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The Effect of Immigration on Economic Growth in an Ageing Economy[1]

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Abstract

Immigration can help to alleviate the burden ageing presents for the welfare states of most Western Economies. To show this, a macroeconomic model is developed which deals with the effect of both ageing and immigration on economic growth, through home-biased capital accumulation. The model includes a detailed description of the labor market, analyzing the interaction with low-skilled unemployment. The empirical relevance of some crucial model assumptions is shown to hold for the Netherlands, 1973 – 2009, using a vector-error-correction model. Simulations of the latter model show that permanent shocks in immigration will help to alleviate the ageing problem in the long run, as long as the immigrants will be able to participate in the labor force at least as much as the native population. Moreover, the better educated the immigrants are or become, the higher their contribution to growth will be.

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1 Introduction

1.1 Motivation

Most of the recent economic literature on the effect of immigration on ageing focuses on the influence of immigration on the labor market and the welfare state with an emphasis on the short run Nannestad (2007). A drawback of this focus is that the effect of ageing and immigration on capital formation and economic growth usually are ignored. Razin and Sadka (1999) and Razin and Sadka (2000) were the first who analyzed the effect of

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immigration on ageing in a general equilibrium long-run context, taking this effect into account. They use a closed economy model, however.[4] Moreover, in the tradition of long–run-focused general equilibrium analysis, they model the labor market in a highly stylized way, assuming full employment. But for the typical European welfare state the interaction between immigration, unemployment and ageing problems cannot be ignored. For that reason we include our analysis a model of the labor market which enables us to analyze the interaction between immigration, unemployment and ageing problems. We also introduce imperfectly mobile capital as a production factor, to facilitate the link with economic growth.

Various studies have argued that immigration can contribute to solve a lack of labor supply that results from an ageing population (EU (2005), Freeman (2006) and OECD (2012). This notion also underlies the recent EU immigration policy, which includes the introduction of the 'blue card' to attract highly skilled workers mid-2011 (a critical discussion is provided in OECD (2012) p. 114).

The underlying, currently dominant view is that migration is good only to the extent that migrants are skilled (see Boeri *et al*. (2012) for a broad introduction). Fehr *et al*. (2004) attribute this to tax progression leading to higher tax revenues than public goods delivered on the basis of computable general equilibrium models. Also using a general equilibrium models (Felbermayr and Kohler, (2007)) find increasing output for all sectors for high skilled migration but mixed results for low skilled migration under the assumption of full employment. For the OECD-average immigration, consisting of 25% high skilled and 75% low skilled, the effects on the GDP per capita are also positive. Vallizadeh *et al*. (2013) find the same result for high-skilled worker immigration and no impact on GDP per capita from medium skilled immigration only; but medium skilled immigration will increase over-education and ,if labour markets are flexible, reduce low-skilled unemployment. These studies consider only working immigrants, with identical skill supply as domestic persons (Fehr *et al*. (2004)) but ignore non-working family members. From the point of view of the ageing process it is, however, also important to look at non-working family members of migrants and natives, because having more dependents will lead to a lower GDP per capita. Muysken *et al*. (2008)provide regressions for the Netherlands finding a positive effect of the low/high skill endowment ratio on the macroeconomic unemployment rate, but no further effect on the labour force/population ratio. From this and the general equilibrium result in (Vallizadeh *et al*. (2013))it follows that the role of a shift in the skill distribution towards higher education mainly reduces unemployment rates. For the impact of immigration on GDP per capita it is also very important that immigrants are in paid employment.

Although the EU blue card seems to be a good instrument to attract more highly-educated individuals, we show in this paper that it may be beneficial to attract also immigrants who are not graduated from universities, as long as the skill distribution of the immigrants is not changed through migration – i.e. maintaining a constant skill distribution. We also show empirically and theoretically that the benefits from immigration could increase further if policy makers successfully work on organizing and increasing the ratio of the working to the inactive population in general, which requires a better integration policy than in the past. The aim of our analysis is to illustrate the relevance of this ratio, in particular in relation to net-immigration. Finally, immigration alone cannot account for keeping our GDP per head at a high level, and we also need other measures like a rising

[4]Fehr *et al*. (2010) also emphasize this point referring to the bulk of the literature.

rate of labor force participation, particularly in the older age classes (see OECD (2012)). For that reason we include the ratio of the working hours to the total population in both our empirical and theoretical analysis.

Therefore, the innovation of this paper is showing a positive impact of immigration on the GDP per capita for a constant skill distribution with endogenous unemployment and participation rates in theory and empirics taking into account unemployment and the activity ratio. Existing literature is missing at least one of the ingredients. Using theoretical modeling with calibration Lundborg and Segerstrom (2002), Felbermayr and Kohler (2007) and Borgy *et al.* (2011) do not consider unemployment; they and also (Larramona and Sanso (2006) and Vallizadeh *et al*. (2013) consider only worker immigration but ignore non-working dependents. Fehr *et al*. (2010) and Fehr *et al*. (2004) do not consider unemployment and assume the same labour supply for native and immigrants for the same age and skill category.Finally, an attractive feature of our macroeconomic model is that it pays explicit attention to the role of the welfare state in maintaining social equilibrium.

In the applied econometrics literature closest to our methodological approach is (Bodman (1998)) using the vector error correction model for a production function approach with some additional variables, but without taking unemployment or the activity ratio into account. Morley (2006) uses an ARDL method for two variables, immigration per head and GDP per head, but does not include unemployment or activity ratios. Muysken *et al*. (2008) show the effect of skill and participation ratios on overall unemployment rates but do not make the empirical step to analyze the GDP per capita. Ortega and Peri (2009) applybi-variate correlations of migration and the activity ratio without taking into account the unemployment rate or GDP per capita. Boubtane *et al.* (2011) carry out bi-variate Granger-causality tests and find no impact of immigration on GDP or unemployment, but they do not look at the activity ratio or other then bi-variate relations.

The setup of our paper is as follows. We present some stylized facts for the Netherlands in section 1.2, which also introduces the data we use in our empirical analysis. We then argue that important elements in the analysis are the extent to which immigration has a positive or negative effect on the activity rate and capital accumulation. In section 2 we find a positive effect for the activity rate can be corroborated for the Netherlands using a vector-error-correction model as a basis for our theoretical model. Using such an empirical model also enables us to establish a two-way causal process between immigration and economic growth. We then develop a theoretical model of the labor market in section 3 and incorporate the long-run features of that model in a macroeconomic theoretical model in section 4. Using the macroeconomic model we define the concept of social equilibrium and explore the effect of immigration on welfare state and ageing problems. Section 5 analyses the dynamics of the model. We conclude in section 6 that for the Netherlands immigration can be used to alleviate the ageing problem if the integration and participation of immigrants in the labor market is improved.

1.2 Stylized Facts for the Netherlands, 1970 – 2009

Population growth has been very low in the Netherlands, falling from 1.4% in 1960 to 0.4% in 1980 and fluctuating around that level thereafter. As a consequence of ageing, the share of population 65+ increased from less than 9 % of total population in 1960 to over 15 % in 2009, and it is predicted to increase till 25% in 2050. This has enormous

implications for the sustainability of the welfare state. The two key challenges due to ageing are summarized by the OECD (2008) (pp. 37 ff.) as follows: (1) returning public finances to a sustainable path, mainly in response to increasing care expenditures and pension benefits which have to be borne by a decreasing share of the population, and (2) compensating for labor market shortages due to a declining work force relative to the population by increasing labor market participation. With respect to the latter the OECD pays special attention to immigration, which has "traditionally been an important source of labor supply."(OECD (2008) p. 43).

Immigration fluctuates around 0.7% of population – this is higher than the average population growth of 0.4% since the 1980's, which highlights the important role of immigration in population growth. Emigration is increasing somewhat over time, but net immigration is usually positive around 0.15% of population.

With respect to the characteristics of immigrants, two observations are relevant. First, the average age of immigrants is much lower than that of the total population, which partly compensates the decline in the labor force. For instance OECD (2012)expects the role of migration in maintaining the size of the labor force to become more important as more baby-boomers retire in many countries.[5] In that context (OECD (2012), p. 125) also observes "The educational attainment of new entrants into the labor force was much higher than that of retiring workers over the period 2000-10. New immigrants had educational levels that were between those of new entrants and retirees, with proportionally more highly educated workers among new immigrants than retirees, but more low-educated workers than among new entrants." The latter can also be seen from our second observation, summarized in Table 1, that the educational composition of the non-native population on average reflects quite well the native population in terms of education – not surprising the "non-western" part of the non-native population has a higher incidence of low education.[6] Various issues of the OECD's Immigration Outlook show that these observations do hold for most Western European countries.[7]

Table 1: Educational composition of labor force, 2001 -2009 (average shares)

	Share in labor force		
		Native	Non-Native
Level of education	Low	0,25	0,30
	Medium	0,45	0,41
	High	0,30	0,28

Source: CBS (Statistics Netherlands)

[5]The OECD ((2012), p. 126) emphasizes that "The potential need for immigrants in the ageing context thus cannot be assessed on the basis of demographic imbalances alone, but must take into account changes in the nature of employment, which appear to be more dynamic than changes in the age composition of the population and labor force.". This is an important observation which we leave for further research.

[6]Table 1 implicitly includes the effect of net migration, because skill biased emigration would affect the skill structure of natives. Emigrants in the Netherlands are on average somewhat higher educated than natives(see Dalen, and Henkens (2011)).

[7]See for instance the Outlook of 2007, Table II.1. Germany has a markedly higher share of low skilled migrants, however.

