# "Vienna: a city beyond aging"– revisited and revised

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In 1988 two of the authors (Lutz and Hanika 1988) published a short piece in the IIASA newsletter, POPNET, entitled "Vienna, a city beyond aging," pointing out that already in 1970 the proportion of the population of Vienna above age 60 had reached a peak of 28 percent which was followed by a decline. In other words, contrary to the general aging trend in Europe, the population of the city of Vienna had become younger in recent decades. This article also presented projections produced by the Austrian Statistical Office (Statistik Austria) which indicated that Vienna's population would get older again in the future, but not return to the high 1970 level by 2050. In 1988, this short paper was considered interesting enough for the American Academy of Arts and Sciences to have it reprinted as the cover story of their widely circulated newsletter (AAAS 1989).

Over the past 15 years interest in population aging and concern about its consequences have significantly increased. While in the 1980s the discussion was still largely limited to academic circles, it is now a topic that can be found in the newspapers almost on a daily basis. There seem to be two reasons for this significantly increased public interest in aging in Europe. First, the year when the large cohorts born during the baby boom of the early 1960s will reach the average retirement age (currently 57-58 years in Austria) has come much closer. The associated dramatic shift in the support ratio is now within less than 20 years and thus already on the radar screen of social security and longer term financial planning. Second, fertility rates fell lower and life expectancy increased more rapidly than assumed during the 1980s, both working in the direction of more rapid aging.

The concern about the consequences of population aging has also reached the highest political levels in Europe. It has repeatedly been a topic at the summit meetings of the European Union heads of state and government, and is seen as a potential threat to the EU's ambitious Lisbon goal of making Europe the world's most competitive knowledge-based economy. The European Commission is also giving increasing attention to population aging both in its planning and research activities. In Austria Federal Chancellor Wolfgang Schüssel, during a discussion about demographic trends, recently asked whether there were any examples of societies that had already experienced such high proportions of elderly persons. Remembering our 1988 piece, one of the authors answered that it might be useful to think back to what Vienna was like around 1970. This discussion provided the incentive to revisit the 1988 article, to see how the demographic trends have actually evolved, to describe what has changed in terms of our outlook for the future, and to discuss the implications.

The original article started with a quote from Ansley Coale at the 1988 Population Association of America meeting in New Orleans. During the discussion in a session on aging, he said: "If you want to see what low fertility populations will look like in the future, go to the streets of Vienna and see all the crusty old ladies." This remark inspired the authors to undertake the original study. We found that Ansley Coale's visit to Vienna had to have been some years back, because in the meantime the proportion of inhabitants above age 60 had already declined from 28 to 25 percent. During the 1990s this trend toward a younger age structure continued even more strongly than anticipated in 1988. At that time, a figure of 23.0 percent above age 60 was projected for 2000. The actual number for 2000 is 20.5 percent. The difference is mostly due to migration to Vienna having been higher than expected.

In the next section we will repeat the still valid historical analysis and then discuss how and why our outlook to the future has changed. Based on this, we present the first probabilistic population projections for Vienna, which to our knowledge are also the first probabilistic population projections for any urban area.

## 2 Vienna's age structure, 1900 to 2000

Figure 1 shows four age pyramids for Vienna spanning a full century. All pyramids use the same scale so that the dark areas are comparable in terms of describing total population size. This shows that in 1900 the total population of Vienna (1.77 million) was greater than today (1.61 million) although the area of settlement was much smaller and most people lived within the inner districts of today's city. At that time Vienna was the capital of a big multi-ethnic empire attracting lots of migrants. The age structure of the population of Vienna in 1900 therefore looks like that of a typical high fertility population with a major migrant population (starting in young adulthood) superimposed to it. Figure 2, which splits up the population increase for each decade into natural increase and migration components, shows that during the last decades of the 19$^{th}$ century migration gains were far more significant in Vienna than the natural increase. This explains why the superimposed migration pyramid also includes adults of higher ages.

World War I brought a radical change in the demographic pattern of Vienna. Figure 2 shows that between 1911 and 1923 Vienna lost people both through higher death than birth rates and net out-migration. During that period the population of Vienna declined by 8 percent. In the following decade 1924-34 Vienna continued to have a big deficit in natural growth but this was balanced again by net migration gains. As a consequence the age pyramid for 1934 shows an extremely distorted age structure. The number of women aged 25-30 was more than three times that of girls aged 0-5. The reason for the very small number of children was the extraordinarily low level of birth rates during the late 1920s and early 1930s. In 1934 the total fertility rate in Vienna was as low as 0.6. The small size of the cohort aged 15 years in 1934 is a consequence of very low fertility levels at the end of World War I. On the other hand, the large number of men and women aged 25-35 not only results from the strong birth cohorts around the turn of the century, but also from substantial migration of young adults into Vienna. Many of the young women who moved to Vienna from the densely populated rural areas in search of jobs remained unmarried and childless during the economic crisis of the 1930s. With increasing longevity this age structure was predetermined to result in extreme population aging over the coming decades.

Before the 1950s migration losses even reinforced this trend. During the 17 years from 1934 to 1951, Vienna lost a total of 320,000 or 17 percent of its 1934 population. This most unusual population decline of a large urban area results predominantly (11 percent of the 17 percent) from the excess of deaths (including war losses) over births. Among the

