Alternating Migration Flows and their Age-Structure Effects on the Long-Term Sustainability of the German Statutory Pension Insurance

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Introduction

Demographic change is often seen as a major threat to pay-as-you-go pension insurance systems. While the ageing of the population and the steady low birth rates are more or less seen as given factors, the third main component of the demographic development, the migration, is often thought of as a possible solution. This is partly due to the fact that, unlike the other two components, especially the immigration can be influenced by political regulation. Various approaches to defining goals for such a regulation seem possible when it aims to mitigate the effects of demographic change on the German statutory pension insurance. On the other hand, migration also has to be viewed as a third component of the at least partially exogenous demographic change. Albeit the immigration to Germany has always depended on political regulations which have been based on various approaches and reasons, a lot of regularities over time across all different types of regulations can be found.

In this contribution, I will focus on three major regularities and their influence on the German statutory pension insurance. The first regularity is the wave-form of the total number of immigrants with an identifiable frequency. The second one is a direct correlation between the net migration and the age and gender structure of the resulting flows of immigration and emigration. The third, albeit much smaller regularity can be found in the correlation between age, duration of stay and labour market participation among immigrants. I use these regularities in order to construct a stylised yet plausible scenario for the development of immigration to and emigration from Germany until the year 2060. This scenario is compared to a version of the commonly used flat net migration scenarios with a constant relative age structure. The average net migration is matched between the compared scenarios to show the differences in the resulting age structure and its effects on the two main variables of the German statutory pension insurance, contribution rate and replacement ratio. To increase comprehensiveness, I equalise the replacement ratio of both scenarios, so all of the impact goes to the contribution rate as the main target variable. For the computation of these effects, a deterministic population projection and labour market participation projection is combined with a macroeconomic growth model and a detailed computation of the budget of the German statutory pension insurance. The population projection runs the two compared scenarios, while the labour market participation projection is sensitive to the third regularity, the one between age, duration of stay and labour market participation. This way, the effects of these regularities on the pension insurance contribution rate (and the replacement ratio) can be observed and measured for the first time. A brief summary of my results is that these effects lead to a general underestimation of the influence of immigration on the German statutory pension insurance within the next forty years.

In the next section, I will give a short summary of the existing literature. This is followed by a description of the migration regularities and the modelling technique for and construction of the migration scenarios. Then I will explain the rest of the simulation model and the data used for initialisation. After this, the results of the computations are explained, before the conclusion is drawn.

Literature Overview

The demographic literature on the prognosis and projection of migration flows shows a lot of different approaches. According to Bohk (2012), a first distinction has to be made between probabilistic and deterministic models. For the choice of parameters to be predicted, the idea of using immigration and emigration probabilities or rates in relation to the respective population introduced by Cruijsen/Keilman (1992) has been identified as too complex. The approach to predict the total amount of migration flows seems to be more promising. According to Bohk (2012), a projection of the total net migration, the net migration separated by categories such as age or gender or a separate projection of immigration and emigration flows by these categories can be the model of choice. The last distinction according to Bohk (2012) has to be made between interpolating (see i.e. Keilman/Cruijsen 1992 or de Beer 2007), extrapolating, theory-based causal (see i.e. Bijak 2006 or Bijak et al. 2004) and multi-causal (see i.e. Rogers 1985 or Bijak 2007) approaches.

While probabilistic multi-causal models such as the one presented by Bohk (2012) are currently up-to-date in purely demographic papers, they seem quite uncommon when it comes to macroeconomic long-term projections of pension systems. There, usually the total net migration is projected with a partially extrapolating and interpolating approach, where a short period of continuation of the current development is followed by a convergence to an exogenously set target value which is then held constant for the rest of the time frame. The relative age and gender structure is usually assumed to be constant over time (see i.e. Werding 2011 or Holthausen et al. 2012). Also the 12th official population projection of the German Federal Statistical Office (Destatis) uses this approach. It is widely used as a basis for macroeconomic projections. A parametric extrapolation in combination with theoretically explained scenarios which also accounts for changes in the relative age structure of immigration and emigration has only been used for a macroeconomic projection of the German pension insurance by Vogt/Althammer (2015).

