) are as from the official Japanese projections, in which foreigners are assumed to have lower fertility than nationals. Therefore, in both variants, immigrants are assumed to be *imin*, i.e. permanent settlers, and not *dekasegi*, i.e. temporary workers who leave the country after a while.

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[6] In fact it is just above the average of the values of the 3rd quartile of the distribution of European countries in the period 2020-29, whose rates however includes the migration of nationals. Including the migration of Japanese nationals, the average rate is actually below that European value. See also the top-right panel of the Figure 2.

[7] European countries are assumed to have shrinking immigration flows after 2020, which contributes to explain the high ranking of Japan under this scenario.

In the first variant (named "Rejuvenation 0.5", black dotted line in both panels of the Figure 10), the decrease of the number of women in reproductive age slows down after 2020 to then restart to decline at the same pace as in the standard scenario after 2030 and getting progressively closer to that case. In the higher variant (named "Rejuvenation 1.0", black dot-dashed line in both panels of the Figure 10), the shrinking of the cohorts of women in reproductive ages is instead stopped after 2020 and a positive trend is projected to take place over that decade. However, afterwards that number would start again to decline down to a value 40 % less than the original size by 2060, but still about 10 p.p. higher than in the Standard scenario. In both variants, the number of births is then boosted in the decade 2020-29, and this "bubble" propagates as a wave in the future, with the oscillations of the number of births getting progressively smaller in amplitude and closer on average to the number of births as from the Standard scenario. By 2060, the live births in Japan would be about 44-50 % (depending on the variant) less than those in 2010, thus 6-12 p.p. higher than in the Standard scenario.

Those births waves are not visible in the projected total population size, but the overall effect yes. In the lower immigration variant, the population decline is stopped, while in the higher variant it is inverted (see left panel of the Figure 10). However, that effect does not last long and the population re-starts its decline after 2030, keeping the same pace of the Standard scenario but with values shifted upwards. In the long term, those temporary deviations would be completely absorbed and the decline would be equal to the one projected in the Standard scenario.

As for the ageing (right panel of the Figure 10), the impact of the migration opening is much more interesting, as the OADR is projected to be on much lower levels, closer to the European values, within the time horizon of the projections. However, as immigrants age as well, when the generations immigrated in the 2020s will reach the older ages, the OADR is likely to climb very rapidly, up to - if not higher than - the levels of the Standard scenario. Depending on the age profile of the immigrants, such effect would probably take place after 2060 and it is therefore not visible in the current analysis.

Therefore, a *temporary* action generates a *temporary* outcome as well. The benefits of a migration limited in time have shorter duration for the population decline, and longer for the population ageing[8]. This may be understood as the effect of a baby boom, where the newborns have the average age of the immigrants[9]: there is a time window in which the demographic conditions are more favorable, but later on all cohorts arrive to older ages. For immigration, the demographic benefit is closer to the date of the event (immigration) than for fertility. From a purely demographic perspective, immigrants could be seen like newborns in their twenties.

[8] For the population size, the objective would be to avoid the population decline, while for the population ageing would be to soften the increase: the durations mentioned in the sentence should be read under this perspective. Otherwise, the extent of the population decline is reduced all over the projections period, which could be as well considered a benefit of the temporary immigration.

[9] For the sake of precision, immigrants are likely to have a different fertility (and mortality) than the host population, at least in the short term, and therefore they are not exactly as a baby boom shifted backwards of 20-30 years.

Partial replacement migration

In this last scenario, named "Replacement", it is again the case of immigrants who become permanent settlers in Japan, but the size of the inflows is this time determined by demographic conditions and not by a quota-like migration policy. It is assumed that approximately[10] a quarter of the projected shrinking of the population in working age as from the official projections is replaced by foreign immigrants, and all other assumptions are as from the Standard scenario. This gives an average annual number of net foreign migrants below 250 thousand, a level far below the one assumed for Italy, whose population size is less than half that of Japan. Compared to the population, this assumptions corresponds to an average crude net migration rate (always restricted to foreigners) of about 2.1 net migrants per 1000 inhabitants, a level which is even below the median of the European countries.