**Figure 1: Age pyramids of Vienna in 1900, 1934, 1971 and 2000.**

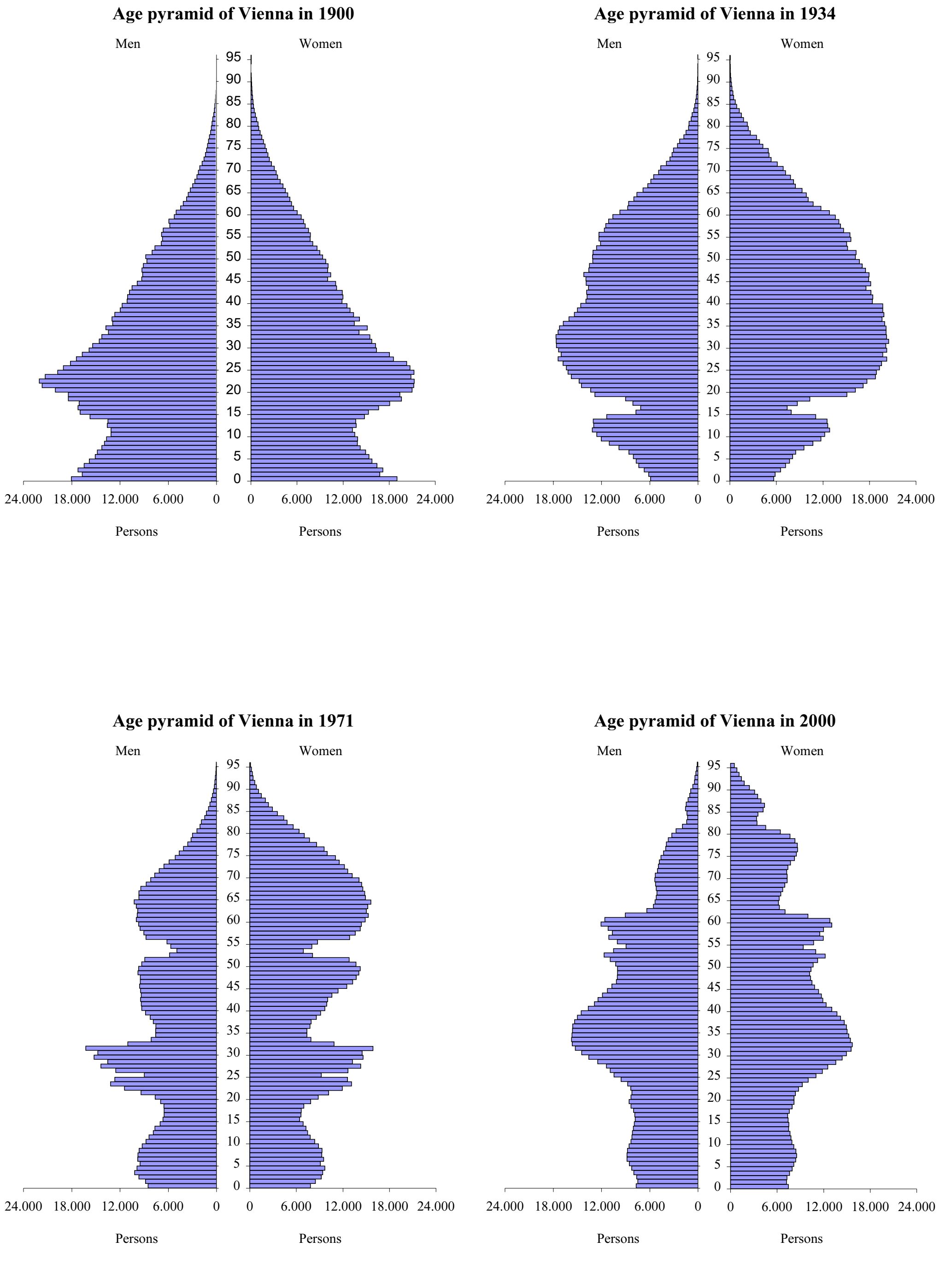
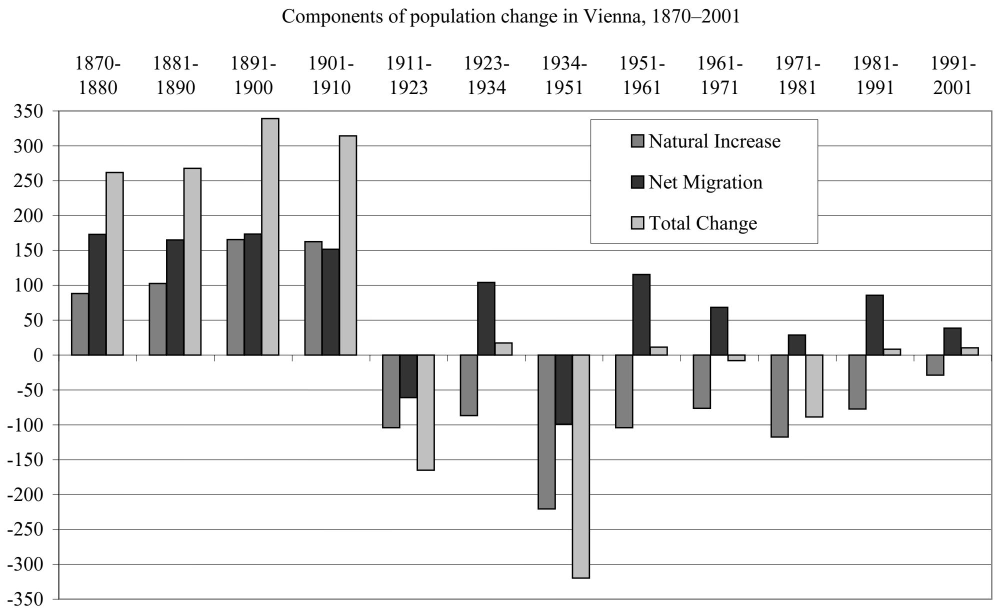


