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Migration and investment: a business cycle perspective

Almut Balleer and Chantal Fusshoeller *

February 14, 2017

Abstract

This paper addresses the dynamic effects of a migration inflow on the host country. In particular, we focus on the role of skill composition and investment behaviour of migrants and show how these affect labour supply and investment behaviour of natives and, hence, the adjustment path of the economy to various shocks in a real business cycle model. We quantify these effects for the recent refugee inflow into the German economy in 2014 and 2015.

Keywords: real business cycles, migration, investment

JEL-Codes: E13, E32, F22

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1 Introduction

The significant inflow of refugees in 2014 and especially in 2015 is the most important migration phenomenon Europe has faced since the Second World War. In 2014 one third of all refugees reaching Europe have seeked asylum in Germany and more than a million refugees reached its borders in 2015 which makes Germany one of the countries most affected by the refugee inflow. As the number of refugees coming to Europe has substantially diminished in 2016, remaining tensions between Turkey and the European Union and the ongoing war in Syria could lead to a substantial re-increase of refugees fleeing to Europe. In order to answer the raising concerns in the population about the impact of this inflow on our country, the goal of this paper is to create an appropriate dynamic stochastic general equilibrium model to analyse the economic impact of the migration wave on the German economy.

Most of the existing research about the effects of immigration on the host country in a theoretical model focuses on a partial equilibrium perspective of the labour market or on static general equilibrium models. Our model however is based on the assumption that wages and employment are not only driven by changes of the population structure but also by changes in investment and working behaviour of the economic agents. In order to include this theory we use the DSGE model of Canova and Ravn for German reunification as a baseline. The refugee inflow is then represented as a positive population shock which affects the population structure and the German economy. Research about static general equilibrium models shows that a migration shock has a negative impact on wages and output per capita in the short run. In the long run, an increase in the capital stock leads to a shift of these variables back to their steady state. However static models do not explain which effects occur on the short to long run. The question of this paper is how skills and investment behaviour affect the adjustment path.

In order to better understand the dynamics of the economic variables, we focus on the fact that according to the Federal Statistical Office the savings rate of high-skilled natives is positive. This means that they are forward-looking because they decide every period which amount of money they save for further prospects. Consequently, their investment and working behaviour can be influenced by their expectations about the composition and behaviour of other agents in the economy, e.g. low-skilled agents or non-natives. We therefore want to study how different expectations of natives about the refugees alter their economic behaviour. Do the skill composition and investment decisions of refugees have any effect on working and investment behaviour of natives and do these reactions change over the time path? What are the income impacts of migration?

Then the second goal of this paper is to analyse how the reactions of natives change over the business cycle. Does a supply or demand shock alter the reaction of natives to the migration shock? Do the income effects change? We therefore add a simultaneous government spending shock to the migration shock in a first scenario and a simultane-

ous productivity shock in a second scenario.

In order to analyse this we allow for a share of skilled immigration, an approach which has been hardly treated in other DSGE research about migration. As indicated above, we look at different skill compositions of incoming refugees in our model. The production function is therefore characterized by skilled and unskilled labour. Skilled workers here represent the economic agents with professional formation and investment behaviour. We then focus on three scenarios for the refugee inflow: in the first scenario refugees are all low-skilled, in the second scenario a share of refugees is high-skilled without investment incentives and in the last scenario a percentage of refugees is high-skilled with investment incentives. We assume that Syrian citizens represent the highest percentage of refugees that will be allowed to stay and work in the country and thus take their qualifications as a baseline for the skills of refugees. According to the TIMSS and PISA assessment, Syrian scholars of the eighth grade have a third grade level compared to the German scholar system, hence Syrian students are 3/8 less educated than German students. According to the Federal Statistical Office of Germany, the percentage of natives having accomplished a professional formation is at 70%. This gives us a 26% percentage for high-skilled refugees.

The inflow of a large group of less qualified refugees then leads to a slight shift of the workforce to unskilled labour. Taking into account that due to German asylum law refugees have to hand off nearly all of their assets when applying for asylum, the migration inflow also leads to a collapse of capital per capita. For our DSGE model, we therefore notice a negative short-run impact of migration on the economy, which is already suggested in static models. Simulations then show that a higher percentage of skilled refugees without investment incentives barely changes the decisions of high-skilled natives about work and investment. Still a higher percentage of skilled incoming workforce leads to a positive impact on the production function and output per capita. Assuming that refugees have investment incentives in the future, the simulations for the third scenario highlight that the percentage deviation of investment and work behaviour not only changes in level, but also dynamically. High-skilled refugees merge with the group of high-skilled natives which sharply reduces skilled income per capita and therefore investment and working incentives of natives in the first years. Even though the negative effects of migration are thus stronger in the short run for this scenario, investment of refugees lead to a better recovery of the economy in the long run and thus a reincrease of the native's working and investment motivation.

We also notice that migration leads to higher income differences in the population in general. The drop of wages leads to a negative income effect for unskilled agents, whereas skilled workers profit from augmented working hours and higher return to capital. The intensity of this effect interestingly depends on the skill composition and behaviour of refugees. While income differences are intensified in case skilled refugees do not invest, the differences are a lot weaker in the long run if skilled refugees tend to

invest in the host country.

As our model allows for a welfare system, we add insurance taxes such that the impact of the migration shock on unskilled income is zero. Combining a government spending shock with the migration shock due to higher integration costs then leads to a negative effect on output per capita and skilled income, but the low-skilled agents do not suffer from this due to the insurance taxes. Interestingly, the proportional taxes have no dynamic effect on the working behaviour of skilled economic agents in case of low-skilled immigration. However, in the presence of skilled refugees who behave like natives, the substitutional effect of taxes on income dominates which has a negative effect on the working dynamics of skilled natives. Furthermore, the spending shock only reduces income differences in the population if the refugees are all low-skilled. Simulating a technology shock and migration shock simultaneously reveals that higher productivity has a positive effect on working and investment behaviour of skilled natives regardless of the skills and behaviour of refugees. The positive effect is slightly more pronounced for high-skilled income in the first years leading to higher income differences.

Summarizing, we can show that the dynamic effects of a positive demand shock on the economy depend on the composition and behaviour of the refugees, whereas the dynamic impact of a positive supply shock is independent of the structure of the refugee inflow. The rest of the paper is organized as follows: Section 2 discusses the existing literature about effects of migration on the economy. Section 3 outlines the DSGE model and calibration of the model parameters and Section 4 analyses the quantitative effects of the skill composition of refugees and the reaction of the government on the economy. Section 5 concludes.

