数も 98,018 であったと見込むことができる。しかしながら、実際の 10 月出生数は 93,676、11 月出生数は 95,813 であった（図 10)。すなわち、10 月出生数は想定出生数の 0.956、11 月出生数は 0.978 という比率であった。阪神淡路大震災は 17 日、東日本大震災は 11 日と発生日が異なる。阪神大震災の場合は 10 月 10 日以降に影響が出、東日本大震災の場合は 12 月初旬から影響がでることを考慮した結果、この影響を 2012 年 12 月に当てはめると、想定出生数の 0.948 となる。8 月までの概数出生数を用いた 12 月出生数 90,438 について、この係数をかけると 85,753 となり（図 11)、年間推計は震災を加味しない 1,050,856 から震災を加味した 1,046,172 に引き下げられる。この数値に整合的になるよう、2011 年の出生順位別出生数および出生順位別年齢別出生率を推定した。

図 10　阪神淡路大震災時の減少分

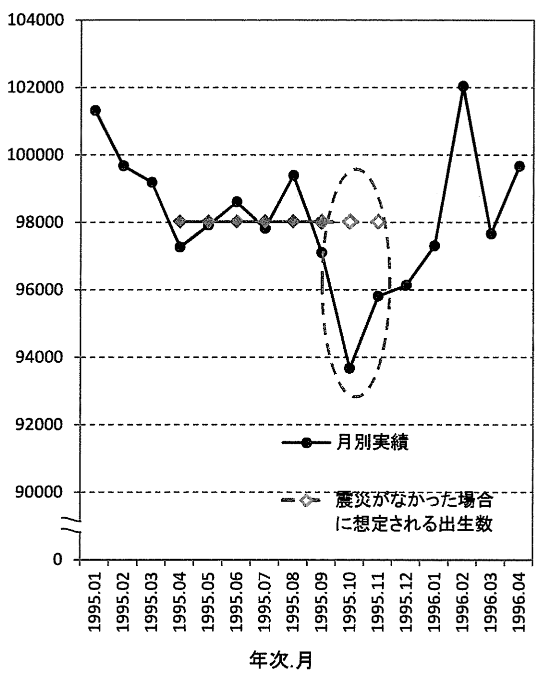
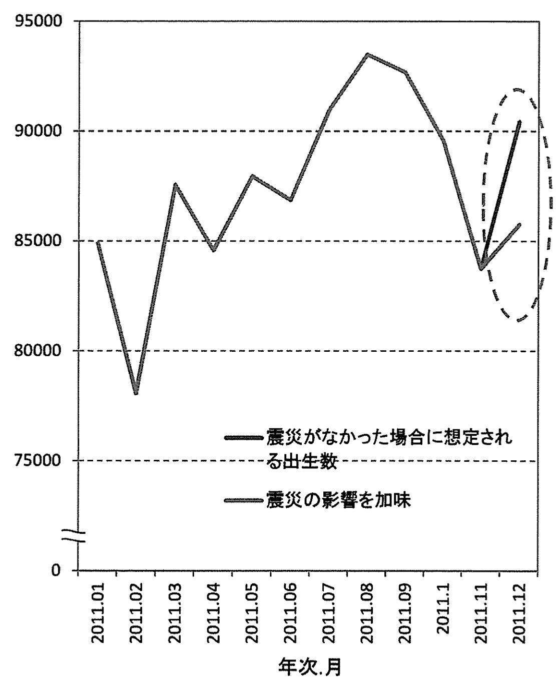


図 11　2011 年の月別出生数予想



注：出生数はセンサス局法 X12-ARIMA による季節調整後の値。

2．2012 年の出生率予測

(1) 自治体へのヒアリングを通じた妊娠届出統計の収集

妊娠届出者数の統計は、各市区町村によって、年に一度（6 月末日)、前年度(4 月～翌年 3 月)分がまとめられ、都道府県を通じて厚生労働省大臣官房統計情報部に報告されている。集計結果は翌年 2 月ごろに、同部によって『地域保健・健康増進事業報告』において公表される。2011 年秋の段階で得られる最新のものは 2011 年 2 月に公表された 2009 年度分の統計となる。2009 年度分の妊娠届出数は 2010 年の出生数の先行指標となりうるが、2011 年以降の出生数の先行指標とはならない。そこで、妊娠届出数をとりまとめている市区町

村へのヒアリング調査を実施し、2010 年度分および 2011 年度分の 9 月までの月別の届出数情報を収集した。

子育て支援課やホームページ等に記載されている健康増進行政を担当する部署を通じ、月別妊娠届出数に加え、地域の特殊事情、震災後の変化等をヒアリングした。2010 年前後に市町村合併などをしていない全国 1703 市区町村の中で、約 800 市区町村に問い合わせをし、2010 年度については 535 市区町村が、2011 年度については 527 市区町村から回答を得ることができた。

2011 年度については最長で 9 月までの統計であるため、都道府県別出生数の月別分布を用いて、市区町村ごとに年間数を推計した。これにより、市区町村ごとに 2009 年度、2010 年度、2011 年度の妊娠届出数が得られ、前年度からの変化率を求めることができる。

(2) 全国値の推定

市区町村ごとの変化率を全市区町村について単純に平均すると、規模の小さな市区町村の影響が過大に反映されてしまう。そこで、各市区町村における再生産年齢女性人口（15～49 歳、2005 年国勢調査に基づく）で重み付けした平均値を求めた。その結果、2009 年度から 2010 年度の変化率は 0.980、2010 年度から 2011 年度の変化率は 0.959 との推定結果が得られた。なお、99％の信頼区間に基づく 2009-10 年度の変化率の上限は 0.986、下限は 0.974、2010-11 年度の変化率の上限は 0.967、下限は 0.950 であった。妊娠数は 2 年連続で減少傾向にあると言えよう。