Outcomes of different immigration scenarios on the German pension insurance contribution rate have only been projected with a macroeconomic simulation model by Börsch-Supan (2002), Werding (2016), Aretz et al. (2016) and Vogt/Althammer (2015). The first three use scenarios constructed via a variation of the net migration with a constant relative age and gender structure, and account for aspects of assimilation such as a different labour market participation and fertility among immigrants. The latter, on the other hand, focus on the changes in the relative age and gender structure of the migration streams and on a more realistic non-constant net migration, while they do not take into account labour market participation and fertility differences. A combination of both effects and a clear measurement of the difference between alternating and constant scenarios are still missing, so this contribution aims to fill this gap.

Regularities in the Migration Streams

Even though immigration to Germany has seen a lot of different regulations since the Second World War, certain regularities can be observed during the different periods. The most obvious among them is the alternating structure of the time series of net migration.

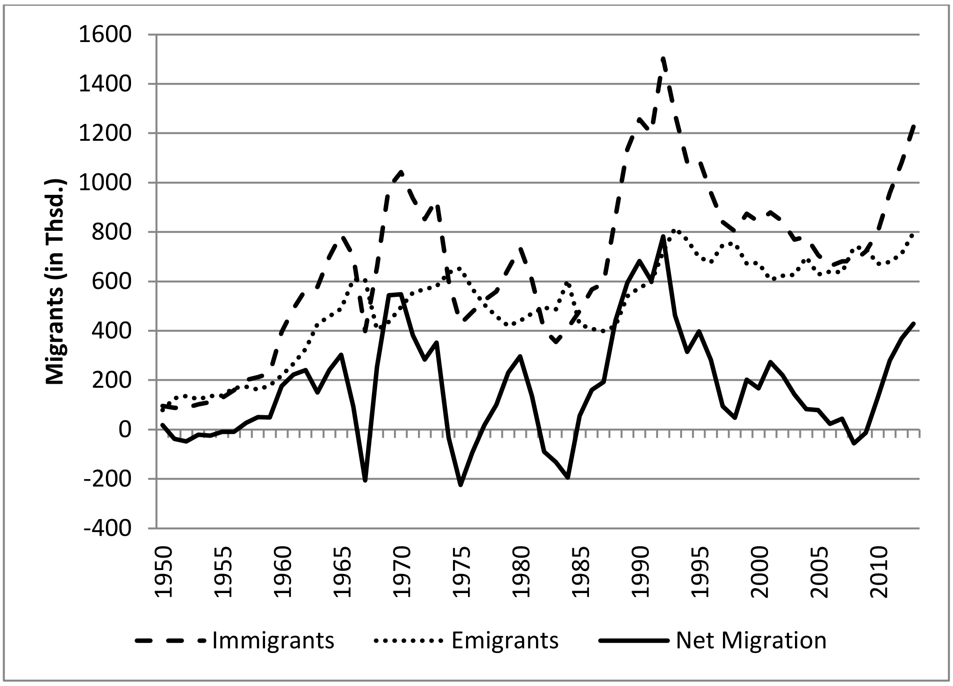

Figure 1: Migration to and from Germany (Source: Destatis)

As shown in Figure 1, the frequency between the main peaks and lows is relatively constant over time, except for some smaller singular variations. The sequence of peaks and lows is strongly correlated to the changes in the regulations, but these at the same time produce and follow the frequency themselves by making access easier or harder and reacting or not reacting to international developments. The amplitude shows larger variations and a less clear development over time, but it can also be described as a series of larger and smaller peaks, with lows in between which differ less than the peaks.