This gives a progressive slowing down of the decline of the cohorts of women in reproductive ages and a similar pattern for the number of births. The increase in births in 2060 is estimated as high as 13 p.p. from the Standard scenario, again under the assumption of a lower fertility of foreigners than Japanese women, a differential comparable to that obtained in the Convergence scenario, where fertility is assumed to increase, and higher than that based on a rejuvenation input.

The final impact (in 2060) in terms of population size and ageing is similar to the previous migration scenario, but the path is smother and progressive, and likely to continue also beyond that time horizon. As shown in the left panel of the Figure 10, the population decline by 2060 estimated under the Replacement scenario is about 20%, a result almost equal to that obtained with a high inflow of immigrants on a short period (variant Rejuvenation 1.0). As for the ageing (right panel of the Figure 10), the impact on the OADR for the next three decades is almost similar to the case of the variant Rejuvenation 0.5, but then it departs from it being on lower levels ending to 0.66, a value below the European maximum projected for that year (taken by Latvia). Here the real difference between the migration assumptions is probably not visible, but it is likely that after 2060 the OADR would remain almost stable in the Replacement scenario, contrary to what expected in the Rejuvenation case.

Hence, this Replacement scenario would see Japan as a "European" country, though penalized by a lower fertility. Migration levels would be comparable to those in Europe, and generated by the needs of the national labor market, therefore without necessarily a pro-active migration policy. As in Europe, continuing immigration flows in a low fertility context is likely to contribute for an important part to the shape of the future population in Japan. This issue is addressed in the following chapter.

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[10] The "replacement" migration is not applied year by year, which would indeed imply a replacement, but it is instead computed once for all from the Standard scenario and added to its migration assumption.

The contribution of migration to the future population composition

The states space

To control for the future changes in the population composition, it is here used a projections methodology based on the transitions between states (see van Imhoff and Keilman 1992). The population is classified accordingly to a combination of characteristics, namely age, sex and citizenship background. For this latter, four states are here used: natives, immigrants, second generation migrants and new citizens. The first category groups all nationals of Japanese parents, the second the foreign immigrants, the third the offspring of these immigrants and the latter all persons who acquire the Japanese citizenship as well as offspring of mixed Japanese-foreign marriages. The persons classified either as immigrants or as second generation migrants are then the *foreign population* or *population with foreign citizenship*, and adding the new citizens gives the *population with foreign background* (see Table 4).

Table 4: states space and its aggregations

<table>
<tr><th>Aggregation by citizenship</th><th>Citizenship background</th><th>Aggregation by background</th></tr>
<tr><td rowspan="2">Nationals</td><td>Natives</td><td>National background</td></tr>
<tr><td>New citizens</td><td rowspan="3">Foreign background</td></tr>
<tr><td rowspan="2">Foreigners</td><td>Immigrants</td></tr>
<tr><td>Second generation migrants</td></tr>
</table>

For the sake of simplicity and due to the lack of information, the stock of second generation migrants as well as that of the new citizens is assumed to be null at the beginning of the projections period. It is also assumed that they are closed to migratory flows: therefore, migrants can only enter either the state of natives or the one of immigrants. As for births, those from natives are considered natives as well, and likewise the offspring of new citizens are classified as new citizens. Births from immigrants can instead be classified either as "new citizen" (because births from mixed unions with one Japanese parent) or as second generation migrants, accordingly to a predefined probability distribution. Births from second generation migrants are instead assumed to be new citizens. This latter assumption makes those newborns to disappear from the "statistical view" of the foreign population, but it is considered that either the degree of integration of the second generation migrants would increase their chances of union with nationals or the development of legislative settings recognizing the *ius soli*[11] for the descendants of foreign background from the third generation onwards may be implemented, as it is in force now for instance in Luxembourg. Anyway, the full contribution of migration to the population composition can be recovered from the

[11] The principle of the *ius soli* foresees that the newborns (can) take the citizenship of the country in which they were born, as opposed to the *ius sanguinis*, where instead the newborns take the citizenship(s) of the parent(s), regardless of the country of birth. The legislative setting of a country may well have a mix of the two principles, also depending on the generation.