With respect to macroeconomic characteristics, two features deserve special attention because we will refer to these features in our macroeconomic model later. First, the Dutch economy is characterized by persistent excess of domestic savings over investment, consistent with a persistent surplus on the current account. The investment ratio shows a slight tendency to decline, after a marked drop in the early 1970s. The savings ratio relative to national income is relatively constant over time: It fluctuates around 25 per cent. There is also a home bias in asset holdings in which the savings accumulate. Although the home bias holdings in the Netherlands is relatively small compared to other countries (see Sørensen *et al.* (2007)), it is still considerable. Holinski *et al.* (2012) find a decrease in the home bias for equity from 0.64 in 1990 to 0.14 in 2005 in the Netherlands. However, (Baele *et al.* (2007), Sørensen *et al.* (2007), Schoenmaker and Bosch (2008) find values of 0.37 for 2003, between 0.3 and 0.4 in 2004 (depending on the method used), and 0.43 in 2004, respectively, for the Netherlands. Vanpeé and de Moor, (2012) find an equity home bias of 0.34 for 2010. Moreover, they also identify a bonds home bias in the Netherlands, which has risen after the euro-crises to 0.64 in 2010. The latter is important, as most studies only focus on the home bias in equity holdings. However, holdings of bonds are in size almost equal to those of equity (see Schoenmaker and Bosch, (2008)). This motivates us to postulate the presence of a home bias in asset holdings in our theoretical analysis.

A second feature is the observation that the strong increase in unemployment which occurred in the 1970s and early 1980s, and its secular decrease thereafter, is not reflected in the development of immigration, as can be seen from Figure 1. Both unemployment and immigration show clear cyclical fluctuations. However, the causality does not necessarily run from immigration to unemployment, as is often presumed in the popular debate –Jean and Jimenez (2011). Jean and Jimenez (2011) also make this point for OECD countries. Actually the reversed causality may be present in the data for the Netherlands. If that would be the case, we interpret this as a policy reaction function of immigration authorities.

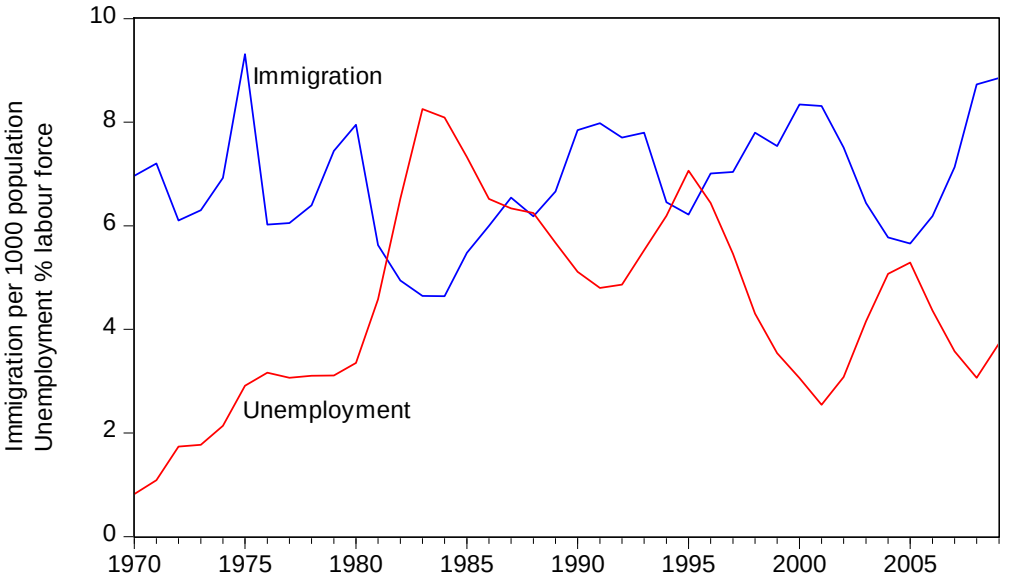

Figure 1: Unemployment and immigration, 1970 - 2009
Source: CBS (Statistics Netherlands)

The above observations corroborate the following stylized facts in our analysis:
(1) a persistently ageing population
(2) positive immigration, with an education quite similar to that of the native population, but on average much younger
(3) a constant propensity to consume
(4) a persistent current account surplus, reflecting excess domestic savings, which are invested with a home bias.
(5) no relationship between unemployment and immigration until 1980 and a counter cyclically negative relation since 1980.

These stylized facts will also appear in the model we develop in the next sections.

2 The Effect of Immigration on GDP/capita for the Netherlands, 1973 -2009

Given our focus on ageing, a natural hypothesis in our model of sections 3 to 5is that immigration has a positive (negative) effect on economic growth if it increases(decreases) the ratio of active over inactive persons, the activity rate N^y / N^0 in our model of sections 3-5 below. This ratio has a positive effect on both capital accumulation and the transitional growth rate. As a consequence immigration has a positive effect too, provided that the percentage increase in active persons is larger than that of inactive persons. In this section we provide some empirical evidence for these statements using data for the Netherlands.

To analyze this further, the crucial question is which effect immigration has on the ratio of hours worked per person in the population and which effect the latter has on GDP per head. For that reason we use the ratio of the total hours worked, *L*, over the total population, *P*, to capture the activity rate. Because capital accumulation plays an important role, we also include the investment to GDP ratio in our empirical analysis. Important features of our theoretical model are that the unemployment rate is not affected by skill neutral immigration, and wage growth remains consistent with productivity growth. For that reason we also include wages and unemployment in our empirical analysis. Finally, immigration is taken as an exogenous variable in the theoretical analysis in section 3in order to limit the complexity of the model. Although policy measures can be used to control immigration, this does only hold to a limited extent for the plans of the prospective immigrants. Moreover, immigration policy may react to the macroeconomic situation. As a consequence we will allow immigration to be endogenous in our empirical analysis.

Our empirical analysis is on the Netherlands, during the period 1973 – 2009, the period before the financial crisis reaches the Dutch labour market. The data for population, GDP per head and gross fixed capital formation in constant 2000 Euros are taken from the World Development Indicators. Wage data are labor compensation per hour worked deflated by the GDP deflator from the KLEMS data base (see O'Mahony and Timmer (2009)) with adjustment of their base year from 1995 to 2000, and two observations added using growth rates from CPB. Employed persons in terms of 1000 full-time equivalents, hours worked per full-time equivalent and unemployment data come from the CPB using the international definition for the latter. Migration data are from the CBS. Precise sources

are provided in Appendix 1, and a general description of the data used has been given in section 1.2.

We want to show that total hours worked per person in the population, which is lower under ageing and probably higher under immigration, has a positive effect on the GDP per head. We estimate a vector-error correction model[8] in the natural logarithm of (i) GDP per head, *log(y)*, (ii) the ratio of gross fixed capital formation as a share of GDP, *log(I/Y)*, (iii) the ratio of hours worked by thousand full-time equivalent workers per person in the population, *log(L/P)*, (iv) real wages, *log(w)*, (v) the unemployment rate, *u*, and *(vi)* net immigration per person in the population, *NMP* = (*im-em)/P*. Because we find that net immigration indeed has a positive effect on hours worked per person, we also use the estimated model to analyze the effect of a permanent shock in net immigration.[9] Consistent with our model predictions, we find that immigration has a positive effect on GDP per head.

2.1 The Vector-error Correction Model (VECM)

A vector-autoregressive model (VAR) in the six variables indicated above and a time trend is unstable if it has four lags. When only three lags are allowed, all lag length criteria but one (Schwarz Information Criterion) indicate that three lags are optimal. The VAR with three lags is stable.[10] The corresponding Johansen cointegration test with two lags indicates five cointegrating equations,[11] which are long-term economic relations, at the 5% significance level for MacKinnon-Haug-Michelis p-values according to both the trace test and the maximum-eigen value test. These long-term relations, with the left-hand side equal to zero in equilibrium, are (with t-values in parentheses):

$$\underset{}{CE1 = \log(y)_{t-1}} \underset{(-34.0)}{- 0.865\log(L/P)_{t-1}} \underset{(-33.6)}{- 0.0155\text{trend}} - 9.64 \quad (1)$$

$$\underset{}{CE2 = \log(I/Y)_{t-1}} \underset{(5.35)}{+ 0.42\log(L/P)_{t-1}} \underset{(3.92)}{+ 0.0023\text{trend}} - 2.99 \quad (2)$$

$$\underset{}{CE3 = \log(L/P)_{t-1}} \underset{(-52.6)}{-169.7(NMP)_{t-1}} \underset{(-6.54)}{- 0.0298\text{trend}} + 1.90 \quad (3)$$

[8]The indications for unit roots according to standard augmented Dickey-Fuller tests are ambiguous. In earlier work we found absence of unit roots using fewer observations. This result is typical of unit root tests with lower power at lower numbers of observations. The probabilities for unit roots were low though when regressors in addition to the package routine (using constant and trend) were included, which is in line with basic econometric lessons (Davidson and MacKinnon (2004) chap. 14.4). However, variables that are integrated of order zero and unity can both be included in error-correction models. As a consequence we do not present results for unit roots.

[9]In the context of VECMs a permanent shock of one of the variables is defined as an increase of the intercept of the equation where it is the left-hand variable.

[10]As the VAR has time trends 'stable' means that the system of difference equations moves asymptotically to a path with the same constant growth rates after any deviation from these growth rates.