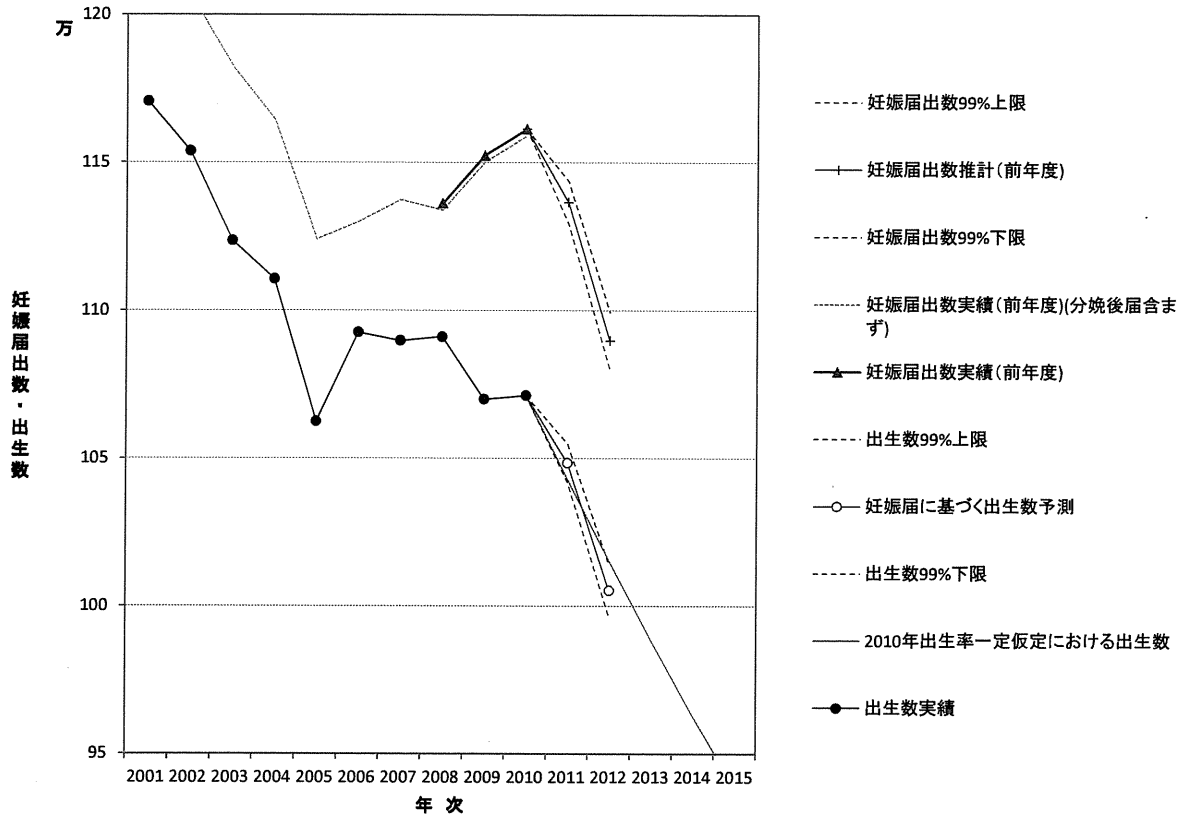
表２　市区町村の妊娠届出数に基づく妊娠届出数の変化率

年度	回答市区町村数（全1,703）	回答市区町村における15-49歳女性人口（2005年国勢調査）	前年度妊娠数からの変化		前年度妊娠数からの変化率（再生産女性人口を用いた加重平均）		
			前年より増えた（%）	前年より減った（%）		99%上限	99%下限
2010年度	535	11,904,130	38.3	61.7	0.980	0.986	0.974
2011年度	527	11,025,697	32.1	67.9	0.959	0.967	0.950

(3) 妊娠届出数に基づいた出生数の推定

2011 年の妊娠届出数が推計されると、過去の妊娠届出数と出生数との比率を使って 2012 年の出生数を予想することができる。ここでは 2010 年の実績に基づく比率を使った。その結果 2012 年の出生数（日本における日本人）は 1,005,322 件と推計された（図 12）。出生率が 2010 年と同じだった場合に想定される出生は 1,015,295 であるため、それよりも数が少なく、TFR も 2010 年より低下する見通しとなる。

図 12　推定された全国妊娠届出数および出生数予測



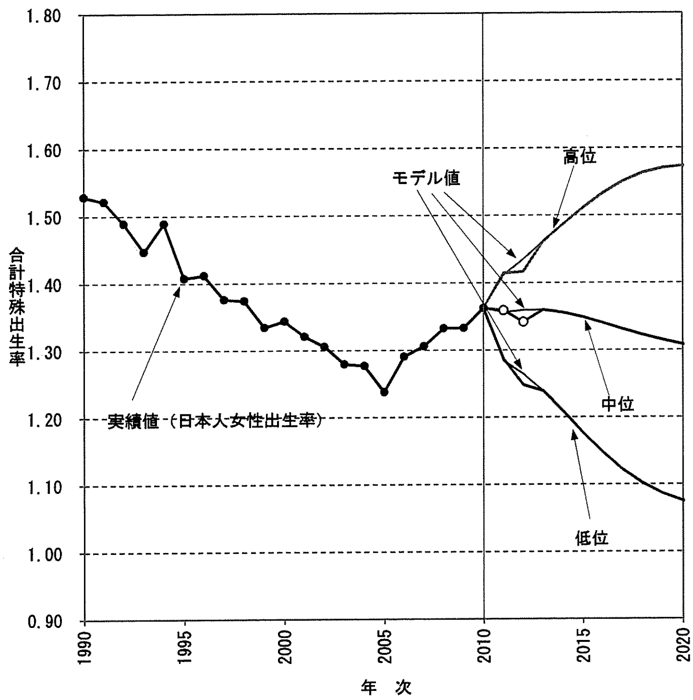
3．まとめ

以上のように東日本大震災の影響を加味した 2011 年、2012 年の出生数に基づき、コーホート要因法によって別途推計された年齢別出生率を調整することによって、東日本大震災の影響を加味した年齢別出生率および合計特殊出生率を推定することができる。図 13 では平成 24 年推計における中位仮定設定のためのモデル値（震災の影響を加味しない）と震災の影響を加味した合計特殊出生率の中位仮定を示した。2011 年はわずかにモデル値より低い値となり、2012 年については、前後の年よりも低い値となっている。ただし、過去における年次の期間変動に比べ、それほど大きな減少ではない。

阪神淡路大震災時は、婚姻や離婚、出生が一時的に減少する影響が見られた。東日本大震災についても、離婚が減少し、出生が減少する兆しが観察されている。婚姻などの家族形成については、精神面、価値観等に震災が影響する可能性が指摘されているが（白河 2011）、現時点で婚姻数に対するはっきりした影響は現れていない。

今回の方法による予測は、実績値が得られた段階で評価を行う必要がある。今回は阪神大震災時の経験を用いて東日本大震災の影響を推定したが、両震災は規模や被災地の状況が異なる。人口動態にどのような特徴がより大きく影響するのかなど、比較研究を通じて明らかにしていく必要があろう。

図13 平成24年推計出生率中位仮定モデル値と震災を加味した合計特殊出生率予測



参考文献

Cohan, C.L.and S.W. Cole. 2002. "Life course transitions and natural disaster: Marriage, birth, and divorce following Hurricane Hugo." Journal of Family Psychology 16(1):14-25.

Nakonezny, P.A., R. Reddick, and J.L. Rodgers. 2004. "Did divorces decline after the Oklahoma City bombing?" Journal of Marriage and Family 66(1):90-100.

Pfefferbaum, B.and C.S. North. 2008. "Children and families in the context of disasters: Implications for preparedness and response." The Family psychologist: bulletin of the Division of Family Psychology (43)/APA Division of Family Psychology (43) 24(2):6-10.

Rodgers, J.L., C.A.S. John, and R. Coleman. 2005. "Did fertility go up after the Oklahoma City bombing? An analysis of births in metropolitan counties in Oklahoma, 1990–1999." Demography 42(4):675-692.

石川晃・別府志海.2011.「年途中までの月別統計を用いた年間合計特殊出生率推計の検討」金子隆一(編著) 厚生労働科学研究費補助金政策科学推進研究事業『人口動態変動および構造変化の見通しとその推計手法に関する総合的研究』平成 22 年度総合研究報告書: 319-335.