breakdown by background, which groups all persons with at least a foreign ancestor. All the other assumptions are taken from the official Japanese projections. In particular for fertility, second generation migrants are assumed to have the same demographic behavior of the (first generation) immigrants, and the new citizens that of the natives. In fact, this implies that the fertility of the population of foreign background converges to the fertility of the natives over generations. As for the transitions between states, migrants of any of the two generations are assumed to acquire the Japanese citizenship based on fixed age- and sex-specific rates, while Japanese people are assumed to never change their citizenship and transitions between immigrant and second generation states are impossible by definition.

The above-mentioned study on population by foreign/national background in the EU countries (Lanzieri 2011b) is used here for sake of comparison with the Japanese case. However, that study uses the variable "country of birth" to identify the national or foreign background and therefore the comparability with the current analysis is not absolute. Moreover, it obviously does not include the case of change of state due to acquisition of citizenship and thus the "new citizens" category does not exist there. Of the four model there presented, the closest to the present study is the Model 3, where there is a fertility differential between foreign- and native-born and all descendants from foreign-born mother (regardless of the generation) are considered of foreign background, here used for comparisons with the projected population with foreign background in Japan. Results from Model 1 in Lanzieri (2011b) are instead the closest to the projected foreign population in Japan, if one ignores the fertility differentials between nationals and foreigners. Results from Model 1 and Model 3 in Lanzieri (2011b) are then used here to represent the projected situation for Europe, but the reader should bear in mind the conceptual differences between the two studies.

Population of foreign citizenship

Under the official assumptions above specified, the size of the population of foreign citizenship is estimated to be about 3.5 million at the end of the projections period (1 January 2060), the 4 % of the total population in Japan (see Table 5). However, its presence is more relevant in the younger population in working age (15-39 years old), where they almost reach the 6 %. Compared to European countries, those values appear very moderate. According to the results from the Model 1 in Lanzieri (2011b), in the EU only Poland and Romania would have so low proportions of foreigners, and together with Bulgaria, Estonia, Latvia and Slovakia below the 10% of the total population.

Some of the alternative scenarios would change this picture. As reported in the Table 5, the proportions of foreigners on the respective age-specific populations almost do not change in the Convergence scenario. In fact, the difference there was on fertility and mortality assumptions, and the effect of the former requires some time before becoming visible. The impact is much more visible in the scenarios based on alternative migration assumptions. In the two variants of the Rejuvenation scenario, in the age group 15-39 it is visible the effect of the migration opening after 2020, moving up to the age group 40-64 by the end of the projections period, due to the progressive ageing of those special generations immigrated in the 2020s. At that time, the share of foreigners is projected to reach between 13 % and 21 %, a level a few times higher than in the Standard scenario. The overall percentage of foreigners would be over 11 % in the higher variant, again a level quite modest if compared to the European countries.

In the Replacement scenario, that overall percentage does not change much (less than 12 %), but the age distribution of the foreign population is more equilibrated than in the Rejuvenation scenario, and the age group in which there is the larger presence of foreigners is always the younger population in working age (15-39 years old).

Population of foreign background

In the breakdown of the population by background, the group of new citizens is moved to the persons with foreign breakdown, which inflates the figures reported above in the classification by citizenship. In the Table 6 it is shown that, based on the assumptions of the official projections, the share of persons with foreign background (thus regardless of their actual citizenship) by 2060 would be about 10-11 % in the younger population: in a few words, a student out of ten would be of foreign background. Again, compared to the European countries as from the results of Model 3 in Lanzieri (2011b), this would be a very modest percentage, even below the lowest share among the countries for which such information is available, projected for Estonia.

In case alternative migratory flows take place in the future decades, those percentages must be substantially revised upwards. However, in none of the alternative scenarios the share of population with foreign background on the total population in 2060 would exceed the 20%, a level which is instead projected to be crossed by many European countries in the next decades, some of them even nowadays. The highest shares by age group are projected in the Replacement scenario, where by the end of the projections period almost one out of three of either students or young labor force would have a foreign background. Unlike in the Rejuvenation scenario, in the Replacement scenario the percentages of persons with foreign background increase progressively over time within each age group.