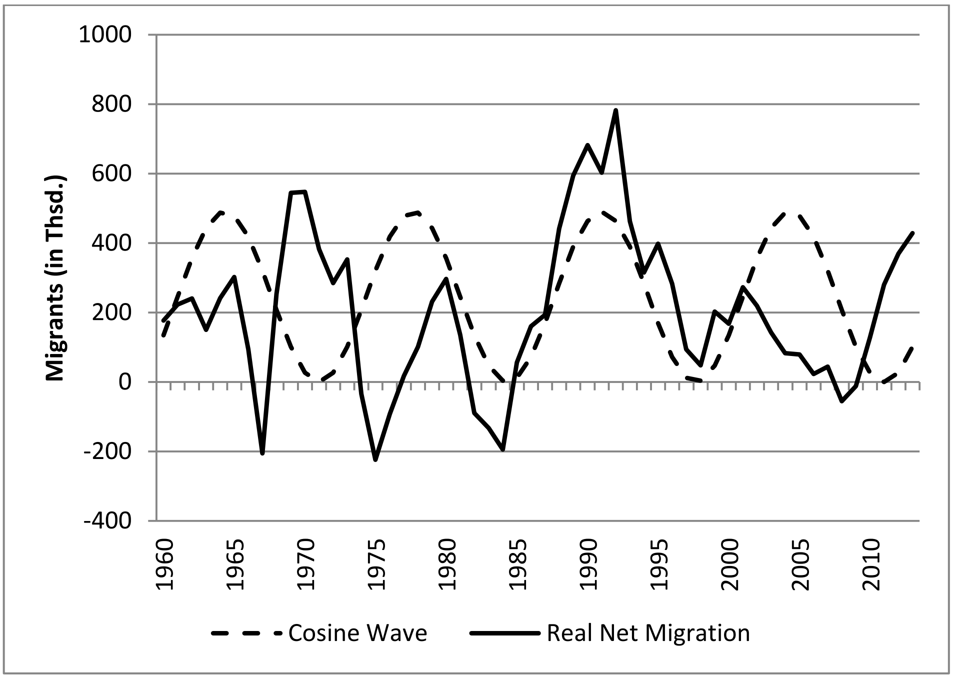

Figure 2: Comparison between Cosine Wave and Real Net Migration (Source: Destatis and own calculation)

As shown in Figure 2, the frequency and a similar average amplitude can be modelled via a cosine function.

The second important regularity in the development of the migration streams can be found in the correlation between the sum of migrants in each of the streams and its relative age structure.

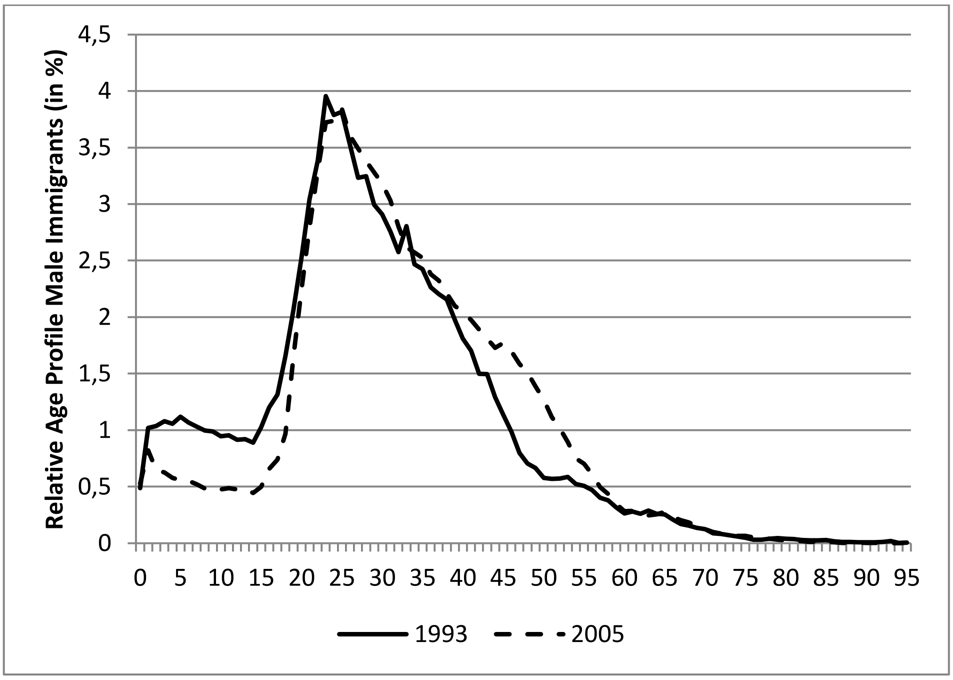

Figure 3: Comparison between Peak and Low Relative Age Profiles (Source: Destatis)