**Figure 2: Components of population change in Vienna, 1870-2001.**

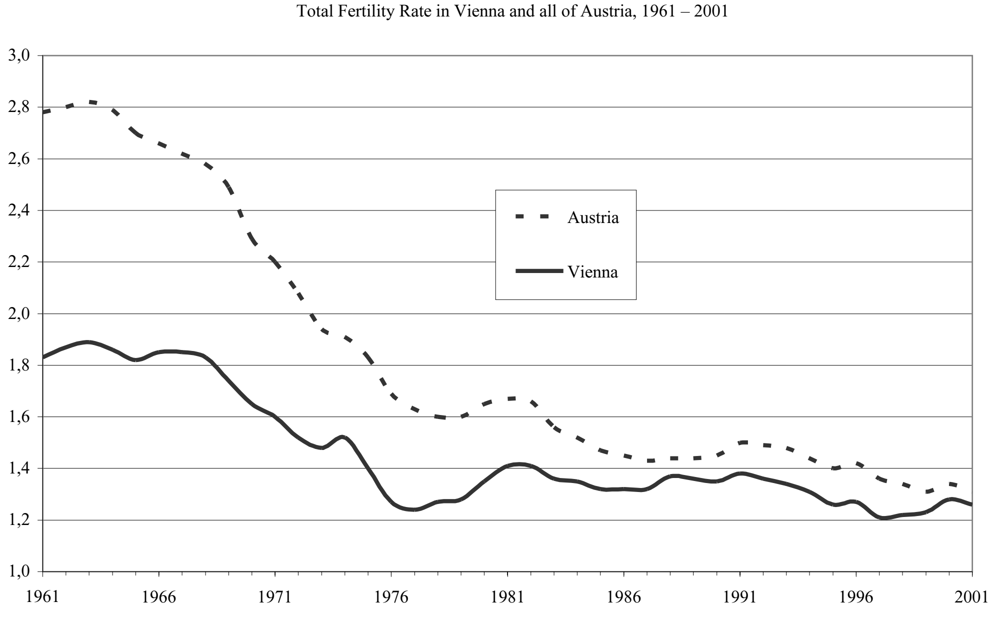



migratory losses the most prominent is the fate of the large Jewish community in Vienna, two thirds of which could emigrate – mostly overseas – while the remaining third was killed in concentration camps all over the Nazi *Reich*.

Since 1951 the pattern has been more stable with a continued deficit of births over deaths being largely compensated by in-migration from other parts of Austria, Hungarian refugees in 1956, and later of guest workers from Yugoslavia and Turkey. Even in the time of the baby boom during the 1960s there were 76,000 more deaths than births in Vienna. Figure 3, which depicts the trends in the total fertility rates for Vienna as compared to that of all of Austria, also shows that even at the height of the baby boom fertility in Vienna stayed well below replacement level.

The census of 1971 counted 450,000 persons above age 60 in Vienna, which was 27.7 percent of the total population, a historical peak both in absolute and relative terms. The corresponding age pyramid in Figure 1 does indeed look odd. It is dominated by the huge group of elderly women between age 60 and 75. This is what Ansley Coale talked about and what was very visible in the streets of Vienna at the time. It was also visible and tangible in many other aspects of life in Vienna, although it was less of a problem for the social security system than it is today or is being forecast for the future for two important reasons: 1) The funding base for pensions is the population of all of Austria which was much younger than that of Vienna in 1971 and at that time was also younger than that of Austria today; and 2) the level of pension entitlements was much lower and many of these “crusty old ladies” lived in very tight financial conditions.

**Figure 3: Total fertility rate in Vienna and all of Austria, 1961-2001.**




## 2 Revisiting the 1988 Projections

The 1988 paper also published projections for the population of Vienna to the year 2050 which were based on the 1988 projections of Statistics Austria. For the year 2000 these projections gave an elderly population above age 60 of 328,800 (23.0 percent of the total population). The actual count in 2000 was 330,428 (or 20.5 percent of the total population). Hence the absolute number of elderly was marginally higher than projected, but their proportion turned out to be visibly lower than estimated because the total population had increased. The difference between the projection and the actual count is mostly due to higher-than-expected migration to Vienna, which resulted in a more rapid increase of the young adult population, and to somewhat greater improvements in old age mortality than anticipated. Figure 2 shows that natural increase continued to be negative over that period but the political changes in the neighboring countries to the north, east and south of Vienna resulted in unexpectedly large migration streams to Vienna. While in 1988 the total population of Vienna was projected to be at 1.429 million in 2000, the actual count in 2000 was 1.609 million. This is a 13 percent error over a period of just 12 years.

As for the future the new 2001 projections of Statistics Austria now foresee a continuation of population growth in Vienna. They project a population of 1.808 million in 2030 and 1.861 million in 2050. This again is very different from the 1988 projections which assumed the total population to decline to 1.365 million in 2030 and 1.310 million in 2050. This is a 32 percent change in the outlook for 2030 and a 42 percent change in the outlook for 2050. The outlook for the elderly population (above age 60) changed even more dramatically. Now Statistics Austria expects 80 percent more elderly for 2050 than were expected in 1988 (cf. Table 1). Table 1 shows that the 1988 and 2001 assessments differ not only in levels but also in trends. While the 1988 projections assumed that a second peak in the proportion of elderly would be reached around 2030 (which with 27.4 percent was to be somewhat lower than the 1971 peak), followed by a subsequent decline in that proportion, the newest forecasts show 28.8 percent for 2030 and even 31.4 percent for 2050.