[11]Identification of the *r=5* cointegrating vectors requires at least *r-1=4* restrictions setting coefficients in the long-term relations to zero (Patterson (2000) chap.14). As we have six variables in each long-term relation four zeros lead to bivariate long-term relations.

$$CE4 = \log(w)_{t-1} + \underset{(17.69)}{0.03u_{t-1}} \underset{(-8.12)}{- 0.007\text{trend}} - 2.79 \quad (4)$$

$$CE5 = (NMP)_{t-1} \underset{(-23.05)}{- 0.0084\log(w)_{t-1}} \underset{(9.16)}{+ 0.002\text{trend}} + 0.014 \quad (5)$$

Eq. (1) indicates that a percentage change in *L/P* translates into the GDP per head with a factor of 0.865.[12] The investment ratio decreases by a factor 0.42 according to Eq. (2) – we interpret that as a substitution effect between labor and capital. Net immigration increases the hours-per-person ratio according to Eq. (3), which is consistent with the notion in our theoretical model that immigration increases the activity rate N^y / N^0. We elaborate the estimated effects of a shock in net immigration on the other variables in section 2.2. Unemployment decreases the wage in Eq. (4), which is the well-known Phillips curve effect. And wages enhance net immigration in Eq. (5) – this is consistent with observations by Nannenstad (2007).

Moreover, Eq. (1), (3) and (5) imply a two-way causality between growth and migration, which works as follows. One way is net immigration as a share of the population, *NMP*, enhancing the activity ratio, *L/P*, in Eq. (3) together with *L/P* enhancing the GDP per head in Eq. (1). The other way is that GDP per head is strongly correlated with wages in our theoretical model and also in Eq. (10) of the empirical model below (the effect of *CE1* on *dlogw*), as well as Figures 2and 3b; then wages enhance net immigration as share of the population in Eq. (5).

Bodman (1998) also finds a small, significantly positive effect of immigration on GDP per capita with two-way causality for Canada and Australia integrating an extended production function concept into a vector-error-correction model with ten variables using quarterly data 1968-1996. In contrast, Morley (2006) uses an ARDL method for two variables, immigration per head and GDP per head, and finds causality going from GDP to immigration but not the other way around for Australia, Canada and the USA, 1930-2002. Similarly, on the basis of bi-variate correlations Ortega and Peri (2009) find no effect of bilateral migration on the *L/P* ratio for a panel of OECD countries, 1980-2005. Boubtane *et al*. (2011) carry out Granger-causality tests and find no impact of immigration on GDP or unemployment. Bi-variate tests in all three cases are probably too simple to take all interactions into account. Two-variable methods can have only one cointegrating equation for the analysis of two directions of causality. They are clearly under the suspicion of omitted variable bias, here implying omitted equations. Our multi-variable method uses Eq. (3) and (1) and the Eq. (1) and (5) – two cointegrating equations per causality direction under consideration.[13] For the effect of immigration on GDP we

[12]Using a linearly homogenous production function, *Y/P = F(K/P, L/P)* and a marginal product of capital equal to the sum of given – through perfect capital movements – interest and depreciation rates, a simplified version of the marginal productivity condition Eq. (14c) below, one would expect a one-to-one relation between *L/P* and *Y/P*. Our result of 0.86 is close to the one-to-one relation and suggests the greater realism of the marginal productivity condition with slightly imperfect capital movements..

[13]For the related literature on migration and growth based on growth regressions derived from otherwise closed economy models see Wolszczak-Derlacz, (2009) and Boubtane and Dumont (2013). Using this approach, Wolszczak-Derlacz, (2009) finds a significantly positive effect of current net immigration flows on growth only for sending countries of the EU 27. Boubtane and

prefer our more elaborate VECM showing a positive growth level effect when taking into account unemployment and the activity ratio.

All equations have highly significant time trends. At a constant *L/P* ratio there would be a growth rate of 1.55% in Eq. (1) as one finds it in the growth literature (see Jones (1995) and Mankiw *et al.* (1992)). This should also be approximately the long-run growth rate of wages in Eq. (4). However, the trend in Eq. (4) – due to the strong fall in unemployment during the time period under consideration (Figure 1) – is considerably smaller. The significant time trend in Eq. (5) also captures the trend in wages and that of emigration. The small but significant time trend in Eq. (2) is probably a feature of the time under consideration with a slightly decreasing investment ratio, but will probably not be a long-run property. Finally, the time trend in Eq. (3) indicates that the increase in hours per person since 1985 is stronger than the fall from 1970 to 1985. As the investment share, *I/Y*, and working hours per person, *L/P*, and the unemployment rate are very unlikely to grow in the long run their time-trends should not be interpreted as steady-state results. Indeed, solving the long-term relations Eq. (1) – (5) for a constant unemployment rate *u* of 4%, we get very small growth rates for the *I/Y* and *L/P* ratios: -0.0032 and 0.002, respectively.

The complete VECM consists of the following six equations (t-values in parentheses, R^2 are adjusted), where we do not show the first and second lags of first differences of all variables here (these are shown in Muysken and Ziesemer (2011)); their position is indicated by '…'):

$$d(\log(y)) = \underset{(-2.13)}{-0.62}CE1 + \underset{(4.32)}{0.66}CE2 + \underset{(2.65)}{0.366}CE3 + \underset{(5.8)}{1.22}CE4 + \underset{(2.73)}{59.2}CE5 + \ldots + \underset{(1.36)}{0.017} \quad (6)$$
R^2: 0.54

$$d(\log(I/Y)) = \underset{(-2.06)}{-1.14}CE1 + \underset{(3.23)}{0.69}CE3 + \underset{(6.49)}{1.84}CE4 + \underset{(3.33)}{108.36}CE5 + \ldots \underset{(-2.84)}{-0.048} \quad (7)$$
R^2: 0.78

$$d(\log(L/P)) = \underset{(2.94)}{0.256}CE2 + \underset{(2.06)}{0.148}CE3 + \underset{(3.8)}{0.46}CE4 + \underset{(1.96)}{23.06}CE5 + \ldots \underset{(-0.52)}{-0.0036} \quad (8)$$
R^2:0.77

$$d(u) = \underset{(-2.18)}{-21.65}CE1 - \underset{(-3.65)}{11.93}CE2 - \underset{(-4.75)}{16.36}CE3 - \underset{(-5.16)}{24.08}CE4 - \underset{(-4.78)}{2485}CE5 + \ldots \underset{(-0.25)}{-0.07} \quad (9)$$
R^2:0.86

$$d(\log(w)) = \underset{(2.71)}{1.18}CE1 - \underset{(-2.29)}{0.37}CE2 + \underset{(2.61)}{0.38}CE3 - \underset{(-1.74)}{0.36}CE4 + \underset{(2.83)}{62.07}CE5 + \ldots + \underset{(3.43)}{0.04} \quad (10)$$
R^2: 0.74

Dumont (2013) add the education of the migrants to the regression as the number of persons is included in the population growth rate. They find a positive impact of education, which, however, is too small for one third of the countries to counteract the population dilution effect. This approach tends to ignore the impact of migration on the international capital movements part of the investment in the calculations. A similar result is obtained by Orefice (2010) without the straightjacket of a closed economy model in the background but also without any control variables. The shock analysis in our VECM avoids these short-comings taking into account the impact on investment and on several other variables.

$$d(NMP) = \underset{(2.7)}{0.07CE1} + \underset{(2.54)}{0.02CE3} + \underset{(1.97)}{2.26CE5} + \ldots \underset{(0.41)}{+0.0003} \qquad (11)$$
$$R^2: 0.58$$

Adjustment coefficients with t-values below unity have been restricted to zero before each re-estimation in order to keep the model simpler. For the imposed restrictions the LR test has a significance level of $p(\chi^2)=0.50$.

Eq. (6) is a growth equation, where the standard population growth term has been replaced by the *log(L/P)* term and the arguments are spread over all error-correction terms. For example investment enters through the second error-correction term, *CE2*. Eq. (7) is an investment equation, where the growth rate of the investment ratio depends on all error-correction terms besides the long-term relation for investment itself. Eq. (8) – (11) show feedback effects of the cointegrating equations on changes of *L/P*, unemployment, wage rates and immigration. Eq. (7), (8) and (11) have in total four insignificant adjustment coefficients, which have been constrained to zero.