奥本佳伸.2000.「季節調整法の比較研究：センサス局法 X-12-ARIMA の我が国経済統計への適用　経済分析 政策研究の視点シリーズ 17」経済企画庁経済研究所.

白河桃子.2011.『震災婚』ディスカヴァー携書.

厚生労働省大臣官房統計情報部『地域保健・健康増進事業報告』

12 Fewer and older: a common destiny for Japan and Europe?

A comparative view at the contribution of migration in ageing populations

Giampaolo LANZIERI*

Abstract

This paper looks at the past and projected demographic trends of Japan in comparison to European countries to highlight similarities and differences between these low-fertility and ageing populations. The role and impact of the two demographic options (fertility and migration) to counteract the prospected population decline and ageing in Japan are analyzed by means of formal demography results and multistate projections. After having assessed the important but limited potential of the fertility contribution, the study quantifies the consequences of various immigration assumptions on its future population composition and compares those results with the European prospects. It is shown that, within the range of the currently foreseeable assumptions, only a migration inflow comparable to that taking place nowadays towards Europe would avoid an excessive population decline and ageing in Japan, but with a relevant diversification of its population composition. Within five decades, the population of foreign background would be particularly important in the younger ages, where its share could reach from 10 % to 30 % of the population, depending on the future inflows.

Introduction

Several countries in the world are now experiencing, or going to experience, population age structures never seen before. An ever increasing life expectancy combined with below-replacement levels of fertility is modifying the shape of the age profile of the population from a well-known and traditional pyramid, made by larger younger cohorts at the bottom, to an almost *reversed* pyramid, where the larger cohorts are among the elderly. The process of ageing, as measured by whatever indicator, is expected to be particularly relevant in selected European countries and in East Asia, notably in Japan.

According to the latest projections from Eurostat, the Statistical Office of the European Union, and from the National Institute of Population and Social Security Research, the population ageing may speed up in the near future, driven by the ageing of the baby boom generations. The ageing may be accompanied by the shrinking of the population size, with further repercussion on the potential labor force, which may be not anymore sufficient to support the economic growth. The demographic solutions envisaged by the countries may differ to this regards, but essentially they target an increase of the fertility levels and/or an increase of the immigration flows. An alternative approach, which would tackle the socio-economic challenges of a shrinking and ageing population without efforts of influencing the

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components of population change (either the natural change or the net migration), is not usually perceived as an option, or adaptations are simply left to the demographic inertia.

Any of those approaches have supporters and detractors. Decision of childbearing are often mentioned to belong to the private sphere of the individuals, and therefore out of the reach of policy actions. On the other side, national policies could be addressed to ensure favorable conditions for fertility, helping those who aspire to larger families sizes to meet their wishes. However, any fertility increase would need at least a couple of decades before becoming "visible" for the labor market. Migration is therefore often proposed as quick and readily available solution to shortages of the labor force. Migratory flows may actually take place without a specific action or will by the host country. Historical events or contingent economic situations, in both the origin and destination countries, as well as the peculiar geographical location, have made some European countries to experience sudden rises of the immigration flows in the recent past. In fact, EU Member States and Japan have different migration histories: over the last decades, the formers have gradually transformed themselves from sending to receiving countries, migration becoming an – if not the most – important component of population change; the latter has always recorded low levels of migration, being its population growth supported by the vital events so far.

However, the impact of migration on the populations' composition has not yet been thoroughly analyzed. In fact, in addition to the arithmetical increase of the population size due to the immigrants, there is their contribution to the demographic change via fertility and mortality. As migrants are usually younger than natives, such a contribution becomes more and more visible with the ageing of the host population. Many commentators highlight the benefits of migration for the economy and for the demographic dynamic in general, but besides the contribution to the labor market, the impact of migration on future population composition may actually be central in discussions about concrete implementation of population policies, as well as the ways to ensure a smoothed inclusion of migrants in the host society. In Europe, migration and integration of migrants are definitely important items in the nowadays political agenda. As rapidly ageing country, Japan may want as well to look at these issues, benefitting of the experience in other areas of the world, comparable as for economic and demographic dynamics.

Previous related studies and current contribution

In general terms, Japan and several European countries are commonly considered to share a common demographic path. Are really the prospected demographic futures as well as their drivers similar between these two areas of the world? Many studies in the past have looked at the peculiarities of Japan, and also Europe is one of the areas of the world on which there is abundance of demographic analyses. However, apart studies which take a global perspective, the direct comparison between the two is somehow missing.

General overviews of past demographic trends on Europe are usually readily available in the international literature and covering various time periods (e.g., regular publications from Eurostat, European Commission 2011, Avdeev *et al.* 2011, Monnier 2004, Bourgeois-Pichat 1981). Population projections for European countries are regularly issued by Eurostat

(Lanzieri 2006, 2011a, Giannakouris 2008) together with their methodological details (Lanzieri 2005, 2009, 2012). Other studies take a much broader and more speculative perspective about the demographic future of Europe (e.g., Demeny 2003, Coleman 2006a).

Perhaps due to difficulties to find comparable and readily available data on this part of the word, such abundance of general demographic trends in the international literature of comparative regional studies is less visible for East Asia, although studies do exist (e.g., Attané *et al.* 2009). Methodological details about the population projections for Japan released by the National Institute of Population and Social Security Research are largely given in Kaneko *et al.* (2008, 2009) and IPSS (2012) and are built upon a number of preliminary analysis and development of specific methodologies about fertility (e.g., Iwasawa and Kaneko 2010, Kaneko 2010) and mortality (e.g., Ishii 2010, Kaneko 2011). Mortality in Japan has received attention in the international literature (e.g., Meslé and Vallin 2006) due to its outperforming trends, which puts Japan as the frontrunner of mortality improvements (Horiuchi 2011). As for fertility, given the importance of its latest trends, several scholars have made comparative analysis between Japan and other East Asian and/or selected European countries on this specific demographic component (e.g., Feyrer *et al.* 2008, Suzuki 2009, Frejka *et al.* 2010), and many studies are focusing only on Japan (e.g., Ogawa and Retherford 1993, Retherford *et al.* 1996, Ogawa 2003, Boling 1998 2008). Such predominance of studies on Japanese fertility is probably due as well to the fact that fertility is perceived as the primary (and for some the only feasible) component on which to intervene in order to oppose the prospected demographic trends.

In comparison to fertility and mortality, studies on the demographic consequences of migration for Japan are less present in the international literature – if any. However, the need for Japan of foreign labor force in consideration of demographic and economic trends has been already presented since some time (e.g., Yamanaka 1993), some studies focusing on ethnic groups specific of the Japanese migration history (Tsuda 1999a, 1999b). As for Europe, the implications of significant immigration flows in low-fertility populations have been stressed since the Eighties (e.g., Espenshade 1986), when the effects of the fall of fertility after the baby boom were becoming clearer, and it has been more and more present in the scientific literature (e.g., Teitelbaum 2004, Coleman 2006b). The issue has received attention also in formal demography, where studies have been dealing with the effect of inclusion of immigration in population models (e.g., Espenshade *et al.* 1982) and its impact on population composition (e.g., Steinmann and Jäger 2000) or structure (e.g., Wu and Li 2003, Alho 2008).