**Table 1: Vienna's population above age 60, 1900-2050. Absolute numbers and percentages of the total population. Empirical data and the 1988 and 2001 projections of Statistics Austria.**

| Year | Absolute (in 1000s) | Percentage of total population |
|---|---|---|
| 1900 | 110 | 6.6 |
| 1910 | 148 | 7.3 |
| 1923 | 166 | 8.9 |
| 1934 | 247 | 13.2 |
| 1951 | 326 | 20.2 |
| 1961 | 410 | 25.2 |
| 1966 | 441 | 27.2 |
| 1971 | 449 | 27.7 |
| 1981 | 386 | 25.2 |
| 1986 | 377 | 25.5 |
| 1990 | 364 | 24.9 |
| 1995 | 336 | 23.3 |

| Year | Projection 1988 | | Projection 2001 | |
|---|---|---|---|---|
| | Absolute | Percentage | Absolute | Percentage |
| 2000 | 328 | 23.0 | 330 | 20.5 |
| 2005 | 354 | 25.0 | 362 | 22.1 |
| 2010 | 364 | 26.0 | 384 | 22.9 |
| 2015 | 359 | 25.8 | 401 | 23.4 |
| 2020 | 360 | 26.0 | 431 | 24.7 |
| 2025 | 369 | 26.8 | 477 | 26.8 |
| 2030 | 374 | 27.4 | 522 | 28.8 |
| 2035 | 363 | 26.9 | 547 | 30.8 |
| 2040 | 343 | 25.8 | 561 | 30.4 |
| 2045 | 333 | 25.2 | 574 | 31.0 |
| 2050 | 325 | 24.9 | 584 | 31.4 |

Table 2 compares the assumptions of the 1988 projections to those of the most recent one produced by Statistics Austria in 2001. It first shows that the fertility assumptions are now somewhat lower than in 1988. In the old projections, the level assumed for 2000 was a TFR of 1.41, which was assumed to further increase to 1.50 by 2015 and then stay constant. Actual fertility in 2000 was 1.28 and the new projections assume an increase to 1.41 by 2015, staying constant thereafter. There is significant uncertainty, however, about the future level of fertility. This is why in the following section we try to quantify this uncertainty.

**Table 2: Comparison of assumptions of the population projection for Vienna made by Statistics Austria in 1988 and 2001.**

| Year | Projection 1988 | | | | Projection 2001 | | | |
|---|---|---|---|---|---|---|---|---|
| | TFR | LEmale | LEfemale | Netmig | TFR | LEmale | LEfemale | Netmig |
| 2000 | 1.41 | 72.6 | 78.9 | 2,000 | 1.28 | 74.6 | 80.4 | 7,460 |
| 2005 | 1.44 | 73.2 | 79.5 | 2,000 | 1.31 | 75.4 | 81.1 | 8,552 |
| 2010 | 1.47 | 73.9 | 80.0 | 2,000 | 1.36 | 76.1 | 81.7 | 8,084 |
| 2015 | 1.50 | 74.5 | 80.6 | 2,000 | 1.41 | 76.9 | 82.5 | 7,640 |
| 2020 | 1.50 | 74.5 | 80.6 | 2,000 | 1.41 | 77.7 | 83.2 | 7,226 |
| 2025 | 1.50 | 74.5 | 80.6 | 2,000 | 1.41 | 78.5 | 84.0 | 6,562 |
| 2030 | 1.50 | 74.5 | 80.6 | 2,000 | 1.41 | 79.4 | 84.9 | 6,213 |
| 2035 | 1.50 | 74.5 | 80.6 | 2,000 | 1.41 | 79.9 | 85.3 | 6,107 |
| 2040 | 1.50 | 74.5 | 80.6 | 2,000 | 1.41 | 80.5 | 85.7 | 5,985 |
| 2045 | 1.50 | 74.5 | 80.6 | 2,000 | 1.41 | 81.0 | 86.1 | 5,759 |
| 2050 | 1.50 | 74.5 | 80.6 | 2,000 | 1.41 | 81.6 | 86.5 | 5,457 |

The main difference between the old and the new projections, however, lies in the mortality assumptions. The old projections assumed that life expectancy by 2015 would reach 74.5 years for men and 80.6 years for women and then stay constant. Official Austrian projections of that time had a time horizon of 2015. Extensions to 2050 were considered hypothetical calculations under the assumption of constant 2015 conditions (rates) in order to illustrate the longer term consequences of the irregular age structure.

For men, the observed life expectancy in 2000 of 74.6 was already higher than the figure assumed for 2015 in 1988. But Statistics Austria was not the only one to make erroneous mortality assumptions in the 1980s. The UN population projections, which have been serving as a model for many countries, also assumed a maximum life expectancy at levels that retrospectively seem amazingly low. In their 1973 assessment it was assumed that maximum life expectancy was going to be 72.6 years for men and 77.5 years for women (Bucht 1996). Ten years later, in 1982, the assumed maximum was 75.0 for men and 82.5 for women. In 1988, the UN had already moved the maximum to 82.5 for men and 87.5 for women. These are even higher levels than the 2050 life expectancies assumed in the most recent 2001 projections. In both cases no substantive justifications are given for the specific mortality assumptions made.

It is evident that over the past decades improvements in life expectancy in Europe and North America have systematically been underestimated by most population projections (cf. Keilman 1997). When discussing this issue with producers of official projections and asking whether we should try to avoid this error in the future, one typically encounters a rather "conservative" attitude to not assume too much of a further improvement. This view also implies that to assume only small increases in the medium run and no further increases in the very long run is "being on the safe side." In the context of population aging, unfortunately, having life expectancy assumptions which are too low means that the speed and magnitude of aging is underestimated, and in terms of the social and economic risks associated with aging one is therefore in fact on the "unsafe" side. The truth of the matter is, we know very little about the future course of life expectancy. The scientific literature on this issue shows two opposing views: one that refuses to expect much further increase, and another saying that if there is a limit to human life expectancy, it lies well above one hundred years. As population forecasters, the only thing we can do in such a situation of relative ignorance is to assume very broad ranges of mortality uncertainty for the future.

There were also marked changes in migration assumptions. While in 1988 a constant net migration gain of 2,000 people per year was assumed for Vienna, this has now been changed into separate assumptions for out-migration rates and in-migration in terms of absolute numbers. These assumptions imply an average annual net migration gain of 6,000 people for Vienna. For all of Austria an average migration gain of 20,000 per year is assumed. These (on a relative scale) much higher assumed migration gains for Vienna are the reason why Vienna's population is now projected to age more slowly than the total population of Austria. But again the future of migration gains or losses in Vienna is highly uncertain, and will depend on all kinds of political and economic changes that are hard to foresee today. For this reason we will also assume broad uncertainty ranges for future migratory movements into and out of Vienna.