Figure 3 shows the relative age structure of male immigration to Germany for the peak year 1993 and the low year 2005 as a typical example. For a detailed analysis of this regularity, I use a method already applied in Vogt/Althammer (2015) and similar to the parameterisation in Castro/Rogers (1981): a parameterisation of the absolute age structure of the migration streams via a Gompertz function, separately for immigration and emigration and for each gender. The Gompertz function is of the type $A \cdot (-b) \cdot \ln c \, e^{\ln c \cdot x - b \cdot c^x}$, with the three parameters A (correlated to the total amount of migrants in the age profile), b (correlated to the position of the peak of the profile) and c (correlated to the skewness of the profile). Thus, the relation between age structure and total amount of migrants can simply be captured by the correlations of the structure parameters b and c to the size parameter A. For the analysis, I use a time series of absolute age profiles for each migration stream from 1991-2011 published by Destatis in their official annual migration statistics. For each year, the parameters are estimated by a nonlinear OLS model, and thus a time series for each parameter is obtained. To account for the differences between the fitted Gompertz curve and the real age profile, a relative error profile is calculated for each year, which remains nearly constant from 1991-2011, so it is assumed to also remain constant in the future. The correlation of b and c to A is measured via linear regression and appears to be highly significant, which clearly indicates that the age profiles and sizes of each migration stream are highly correlated. Also the correlation between the size of each stream and its parameter A has to be computed via linear regression. As a next step, I assume that male and female emigration remains constant in the future, an assumption which seems plausible considering the amount of emigrants in the past. This assumption can also be found in most other population projections for Germany, i.e. Destatis' official population projections. Thus, the number of immigrants in each age group can be fully defined by setting a future path for net migration.

The third relevant regularity I will describe in this paper is the correlation between age/gender, duration of stay and labour market participation rates among immigrants, or in other words, the labour market integration process for immigrants. For this purpose, I use a special evaluation of the micro-census received from Destatis (2016a) which contains data about the labour market status of immigrants by duration of stay and age for the year 2015. Gender differences are estimated via linear regressions to obtain gender coefficients for the participation rates using the official migration evaluation of the micro-census with immigrants by labour market status, age groups, duration of stay and gender. Then, the relation between age/gender, duration of stay and labour market participation is used to alter the labour market participation projected by the labour market module of the model for immigrants within the first five years of their stay. This is done by computing discount factors by age/gender and duration of stay which are multiplied with the participation rates. I hereby assume that the differences in the labour market participation by duration of stay remain constant in the future, which is not a very realistic assumption, but necessary, as a prediction of the future development is hardly possible. The unemployment rate is also altered by duration of stay via discount factors, taken from the same special evaluation by Destatis (2016a), and also here the unrealistic, but necessary assumption is made that the differences remain constant in the future. With these assumptions, the labour market performance of immigrants altogether largely depends on the age/gender composition and size of the immigrant cohorts.

Taking these three major regularities together, the two scenarios investigated in this paper can now be defined. Actually, the difference between the scenarios is defined by a difference in the first regularity: the baseline scenario ‘Constant Path’ ignores the alternating character of the time series of net migration, and keeps it constant at a level of approx. 245,000, which represents the approach found in the existing literature. Thus, the relative age structure also remains constant in this scenario, due to its correlation to net migration. The other scenario, ‘Alternating Path’, has the same average net migration over time, but its time series of net migration is formed by the multiplication of this value with a cosine wave with the frequency and amplitude as shown in Figure 2 above. Thus, also the age structure has an alternating form, and follows the same cycle as the net migration. The overall labour market performance of the immigrant population also shows such cycles, as the number of immigrants within the first five years of their duration of stay follows the cycles, and also the number of immigrants within more and less performant age/duration-of-stay groups varies largely with the age composition in this scenario. Figure 4 depicts the different net migrations in both scenarios.