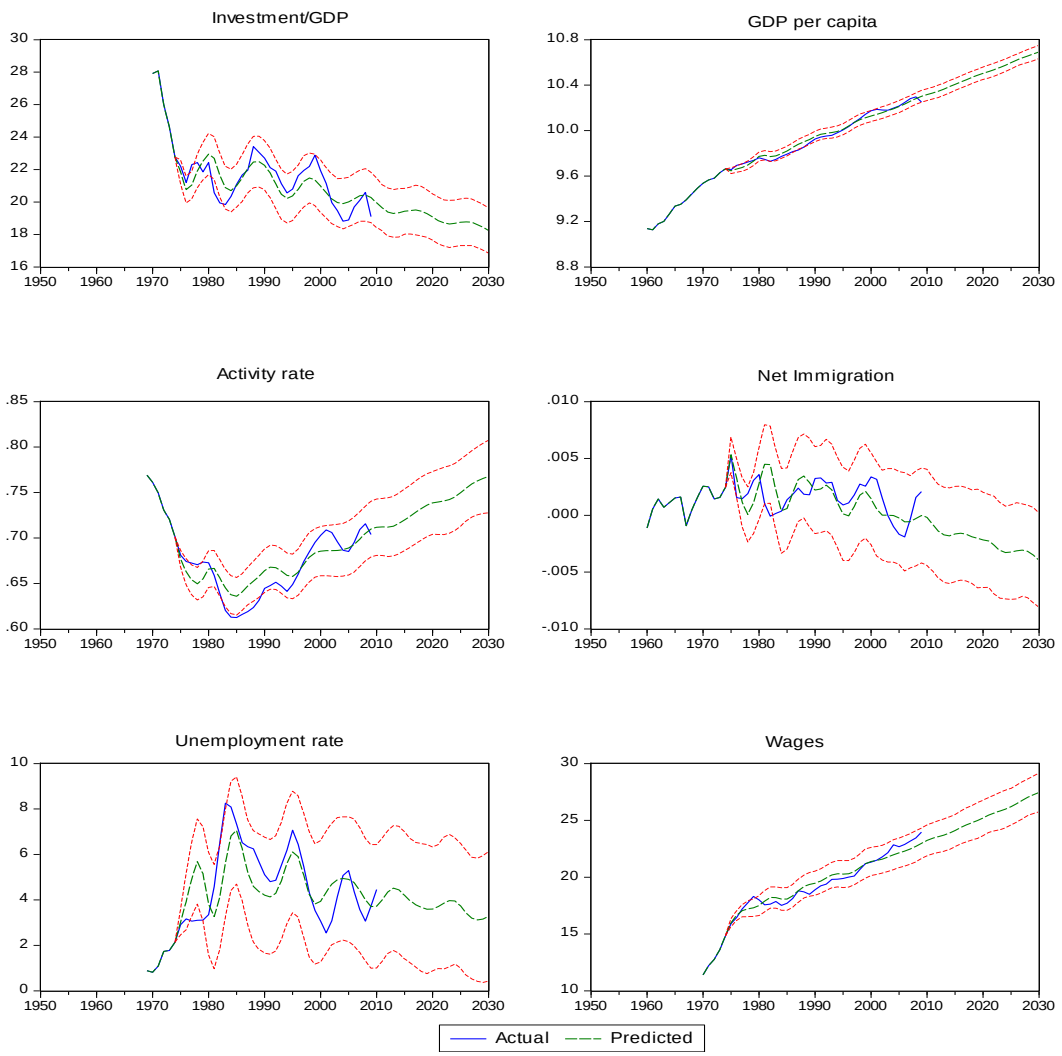

Figure 2: Dynamic stochastic simulation of the VCEM model (with ± 2SE bounds)

We demonstrate the working of the model in Figure 2, which shows the results of a dynamic stochastic simulation with thousand runs of a Monte Carlo method only using the observed values in the base year(s) as starting values for the variables.[14] The data for unemployment are outside the interval of two standard deviations only for the period of the second oil crisis in 1979; data for hours worked per person and net immigration are outside the interval after the start of the wage-moderation policy in 1982 and for investment share in both of these periods. In brief, only during times of severe shocks do the data go out of the interval of two standard errors.

In particular, our model nicely traces the u-shaped development of hours per person, *L/P*, with its minimum value in 1985, the inverted u-shape of the unemployment data and a similar but much milder inverted u-shape in the net immigration data. This is remarkable because the model is based on a linear VAR. Each economic variable though has in principle three types of coefficients, those in the long term relation, the adjustment coefficients, and the coefficients of the first-differenced lags. Together they are well capable of capturing non-linear developments in the data.

A second observation from the simulation results presented in Figure 2is that the endogenously simulated development of all variables over the next twenty years until 2030 shows time trends which are quite plausible. This shows that in the out-of-sample simulation the time trends in the long term relations do not cause serious problems, at least in the medium run.

A third observation is that the estimation results are very robust as we found in various earlier versions of this article. In earlier work we estimated the model in single equation form, using data till 2003/2005, and using slightly different sources; later we estimated the model in an error correction specification, without migration, using data till 2007; and even later again we estimated the model in an error correction specification, including gross immigration, using data till 2009 – a discussion of these results is provided in Muysken and Ziesemer (2011). The conclusions and simulation results from all these estimations are remarkably similar to the present analysis, where we also used data till 2009. Hence the results are quite robust with respect to the periods of observation and the data sources. However, the results for transitory and permanent shocks discussed below, showing a positive effect of immigration on the GDP per capita, do not hold anymore when we add the crisis years 2010 and 2011.[15] During a crisis increases of labour supply do not increase the GDP per capita as one would expect.

A final point which should be observed is that the estimation results using either gross or net immigration or joint or separate estimation of the equations for migration are also highly similar. In earlier work we found similar results for gross immigration rather than net immigration.[16] This can be seen as an indication that it is in particular immigration

[14]Data are in natural logarithms except for migration and unemployment.

[15]Employment and wage data for this update are taken from the KLEMS data base because the CBS has constructed a new series of employment per full time equivalent from 2009 onwards, which is not linked anymore to the old series. Unfortunately, the KLEMS database currently goes only until 2011. When post-crisis years can be added our results may hold again, but currently the share of crisis years is too large.

[16]When gross immigration and gross emigration both as a share of the population are considered separately, immigration has no unit root but emigration does, and they are not cointegrated – all with and without logs, with and without dividing by the population. The estimation in first differences with use of an ARMA(4,4) then is (t-values in parentheses)

which is the main driving force in the relation between migration and growth, at least in the Dutch and Western European context. That observation might also be one of the explanations why migration policy is mainly focused on immigration rather than emigration.

2.2 Effects of a Permanent Shock in Net Immigration

Consistent with our theoretical model, we have found that net immigration indeed has a positive effect on hours worked per person. We then can use the empirical model results to simulate the effect of a permanent shock in net immigration on the other variables in the model – a much debated answer to the ageing problem. We find a positive effect on GDP per head in the long run.[17]

A permanent shock on net immigration is carried out as an increase of the intercept of Eq. (11) from 1975 onwards. This value of $0.312*10^{-3}$ is enlarged by $0.148*10^{-3}$, where the latter is 10% of the mean of net immigration as a share of the population, *NMP*. We run two deterministic, dynamic forecasts, one without any shock (baseline) and one with a permanent shock. We then show in Figure 3the value after the shock compared to the baseline.

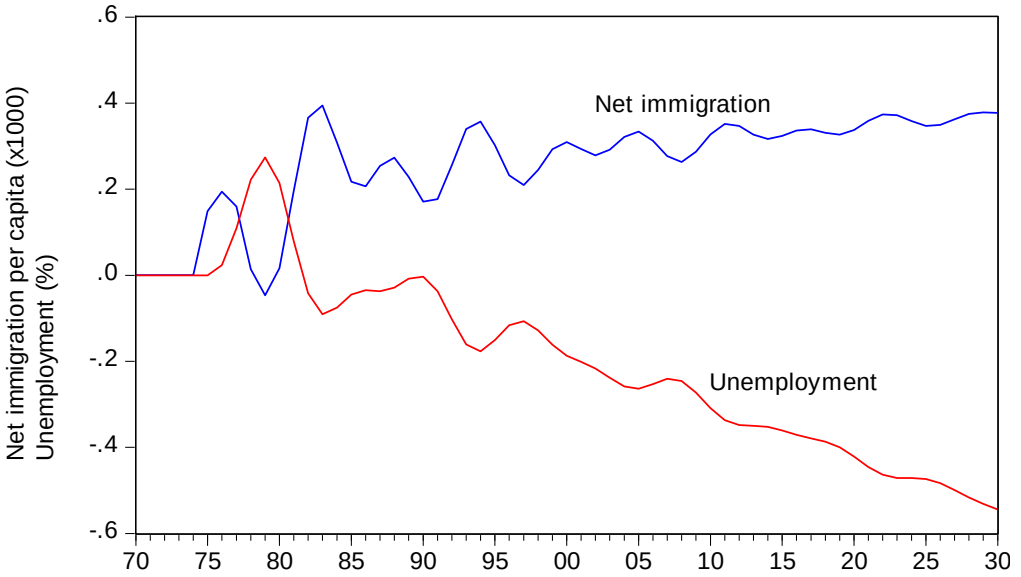

Figure 3a: Effect of a permanent shock on net immigration and unemployment(absolute difference with base line)

D(log(em/p)) = 0.012 -0.24D(log(im/p)) Adj. R^2 = 0.35
(1.16) (-3.91)

If the growth rate of immigration increases by one percentage point, that of emigration decreases by 0.24 percentage points. Together with the absence of cointegration this is a non-negligible but still weak correlation. Both procedures, using net or gross immigration seem legitimate, and lead to similar results. In that respect it is interesting to observe that Dalen and Henkens (2011) emphasize that emigration in the Netherlands is not driven primarily by economic factors.

[17]In Muysken and Ziesemer (2013), using gross migration data, we find similar results for a temporary shock – the mirror image of past policies - but the transition path shows more volatility.

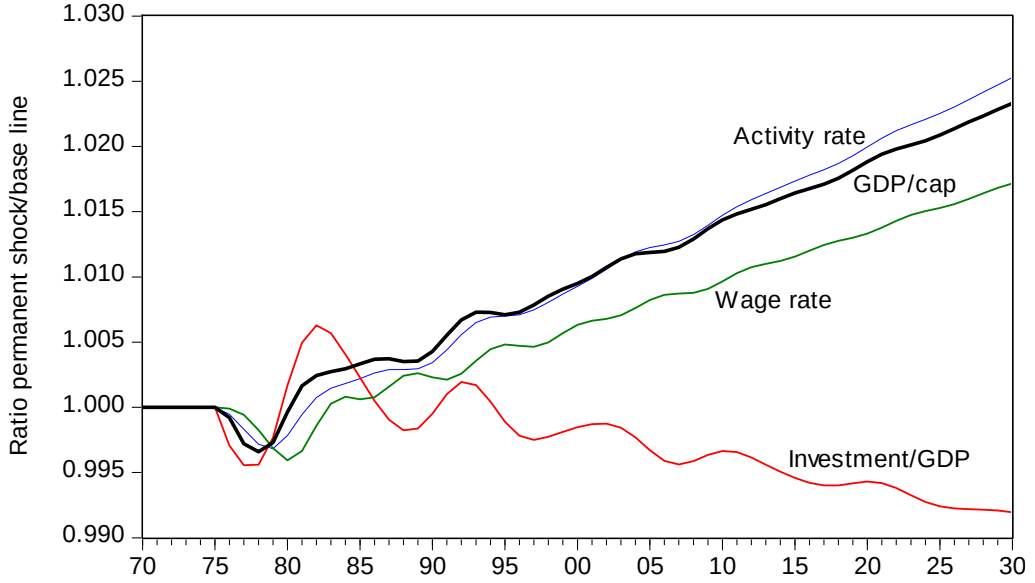

Figure 3b: Effect of a permanent shock on other variables (relative to base line)

Figure 3a shows that the permanent migration shock increases net immigration for the period 1975-2005, with the exception of the 2nd oil crisis year 1979.[18] Unemployment first goes up for six years and thereafter it is lower. Correspondingly, wages in Figure 3b are first lower

and then higher. Parallel with unemployment, the activity rate, *L/P*, first decreases and then increases, and GDP per head reacts in the same way. The investment/GDP ratio first is lower as all other variables, then increases, but until 2030 it falls by almost 1%-point. The latter is consistent with the substitution effect which we discussed when presenting Eq. (2).