## 3 New Probabilistic Population Projections for Vienna

We have seen in the above analysis that already 13 years after the 1988 projections things look rather different, both in terms of the demographic reality today as well as in terms of our outlook for the future. Vienna today is significantly younger than projected in 1988 due to the unexpected influx that has to do with the political changes in the former communist neighbor countries. Over the coming decades, however, we assume that Vienna will become significantly older than projected in 1988. This clearly shows that in terms of population projections, several things can go wrong at the same time. In the case of Vienna 1988-2000 it meant underestimating both migration and life expectancy gains as well as overestimating fertility.

What should demographers do in such a situation? A frequent response is to feel embarrassed and try not to talk too much about the old projections but just focus on the new ones. That way, however, we do not learn much from history. An alternative approach is therefore to try to analyze why such assumptions were made in the past. This is more than simply calculating the mean percentage errors of past projections and then assuming that similar percentage errors in total population size are also going into in our current forecasts (National Research Council 2000). A more useful approach would be to have a look at the individual fertility, mortality and migration assumptions made in the old projections, compare them to empirical trends, and try to understand the mindset and reasoning that brought about these assumptions in the past.

Concerning the specific projections for Vienna, the case is rather clear. The bulk of the error is due to having underestimated migration into Vienna. In 1988 Vienna lay in the outmost corner of the Western world, a dead end bordered to the north, east, and south by the iron curtain which was assumed to remain tight for the coming decades. A big historical surprise around 1990 changed this situation significantly. Would it have been possible to foresee this in 1988? Certainly not in terms of the conventional "business as usual" scenarios and probably not in the context of the usual way of defining "plausible" ranges either. However, when stepping back and thinking in terms of theoretically possible, high impact but low probability events, the possibility of increased migration as a consequence of a hypothetical fall of the iron curtain could have been identified as one possible future.

The other main error was less due to surprising political events but to a "conservative" mindset. As discussed above, the dominant view in the 1980s was that life expectancy was already close to its limit (Bourgeois-Pichat 1984; Day 1991; Duch_ne and Wunsch 1991). This was largely taken as self-evident and almost no official population projections included mortality uncertainty variants. Although there were some dissenting views (Manton 1986; Vaupel and Gowan 1986) most projection-producing agencies did not take them seriously. It was only around 1990 that some population projections started to systematically consider alternative mortality paths with continued gains in life expectancy (Lutz 1991). In the meantime it is generally accepted in the scientific community that there is considerable uncertainty about the future path of mortality. However, many agencies still do not explicitly consider this in their projections.

What can we learn from this short substantive account of the reasons for the errors made in the 1988 projections? We can learn that we should try not to be constrained in our thinking about the future by conventional wisdom and limiting conservative mindsets. We should develop projection models that allow for the consideration of low probability/high impact events in all three components. In this, analysis of the variation of past trends and assessment of past forecasting errors can be very useful pieces of information, but this information should not automatically and mechanistically be converted into probabilistic population projections. The challenges of the future can and mostly likely will be different from what we have observed in the recent past. There is no substitute for human imagination together with informed reasoning and critical peer evaluation in trying to draw up alternative future paths. On the other hand, we have to be aware of the biases that inevitably are part of any human expert judgment. An extensive discussion of these questions in the context of probabilistic population projections is given in Lutz and Goldstein (forthcoming).

In the remaining part of this paper we will try to convert these thoughts into probabilistic population projections for Vienna. Essentially, these are based on the new 2001 population projections supplied by Statistics Austria (Hanika 2001). The median paths of assumed future fertility, mortality and migration distributions are identical to the projection assumptions described in Table 2. The projections of Statistics Austria also include high and low variants for each of the three components (fertility, mortality and migration). It is unknown, and remains undefined, what percentage of all possible future paths are assumed to lie within the high-low ranges. The guiding principle in defining these alternative assumptions was the widely used notion of a "plausible" range. Here we operationalize these assumptions by fitting a normal distribution for which 67 percent cover the high-low ranges given by the Austrian experts. Since the normal distribution has long tail ends, this distribution also includes extreme rates with low probability. These ranges were chosen wide enough to cover the extent of the errors in the 1988 projections as described above. The stochastic model chosen corresponds to that described in Lutz et al. (2001) which assumes annual fluctuations in all three components and no correlation among the components.

# 4 Results

Figures 4 to 7 and Table 3 present the results of these probabilistic population projections for Vienna in terms of fractiles of the resulting distributions, based on the outcomes of one thousand independent cohort component projections that draw from the fertility, mortality and migration distributions as described above. Table 2 gives a rather complete listing of output parameters for both absolute numbers and proportions as well as specific small age groups that may be important for the planning of school building projects, etc. The table lists the medians of the resulting distribution and the 10 and 90 percent fractiles, i.e., the range representing 80 percent of all projected cases.

Figure 4 shows the results for the proportion above age 60, which was the main point of interest objective of both the original 1988 paper and this revision. We see that over the coming years this proportion has a very small uncertainty range. Its level will start to increase significantly only after 2020, and the uncertainty range will greatly expand. We also see that the 95 percent uncertainty interval is highly asymmetric with greater upward than downward deviations. This is a consequence of the interaction between mortality uncertainty and migration uncertainty.