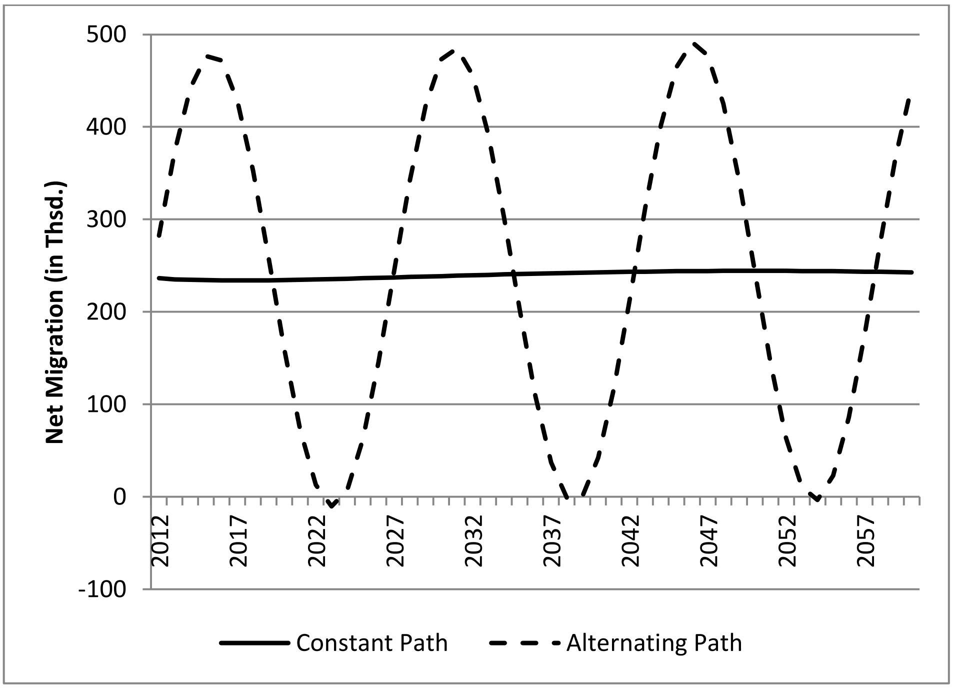

Figure 4: Comparison between the Scenarios (Source: own calculations)

Demographic Macroeconomic Pension Simulation Model

The simulation model I am using in this paper is an updated version of the model used in Vogt/Althammer (2016). It consists of four parts: a population projection, a model of labour market participation, a macroeconomic growth model and a detailed projection of the budgets of German Statutory Pension insurance. The model is a partial-analytical and mainly deterministic framework, as most of the common models of the German pension system such as the ones described in Werding (2011) or Holthausen et al. (2012) are.

Population projection

The population projection is constructed as a purely deterministic and exogenously induced process via the cohort-component method, as it is usually the case in official population projections and macroeconomic pension models. It follows the technique of Leslie matrices (see Caswell 2001). Here, the domestic population of each year is projected into the following year via the multiplication with age- and gender-specific survival and fertility rates. On the individual level, these rates represent survival and fertility probabilities, while on the aggregate level they are interpreted by the law of large numbers as the shares of people for who the events of survival or birth of a child happen.

The survival rates are assumed to be non-constant. They are projected using the method of Bomsdorf/Trimborn (1992), which is a simplified equivalent to the common Lee-Carter method and fits well to the circumstances in Germany (see Babel et al. 2008). It applies a regression of the logarithm of the mortality rates by age/gender to a time index, and leads to an increase in life expectancy by five years for women and six years for men from 2010 to 2060.

For the fertility rates, a common specification (see i.e. Holthausen et al. 2012) is used. In each age group, the specific fertility rate is kept constant at the level of 2010, so that the total fertility rate remains at the 2010 value of 1.4 for the whole simulation period.

The migration part of the simulation model is fully taken over by the scenarios described in the previous section. Regarding pensions, the common assumption is made that emigrants fully lose their previous pension claims and completely disappear from the model. As a major difference to the previous version of the model in Vogt/Althammer (2016), the immigrant population is not only integrated into the population altogether, but also kept in a separate population list by duration of stay.

The initial data for the population projection comes from statistics of the current population for the year 2010 and life tables of Destatis for the years from 1975 to 2010. The main results are fully in line with the literature (i.e. Holthausen et al. 2012) and Destatis' 12th coordinated population projection, as shown in Vogt/Althammer (2016).

Labour market participation

Labour market participation is modelled in three steps. The module follows a modified version of the approach of Burniaux et al. (2004) for the projection of age-/gender-specific participation rates. It uses age-/gender-specific entry and exit rates to and from the labour market which transform the participation rates of one year to the ones of the following year. They are taken from tables of the participation rates of the years 2005 to 2011 out of the official labour market statistics publications of Destatis.

Entry and exit rates are not assumed to be constant. Instead, they are projected via an algorithm similar to the one described by Burniaux et al. (2004). This way, they are adjusted to current trends like later entry into the labour market or later retirement and less clear child-rearing break behaviour, and they are also adjusted to the changes in the official retirement age. As the retirement age is quite inflexible in Germany, the participation rates are adjusted by shifting the exit behaviour to the later age classes around the new retirement age. This means that a shift of the retirement age is almost fully reflected in the actual retirement behaviour, which is not unrealistic unless greater flexibility is introduced by legislation.