The capital accumulation effect from our theoretical model shows up in the increased investment per head(the product of I/GDP and GDP per head, the latter increasing more than the former falls) of about 1.5%-point implied by Figure 3b, as well as in the increased GDP per head and wage rates. All effects are fairly small, but growing over time because of the significant time trends in the estimates. The early negative effects might be mitigated by a careful phasing in of the shock towards its long-run level.

The vector-error correction model used in our analysis uses three lags and information on longer lags is ignored. Moreover, for policy recommendations the relevant policy variable is gross rather than net immigration. For those reasons we investigate in the second step of our analysis to what extent gross immigration has a positive effect on the *L/P* ratio when more lags are allowed for. Our findings indicate that the positive effect of immigration on hours per person is positive for the first nine years but negative later (see Muysken and Ziesemer (2013)). Our interpretation of this finding is that even if some members of an immigrant family work, there are relatively more dependents after ten years. Moreover, as we found a significantly positive coefficient of immigration in a

[18]The average increase is $0.259*10^{-3}$ which is higher than the shock of $0.148*10^{-3}$. The reason is that the wage increase will also attract more immigrants.

similar regression for persons rather than hours worked in the labor force in earlier work, fewer hours worked per person after the movement of labor-intensive branches to low-wage countries might also be part of an explanation. Hence the challenge for immigration and integration policies is to find a way to increase the activity rate permanently after immigration.

3 A Model of the Production Structure and the Labor Market

To allow for capital accumulation as a source of economic growth, we distinguish physical capital as a separate production factor next to low and high skilled labor. Moreover, when we look at the interaction between immigration and ageing in the context of the welfare state, unemployment should play a role. For that reason we first present the production structure and a model of the labor market with wage bargaining, which allows for unemployment to occur. The long run properties of this model then will be included in a long run growth model which we develop in the next section.

3.1 The Production Structure and Firm Behavior

To allow for a reasonable flexibility, while still analytically manageable, we use a two-level CES-production function. That is, output Y is produced according to a nested CES-production function allowing for the widely observed capital-skill complementarity:[19]

$$Y = \left[(\lambda L)^{-\rho} + \left[(\partial H)^{-\phi} + (\iota K)^{-\phi}\right]^{\frac{\rho}{\phi}}\right]^{-\frac{1}{\rho}} \qquad \sigma = \frac{1}{1+\rho} \geq 0 \tag{12}$$

H and L represent employment of high-skilled and low-skilled workers, respectively, and K is capital. The parameters λ, ∂ and ι are productivity parameters. Low-skilled labor has a constant elasticity of substitution σ with capital and high-skilled labor. The latter form a complex F with a constant elasticity of substitution, ς:

$$F(H,K) = \left[(\partial H)^{-\phi} + (\iota K)^{-\phi}\right]^{-\frac{1}{\phi}} \qquad \varsigma = \frac{1}{1+\phi} \geq 0 \tag{13}$$

When $\varsigma = 0$, capital and high-skilled labor are complements, as is sometimes assumed in the literature.[20] CES functions are used in most empirical work. When functions have more than two arguments having only one CES parameter would lead to pair wise identical elasticities of substitution. The nesting of two CES functions each using only two arguments as used above is the most common way out of this problem and therefore this function is the one used most frequently in the literature.

[19]This also allows for more flexibility in the substitution between high and low skilled labor compared to the Cobb-Douglas production function which is usually assumed in this type of analysis (see Kemnitz (2003), Krieger, (2004), Boeri, and Brücker (2005), Brücker and Jahn (2011) do allow for more flexibility in the substitution between high and low skilled labor, but capital is still included in a Cobb-Douglas framework.

[20]Kemnitz (2003) uses this assumption to ignore capital in his analysis.

This formulation of the production structure is much more general than Razin and Sadka (2000), who assume perfect substitutability between low and high-skilled labor, and Kemnitz (2003), who assumes the elasticity of substitution to be unity ($\sigma = 1$) because he uses a Cobb-Douglas production function.[21] Many studies find capital-skill complementarity, which is associated with $\varsigma < 1$, and substitutability between high and low skilled labor, with $\sigma > 1$.(See Ben-Gad (2008), Papageorgiou and Saam(2008)). We will use these restrictions in our analysis.

Profit maximization by the firm implies that marginal productivities should equal factor prices. Hence, when the low-skilled wage is w_L, the high-skilled wage is w_H and the interest rate is r, we find:

$$w_L = \frac{\partial Y}{\partial L} = \lambda^{1-\frac{1}{\sigma}} . \left[\frac{Y}{L}\right]^{\frac{1}{\sigma}} \tag{14a}$$

$$w_H = \frac{\partial Y}{\partial H} = \left[\frac{Y}{F}\right]^{\frac{1}{\sigma}} . \partial^{1-\frac{1}{\zeta}} . \left[\frac{F}{K}\right]^{\frac{1}{\zeta}} \tag{14b}$$

$$r + \delta = \frac{\partial Y}{\partial K} = \left[\frac{Y}{F}\right]^{\frac{1}{\sigma}} . \iota^{1-\frac{1}{\zeta}} . \left[\frac{F}{K}\right]^{\frac{1}{\zeta}} \tag{14c}$$

The workforce consists of N_H and N_L high-skilled and low-skilled persons, respectively. Labor supply is taken as exogenous to keep the analysis manageable.

3.2 Wage Bargaining and Social Equilibrium in the Presence of Unemployment

The high-skilled labor market is competitive, which implies that the wage rate w_H is determined by full employment for all high-skilled persons.[22]The marginal productivity condition for capital holds at some value denoted $K^*$and world market interest rate r^*, where r^* is the interest rate in the absence of home bias, or at some value $K < K^*$ and a higher rate, $r > r^*$, where r is the international and domestic interest rate in the presence of home bias.[23]

For low-skilled workers the wage is determined by union bargaining,[24] where the unions take both the employment of high-skilled workers, which follows from labor supply, and the capital stock as given. We assume a right-to-manage model, where wages are bargained respecting labour demand by employers. The bargaining power by unions

[21]The Cobb-Douglas production function is also used in Casarico and Devillanova (2003) and Krieger (2004)– and in more encompassing, applied models like Boeri and Brücker (2005), Brücker and Jahn (2011).

[22]This is also assumed in Kemnitz (2003). It is relatively easy to extend the model for separate wage bargaining of high-skilled workers, see Boeri and Brücker (2005), Brücker and Jahn (2011) for an ad hoc application in a similar model of the labor market.

[23]The assumption here is that a strong home bias of large countries may lead to a higher world market interest rate.

[24]In all countries in which unions exist this is what happens mostly every year. Countries may differ in the level of the bargaining process – firm, sector, region or central. However, in our macroeconomic model we model only one such bargaining process.

equals ε – this encompasses Kemnitz (2003) monopoly union model by setting $\varepsilon = 1$, and Razin and Sadka (2000) full competition when $\varepsilon = 0$. Denoting the level of unemployment benefits by b and assuming a tax rate t_u, the expected income of a low-skilled worker is $(1 - u).t_u.w_L + u.b$, where u is the low-skilled unemployment rate, $u = (N_L - L)/N_L$. The firm negotiates with the unions about the wage, given its capital stock and employment of high skilled workers.

Social equilibrium requires that the employed pay taxes at a rate t_u to finance their unemployed colleagues. We assume a pay-as-you-go system where government sets the tax and benefit rates such that unemployment benefits are covered by tax revenues. Because we focus on low-skilled unemployment, we assume that the benefits are paid by taxes on the low-skilled wage only.[25] While Kemnitz (2003) assumes that the tax rate t_u is determined a priori by government and benefits follow endogenously, we assume in line with the method more commonly used in the literature – e.g. for instance Boeri and Brücker (2005) –that government sets a replacement rate β with respect to the net wage, and then the tax rate follows.

When setting the replacement rate at β, we find that the equilibrium rate of unemployment u^* is given by (see Muysken and Ziesemer (2011)):

$$u^* = 1 - \frac{1}{1+\Psi} \text{ with } \Psi = \frac{\beta.\varepsilon.\sigma - [1+\varepsilon.\nu.(\sigma-1)].[\lambda' + \varepsilon.(\sigma-1)]}{(1-\varepsilon).\lambda'.\beta} \tag{15}$$

We find the familiar result that equilibrium unemployment is higher the larger the replacement rate (see Boeri and Brücker (2005)).[26] Similarly, a higher union power ε also leads to a higher rate of unemployment, while an increase in low-skilled labor augmenting technological productivity, that is a higher value of λ, would lead to a lower rate of unemployment. Finally, an important observation is that from the analysis it follows that the equilibrium unemployment rate of low-skilled workers, u^*, is not affected by the supply of low skilled workers.