Figure 5 shows the distribution of children at the age of lower secondary school. Since school attendance is still compulsory at age 10-13, this is a highly relevant figure in the planning of new, or the restructuring of existing, schools. Not surprisingly, we see that over the coming 10-13 years there is virtually no uncertainty because these cohorts have already been born and only few migrant children arrive in this age group. But after 2013 the uncertainty range explodes due to the significant uncertainty about future fertility lev-

**Figure 4: Vienna, proportion above age 60.**

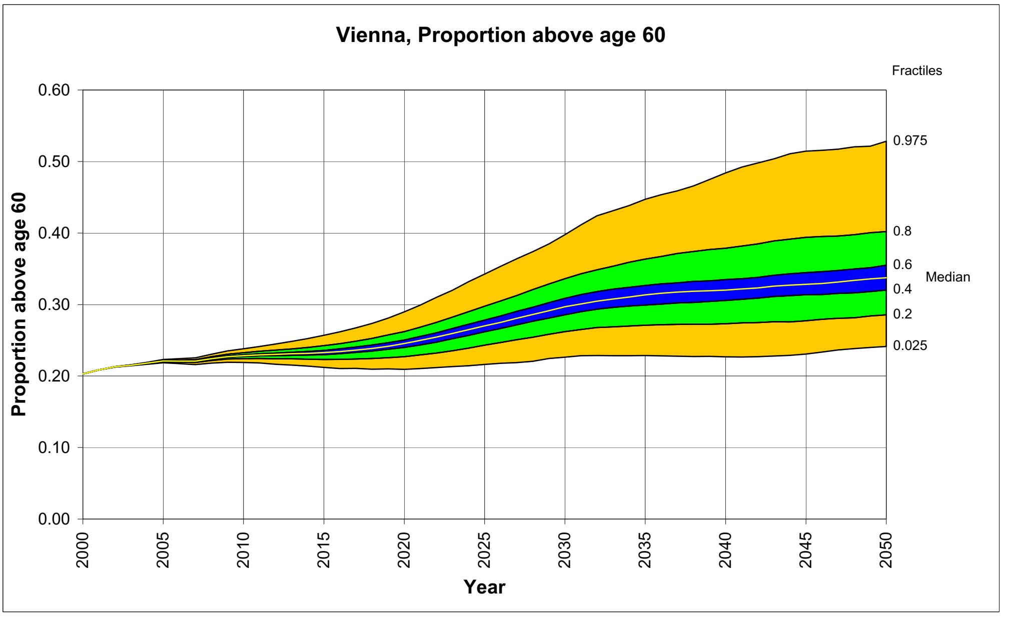
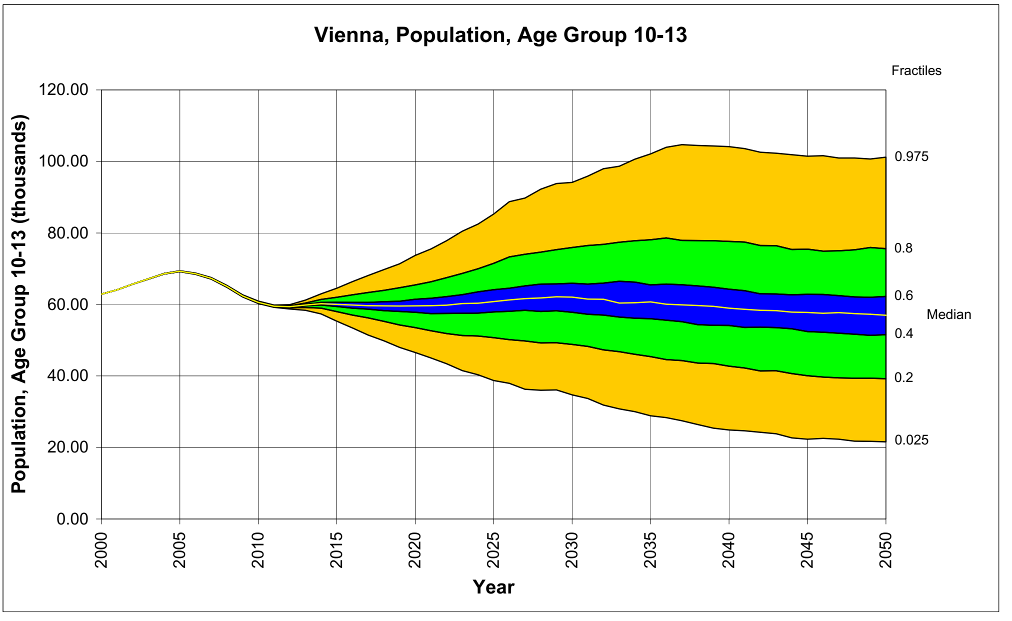


**Figure 5: Vienna, population, age group 10-13.**




els in Vienna, though uncertainty about the children of possible migrants adds to this as well. It should be noted that the assumed age pattern of migrants is based on empirical observations over the past years, including fewer children than in usual standard migration schedules

Figure 6 depicts the range of another special age group, i.e., men and women between the ages of 55 and 64 who are particularly relevant for policies concerning early retirement schemes. As we see, significant fluctuations with very low uncertainty are already programmed in the age structure for the coming 35 years, essentially the consequences of the baby boom and the subsequent fertility decline. Only after 2035-40 the uncertainty starts to increase significantly. Since this is too early to be the fertility uncertainty (as we already know the size of the cohorts), it is a consequence of mortality uncertainty increasing with age and cumulated migration uncertainty. This figure clearly shows that we can talk of the size of this age group with much higher certainty in 2030 than of the same age group in 2040. Without this kind of probabilistic projection we would not be aware of such a simple consequence of population dynamics.

Figure 7 shows the full probabilistic population pyramid for Vienna in 2030. It gives the fractiles of the uncertainty distribution applying to each single year age group (but not to the whole pyramid jointly). The pyramid looks a bit unusual due to the large uncertainty around age 30-40 which is a consequence of the very wide migration uncertainty assumed in these projections. We also have to be aware that for a city interacting with its surroundings, migration tends to be relatively more important than in the projection of a whole nation. To our knowledge this is the first probabilistic projection of a city rather than of a country. Again this probabilistic age pyramid shows that uncertainty differs greatly with age – an important piece of information for any kind of planning that is not apparent from conventional population projections.