In a second step, the participation rates are adjusted to the duration of stay for immigrants within their first five years in Germany according to the method described above. With these participation rates, the labour force among the population is not only calculated for the population altogether, but also separately for the immigrant population by duration of stay.

In the third step, the unemployed are split from the employed within the labour force. The unemployment rate is hereby assumed to be exogenous with the same scenario as in Vogt/Althammer (2016), with a linear decrease from 7.7 per cent in 2010 to 5 per cent until 2020 and then a constant value of 5 per cent until 2060, which is found to be plausible according to the German Council of Economic Experts (see i.e. Werding 2011). The unemployment rate is altered for migrants by duration of stay, and the special unemployment rates by duration of stay are used to split the labour force groups separated by duration of stay into employed and unemployed persons. Finally, the altogether employed and unemployed persons by age/gender are composed from the separate groups of employed and unemployed by age/gender and duration of stay.

Macroeconomic growth

The overall economy is modelled via a Solow-Swan type growth model. As a production function, a Cobb-Douglas function with two types of inputs, capital and human capital, is used. Total factor productivity is assumed to grow by a constant growth rate each year. The stock of human capital, which is taken from the labour force described above, is weighted by a human capital quality index which is assumed to also grow with a constant growth rate. The projection equation for the capital stock is modelled with a constant savings rate applied to average earnings and a constant depreciation ratio. The two outcome variables from the macroeconomic growth module used in the rest of the model are the labour productivity growth as a proxy for the average wage development (with the assumption that wage growth directly follows labour productivity growth) and the growth of the gross domestic product. The calibration data is taken from the ifo Productivity Database via the values published in Werding/Hofmann (2008). The outcomes are in line with other projections such as Werding (2011) or Holthausen et al. (2012).

Pension insurance budget

The pension insurance budget module conducts a detailed computation of the revenues and expenditures of German statutory pension insurance. It follows the approach described in Vogt/Althammer (2016) and contains the following steps:

The first step is a full tracking of each cohort's earnings history. A relative age profile of the wages subject to contributions is taken from data of the German statutory pension insurance. It is kept constant for the whole simulation period. As stated above, the growth of average gross wages and of wages subject to contributions is assumed to follow the growth of labour productivity. The average remuneration points of each cohort by each year are derived from the relation between an average cohort member's wage and the average wage of all insured persons. Then, remuneration points achieved before the initial year are added to the cohorts' sums of life-time remuneration points. Differences within each cohort such as different entry into retirement, different entry into the labour market, times of inactivity or unemployment or immigration are taken into account in the cohort's average sums of remuneration points and deduction factors. Wage heterogeneities within cohorts have to be ignored in the model except for gender differences.

In the next step, an iterative year-by-year calculation of contributions and pension payments is conducted. The value of a remuneration point in Euros (the 'current pension value') is projected from one year to the next via the formula defined in Social Code VI (Sechstes Buch Sozialgesetzbuch – SGB VI). Pension payments for old-age and reduced earnings capacity pensioners and several other benefit payments by the statutory pension insurance are derived from the remuneration point tables from the previous step via multiplication with the current pension value. The revenues from other sources, mainly the government subsidies, are projected via the projection formulas defined in Social Code VI, before the total sum of income subject to contributions is calculated, and then finally the contribution rate is defined such that it balances the budget for this year.

Finally, the replacement ratio in form of the net replacement ratio before taxes is calculated from the current pension value, the contribution rate, the average gross wages and the exogenously set contribution rates of the other social insurances. The exogenous paths of these contribution rates are taken from the German Council of Economic Experts (see Werding 2014).