Using Eq. (4), the aggregate rate of unemployment, u_{tot}, is given by:

$$u_{tot} = 1 - \frac{(1-u^*).N_L + N_H}{N_L + N_H} = \frac{N_L}{N_L + N_H} u^* \tag{16}$$

One sees that when the number of available low-skilled workers increases relative to the number of high-skilled ones, the aggregate rate of unemployment increases. However, when both numbers increase proportionally, the aggregate rate of unemployment is unaffected. The latter is consistent with stylized fact (5) from section 1, which shows that there is no causality going from immigration to unemployment. Here one should also take into account stylized fact (2) that immigration is roughly speaking skill neutral in the Netherlands.

A final observation is that because $L = (1 - u^*).N_L$, we know from Eq. (3a) that the low skilled wage decreases when the supply of low-skilled workers increases. This is an important result because a popular perception is that most immigrant workers are unskilled and as a consequence immigration leads to a lower wage for unskilled workers.

[25]This assumption, which is in line with Kemnitz (2003), is motivated by analytical tractability.

[26]Here $\lambda' = \lambda^{1-\frac{1}{\sigma}} > 0$ and$\nu > 0$ is a constant. A necessary and sufficient condition for positive unemployment is $\beta > [1 + \varepsilon.\nu.(\sigma - 1)].[\lambda' + \varepsilon.(\sigma - 1)]/\varepsilon.\sigma$.

However, apart from the bias in this perception – see stylized fact (2) – this result does only hold unambiguously in the short run, when the capital stock and skilled labor, *H*, are given. In the next section we analyze the interaction of changes in labor supply with the capital stock.

3.3 Capital Accumulation and Long-run Equilibrium in the Labor Market

To model economic growth we assume skill-neutral labor augmenting technological progress at a rate *a*, that is both productivity parameters λ and ∂ grow at that rate, while ι is a constant. Moreover, the labor force grows in a skill neutral way at a rate *n*, that is both N_L and N_H grow at that rate. These assumptions are not only motivated by analytical convenience, but also by our aim to show the effect of skill neutral immigration – which is consistent with stylized fact (2) – on economic growth.
In a situation of perfect capital mobility, the firm follows Eq. (14c) with equality when determining its desired capital stock, given the world interest rate which is set at an exogenous level, *r**. Then the equilibrium capital stock, *K**, can be solved as a linear homogenous function *f* of N_L and N_H :[27]

$$K^* = f(\lambda.N_L, \partial.N_H; r^* + \delta, u^*) \qquad f'_1, f'_2 > 0 \tag{17}$$

The equilibrium capital stock *K** increases proportionally with N_L and N_H, and grows at rate $a + n$. A lower interest rate or a lower rate of low-skilled unemployment will lead to a higher equilibrium capital stock.
Aggregate employment equals:

$$E = (1 - u^*).N_L + N_H \tag{18}$$

and the average real wage rate net of unemployment taxes is:

$$w = [(1 - t_u).w_L.(1 - u^*).N_L + w_H.N_H]/E \tag{19}$$

In the long run employment will grow at a rate *n* and the wage rate at a rate *a* - compare Eq. (14a) and (14b). We will use the properties of Eq. (18) – (19) in the long run model of the next section.

4 The Effect of Ageing and Immigration on Home-biased Capital Accumulation

In the previous section, we presented a model of the production structure and the labor market, where we assumed the capital stock to be determined at its equilibrium level under perfect capital mobility and for a given world market interest rate *r**as one of the possible cases. In this section we add household behavior to the model, to include consumption and savings behavior. The overlapping-generations structure of the model allows us to analyze the influence of ageing on consumption and savings through the

[27]This is elaborated in Muysken and Ziesemer (2011).

effect of pay-as-you-go pension contributions. Moreover, the possible presence of a home bias in asset formation affects capital accumulation and hence economic growth and deviates from the case of perfect capital movements. The resulting model enables us to discuss the interaction between economic growth, the labor market and the welfare state. The model shows how ageing affects capital accumulation in a negative way, which can be reversed by immigration.

4.1 Household Behavior

To model consumption and savings behavior, next to the pension system, we distinguish between two generations. The younger generation ('young' for short) consists of $N^y = N_L + N_H$ persons, of which E are working, saving and paying pension contributions. Aggregate employment equals $E = (1 - u^*).N_L + N_H$ and the average real wage rate net of unemployment taxes is w. The older generation ('old' for short) lives from pension benefits and dissavings; it consists of N^o persons.

The employed young contribute a share t_p of their income to pension benefits of the old in a pay-as-you-go system. The working young both earn wages and have income from assets – we assume the young to own a share φ of total assets A in the economy.[28] Disposable income of the employed young, Y^y, then equals:

$$Y^y = (1 - t_p).[w.E + r.\varphi.A] \tag{20}$$

The employed young consume a share c of their disposable income.[29] The unemployed consume their benefits $B = t_u.w_L.(1 - u^*).N_L$.

Disposable income of the old, Y^o, consists of their income from assets and the pension benefits financed by the young:

$$Y^o = r.(1 - \varphi).A + t_p.[w.E + r.\varphi.A] \tag{21}$$

The old do not only consume their disposable income, but also their asset stock at a rate ξ; hence their dissavings equal $\xi.(1 - \varphi).A$.

Domestic savings then equal savings of the young minus dissavings of the old:

$$S = (1 - c).Y^y - \xi.(1 - \varphi).A \tag{22}$$

Hence consumption is $C = c.Y^y + B + Y^o + \xi.(1 - \varphi).A$, and the accounting identities $X = Y^y + Y^o + B = w^g E + rA = C + S$do hold for national income X, where the gross wage rate per worker is given by:

$$w^g = (w_L.(1 - u^*).N_L + w_H.N_H)/E \tag{23}$$

[28]The exogenous nature of this share can be motivated for the Netherlands by the presence of a three-pillar pension fund. This implies that the young "own" only a small share of the assets, because they can access the income from these assets only when they are old.

[29]The constant propensity to consume of the young and full consumption of the old is consistent with intertemporal optimizing behavior; see for instance Razin and Sadka (2000) – see also stylized fact (3) from section 1.2.

The difference of national income with GDP, $Y = w^g E + rK$, is net foreign income. We discuss that in the next section.

4.2 Home Bias in Asset Accumulation

As we discussed in section 3.3,both output and equilibrium capital will grow at a rate $a + n$, when there are no constraints on investment and assuming perfect capital movements. However, in the presence of a home bias less capital will be accumulated than K^*, and a different rate of growth of the capital stock K might result.
Taking into account that capital depreciates at a rate δ, gross investment I equals:

$$I = K - (1 - \delta).K_{-1} \tag{24}$$

Because savings S contribute to asset accumulation, we find:

$$A = A_{-1} + S \tag{25}$$

In a closed economy version of our model national income, X, equals GDP, Y, and assets are equal to the capital stock. Asset accumulation then follows from $K = K_{-1} + S$ and consistency with investment requires: $S = I - \delta K_{-1}$, Eq.(24). The equality between savings and net-investment is obtained by adjustment of the interest rate. As a consequence the interest rate is endogenous and no longer given by the world market. This is for instance the case in Razin and Sadka (2000).
We prefer a more general method which encompasses both extremes of a closed economy and an open economy with perfect capital movements. In line with our stylized fact (4) we assume the presence of a home bias. A certain proportion $\mu$of the assets in a country will be invested in the domestic capital stock– this is consistent with the definition of home bias (see Sørensen *et al.* (2007))– where we assume $\mu A < K^*$.[30] The gap between the desired capital stock at the world interest rate and domestically available assets then can be filled through capital inflows by only a fraction ζ, hence of home bias in the rest of the world; as a consequence this fraction ζ is negatively related to μ. This implies for the capital stock:

$$K = (1 - \zeta).\mu A + \zeta.K^* \qquad 0 \leq \mu, \zeta \leq 1 \tag{26}$$

Moreover, arbitrage then will lead to a domestic interest rate $r = Y_K - \delta$, with $r > r^*$.
One sees that when both $\zeta = 0$ and $\mu = 1$, holds $A=K$ and we are in the closed economy situation and savings equal investment – the endogenous interest rate then also guarantees that Eq. (14c) holds with equality but with a domestic interest rate. When $\zeta = 1$and $\mu = 0$ we find $K = K^*$ – then home bias plays no role and there are no constraints on investment. In that case the equilibrium capital stock K^*will always be obtained at the world market interest rate, compare Eq.(6). For values of openness between these extremes, lower home asset preference and lower openness reduce the capital stock K and the corresponding interest rate is r.

[30]The proportion μ should exceed the share of assets of the country in the world asset market in case of a home bias.

In our more general method we can derive from Eq.(20), (22) and (25) at a constant share of wage income, α:[31]

$$A = (1/d).A_{-1} - (T.\ \alpha^*r/d).K \tag{27}$$

with $\alpha^* = \alpha/(1-\alpha)$, $T = (1-c)(1-t_p)$, $d = 1 - T.\varphi.r + \xi.(1-\varphi)$ and using $\alpha^* rK = wE$.