**Figure 6: Vienna, population, age group 55-64.**

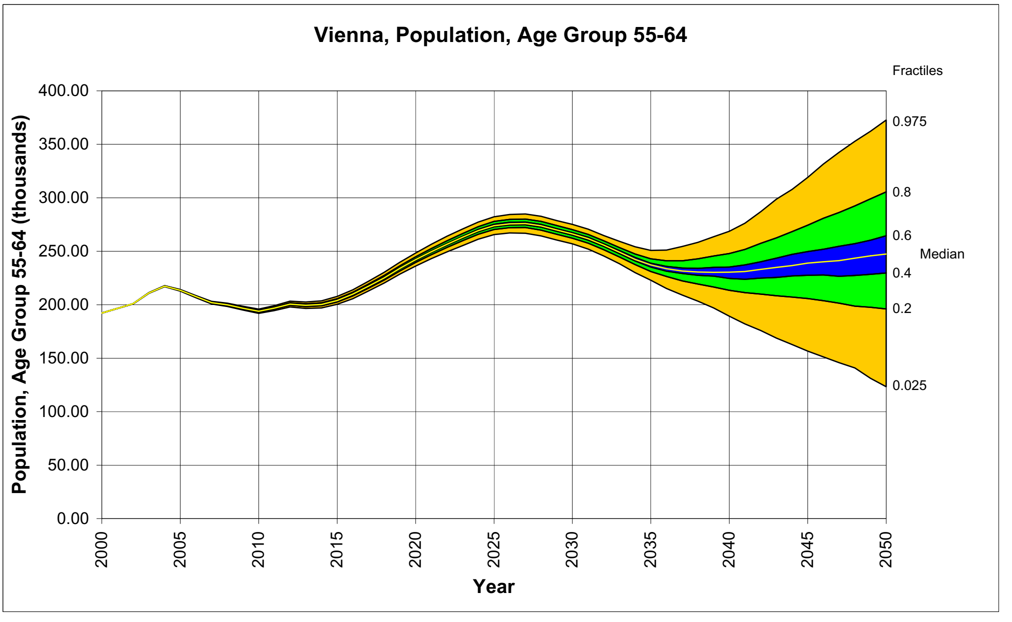



**Figure 7: Probabilistic age pyramid for Vienna, 2030.**

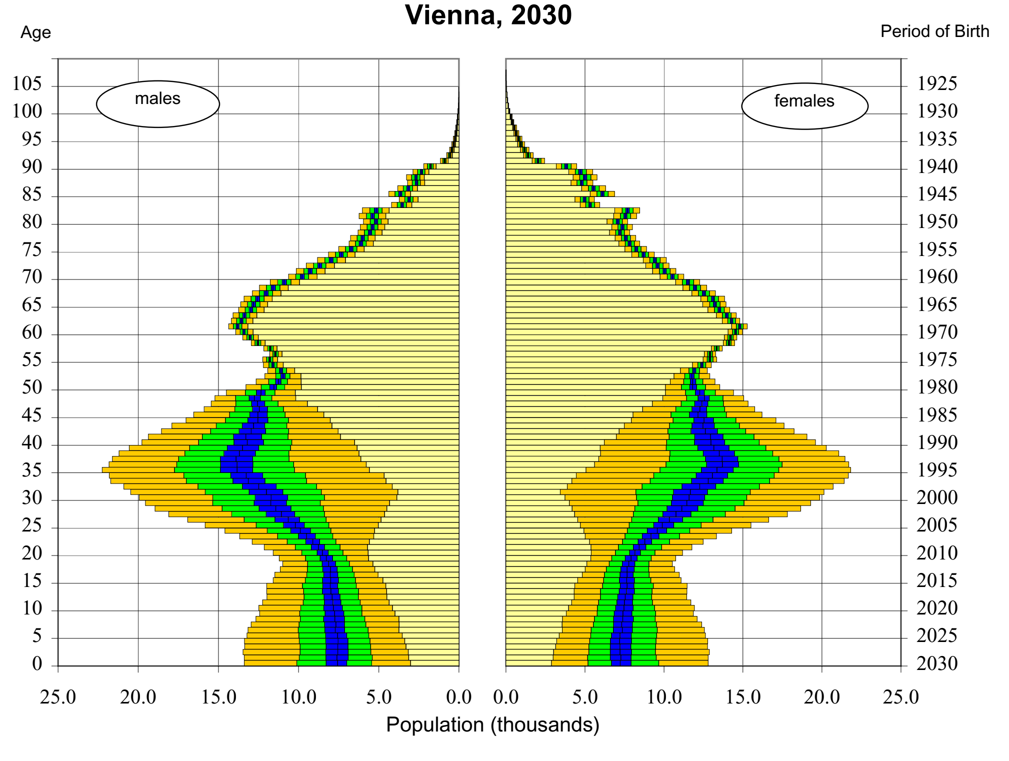


**Table 3: Results of the probabilistic population projections for Vienna to 2050. Selected age groups and proportions. Medians and 80 intervals (in parentheses).**