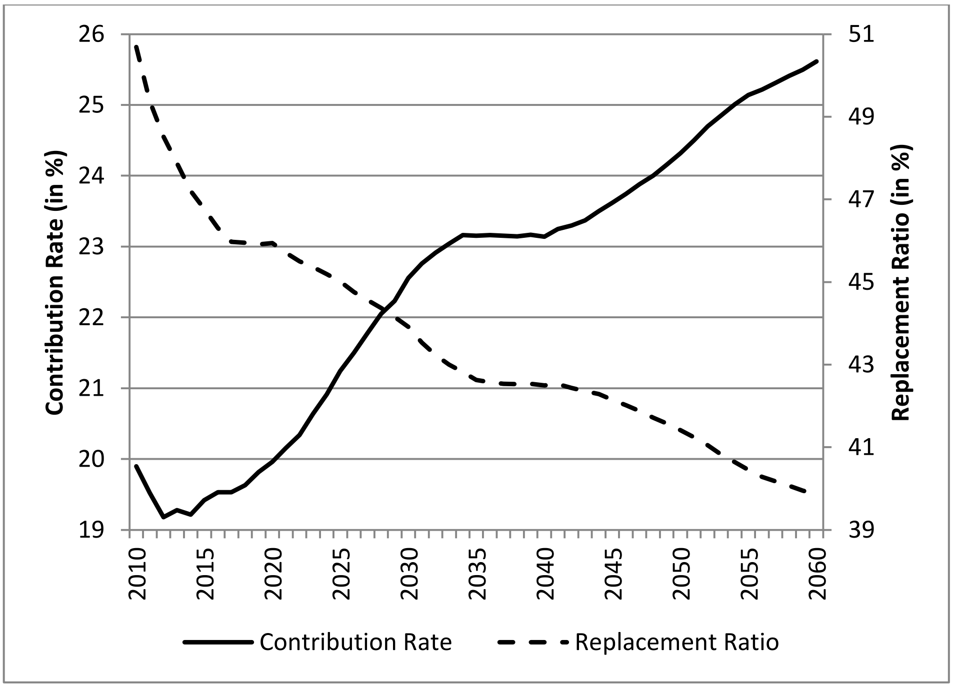

Figure 5: Calibration Results in the Scenario 'Constant Path' (Source: own calculations)

As Figure 5 shows, the model generates plausible results in the baseline scenario 'Constant Path' for contribution rate and replacement ratio. For a more comprehensive analysis of the results, the model is first run in the baseline scenario 'Constant Path', then its replacement ratio is set as a target for the scenario 'Alternating Path', so for this second scenario the contribution rate is computed which is necessary to achieve the same time series for the replacement ratio as in the baseline scenario. This way, all differences can be shown in the difference between the contribution rates.

Results

The main result is that the difference in the contribution rate between the two scenarios is highly relevant for two reasons, as can be seen in Figure 6. First, it has a systematic pattern, and second, it is of a very relevant size.

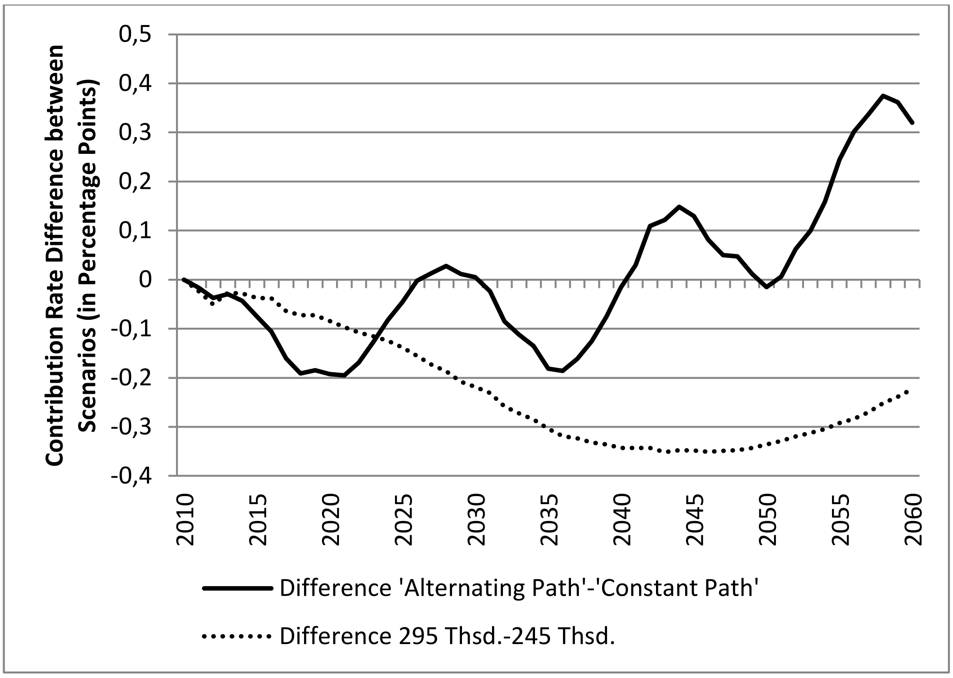

Figure 6: Difference between the Scenarios in the Contribution Rate with a Standardised Replacement Ratio (Source: own calculations)