2 Related Literature

As already stated in the introduction, most of the existing literature about the effects of immigration on the host country focuses on labour market equilibrium only. Many of those studies use an empirical framework to analyse the impact of immigration on wages and employment. For example Altonji et. al. [1] and LaLonde et. al. [19] study the labour market effects of immigration on different geographical areas in the US in the 1970's and 1980's. They deduce that the change in labour supply leads to a slight decrease of wage rates. Card [7] shows that the Mariel boat lift in 1980 had no effect on wage rates and unemployment of less-skilled non-Cuban workers. Friedberg [14] and Cohen-Goldner et. al. [11] both highlight that immigration to Israel had a negative effect on wages. Boeri and Brücker [3] examine the impact of Eastern Enlargement on employment, wages and income distribution in EU member states. They deduce a slight decrease of German wages and a small increase of the individual dismissal risk for natives. Grossmann [16] looks more closely on the production characteristics of immigrants and natives. He concludes that all labour groups are substitutable for

one another, but that immigration inflows barely affect the wages of natives. Cortes [12] finds that in major cities of the United States the wage decrease resulting from immigration increases the purchasing power of high-skilled workers but reduces the purchasing power of low-skilled workers and thus generates a redistribution of wealth. Other partial equilibrium studies use a theoretical framework to analyse the impact of migration on the macroeconomy. Borjas [4] develops a simple static theoretical framework to describe how immigration affects the labour market of the host country. Chasamboulli and Peri [9] create a static model representing two connected labour markets for the United States and Mexico to study the effects of reducing the number of illegal immigrants. They assume that both legal and illegal immigrants are low-skilled. Their simulations show that restrictive policies as the increase of border control, illegal work costs and frequency of deportation have a depressing effect on wages and employment of natives. On the other hand, increasing the probability of legalization induces a gain in income and a decrease of unemployment of natives. Ottaviano and Peri [21] compare the market effects of immigration on the German and the US economy in a dynamic framework. They distinguish between natives, old immigrants and new immigrants. Concerning the German market in the 1990's, they deduce that the impact on wages of the native population is moderate and the employment level does not change. On the contrary, the effects on both wages and employment level of old immigrants are negative.

A new study closer to ours is Junker and Fratzscher [13] who simulate the positive and negative effects of the inflow of refugees on the German economy. Junker and Fratzscher find out that in the first years the effects are negative for output and income per capita. However, in the long term, the positive effects of labour increase overbalance the negative effects for both output and income per capita. The simulations lack a profound micro foundation, i.e. an explicit model of the economic behaviour of agents, as our DSGE model can provide. Moreover, they do not and possibly cannot address the aspects of interest here: the role of fiscal policy, the role of the production structure and, most importantly, expectations and economic uncertainty.

The above examples show the importance of the skill composition of the immigration inflow compared to the existing population in a host country. However, due to the partial equilibrium setup, the studies neglect the interaction between labour and capital market decisions and therefore lack an endogenous and dynamic description of investment behaviour which, in turn, will be important for output. Even though the literature is still relatively scarce, a few studies exist that combine migration aspects and DSGE models. Chortareas et. al. [10] develop a dynamic stochastic general equilibrium model with a migration shock. They assume that incoming migrants only compete with the foreign-born population on the labour market, hence the wage earning of foreign-born agents are negatively affected by the migration shock. Chortareas et. al. show that permanent immigration shocks have a positive effect on output and native's wealth.

Mandelman et. al. [20] create a two country real business cycle framework with a productivity shock. They deduce that the overall gain from unskilled immigration increases with the degree of complementarity of skilled and unskilled labour. Iakova [17] uses a general equilibrium model with homogeneous labour to show that the medium to long-term effect of immigration on real GDP per capita is positive.

Our model is based on the paper of Canova and Ravn [6] who study the macroeconomic effects of the German re-unification. They develop a general equilibrium model in a business cycle framework that serves as a sound initial approach for researches on the macro-level. Canova and Ravn assume that the original equilibrium of the German economy encounters a immigration shock due to the unification, where the immigrants are composed of low-skilled workers only. They observe that the shock and the ensuing sudden change of the population structure is welfare-improving for the native workers but has a negative effect on output per capita. Our baseline model adapts the Canova and Ravn model to the current situation in Germany.

Two studies addressing heterogeneous migrants in a dynamic general equilibrium model are Gad [15] and Izquierdo et. al. [18] who assume that migrants differ in productivity. Both studies however neglect different savings behaviour in the population and thus cannot address the impact that investment decisions of migrants has on the behaviour of natives. Baas and Melzer [2] focus on migrants with heterogeneous remittances decisions and study the effects on Germany in an open-economy model. As they only cover migrating households, the decisions of natives are not studied here.

The only study addressing uncertainty is Chami et al. [8] who create a stochastic dynamic general equilibrium model to investigate the influence of countercyclical remittances on a receiving economy. They deduce that a positive technology shock which raises productivity and output leads to lower remittances. However in case of a positive government spending shock and a raise in labour taxes, the increasing remittances lead to a drop of labour supply and therefore to a decrease of output and an intensification of inflation. Hence remittances create a higher business cycle volatility and an increase of macroeconomic risks. This study shows that the migrant's decision about remittances alters the macroeconomic affects and hence also the behaviour of the native population.

As will be shown in the simulation results, the static and dynamic effects can vary significantly, which is the reason why we will use a dynamic model. The theoretical general equilibrium models of Chortareas et al. [10], Mandelman et al. [20], Iakova [17], Canova and Ravn [6], [15], [18], [2] and Chami et al. [8] listed above all use a dynamic framework. The empiric researches of Card et. al. [1], Card [7] and Grossmann [16] are done within a static context, whereas LaLonde et. al. [19], Friedberg [14], Cohen-Goldner et al. [11] and Cortes [12] use a static empirical model. Borjas [4] and Chassamboulli et. al. [9] use a static theoretical model to describe labour market effects of immigration contrary to Ottaviano and Peri [21] and Junker et. al. [13] who

use a dynamic model.

3 Model

For the baseline case, we model the migration shock as an inflow of low-skilled refugees. We therefore use the model developed by Canova and Ravn [6] to model this scenario. We then extend it by involving a percentage of high-skilled refugees without investment incentives or a percentage of high-skilled refugees who behave like high-skilled natives. The migration shock is further accompanied by a demand and a supply shock through a government spending shock and a productivity shock.

The objective of the agents is to maximize their intertemporal utility function which describes their preferences regarding current and future consumption, investment and labour. First, it is assumed that output depends on aggregate capital and labour, whereby labour input is determined by the size and structure of the population and working hours. Before the refugee inflow the size of the population is in a steady state, which reflects quite well the fact that the population of Germany has barely changed in the last 20 years. It is important to take into account that domestic labour is composed by high-skilled workers holding a professional qualification and low-skilled workers. This is significant for the modelling, since low-skilled workers are less productive and do not own any capital that can be used for the creation of output. Consequently, the skill-composition of the incoming agents plays a crucial role for the resulting output of the population.

The refugee inflow is then modelled as an exogenous shock which hits the structure of the local population and destabilizes it from its original equilibrium. We assume that refugees do not own any capital upon arrival. As stated in the introduction, this seems reasonable as they are obliged to hand off nearly all their assets. Nevertheless we can consider the scenario where the high-skilled refugees save a part of their income in the future to invest in the host country.

The rest of this section describes our modelling approach in detail. Section 4 presents the results of the macroeconomic responses to the migration shock for the different scenarios.

3.1 Model equations

3.1.1 Structure of the population

The population is divided into different skills and age groups. Each period, the agents currently alive face a probability of death $\pi \geq 0$. As the population here coincides with the labour force, death is identified with the entry into retirement age. The individuals that die are replaced in equal number by newborn individuals, who are the agents entering the labour market. Every newborn at any date is high-skilled with probability

p and low-skilled with probability $(1 - p)$.