This interaction of low fertility and immigration is considered essentially a "Western issue", and it is also argued that these countries may follow a different pattern of ethnic diversification than East Asian countries (Coleman 2009). However, while drawing the attention on this issue, no estimation of the migration impact on the future composition of the population was usually provided, or it was done so by assembling available projections (but of different methodologies) carried out in single countries. Finally, a comparative quantitative study has been carried out on the EU Member States (Lanzieri 2011b), showing the relevant impact of migration on the future European population composition. These results were also recalled in the latest official demographic report of the European Commission (2011), which has focused on the implications of migration on the population composition, highlighting how migration is contributing to the shape of *new* Europeans.

This study intends primarily to look at the potential demographic contribution of migrants to the population change in Japan, compared to the situation in the Member States of the European Union (EU) and in the countries of the European Free Trade Association (EFTA). As demographic changes may take a long time to fully develop, the period here considered goes from 1960 to 2060, thus 100 years equally split in observed (1960-2010) and projected data (2010-2060), these latter as from the official projections exercises in Japan and in the European Union. In the first part, a descriptive comparison is made between the past and projected demographic trends of Japan and of the European countries. Besides being a necessary starting point, by overlapping those trends the peculiarities of Japan are made straightly visible. In the second part, the analysis is deepened to identify the major demographic components responsible for population decline and ageing, also by using relations from formal demography. Its outcomes may be helpful to shed further light on the factors behind the population dynamics in Japan and thus to identify potential demographic levers. In the third part, the focus is on the future developments and Japan is assumed to behave demographically like the European countries or to experience different migratory flows. What would then be its demographic perspective? In fact, considering alternative scenarios highlights the importance of attributing the right meaning to the projections, which is not of pure forecasts. Projections have instead an important informative function for policy-makers, who should become used to be confronted with various scenarios, as in other domains where future developments are analyzed. Finally, the fourth part focuses on the contribution of migrants to the demographic changes, comparing the prospected population composition in Japan and in the European countries. This final part provides probably for the first time specific quantitative information to the discussion on migration policies in Japan.

The perspective taken in this study is to set the spotlight on Japan and to use the European countries as background for comparisons. Obviously, Europe groups countries whose demographic profile is quite different, and therefore efforts are here made to keep the analysis at national level, but without blurring the picture with a series of country-by-country comparisons. This analysis also keeps a purely demographic perspective, without entering in the field of possible population policies, although actually not necessarily *demographic* issues require *demographic* solutions. Finally, this study looks at the population dynamics from three points of view: population size change (growth/decline), population ageing and population composition. While the former two are basic standards for analysis, the latter has received relatively little attention so far. To tackle the population composition, the multistate population projections technique is here used.

Therefore, the first contribution of this study is to look at the past and future demography of Japan in relative terms, where European countries provide the benchmark for the assessment. Then, it shows what the potential influence is and thus what the margins of action are of the demographic levers (fertility and migration) to counterbalance the current demographic trends in Japan. It clarifies the extent of the validity of the claimed demographic similarity between Japan and Europe. Further, it gives a clear quantification of the effect of migration on the prospected population composition of Japan, so far missing in the literature. To do so, the analysis uses also results from formal demography and an advanced projections methodology, this latter applied keeping the consistency with the latest official results. This study thus indirectly shows as well the benefits of different methodologies for the demographic analysis of Japan.

Data sources and geographic coverage

European data are from Eurobase, the database of the Eurostat, apart very few data about past fertility and mortality indicators, taken from the Database of Developed Countries of INED, the National Institute of Demographic Studies of France. Input data on Japan are mainly from the Statistics Bureau (population estimates and vital events), the Ministry of Health, Labor and Welfare (vital events), the Ministry of Justice (migration) and the Japanese Mortality Database (mortality) for the past data and indicators, and from the National Institute of Population and Social Security Research for projections data. However, all computation of rates and projected indicators for both Japan and European countries has been made in this study with a common methodology. Unlike most of the statistics usually available, data for Japan here includes foreigners, apart the live births from foreign mother which are not available for the period 1967-1986.

To easier the comparisons between Japan and the European countries, a few adaptations have been necessary. All the population data are here expressed as of 1 January of the given year(s) and all flow data (either vital events or migration) refer to the calendar year, i.e. the period from 1 January to 31 December of the given years(s). This time referencing is slightly different from the one adopted in Japan, where the so-called Fiscal Year (FY), running from 1 April of a given year to 31 March of the following year, is the usual time window of reference, and 1 October (which is in fact the mid-period of the FY) is the date at which population data are referred. As for the unknown, persons with unknown citizenship have been attributed to the foreign population and persons with unknown age have been proportionally attributed to the single age classes. Therefore, the figures computed in this study cannot match exactly the values reported in other official Japanese publications, although they should be a close approximation.

Further, the graphs showed in this paper make use of statistics of distribution for Europe. For each year, the solid bold gray lines represent the minimum and maximum values recorded among European countries, which of course do not necessarily refer to the same country over the whole period. The gray bold dashed lines corresponds to the 1^{st} and 9^{th} deciles, the dashed black lines to the 1^{st} and 3^{rd} quartile and the central dotted line to the median. As the number of countries here considered is 31, the median in fact identifies a specific country; further, in each side, the dashed gray line identifies a specific country and excludes the 3 European countries with the most extreme values, the interval between the black and gray dashed lines contains the further 4, and the one between the median and the dashed black line the residual 7. Japan is always showed with a solid black line. For few indicators, the values are not available for all European countries and the corresponding time series are then showed only for the years for which there is a full coverage.

Initial estimates of the foreign population in Japan are based on the latest Census 2010 results. However, in any country, the census exercise may be confronted with population groups difficult to reach and typically this is the case of the foreign population. Thus, it should not be surprising if this specific group would be under-covered by the Japanese census, and the effective size of the foreign population in Japan could be even one third higher than the one resulting from the census. The outcomes presented in this study referring to the foreign population size should therefore be considered an underestimate.

For the sake of simplicity, the following set of 31 European countries, members of the EU or of the EFTA, is referred to here as 'Europe', although it does not cover the whole continent: Austria (AT), Belgium (BE), Bulgaria (BG), Cyprus (CY), the Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (EL), Hungary (HU), Iceland (IS), Ireland (IE), Italy (IT), Latvia (LV), Liechtenstein (LI), Lithuania (LT), Luxembourg (LU), Malta (MT), the Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE), Switzerland (CH) and the United Kingdom (UK). Occasionally, two further aggregates are presented for Europe: one is the simple arithmetic average of the values recorded in the European countries (Avg EU+), the other is the value referring to Europe as a whole (EU+), where therefore the relative weight of the countries plays a role.