The systematic pattern reveals that the influence of the 'Alternating Path' is cyclical in the short run. It follows the peaks and lows of net migration with a time lag of approx. 5 years. In the longer run, overlapping effects can be found. The difference does not go back to zero in the first peak, but already reaches a level higher than zero. In the longer run it seems that the higher number of immigrants arriving during peaks cannot compensate for the smaller number coming in during the lows, so the time series of the difference shows an upward trend. The reason for this is that the 'Alternating Path' leads to a much more uneven age distribution among the whole population, as the age profile of immigration during peak years is much more concentrated on the age group of people in their mid-twenties than during low years, so the overall cohorts which are in their mid-twenties during a peak are much larger than cohorts which are of that age during the lows. On the other hand, the peak cohorts also have a more fragmented earnings history on average, as they have a larger share of immigrants among them. Altogether the overlapping effect stems from the retirement of the immigrants from the first peak, which happens mainly at the time of a low in immigration, so both effects add up to a high peak in the contribution rate. But the retirement of the immigrants of the first peak is distributed like their age distribution, so it also happens before and after this low, so this explains the upward trend from 2040 to 2060. And, as the domestic population shrinks, their amount matters much more during the time they retire between 2055 and 2060 than during the time when they first arrived on the labour market back in 2015.

The relevance of the size of the contribution rate difference can be shown when a comparison is made to a common type of scenario which is assumed to create a big difference: a scenario with a yearly net migration of constantly 50,000 people more than in the baseline scenario 'Constant Path'. Figure 6 shows that the difference between 'Constant Path' and 'Alternating Path' grows much larger than the difference between 'Constant Path' with 245,000 surplus immigrants and a constant scenario with 295,000 surplus immigrants. This indicates that the impact of the 'Alternating Path' is highly relevant, as a difference of 50,000 people in the net migration is already half the distance between the highest and the lowest migration scenario used by Destatis in their official population projections, which are chosen to represent rather the upper and lower end of the plausible spectrum.

Conclusion

In this paper I have discussed three major regularities of the migration development in Germany: the alternating size of net migration, the correlation between size and age structure of the migration streams and the correlation between age/gender, duration of stay and labour market participation among immigrants. The alternating size of net migration can be approximated by a cosine wave, so that the frequency is consistent with the data of past migration and that the amplitude fits reasonably well to most of the peaks and lows of the past. The correlation between size and age structure of the migration streams can be approximated by a parameterisation of the absolute age profiles via a Gompertz function and then linear regressions of the structure parameters to the size parameter. For the third regularity, it was necessary to assume that the correlation taken from the data of one year, 2015, remains constant during the modelled period until 2060, as a prediction of a further development was impracticable. Nonetheless, taking this regularity into account is necessary in order to achieve realistic results.

Out of these regularities, I have constructed two scenarios: 'Constant Path' represents the commonly used specification of a constant net migration for the whole simulation period. Here, the correlation between size and age structure of the migration streams does not matter, as it stays constant as well. Also, the correlation between duration of stay and labour market performance does not play such an important part, as it simply means a constant delay for the arrival of immigrants on the labour market. ‘Alternating Path’ represents the opposite, a scenario where all three regularities matter. It is constructed by altering the same average net migration as in ‘Constant Path’ with a cosine wave. This automatically leads to a cyclically changing age structure of the immigration streams, and a cyclically changing delay of the average labour market integration duration.

The impact of the ‘Alternating Path’ on the contribution rate (with a standardised replacement ratio) in comparison to the ‘Constant Path’ is remarkable, both in its size and in its time pattern. The size of the effect grows larger than the effect which a higher constant net migration of 50,000 people per year would create, which clearly indicates a high relevance. The time pattern does not only show an alternation similar to the one in net migration with a time lag, but also overlapping effects caused by the retirement of the peak immigrant cohorts which account for much larger differences than the arrival of the immigrants on the labour market.

Altogether it can be concluded that the effects of immigration can both be largely over- or underestimated when the common constant migration scenarios are used. The alternating character of net migration in combination with the highly correlated age structure and the side effects caused by the age- and gender-specific duration of the labour market integration process have a large influence on the contribution rate, and the sign of the effect can both be positive or negative and change through time.

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