The measure of all workers in the economy at any date t is denoted by N_t . In year zero, before the migration shock, this measure is equal to 1. The inflow of refugees is denoted by N_t^m , hence the aggregated labour force at date t can be described by

$$N_t = N_{t-1} + N_t^m, \quad t \geq 1.$$

The measure of workers of age a at date t is denoted by $N_{a,t}$. Aggregating all ages and respecting the fact that one part λ of the newcomers are high-skilled, the measure of respectively high-skilled N_t^s and low-skilled workers N_t^u can be denoted by

$$N_t^s = (1 - \pi)N_{t-1}^s + p\pi N_{t-1} + \lambda N_t^m,$$

$$N_t^u = (1 - \pi)N_{t-1}^u + (1 - p)\pi N_{t-1} + (1 - \lambda)N_t^m.$$

The skilled rate or share of high-skilled workers in the population at any date t is denoted by

$$\gamma_t = \frac{N_t^s}{N_t}.$$

If skilled refugees do not invest, the number of skilled natives and skilled refugees are defined separately by the equations

$$N_t^s = (1 - \pi)N_{t-1}^s + p\pi N_{t-1},$$

and

$$N_t^{ni} = (1 - \pi)N_{t-1}^{ni} + \lambda N_t^m.$$

where N_t^{ni} denotes the number of skilled refugees and γ_t denotes the share of skilled natives. The number of unskilled agents N_t^u is described as before.

The inflow of refugees is represented by the stochastic process

$$m_t = \theta_m m_{t-1} + \epsilon_t^m$$

and is measured as a percentage rate of the initial population such that $N_t^m = N_0 m_t$. Using these definitions for the German demography, it is now possible to establish the model which measures the impact of the migration wave on the German economy. The model incorporates the maximization problems of the firms, the high-skilled and the low-skilled agents.

3.1.2 Firms

The firms aim to maximize their profit. They produce output using total capital K_t of the high-skilled agents, total skilled working hours H_t^s and total unskilled working hours H_t^u . Each period every firm makes profit out of the output, and loses a part of

its earnings by paying the wages w_t^s and w_t^u to the labour force and the rental rate of capital r_t to the high-skilled population.

The maximization problem of every firm is thus denoted by

$$\max_{H_t^s, H_t^u, K_t} \left[\Omega (H_t^s)^{1-\rho} + (H_t^u)^{1-\rho} \right]^{\frac{\alpha}{(1-\rho)}} K_t^{1-\alpha} - w_t^s H_t^s - w_t^u H_t^u - r_t K_t$$

where Ω measures the productivity difference between high-skilled and low-skilled workers and ρ measures the elasticity of substitution between the two labour groups. Output per capita is thus defined by

$$y_t = (h_t^e)^{\frac{\alpha}{(1-\rho)}} k_t^{1-\alpha} = \left[\Omega (\gamma_t h_t^s)^{1-\rho} + ((1-\gamma_t) h_t^u)^{1-\rho} \right]^{\frac{\alpha}{(1-\rho)}} k_t^{1-\alpha}$$

where h_t^e denotes the efficiency hours. The first-order conditions in per capita terms are described by

$$r_t = (1-\alpha) \frac{y_t}{k_t},$$

for return to capital and

$$w_t^s = \alpha \Omega \frac{y_t}{(h_t^e)^{1-\rho} (\gamma_t h_t^s)^\rho}$$

$$w_t^u = \alpha \frac{y_t}{(h_t^e)^{1-\rho} ((1-\gamma_t) h_t^u)^\rho}.$$

for the wages of skilled and unskilled labour.

3.1.3 Low-skilled workers

Every low-skilled agent of age a at any date t intends to maximize his utility function which depends on consumption $c_{a+j,t+j}^u$, working hours per capita $h_{a+j,t+j}^u$ and the subjective discount factor β . The maximization problem in per capita terms is then denoted by

$$\max_{h_{a,t}^u} E_t \sum_{j=0}^{\infty} \left(\beta(1-\pi) \right)^j \left(\ln c_{a+j,t+j}^u + A \ln(1 - h_{a+j,t+j}^u) \right)$$

subject to the constraint

$$c_{a,t}^u = w_t^u h_{a,t}^u (1 - \tau_t^u) = (1 - \tau_t^u) y_{a,t}^u.$$

Here, τ_t^u is the income tax rate, $A > 0$ is a weight parameter and y^u denotes unskilled income per capita.

Aggregating the first-order conditions at time t then gives the optimal equation

$$h_t^u = \frac{1}{1+A}$$

for unskilled hours per capita and consequently

$$c_t^u = (1 - \tau_t^u)y_t^u = \frac{1}{1 + A}w_t^u(1 - \tau_t^u).$$

for unskilled consumption per capita.

3.1.4 High-skilled workers with savings

Contrary to unskilled workers, high-skilled natives lend a part of the income they accumulate to the firms for the production of output. So they decide every period how much of their income they save for future purposes. Income of high-skilled agents is then determined by their wages and by the rental rate of capital they receive for their investments. They otherwise do not differ in their preferences from the low-skilled agents and thus use the same utility function. If the skilled refugees decide to save a part of their income for investments, their consumption, investment and work decisions are identical with the decisions of skilled natives, and can thus be modelled by the same equations.

The maximization problem is denoted by

$$\max_{h_{a,t}^s} E_t \sum_{j=0}^{\infty} \left(\beta(1 - \pi) \right)^j \left(\ln c_{a+j,t+j}^s + A \ln(1 - h_{a+j,t+j}^s) \right)$$

subject to the constraint

$$c_{a,t}^s + x_{a,t}^s = (w_t^s h_{a,t}^s + r_t k_{a,t}^s)(1 - \tau_t^s) = y_{a,t}^s(1 - \tau_t^s).$$

The aggregated capital accumulation equation is given by

$$k_{t+1}^s = \frac{N_t^s}{N_{t+1}^s}((1 - \delta)k_t^s + x_t^s).$$

Note that k_t^s and x_t^s are capital and investment per high-skilled agent. Thus per capita measures for investment and capital used in the firm's optimization problem are given by $k_t = \gamma_t k_t^s$ and $x_t = \gamma_t x_t^s$.

Aggregating the first-order conditions at time t then gives the solution

$$h_t^s = 1 - A \frac{c_t^s}{w_t^s(1 - \tau_t^s)}$$

and the Euler equation

$$\frac{1}{c_t^s N_t^s} = E_t \beta \frac{1}{c_{t+1}^s N_{t+1}^s} (1 + (1 - \tau_{t+1}^s)r_{t+1} - \delta).$$

where h^s and c^s are skilled hours per capita and skilled consumption per capita.

3.1.5 High-skilled refugees without savings

We consider now the case where refugees are as productive as skilled natives but they have no investment intentions. This can be for example explained by the fact that the newcomers do not have enough informations about the host capital market. We thus assume that high-skilled refugees consume all their income in every period. Their maximization problem is identical to the one of low-skilled agents, consequently the resulting optimal equations from Section 3.1.3 for consumption per capita and working hours per capita can also be applied here:

$$c_t^{ni} = \frac{1}{1+A} w_t^{ni} (1 - \tau_t^{ni}).$$

$$h_t^{ni} = \frac{1}{1+A}$$

where h_t^{ni} , c_t^{ni} and τ_t^{ni} denote working hours, consumption per capita and the tax rate of skilled refugees.