4.3 Capital Accumulation in Presence of a Home Bias

The analysis of the previous section enables us to analyze the effect of the presence of a home bias on capital accumulation and shows how a pay-as-you-go pension system can affect that accumulation negatively in the presence of ageing.
The system of Eq.(26) and (27) should be closed with the observation that K^* grows at a rate $a + n$, hence

$$K^* = (1 + a + n).\ K^*_{-1} \tag{28}$$

This yields a dynamic system of three equations in K, K^* and A. The dynamics of the system of equations(26) – (28) is analyzed in section 5. Here we concentrate on stable cases of imperfect capital movements, $\zeta < 1$, and some home bias in investment, $\mu > 0$, that lead to a positive steady-state value for the ratios A/K^* and K/K^*.Moreover, we are particularly interested in the effect of the rate of contribution t_p on capital accumulation, because the pension contribution rate is the policy parameter that will be adjusted to absorb shocks in the ageing process.
In the steady state assets A grow at a rate $a + n$ and Eq. (27) becomes:[32]

$$K = \left[\frac{\left\{1 + \xi(1-\varphi) - \frac{1}{1+a+n}\right\}}{(1-c).(1-t_p)\propto^* r} - \frac{\varphi}{\propto^*}\right] A = x_{CA} A \tag{29}$$

Inserting this in Eq. (26) yields:[33]

$$K = \zeta \frac{1}{1-(1-\zeta).\frac{\mu}{x_{CA}}} K^* \tag{30}$$

The implication of this equation is that higher pension contribution rates t_p lead to lower values of the capital to efficient capital ratio, K/K^*, in the steady state, provided some home bias is present ($\zeta < 1$). Starting from an initial valuet_p^*, an increase in t_p then will lead to lower capital growth in the transition process. The intuition is that in this case fewer funds are available for investment, as they are used for the consumption of the old as in Eq.(21). As a consequence a lower capital stock will result in the steady state and in the transition.

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[31]Strictly speaking the latter only holds in the steady state and using w^g instead of w.
[32]The positive effect of A on K is consistent with an endogenous interest rate in x_{CA}, because $r = Y_K - \delta$ moves in the opposite direction of K.
[33]We assume that $t_p > 1 - \frac{1 - \left[\frac{1}{1+a+n}\right] + \xi(1-\varphi)}{(1-c)\varphi r} > 0$ does hold. This also ensures $x_{CA} > 0$.

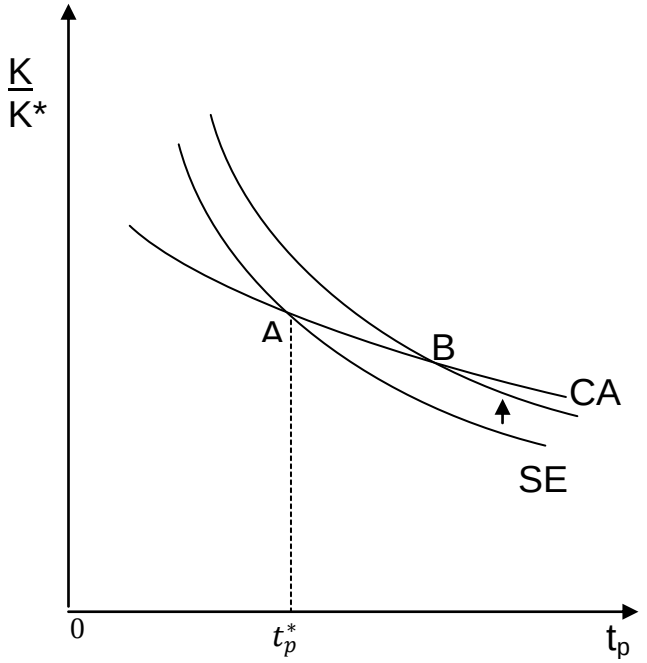

Figure 4: The CA and SE-curves, and the effect of ageing

The downward sloping relation between the capital to efficient capital ratio, K/K^*,[34] and the contribution rate t_p is presented in Figure 4. We name this relationship the capital-accumulation or CA-curve, because for each different contribution rate t_p we get a different capital to efficient capital ratio, as long as capital accumulation is related to growth of domestic assets, that is as long as holds $\zeta < 1$. When $\zeta = 1$, that is absence of home bias, the CA-curve is the horizontal line at unity.

The CA-curve will shift upwards when the propensity to consume c decreases, because more income then will be saved at the same contribution rate. The same occurs when the old dissave less, that is when ξ decreases or φ increases, and when productivity growth and population growth, $a + n$, decrease. Also a higher share of labor income α and a higher interest rate r also lead to an upward shift of the CA-curve. Finally, there is no direct effect of the ageing process through the ratio of old over young persons, N^o/N^y on the CA-curve.

4.4 Social Equilibrium in the Welfare State

Next to unemployment compensation, discussed in section 1.2, social equilibrium in the welfare state also requires that consumption per head of the old is at least equal to a constant fraction η of consumption per head of the working young.[35] This is a matter of social responsibility, for the old have contributed in their young days to the development of the economy as it is now for the young. Moreover, political reality requires that the old

[34] We use the word 'efficient' here in the sense of 'free from home bias'.

[35] We ignore here details of pension systems such as former unemployment of the old, which has an impact on their pensions in most countries' systems.

have sufficient benefits, because they represent a growing part of the electorate in an ageing economy. Social equilibrium then requires:

$$\eta.c.\ Y^y/N^y = [Y^o + \xi.(1-\varphi).A]/N^o \tag{31}$$

The term in brackets of Eq.(31) is consumption of the old.
Because the pension contribution rate t_p is the policy parameter that will be adjusted to absorb shocks in the ageing process, we assume that t_p will be adjusted instantly to maintain social equilibrium in reaction to shocks to the economy.
Substituting Eq.(20) and (21) in Eq.(31) yields, using the domestic interest rate:[36]

$$K = \left[\frac{1}{\eta.c.(1-t_p).\frac{N^o}{N^y} - t_p}.\frac{r+\xi}{r}.\frac{1-\varphi}{\propto^*} - \frac{\varphi}{\propto^*}\right].A = x_{SE}.A \tag{32}$$

Using (32) to replace A in Eq.(26) yields:[37]

$$K = \zeta \frac{1}{1-(1-\zeta).\frac{\mu}{x_{SE}}} K^* \tag{33}$$

Eq.(33) shows that the rate of growth of capital consistent with social equilibrium is that of K^*, $a + n$, as long as the other parameters of the model remain constant. However, any change in the parameters constituting x_{SE} will lead to a change in the ratio K/K^* and hence will have temporary growth effects in the sense of shifting steady state values (see also section 2). Focusing on pension contributions, a decrease in the ratio K/K^* while moving along the SE-curve, implies a decrease in the growth rate of K, at least initially, and will lead to an increase in the rate of contribution t_p. This is intuitively plausible because lower capital accumulation implies a lower wage income and hence lower income for the old – provided the pension contribution rate is below 50 per cent.
For that reason the social equilibrium Eq.(33) is presented as the decreasing SE-curve in Figure 4. The curve will shift upwards when the consumption-share of the old η or the propensity to consume c increases, and the curve shifts downwards in case of a lower share of labor income in GDP α and a lower return on investment r. Finally, there is a positive effect of the ageing process on capital accumulation from the ratio of old over young persons, N^o/N^y, on the SE-curve because in that case the young want to increase their wage income in order to be able to finance the consumption of more old persons and their own according to Eq. (31), both reducing savings and steady-state capital stocks.

4.5 The Effect of Ageing and Immigration

Figure 4summarizes our model by determining the capital accumulation consistent with social equilibrium. In equilibrium the SE-curve intersects with the CA-curve at the contribution rate t_p^*.

[36]The positive effect of A on K is reinforced by an endogenous interest rate in x_{SE}, because $r = Y_K - \delta$ moves in the opposite direction of K.

[37]Provided that holds: $t_p > \left[\eta.c.\frac{N^o}{N^y} - \frac{1-\varphi}{\varphi+(1-\lambda).\mu\propto^*}.\frac{r+\xi}{r}\right] / \left(1 + \eta.c.\frac{N^o}{N^y}\right) > 0$. This also ensures $x_{SE} > 0$.

Setting $x_{CA} = x_{SE}$, we find t_p^* from:

$$\frac{t_p^*}{1-t_p^*} = \eta c \frac{N^o}{N^y} - \frac{(r+\xi)(1-\varphi)(1-c)}{1+\xi(1-\varphi)] - \left[\frac{1}{1+a+n}\right]} \tag{34}$$

The steady state capital stock is found by substituting t_p^* in Eq. (30); it grows at a rate $a + n$.

Eq. (34) shows that ageing leads to a higher pension contribution rate in the steady state; Eq. (30) shows that the steady state capital stock will be lower in that case. Because the SE-curve shifts upwards with ageing, while the CA-curve is not affected, Figure 4illustrates how ageing moves the economy from equilibrium point A to B with a higher pension contribution rate and a lower capital stock and as a consequence a lower transitional growth of the economy.

In section 3.3 we argued that the steady state properties of the model hold when the labor force grows in a skill neutral way. This is consistent with the notion of skill neutral immigration, in line with stylized fact (2). Another aspect of immigration, which we have not yet discussed, is that generally immigrants are younger than the average native population. As a consequence skill neutral immigration can reverse the ageing process by increasing the ratio of young to old and hence shifting the SE-curve downwards. For that reason skill neutral immigration can be seen as a contribution to the solution of the ageing problem.[38]

Because most countries want to have skilled rather than unskilled immigration, we should also consider the effect of high-skill biased immigration. Skill-biased immigration leads to a higher labor income *wE* according to Eq. (19), provided the effect of immigration of wages is relatively small.[39] This in turn leads to a higher income of the young in Eq. (20) and of the old according to Eq. (21) through higher pension contributions received. Income of the young increases more than that of the old, assuming a pension contribution rate below 50%. According to the requirement of social equilibrium Eq. (31) this would result in a higher path of assets *A*. It follows from Eq. (32) - for constant N^o/N^y when looking at the skill bias only - that *K* must also be higher and from Eq. (33) that *K** would be higher. This is in line with the intuition that relatively more human capital increases the marginal product of capital more than neutral immigration, capital inflows are higher and so is asset accumulation because of the higher income, with and without perfect capital markets.