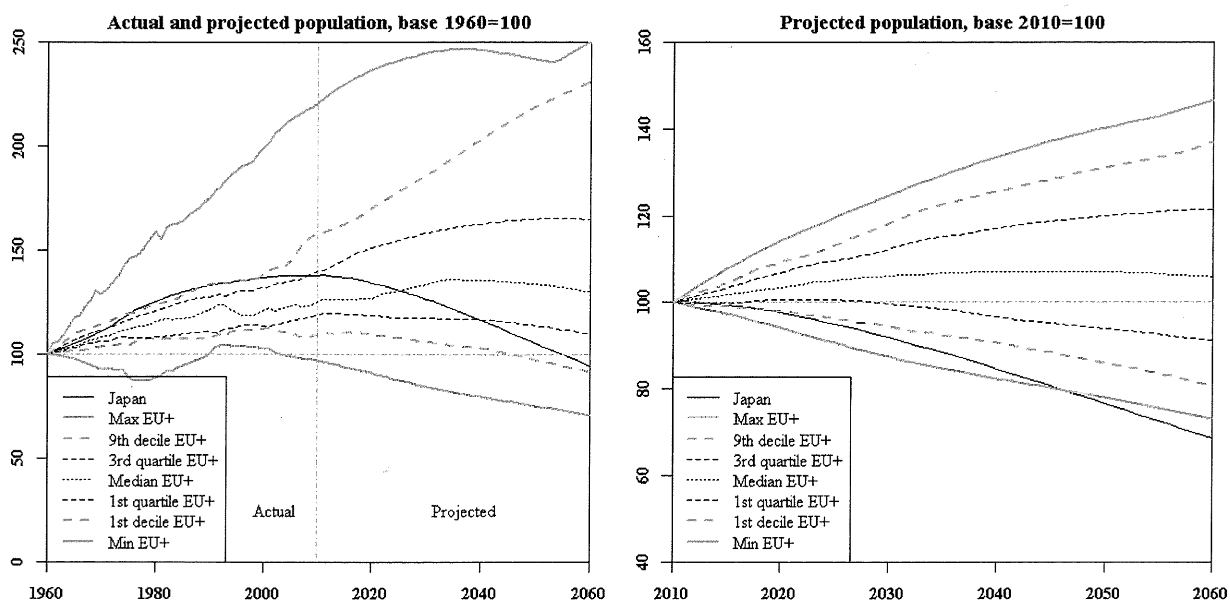
A description of past and future demographic trends in Japan and Europe

Starting from 1960, the population size has been increasing in Japan and in many, but not all, the European countries. The left panel of the Figure 1 shows the population trend of Japan compared to distribution statistics for Europe.

For the first five decades, the population size of Japan has been growing like in the European countries with higher growth, but this trend is projected to be reversed in the half-century to come, classifying Japan in the group of European countries with low population growth or even decline compared to 1960 (Czech Republic, Estonia, Lithuania and Romania). For at least 3/4 of the European countries instead, the population size in 2060 is projected to be higher than 100 years before.

Since in the projected period there is a reversal of past trends, it is interesting to have a closer look at it, as in the right panel of the Figure 1. Compared to the situation on 1 January 2010, Japan is projected to experience the faster population decline. Already in the 2020s, its population decline would be comparable to the one projected for Latvia and Lithuania, and before 2050 the population of Japan would have a stronger shrinking than Bulgaria, the country with the highest projected population decline in Europe, ending in 2060 with a population size about one third smaller than in 2010. More than half of the European countries are instead projected to have a larger population size at the end of the projections period.

Figure 1: actual and projected population size



Assumptions on the future course of fertility, mortality and migration

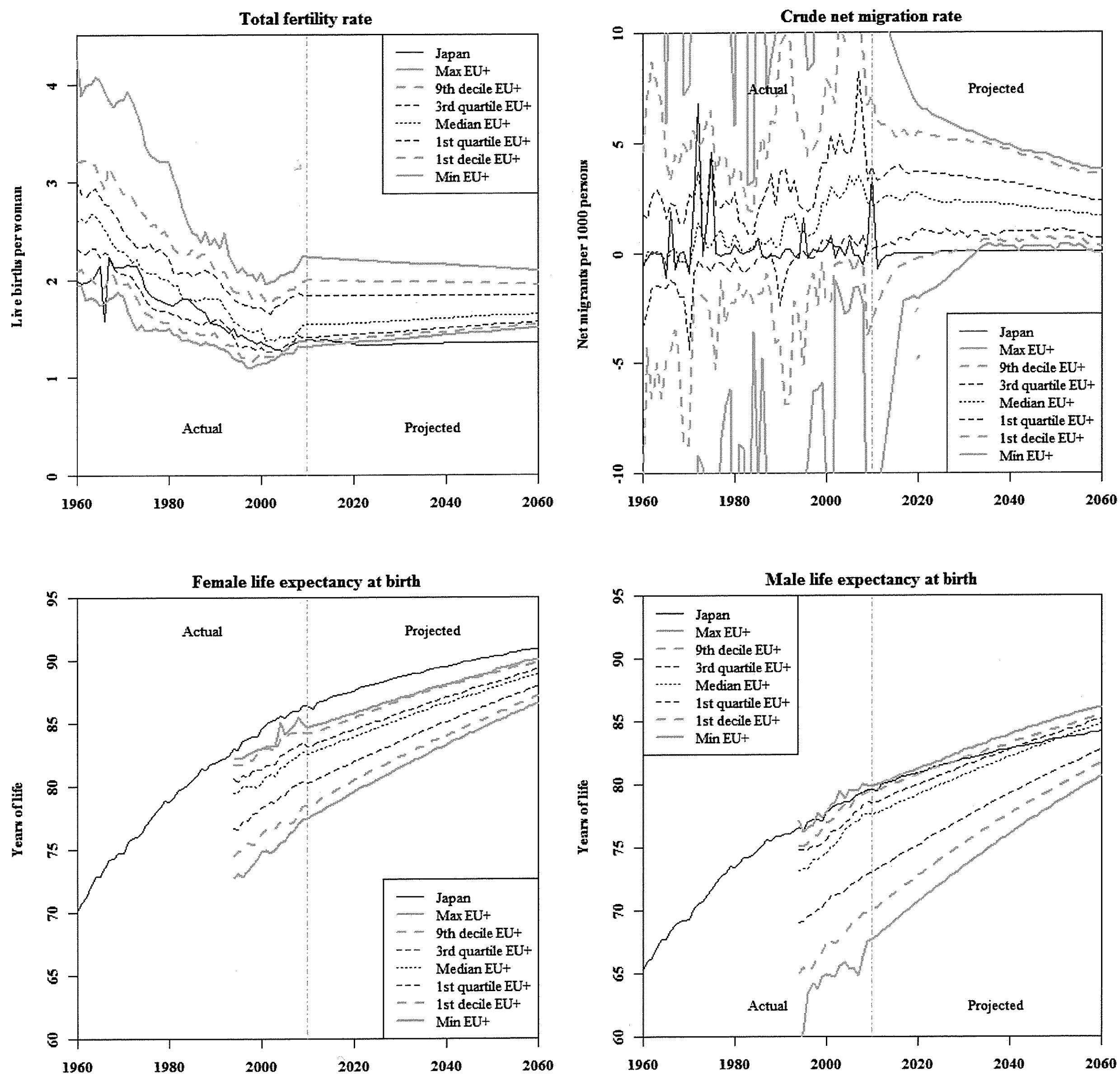
According to the latest respective projections exercises, assumptions for future levels of fertility in Japan are almost stationary after the upturn started in 2006, while for Europe it is projected a slight increase and convergence between countries (see top-left panel of the Figure 2). Hence, while since the year after the "Fire-Horse" (*Hinoe-Uma*) year[1] the fertility in Japan has been decreasing together with the mainstream of the European countries, from 2020 onwards its level is assumed to depart from the general European trends, progressively increasing the distance from Latvia, the European country with the lowest projected fertility. In fact, perhaps contrary to the common belief, the European country which had in the past the smallest differences from Japan in the path of fertility decline is Hungary. Even focusing on the latest decade, this still holds, although similarities with other countries (such as Poland, Romania, Germany and Italy) also emerge.