High-skilled refugees are assumed to be as productive as skilled natives, hence their optimal equation for wage is identical to the one of skilled natives:

$$w_t^{ni} = \alpha \Omega \frac{y_t}{(h_t^e)^{1-\rho} (\gamma_t^{ni} h_t^{ni})^\rho}$$

Here w_t^{ni} describe wages and γ_t^{ni} the population share of skilled refugees.

3.1.6 Welfare system with taxes

We assume that there is a welfare state which imposes an income tax τ . The tax returns are redistributed to the low-income labour class and used for government spending in per capita terms g . The state makes no profit, hence its budget is always zero. This yields the equation:

$$\tau_t^s y_t^s + \tau_t^s y_t^{ni} + \tau_t^u y_t^u - g_t = 0,$$

where τ^s is the income tax for high-skilled agents and $\tau^u = \tau^s - \mu$ is the income tax for low-skilled workers. In the scenario where high-skilled refugees do not save money the income of high-skilled natives y^s and of high-skilled refugees y^{ni} differ, so we use different tax rates for both labour groups. In case high-skilled agents invest the variable y_t^{ni} drops out of the equation.

We assume that the tax system is given by an insurance rule which makes sure that the income of low-skilled workers is not affected by fluctuations and stays constant over time. The equation describing this rule is then given by

$$(1 - (\tau_t^s - \mu)) y_t^u = \bar{y}^u.$$

where \bar{y}^u is the constant income after tax of low-skilled agents. The variable μ is endogenously chosen such that the above equation holds in every period.

The equation for the government spending shock is given by

$$\log(g_t) = \theta_g \log(g_{t-1}) + (1 - \theta_g) * \log(g_{ss}) + \epsilon_t^g.$$

g_{ss} is government spending per capita in steady state and resolves to $g_{ss} = By$. It is thus equal to a fixed share B of output per capita.

3.1.7 Technology shock

Assuming that output depends on productivity and technology level of the economy, the equation for output can be written as:

$$y_t = z_t (h_t^e)^\alpha k_t^{1-\alpha}$$

where z is the productivity of the economy. If the economy is subject to productivity shocks, the productivity z_t is given by

$$z_t = \theta_z z_{t-1} + (1 - \theta_z) + \epsilon_t^z$$

where θ_z is the persistence parameter for the productivity shock ϵ_t^z .

3.2 Calibration

The parameters of the model are determined to match the situation of Germany in 2015. The objective of the citizens is to maximize their intertemporal utility function which describes their preferences regarding current and future consumption, investment and labour. The parameters of the intertemporal utility function include the time preference λ , the probability of death π and a weight parameter for leisure A . The utility function and the parameters are the same for both high-skilled and low-skilled workers.

The time preference is a parameter that takes into account present and expected needs and incomes. In the current case, this parameter is denoted by $\lambda = 1/1.04$.

The probability of death is used to describe the fact that the preference of a citizen to save for future periods diminishes the older he gets. If π is the probability of death then $1 - \pi$ can be denoted as the probability to be alive. In this model, the newborns are synonymous with the citizens entering the labour market and the agents dying are equivalent to the workers going to retirement. Thus the probability to be working in year 0 is $1 = (1 - \pi)^0$, the probability to be working in year 1 is $(1 - \pi)$ and so on. As in Germany the duration of employment is approximatively 40 years, the parameter π can be calculated using $\sum_{a=0}^{\infty} (1 - \pi)^a = 40$ which yields $\pi = 0.025$.

In the optimum of the low-skilled worker's problem, working depends only on the constant weight parameter A . Therefore the variable for unskilled hours is constant and set to $h^u = 0.3$ which means that the low-skilled agents work 30% of their available time. This accounts for approximatively seven hours per day. Thus the weight parameter A is set to $A = (1 - h^u)/h^u = 2.33$.

The output of the firms depends on labour, capital and labour share of income α . This parameter indicates the change rate of output if labour changes by one percent. For the considered production function, the labour share of income is given by $\alpha = 0.64$. This also means that the variation of output depends more on the variation of labour than on the change of capital. The capital depreciation rate is denoted by $\delta = 0.1$ which implies that capital depreciates by ten percent every year.

As stated above, labour is partitioned into high-skilled and low-skilled workers. Conforming to the data of the Federal Statistical Office of Germany, around 70% of employees detain a degree of a higher institution or have completed a professional apprenticeship. Hence the share of high-skilled agents in the original equilibrium is set to $p = 0.7$. Comparing the wages in Germany between the two groups, the high-skilled employees earn on average 38% more than the employees without professional formation. Therefore the productivity difference between high-skilled and low-skilled hours is defined to be $\Omega = 1.38$. According to the Federal Statistical Office the saving rate of household with a net income of 2000€ until 2600€ is 4.4%. Taking into account that the medium gross income of employees without professional degree is at 2300€, we can assume that only high-skilled agents save and invest a part of their income.

As reported in the Bildungsbericht 2014 the real monthly income of an employee with professional formation is on average at 3250€ which amounts to a tax rate of approximatively 15%. Using the numbers for 2014 of the tax and contribution ratio of employees, the welfare spending of Germany and the insurance contribution on welfare spending, we deduce that one third of employee contributions are used for welfare redistribution. Consequently, the tax rate in our model amounts to $15/3 = 5\%$ for a welfare system without government spending.

According to the numbers of the Ministry for Finance, the tax share of GDP amounts to 0.23% in 2014. We add to this number the charges for unemployment insurance which is 0.03% of GDP. Hence we use $\tau^s = 0.26$ for the tax rate of high skilled agents in case there is government spending. Using the data of the Ministry of Finance for the public spending ratio, public expenses without social security issues amount to 0.25% of national output. We use this number for government spending in steady state.

The migration shock is represented by a stochastic process with a shock parameter ϵ^m and a persistence parameter θ_m . The shock parameter describes the impact the refugee inflow has on the German population in the first year. Considering recent numbers, one million refugees arrived to Germany in 2015 which makes 1.25% of the 80 millions German citizens. Hence the variance to the migration shock in the first year is set

to $\sigma_m = 0.0125$. As the number of refugees coming in 2016 is expected to be still quite important, the persistence parameter is set to $\theta_m = 0.75$. This means that the number of incoming refugees diminishes by 25% every year, which would result in a total of 750000 newcomers in 2016. According to the TIMSS and PISA assessment, the Syrian scholars of the eighth grade have a third grade level compared to the German scholar system. Hence, assuming that Syrian students are 3/8 or 62.5% less educated than German students, we assume that $0.375 \cdot 0.7 = 26\%$ of the incoming refugees are high-skilled.

For the productivity shock we set the persistence parameter to $\theta_z = 0.95$ and the variance to the productivity to $\sigma_z = 0.008$. For the government spending shock we use $\theta_g = 0.97$ for the persistence parameter and $\sigma_g = 0.01$ for the variance to the government spending mean.