5 Asset and capital stock dynamics in presence of a home bias

In section 4 we discussed the effect of ageing in a steady state context and we showed that the policy reaction would be an increase of the pension contribution rate t_p, leading to a

[38]Apart from that, immigration can affect many other parameters of the model, which we do not elaborate here. As we argue in Muysken and Ziesemer (2013) immigration can affect productivity growth *a* positively in various ways (for instance through product differentiation and over-qualification), while ageing is well documented to affect productivity growth negatively. However, that is beyond the scope of the present analysis, which focuses on capital accumulation.

[39]Many studies confirm that wages are not affected too much by immigration. For a recent survey see Kahanec and Zimmermann (2010).

decrease of the capital stock in the steady state. In this section we analyze the dynamic process underlying the transition between two steady state positions. In particular we focus on the adjustment of the capital stock – in terms of Figure 4the shift along the CA-curve, for that curve represents the reaction of capital accumulation in relation to changes in t_p.

The dynamic equations constituting the capital accumulation process are Eq. (26) - (28). This is a system of three difference equations in *A*, *K*, and *K**. In order to transform it into one equation in $b \equiv A/K^*$, we define $k \equiv K/K^*$. Dividing both sides of Eq. (27) by *K** and multiplying and dividing the first term on the right-hand side by K^*_{-1} and using Eq. (28) yields

$$b = \frac{1}{a+n+1}\frac{1}{d}b_{-1} + \frac{T\alpha^* r}{d}k \qquad (27')$$

with $\alpha^* = \alpha/(1-\alpha)$, $T = (1-c)(1-t_p)$, $d = 1 - T.\varphi.r + \xi.(1-\varphi)$.

Dividing both sides of Eq. (26) by *K** yields

$$k = (1 - \zeta)\mu b + \zeta \qquad (26')$$

Insertion of Eq. (26') into (27') yields a difference equation in *b*:[40]

$$b = \frac{1}{(1+a+n)[1 - \mathrm{Tr}\{\varphi+\alpha^*(1-\zeta)\mu\}+\xi(1-\varphi)]}b_{-1} + \frac{\mathrm{Tr}\alpha^*\zeta}{1 - \mathrm{Tr}\{\varphi+\alpha^*(1-\zeta)\mu\}+\xi(1-\varphi)} \qquad (35)$$

This equation can be drawn with *b* on the vertical axis and b_{-1} on the horizontal axis. Realistic cases have a positive and constant long-run value of $b^* = (A/K) > 0$. This requires a negative or positive slope that is below unity and a positive intercept.

The intercept and the slope are positive as long as holds:

$$\varphi + \alpha^*(1-\zeta)\mu < \frac{1+\xi(1-\varphi)}{(1-c).(1-t_p)r} \qquad (36)$$

The slope is below unity as long as:

$$\varphi + \alpha^*(1-\zeta)\mu < \frac{1+\xi(1-\varphi)}{(1-c).(1-t_p)r} - \frac{1}{(1+a+n)}\cdot\frac{1}{(1-c).(1-t_p)r} \qquad (37)$$

As long as the condition in Eq. (37) is met, the condition in Eq. (36) is also met. Hence, the condition in Eq. (37) is the only condition that should hold. For reasonable parameter values this condition does not seem hard to satisfy.[41] However, in the extreme case of all wealth owned by the old, $\varphi = 1$, and at the same time no growth, $a = n = 0$, the condition in Eq. (37) does not hold, but (36) does. *A/K* would grow permanently and increasingly

[40] In the analysis in this section we ignore for simplicity the effect of changes in the capital stock on the interest rate. From Eq. (29) one sees that the direction of the relationship between *A* and *K* is not affected.

[41] We have varied parameter values around the baseline case $\eta = 0.5$; $c = 0.8$; $N^o/N^y = 1$; $r = 0.04$; $\xi = 0.8$; $\varphi = 0.6$; $\alpha* = 2$; $a = 0.015$; $n = 0.005$.

much capital would be held abroad. This case seems unrealistic in terms of assumptions and outcomes and we have concentrated on the stable ones.
If b goes to a constant value it follows from Eq. (26') that $k=K/K^*$ goes to a constant value. By implication $b/k=A/K$ also go to a constant value. Hence if b is constant, then A and K^* grow at the same rate and K must have the same rate as well, which is $a + n$.
We are particularly interested in the effect of the rate of contribution t_p on the growth rate, which appears in $T = (1 – c)(1 – t_p)$. Higher pension contribution rates t_p lead to a lower value of the slope and of the intercept in Eq. (35) and as a consequence to lower growth rates of A/K^*. As a consequence higher rates reduce the private assets to efficient capital ratio, A/K^*. According to Eq. (28) and (26') capital growth is below $a + n$ to the extent that A/K^* is falling. Hence capital also has a growth rate that is falling with t_p.
The dynamic process underlying the transition from point A to point B in Figure 4can be explained using the observation that Eq. (32) and (33), constituting the SE-curve, were derived without any steady-state assumption. Essentially the SE-curve describes how the pension contribution rate t_p is adjusted in reaction to shocks to the economy. The effect on capital accumulation then follows from the CA-curve. If the capital stock initially would remain constant, the effect of the ageing process will lead to an increase in the pension contribution rate following the SE-curve, Eq. (33). The dynamic process described in Eq. (35) then shows how in reaction to the increased t_p lower capital accumulation leads to a relative decrease in the capital stock. Social equilibrium in Eq. (33) then leads to a further increase in the pension contribution rate. This process continues till the equilibrium position summarized in Eq. (34) is reached. However, the speed of adjustment is infinitely high, because Eq. (32) and (33) guarantee constant values of K/A and K/K^*. In short, social equilibrium ensures that the economy is always in the steady state – unless we impose assumptions causing delays– and all changes are shifting steady-state values as assumed in section 4.

6 Concluding Remarks

Our empirical analysis for the Netherlands reveals that in order to get a positive effect of immigration on the economy, at least hours worked relative to the population must increase. To motivate this finding we have extended the immigration models of Razin and Sadka (2000), Kemnitz (2003), Boeri and Brücker (2005), Brücker and Jahn (2011) by analyzing immigration in a general equilibrium context, including physical capital in a CES production function, using a right-to-manage wage bargaining model, and allowing for unemployment. The main conclusion from the theoretical model is that income per head will increase due to immigration, under the condition that the immigrants find employment, increase the ratio of working hours to the population and contribute to the skill distribution at least proportionally to the native population. This finding contradicts parts of the literature that claim that mainly capital brought in by the migrants matters (see Kemnitz (2001)) or denies a relation with unemployment or effects on GDP per capita (see the discussion of the literature in Section 1). The main determinant of economic growth when analyzing the benefits of immigration is the increase in home-biased capital accumulation following immigration. Apart from that, immigration can affect many other parameters of the model, which we do not elaborate here. In line with the arguments followed by the United Nations, the European Union and the OECD in their advice to

allow for more immigration, the latter can affect productivity growth positively in various ways – for instance through product differentiation and over-qualification (EU (2005), OECD (2012)).

Hence to stimulate economic growth it is of utmost importance that immigration policy as a means to mitigate the aging problem should not only focus on the number of immigrants, but also on their employability by keeping the skill structure in line with the skill distribution of domestic labor market entrants. This requires two steps: (1) skill neutral admission of immigrants and (2) an education policy that has the ambition and ability to educate the second and third generations of immigrants, at least in line with the average skill distribution in a country.

Our conclusions support the view of the European Commission that immigrants in general have a positive effect on the economy provided that they are employed. As the European Commission puts it: "The current situation and prospects of EU labor markets can be broadly described as a 'need' scenario. Some Member States already experience substantial labor and skills shortages in certain sectors of the economy, which cannot be filled within the national labor markets. This phenomenon concerns the full range of qualifications - from unskilled workers to top academic professionals." (See EU (2005)). In line with this statement by the European Commission we argue, following our theoretical and empirical results, that the immigration policy of the European Union with respect to the blue card and the admission of some other specific groups may be too restrictive to maximize the benefits from immigration in the light of an ageing population.

Finally, the expectations from immigration as a single cure for falling birth rates and an ageing population should not be too high, because it is only one policy instrument within a broader mix and it has only small effects as shown in our empirical analysis.[42]Many countries in the European Union should worry about their high unemployment and low employment rates, and give more priority to increase employment. However, our analysis shows a slightly positive effect of immigration on employment after some years. Immigration policies should go hand in hand with active labor market policies and education policies to get the low-skilled unemployed back to work and to prevent young people, both natives and immigrants, from early school leaving, thereby raising their level of education and opportunities on the labor market OECD (2008).

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[42]See also Fehr *et al.*(2010) and Borgy *et al.* (2011) supporting this using a great variety of assumptions.

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Appendix

The data used

Variable	Source	Definition
w	KLEMS	Real wage (Labor compensation per hour worked deflated by GDP deflator 2000). This series is only available till 2007.
P	WDI	Population (mid-year)
y	WDI	GDP pc
I/Y	WDI	Gfcf/GDP
L	WDI	Labor force. total
u	CPB	Unemployment rate; international definition
EMPFTE	CPB	Employment in full-time equivalents
hours	CPB	Working hours of a full-time employee (in hours/year)
im	CBS	Immigration
Em	CBS	Emigration

CBS: Statline, http://statline.cbs.nl/StatWeb/dome/default.aspx

CPB: CEP, 2011, http://www.cpb.nl/en/publication/central-economic-plan-2011

KLEMS: EU KLEMS Productivity Report: http://www.euklems.net

WDI: World Development Indicators, Worldbank