As for the assumptions on mortality, life expectancy at birth for men in Japan, while increasing with the group of the European countries with higher values in the latest 15 years (such as Sweden and Switzerland), it is projected to depart from them and to converge towards the median of the European values, going even further below (see bottom-right panel of the Figure 2). Values of Japanese male life expectancy at birth at the end of the projections period are thus comparable with those projected for countries such as Austria, Denmark, Ireland, Portugal, Slovenia and Finland. Projected values for the Japanese female life expectancy at birth (bottom-left panel of the Figure 2) keeps instead the top ranking, although reducing the distance from those European countries with which Japan had closer values over the past decade (France, Spain and Switzerland).

[1] According to the Japanese calendar, that year corresponds to a particular astrological combination occurring every 60 year and believed to have negative consequences on the girls born that year. This belief may have affected the fertility rate of that year.

Finally, the graph showing the net migration rates (top-right panel of the Figure 2) highlight the volatility of this component, amplified by the fact that those values are here computed as residual from the demographic balance and therefore incorporating all possible errors[2]. Japan is assumed to continue to take net migration values close to zero in the projections period, thus below the European countries with the lowest rates within 2-3 decades, despite of the declining rates assumed for net migration in Europe.

Figure 2: actual and projected values of fertility, migration and mortality indicators



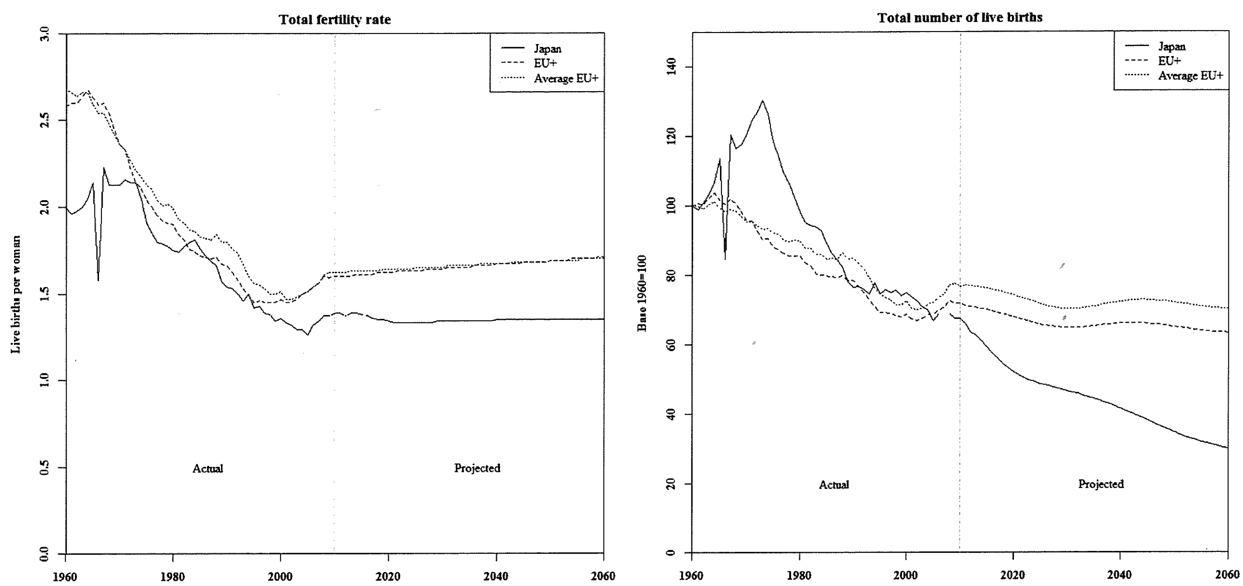
Number of events and age structures

Therefore, in comparison to the European countries, Japan is assumed to have lower but almost stable fertility, lower (for women) or similar (for men) mortality, and lower migration

[2] For instance, the peak for Japan in 2010 includes the difference between the new census results and the population estimate for the previous year without post-census revision.

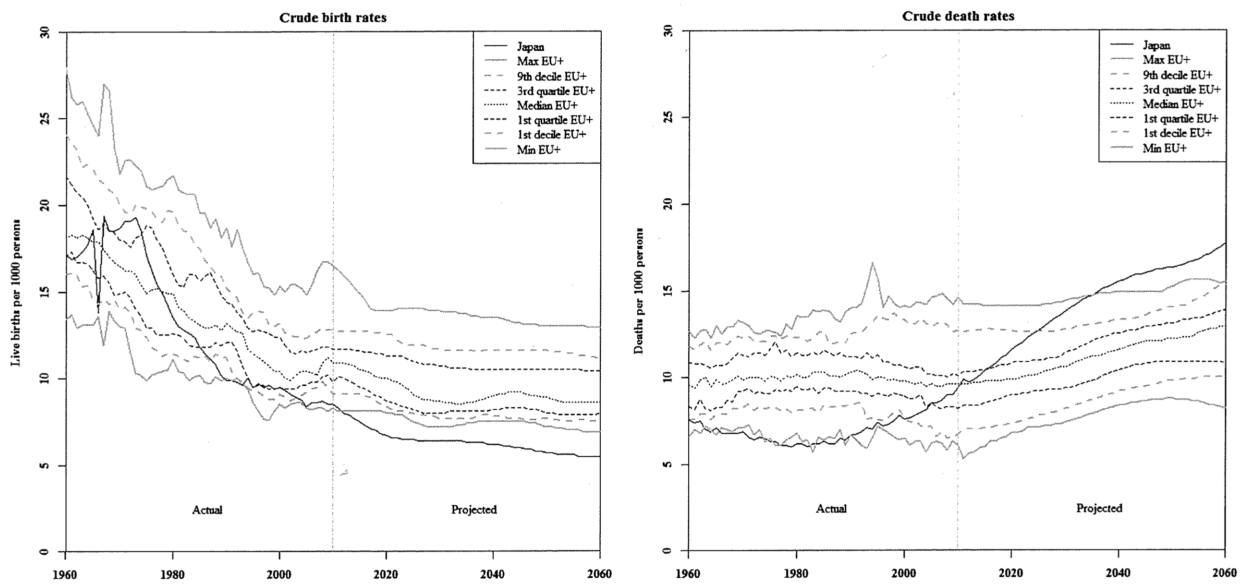
as well. However, to explain the projected trend reversal of the population size, these indicators have to be translated in number of events. The Figure 3 shows the trends of the total fertility rates compared to the one of the number of births. Although the fertility remains almost stable in the projected period, the number of births continues to decline in Japan, falling to about half million at the end of projections period. In Europe, the slight increase of the fertility produces a just slightly declining number of births instead. This is because smaller cohorts of women in reproductive ages will indeed deliver a shrinking number of births even in presence of constant fertility rates.