All the parameters are summarized in the table below.

Parameter	Value	Description
β	1/1.04	Subjective discount factor
π	0.025	Probability of death
h^u	0.3	Working hours of low-skilled agents
A	2.33	Preference parameter
γ	0.7	Share of high-skilled agents in steady state
α	0.64	Total labour share of income
ρ	0	Inverse of elasticity of substitution between high- and low-skilled hours
δ	0.1	Capital depreciation rate
Ω	1.38	Productivity difference between high- and low-skilled agents
τ^s	0.05, 0.26	Marginal tax rate for skilled agents
σ_m	0.0125	Variance to the migration mean
θ_m	0.75	Persistence parameter of the migration shock
λ	0.26	Share of incoming high-skilled refugees
θ_z	0.95	Persistence parameter of the productivity shock
σ_z	0.008	Variance to the productivity mean
θ_g	0.97	Persistence parameter of the government spending shock
σ_g	0.01	Variance to the government spending mean
B	0.25	Government spending share of output

Using this numbers, the migration shock on the original general equilibrium can be

simulated using Matlab.

4 Simulations of the baseline model

4.1 Low-skilled immigration shock

We first analyse the results of the economic response to a migration shock in case the refugees are all low-skilled and all labour groups are perfect substitutes. In the first year, the migration shock affects the measure of low-skilled agents and therefore also the measure of the whole population, both grow by 1.25%. The number of skilled agents stays constant, hence the skilled rate drops in the first year. The sudden inflow of refugees without capital belongings then leads to a collapse of capital per capita.

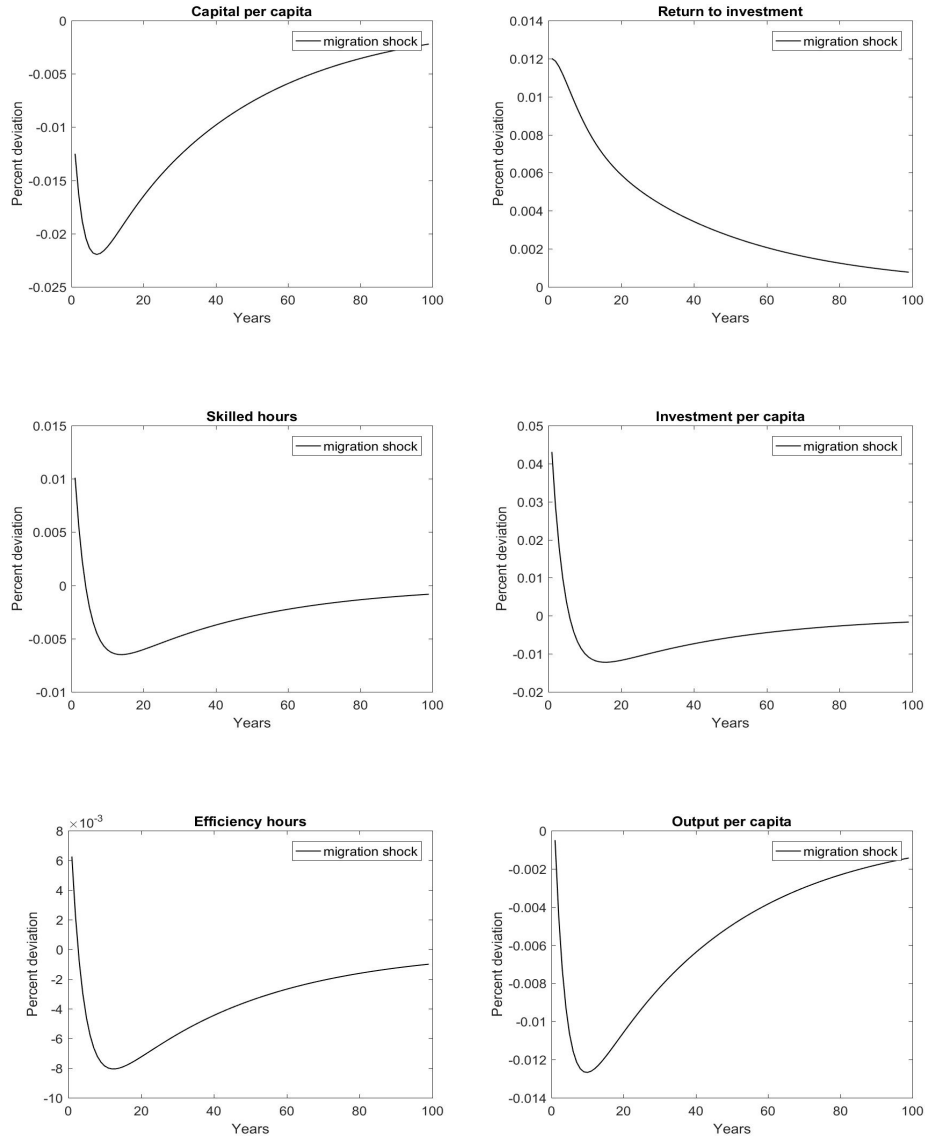
As capital stays constant, the boost of total working hours leads to a lower marginal productivity of labour. Assuming that all labour groups are perfect substitutes, the wage rate of skilled workers also declines. Nevertheless the boost of total working hours leads to an increase of the marginal productivity of capital and hence also of return to capital. This increases the incentives of high-skilled natives to invest and hence also to augment their income by higher working hours which leads to a positive labour supply shift of high-skilled workers and hence efficiency hours increase. At the same time the higher return to capital results in an investment boom in the first year.

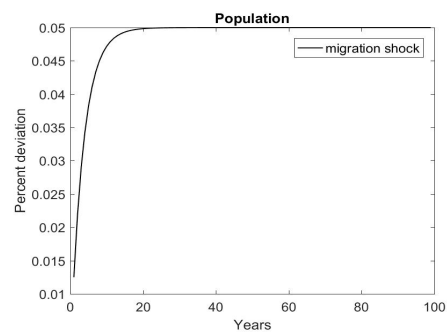
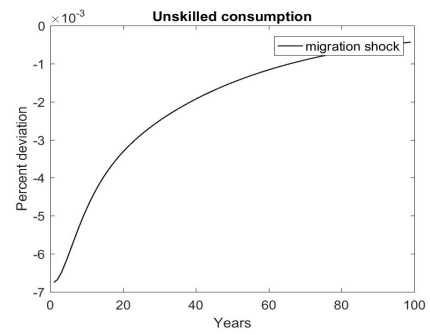
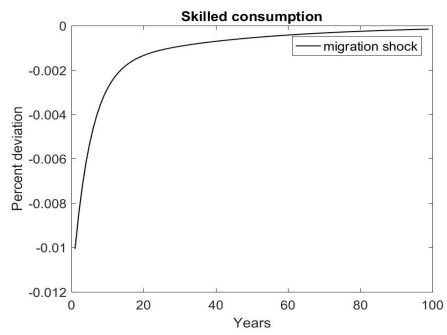
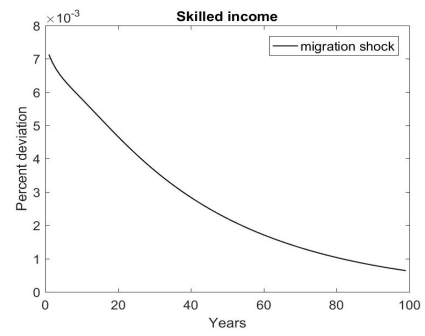
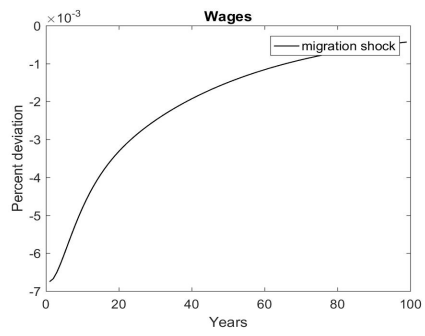
The increase of efficiency hours then attenuates the negative effects of the capital per capita drop on output per capita. Consumption per capita of unskilled agents declines in the first year due to the drop of wages whereas the decrease of skilled consumption per capita results from increased investment incentives. The inflow of refugees is nevertheless strongly welfare-improving for high-skilled natives, since their income increases vigorously due to the higher value of their invested capital and increased working hours. The positive income effect and the negative impact on return to capital then lead to a decrease of investment per capita and skilled labour supply. These effects combined with an ongoing inflow of low-skilled refugees result in a decline of output on the medium term. The percentage deviation of wages is equal for both labour groups as wages differ only by a productivity constant. Consequently, the increase of marginal productivity of labour raises wages of both skilled and unskilled agents.