The challenge of the integration of migrants

The permanent settlement of relevant immigration flows brings new challenges to the host populations and the policy-makers may wish to implement policies to easier the integration or assimilation of the immigrants. Besides the immigrants, a new community sees indeed the light, that so-called second generation of migrant who, despite of being born in the host country, may wonder about the country of origin of their parents and face peculiar difficulties for the integration. Or, on the other extreme, they may be much more assimilated than their parents, even refusing any reference to the culture of origin, which may create conflictual situations within the families. In between these two extremes there are of course also the (likely majority) cases of unproblematic integration/assimilation in the host countries.

The Table 7 shows the composition of the population in Japan by single citizenship background. Due to the assumptions on the second generation migrants here applied, their share grows very slowly over time, only "fed" by migration. Nevertheless, depending on the scenario, that little quota means a group size from half million to a bit less than 2 million of people. If the assumption about the naturalization of the third generation migrants does not apply and/or the current stock would be much different from zero, then those figures would be definitely higher.

Those who become Japanese citizens may be seen as successful cases of integration. Their share is quite relevant in the alternative migration scenarios (between 6 % and 9 % of the total population), although part of it comes from the assumption about the births from second generation migrants. Further, those shares depend as well on the policies regarding the acquisition of the citizenship, which may of course change over time.

Table 5: age-specific percentages of the population of foreign citizenship in Japan in selected years by scenario and major age group

Standard						
Age group	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
0-14	0.8%	1.4%	2.1%	2.4%	2.5%	2.5%
15-39	2.2%	3.5%	4.3%	5.1%	5.7%	5.9%
40-64	1.1%	1.5%	2.4%	3.6%	4.7%	5.3%
65+	0.4%	0.5%	0.7%	1.0%	1.5%	2.4%
Total	**1.3%**	**1.7%**	**2.3%**	**2.9%**	**3.5%**	**4.0%**
Convergence						
Age group	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
0-14	0.8%	1.4%	2.0%	2.3%	2.4%	2.4%
15-39	2.2%	3.5%	4.3%	5.1%	5.4%	5.5%
40-64	1.1%	1.5%	2.4%	3.6%	4.7%	5.2%
65+	0.4%	0.5%	0.7%	1.0%	1.5%	2.4%
Total	**1.3%**	**1.7%**	**2.3%**	**2.9%**	**3.4%**	**3.9%**
Rejuvenation 0.5						
Age group	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
0-14	0.8%	1.4%	5.0%	7.1%	5.5%	3.1%
15-39	2.2%	3.5%	15.8%	13.7%	8.1%	8.4%
40-64	1.1%	1.5%	2.5%	6.9%	13.4%	13.5%
65+	0.4%	0.5%	0.6%	0.8%	1.4%	3.2%
Total	**1.3%**	**1.7%**	**5.8%**	**6.6%**	**7.1%**	**7.6%**
Rejuvenation 1.0						
Age group	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
0-14	0.8%	1.4%	8.1%	11.4%	8.4%	3.8%
15-39	2.2%	3.5%	25.9%	21.7%	10.6%	10.7%
40-64	1.1%	1.5%	2.7%	10.5%	21.3%	20.9%
65+	0.4%	0.5%	0.4%	0.5%	1.2%	4.1%
Total	**1.3%**	**1.7%**	**9.5%**	**10.4%**	**10.9%**	**11.2%**
Replacement						
Age group	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
0-14	0.8%	2.6%	5.1%	6.8%	8.1%	8.5%
15-39	2.2%	8.6%	11.7%	15.7%	18.9%	18.7%
40-64	1.1%	1.6%	3.8%	8.4%	12.7%	16.0%
65+	0.4%	0.4%	0.6%	0.8%	1.6%	4.7%
Total	**1.3%**	**3.3%**	**5.0%**	**7.6%**	**9.9%**	**11.8%**