Figure 3: comparison of total fertility rates and number of live births



Reporting that declining number of births to the shrinking population gives a slightly slower decline (see left panel of the Figure 4). However, Japan is projected to have in the next years a crude birth rate lower than Germany, which is at the bottom of the European ranking for fertility for most of the previous and current decade, and to increase the difference from the lower European performer over time. The influence of the age structure is visible also in mortality, where, regardless of the improvements of the life expectancy, the crude death rate of Japan climbs rapidly from the lowest European levels (Iceland or Liechtenstein) and in 40 years overtakes the level of the European countries with the highest crude death rate (Bulgaria, then Germany and Romania).

Figure 4: actual and projected crude birth and death rates



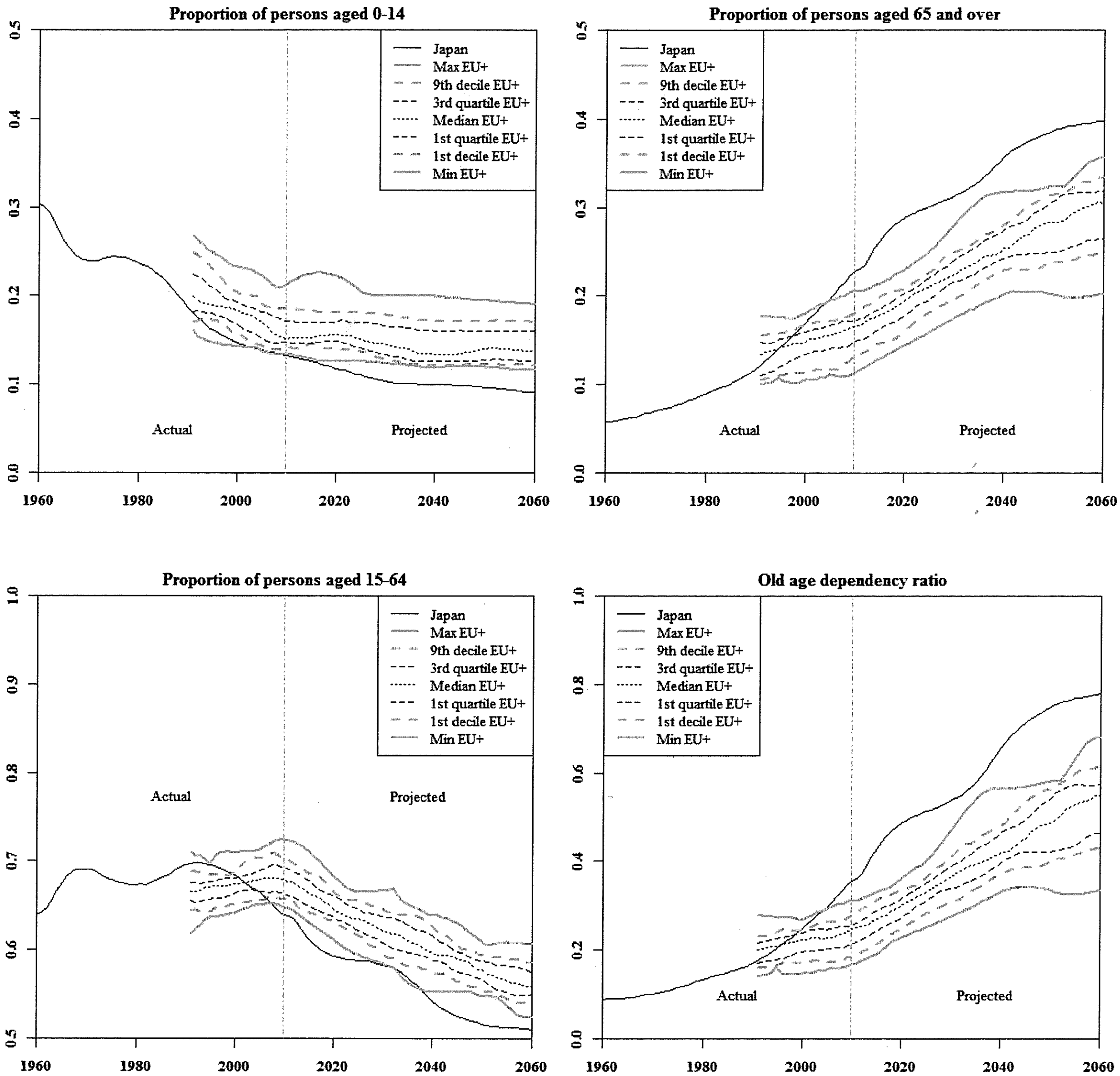
Changing age structures

The top-left panel of the Figure 5 shows the declining trend of the proportion of young people (under age 15) in Japan. Already in 2010, this percentage is below the one of Germany, the European country with the lowest share of young people. Japan is projected to further depart from the European countries and to end up with a negative difference of more than 2 p.p. in 2060 from Romania, by then the country with the lowest percentage in Europe.

The older age structure of Japan in comparison to European countries is clearly visible looking at the ageing indicators in the same Figure 5. The percentage of population aged 65 and over in Japan is already higher than the currently older (in demographic terms) European countries (Germany and Italy), and that difference is projected to increase up to about 4 p.p. by 2060 (from Latvia at that time). The impact on the Japanese pension system is more understandable looking at the old age dependency ratio, which shows a dramatic increase from 0.1 in 1960 to almost 0.8 elderly for every person in working age (15-64) in 2060. By that time, the European country which is projected to have the highest OADR is Latvia, on a level lower than Japan by more than 10 %.

Bloom *et al.* (2000) explain the important role played by the demographic change for the economic growth in East Asia, and in particular by the so-called demographic dividend, delivered from the demographic transition and the resulting population change via labor supply, savings and human capital (Bloom *et al.* 2003). The importance of the links between the changing age structure and economy is highlighted also in Ogawa *et al.* (2010), who illustrate how the demographic transition translates in fact into two demographic dividends, the first (corresponding to the growth rate of the economic support ratio) being transitory while the second (corresponding to the growth rate of productivity) potentially more long-lasting, depending upon the implemented policies. According to the official projections, that economically favorable demographic window is thus coming to an end in the next decades, as rapidly in Japan as in the European countries, as shown by the fall of the percentage of population in working age (bottom-left panel of the Figure 5).