As the migration inflow dies out in the long run, the population growth converges and the other measures re-approach the steady state level.

These simulations reflect similar effects as the ones predicted by Borjas [5] concerning the short-run and long-run impact of immigration on the labour market equilibrium. He argues that if capital is held fixed, the shift of the labour supply curve due to immigration leads to a decrease of wages. Total employment raises but on the contrary to our model, Borjas predicts that employment of natives falls as he does not consider the

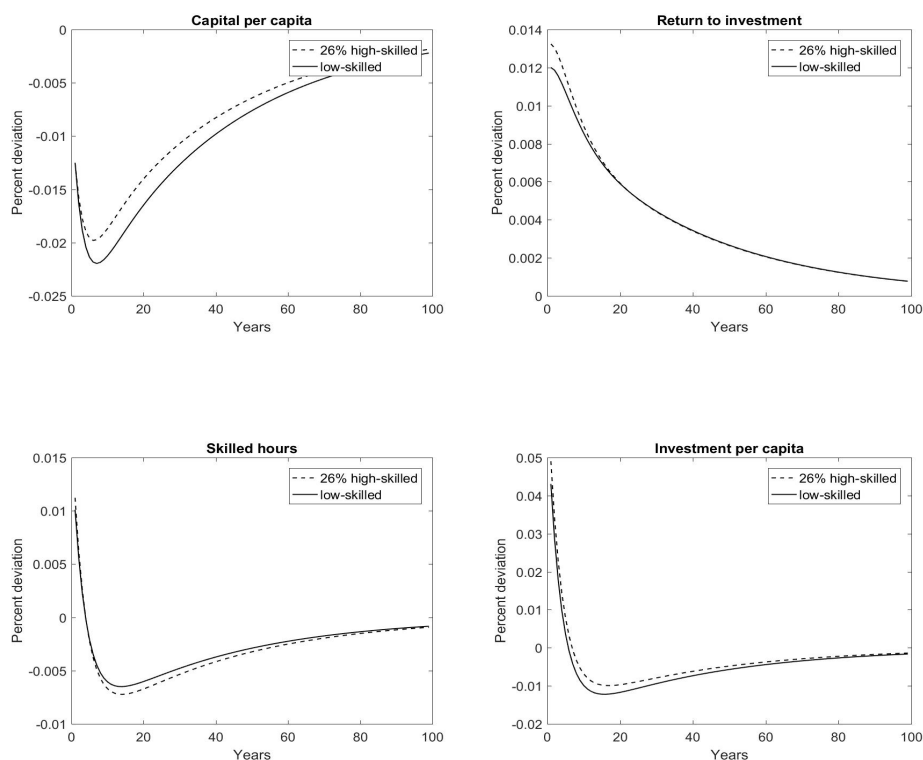
effects of return to investment on labour of high-skilled natives. Borjas assumes that return to capital is fixed in the long run which implies that capital stock must increase by the same rate than the number of workers. This implicates that the labour demand curve shifts to the right and that wage rates stay constant in the long run, such that the employment rate of natives falls back to its normal level. These predictions can be easily verified looking at our simulations.

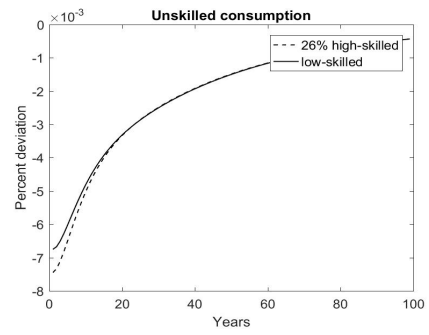
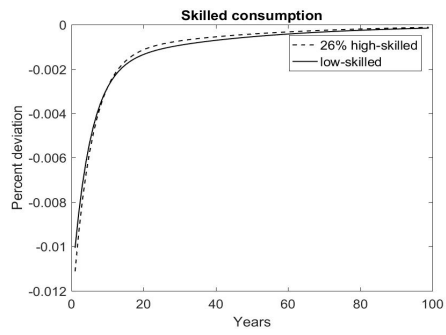
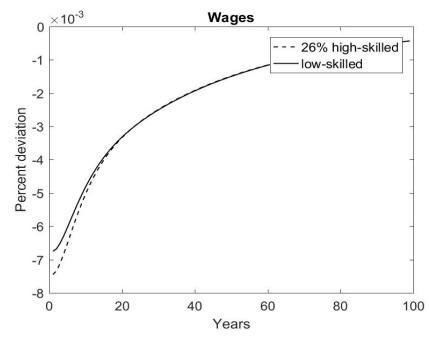
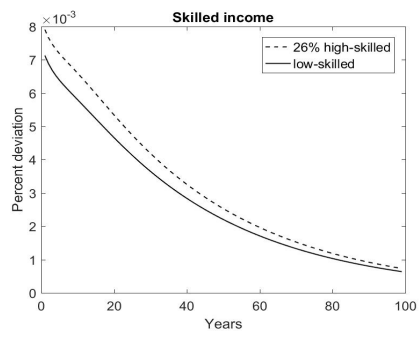
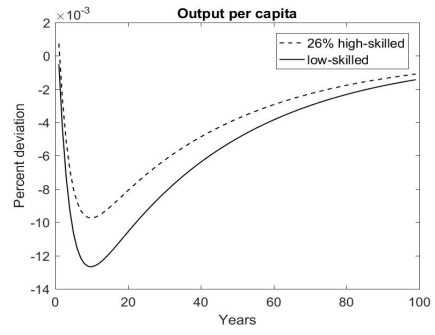
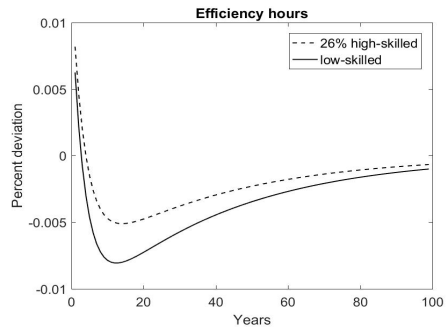