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Total population (millions) | 1.606 (1.606-1.606) | 1.679 (1.641-1.709) | 1.748 (1.599-1.894) | 1.797 (1.520-2.082) | 1.813 (1.422-2.200) | 1.802 (1.335-2.278) |
| Population below age 15 (thousands) | 240.697 (240.697-240.697) | 226.932 (212.827-239.796) | 228.263 (175.941-282.203) | 227.414 (152.077-317.417) | 215.887 (129.004-318.520) | 207.018 (118.801-319.723) |
| Population aged 15-60 (millions) | 1.039 (1.039-1.039) | 1.069 (1.035-1.098) | 1.090 (0.964-1.212) | 1.036 (0.803-1.264) | 1.012 (0.686-1.328) | 0.986 (0.621-1.347) |
| Population aged 60+ (thousands) | 325.976 (325.976-325.976) | 383.062 (378.671-387.276) | 427.507 (412.533-443.799) | 534.317 (502.846-562.480) | 578.403 (534.839-621.702) | 603.118 (530.152-682.216) |
| Population aged 80+ (thousands) | 66.486 (66.486-66.486) | 79.866 (78.502-81.269) | 77.533 (73.062-82.527) | 113.933 (101.972-125.643) | 130.437 (110.677-151.609) | 179.294 (144.735-221.295) |
| Special age groups | | | | | | |
| Age group 3-5 (thousands) | 49.488 (49.488-49.488) | 44.427 (39.661-48.821) | 46.068 (32.952-60.631) | 44.602 (27.749-65.517) | 42.378 (24.331-63.939) | 40.871 (22.679-64.920) |
| Age group 6-9 (thousands) | 68.178 (68.178-68.178) | 59.840 (57.970-61.689) | 60.583 (46.170-74.875) | 60.616 (39.650-86.685) | 57.297 (32.919-86.214) | 55.030 (31.002-85.298) |
| Age group 10-13 (thousands) | 62.880 (62.880-62.880) | 60.588 (60.350-60.802) | 59.853 (50.204-68.877) | 62.015 (42.053-84.293) | 58.658 (35.311-87.373) | 56.193 (31.958-84.820) |
| Age group 14-17 (thousands) | 61.220 (61.220-61.220) | 70.376 (69.282-71.389) | 61.514 (56.291-66.493) | 62.656 (45.807-81.476) | 61.541 (39.400-88.398) | 58.672 (33.469-87.433) |
| Age group 18-29 (thousands) | 244.599 (244.599-244.599) | 249.277 (226.315-269.941) | 251.211 (189.919-314.245) | 231.647 (157.850-301.616) | 231.840 (153.230-311.869) | 220.962 (138.535-319.284) |
| Age group 30-54 (thousands) | 629.942 (629.942-629.942) | 667.486 (658.346-675.443) | 657.519 (591.288-718.963) | 625.209 (461.337-788.010) | 614.887 (383.448-838.024) | 586.188 (348.284-810.829) |
| Age group 55-64 (thousands) | 192.275 (192.275-192.275) | 193.895 (192.531-195.318) | 242.206 (238.064-246.387) | 266.366 (259.916-272.090) | 231.341 (202.666-256.025) | 246.266 (162.487-329.360) |
| Age group 65-79 (thousands) | 185.916 (185.916-185.916) | 207.196 (205.301-209.000) | 243.993 (235.932-252.573) | 281.927 (266.560-296.256) | 339.196 (316.873-358.954) | 305.214 (274.340-335.370) |
| Proportions | | | | | | |
| Proportion below age 15 | 0.150 (0.150-0.150) | 0.135 (0.128-0.142) | 0.132 (0.107-0.154) | 0.127 (0.096-0.157) | 0.120 (0.087-0.152) | 0.117 (0.083-0.150) |
| Proportion 15-60 | 0.647 (0.647-0.647) | 0.636 (0.628-0.645) | 0.623 (0.595-0.651) | 0.575 (0.523-0.615) | 0.557 (0.482-0.613) | 0.545 (0.459-0.599) |
| Proportion above age 60 | 0.203 (0.203-0.203) | 0.228 (0.222-0.235) | 0.245 (0.220-0.274) | 0.298 (0.245-0.364) | 0.321 (0.253-0.418) | 0.334 (0.267-0.440) |
| Proportion above age 80 | 0.041 (0.041-0.041) | 0.048 (0.046-0.049) | 0.044 (0.039-0.050) | 0.064 (0.051-0.079) | 0.073 (0.054-0.098) | 0.102 (0.071-0.147) |

# 5 Conclusions

Revisiting the 1988 population projections and comparing them to actual trends revealed certain errors in all three components of population change that are quite typical for most European projections: fertility was overestimated while life expectancy and in-migration were underestimated. While the fertility and mortality errors tend to compensate each other in terms of the projected total population size, they work in the same direction of underestimating aging. During the 1990s, however, this underestimated speed of aging was more than compensated by unexpectedly high in-migration.

With a view to the significant deviations of empirical population paths from those projected just a little more than a decade before, we may conclude that we can be quite confident that the actual future path will also be different from the new medium projection as described in Tables 1 and 2 of this paper. We could easily have wrapped up our paper with this statement which sounds like a wise conclusion but would not really be helpful to the users. To say, "here is my best guess as of today, but I am pretty sure the outcome will be different anyhow," does not help in the planning of an uncertain future. What needs to be said is more precisely how different the future can be, and how likely the different degrees of deviation from the path are considered to be. Such information can only be given by probabilistic population projections.

Probabilistic projections also help us to describe learning with the passage of time (cf. Lutz et al. forthcoming). Time resolves uncertainties and this leads to a new vision of the future. New forecasts make the old ones appear to be wrong if they were of particular numbers rather than distributions. Probabilistic forecasting allows us to see that changes in our forecasts are themselves foreseeable. It is inevitable that a forecast of Vienna's population made in 2011 will have a different median value than one made in 2001, even if the earlier projection had been completely correct. If the actual trend until 2011 turns out to be below the median, the new median of forecasts produced in 2011 for 2021 will also be below the median of our 2001 projections. This results from the intrinsic indeterminacy of demographic trends together with the relative persistence of aggregate population paths. Rather than interpreting changes in forecasts made at different dates for a fixed future year as failures in forecasting, we now see this as an essential and interesting part of the forecasting process.

Substantively, we now consider it most likely that the Viennese aging peak of 1971 was only a temporary maximum and that its level will again be reached and surpassed over the coming three decades. Hence Vienna, in all likelihood, was only temporarily "beyond aging" due to its very specific and unusual demographic history and will now more or less follow the path of other major European cities. This expectation makes it even more interesting to study in more detail what were the cultural, social and infrastructural implications of this bulge of "crusty old ladies" in Vienna around 1971, so that we can be better prepared when Vienna will experience an even more pronounced demographic phenomenon of this sort in the years to come.

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