Figure 5: actual and projected age structure indicators



The main factors of population dynamics in Japan

Therefore, when it comes to numbers, the live births decreases due to the shrinking of female generations reaching the reproductive ages, and the deaths increases due to the larger cohorts (from the baby boom period) reaching older ages. Still another component may play a role in the population change: migration. The total population change can indeed be decomposed in a part attributable to the natural change (live births minus deaths) and the other to the net migration (including adjustments, if computed as residual from the demographic balancing equation). Representing these two components on an plan (with the cross of the axes at value 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)

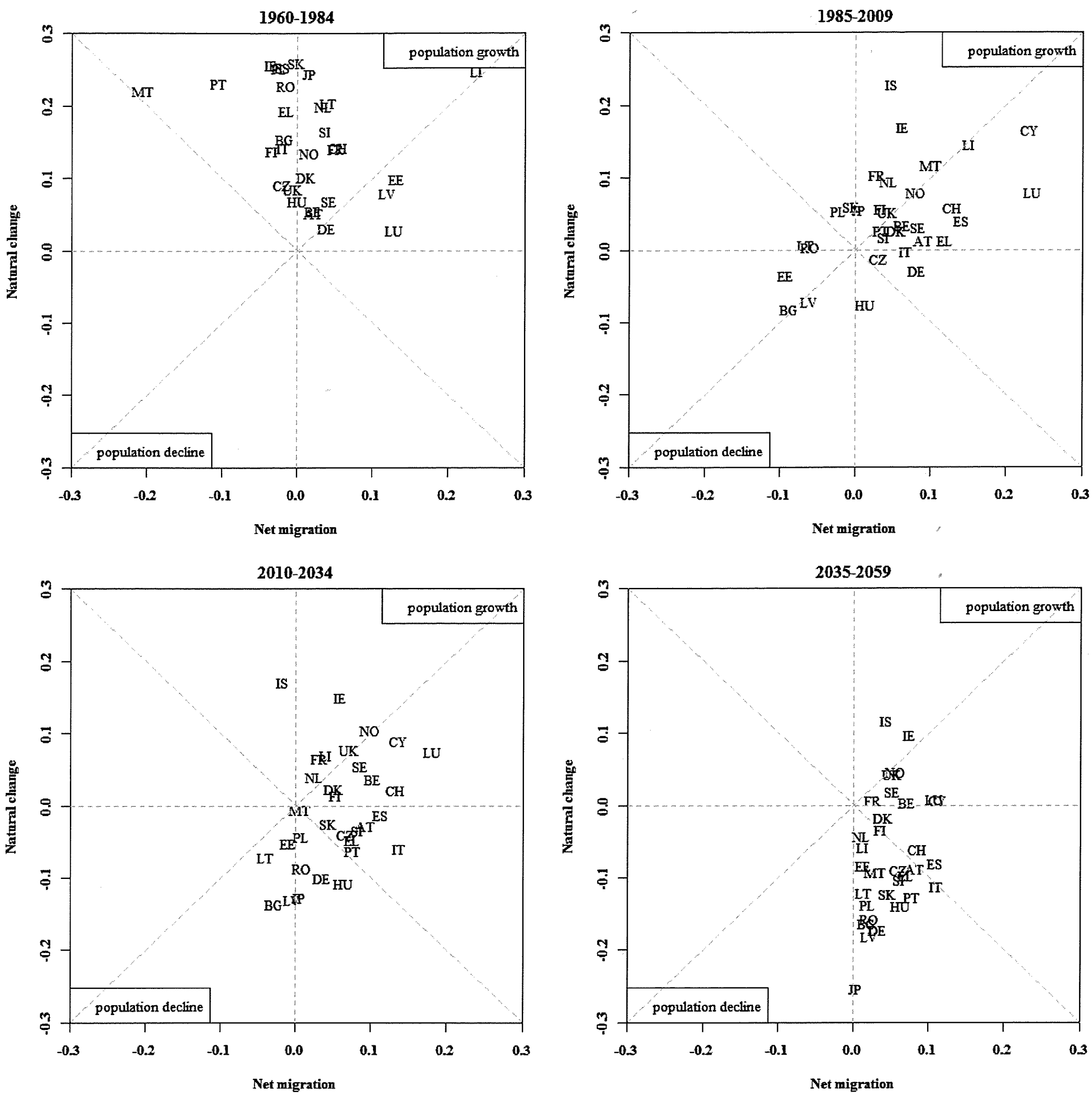
Note: N means natural change, M net migration and () the absolute value.

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

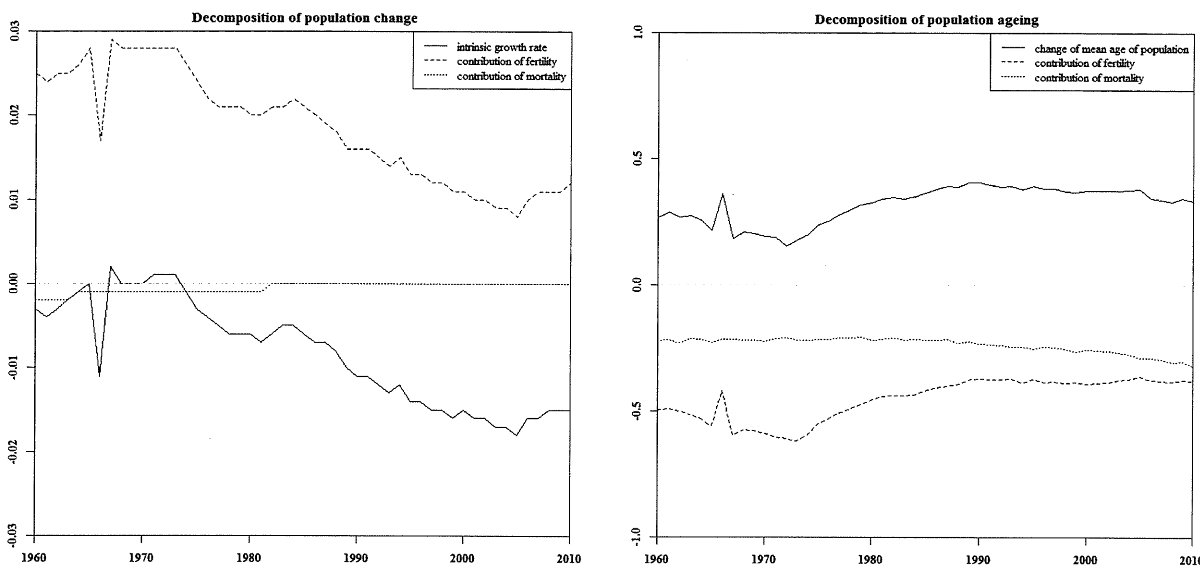
If natural change is the main factor behind the population change (growth/decline) of Japan, it may be interesting to look at which component between fertility and mortality has played the most important part. The first, most intuitive comparison would be between the respective crude rates. Looking again 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).