4.2 Skill composition of refugees

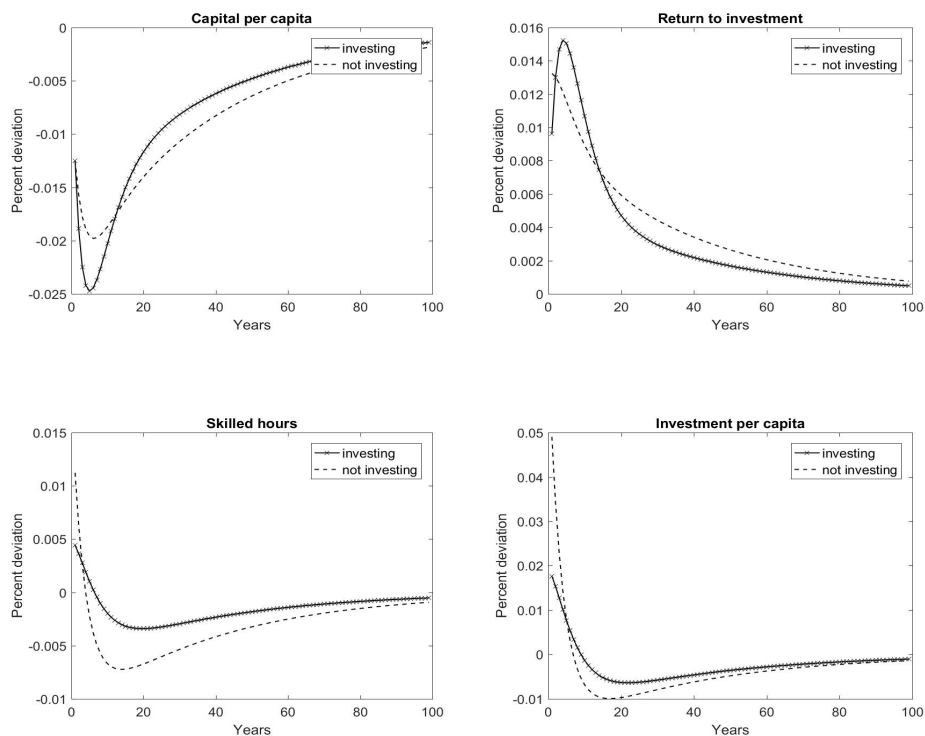
We now consider the case where a percentage of refugees are high-skilled and thus are as productive as skilled natives. Assuming that skilled refugees for example don't have enough knowledge about capital markets in the host country, they have no motivation to save and invest a part of their income. Considering the optimum equations in 3.1.5 their working time is constant and equal to the working hours of unskilled agents. Compared to the case where refugees are all low-skilled, a percentage of skilled refugees induces a positive effect on the percentage change of output per capita and return to investment. This raises the investment incentives of skilled natives, such that the percentage change of investment per capita and skilled hours is slightly higher in this scenario in the short run. The negative effect on consumption per capita of both labour groups is more pronounced here as skilled refugees increase efficiency hours and thus reduce wages. The invested capital of skilled natives has a positive impact on capital per capita, output per capita and skilled income in the medium to long run. The latter increases income differences between the two labour groups.

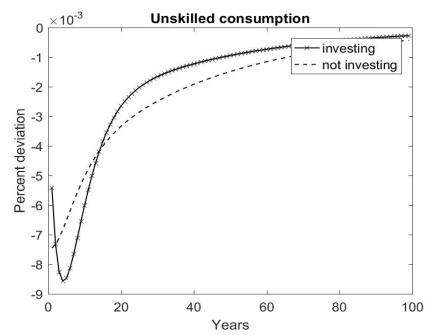
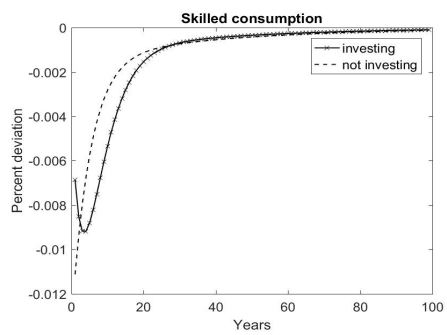
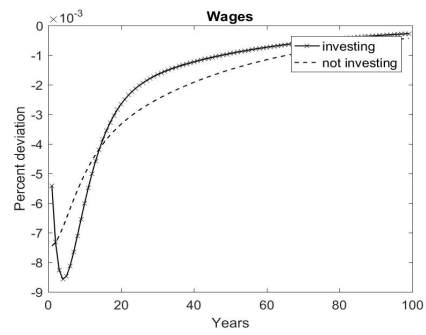
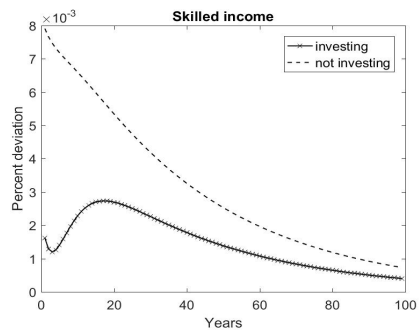
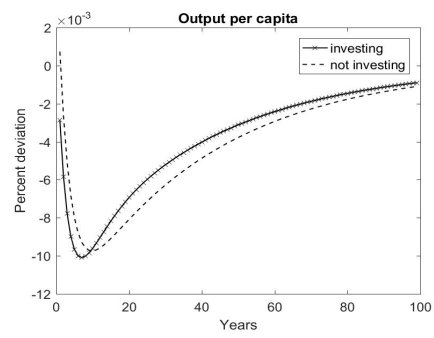
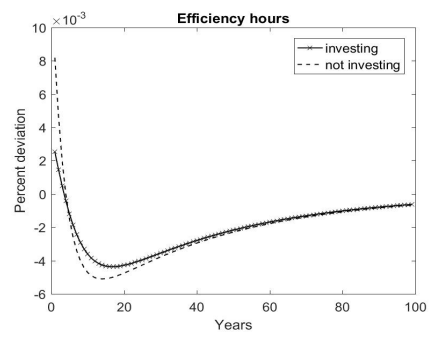




4.3 Investment decisions of high-skilled refugees

In case skilled refugees participate in the capital market they belong to the same labour group as skilled natives and their investment and working decisions can be identified with the choices of natives. Consequently the capital share and capital income of skilled natives diminishes which has a negative effect on the percentage change of investment and working decisions of skilled natives on the short term. In the first years after the migration shock, the negative impact on output and capital per capita is thus stronger if a part of the refugees are high-skilled and behave like skilled natives. However the stronger drop of capital per capita has a positive impact on the percentage change of return to investment in the following years which re-motivates skilled agents to invest. The generated effect is so strong that in the medium to long run the negative impact of migration on capital and output per capita is less pronounced if skilled refugees behave like skilled natives. Income differences in this scenario are smaller which is caused by the slighter increase of capital income due to the higher share of investors.



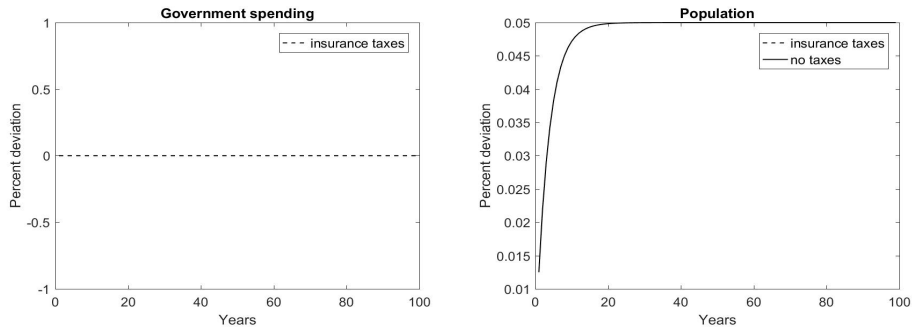


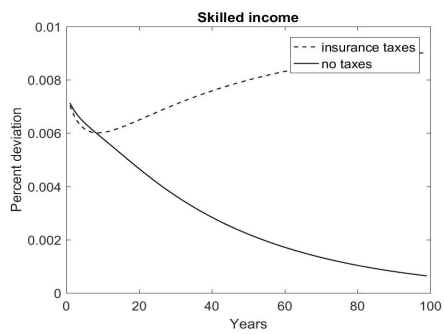
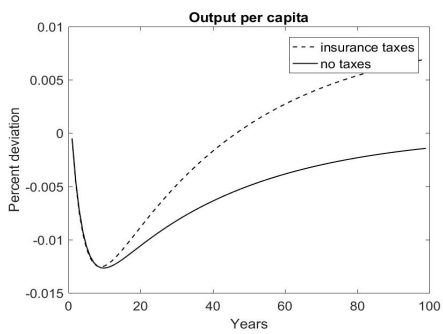
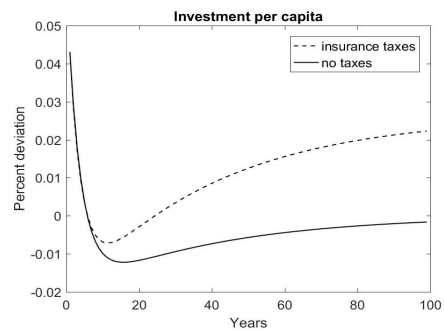
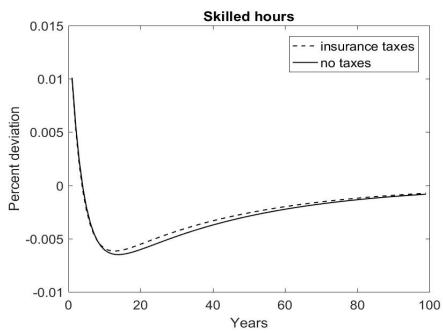
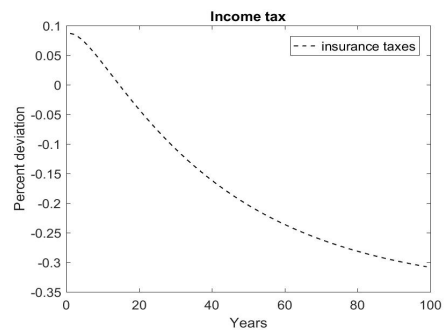
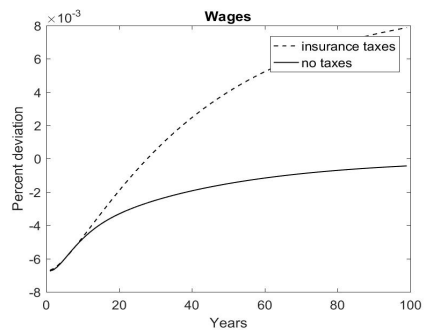
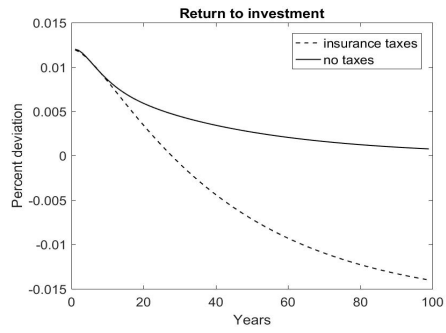
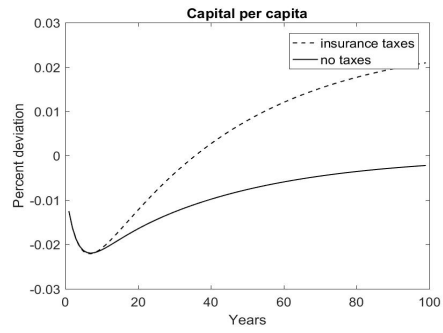
4.4 Welfare system with taxes

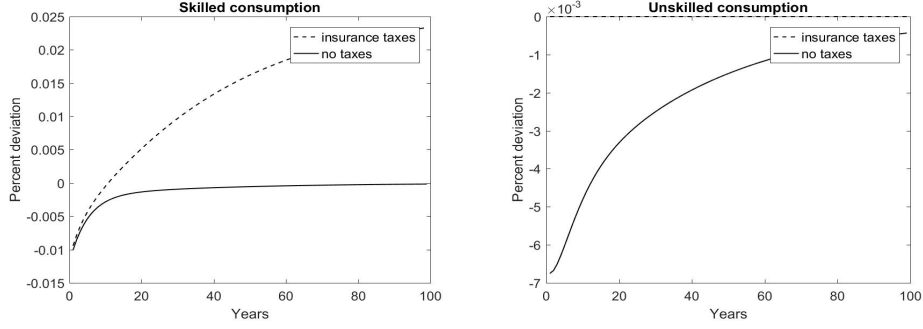
The following pictures show the differences of effects of a low-skilled immigration shock for a state with and without welfare system. The insurance tax is collected from the skilled natives to keep unskilled consumption constant over time.

Over the whole time period after the migration shock, the percentage change of skilled hours barely differ between both cases. This is explained by the fact that the substitutional effect and the income effect resulting from income tax changes compensate each other and that the tax rates thus have no effect on working behaviour of skilled natives. In the first years the percentage deviations of skilled income, skilled consumption and investment are thus nearly equal for both scenarios. In the following years the attenuated migration inflow leads to a gradual re-increase of wages and unskilled income before taxes such that the income tax diminishes. This has a positive impact on after tax skilled income and consequently on skilled consumption and investment. The percentage deviation of capital and output per capita gradually increases compared to the scenario without welfare system. These effects are intensified over the years such that in the long run the sizes of the economy recover more quickly and the migration shock has an overall positive effect on skilled income and output per capita.

As unskilled hours are constant the percentage deviation of unskilled income can be identified with the percentage change of the wages. Although unskilled income raises sharply in the medium to long run, we also observe an increase in income of skilled natives. Income differences are thus not reduced in a welfare system, nevertheless the tax system is welfare-improving for both labour groups.



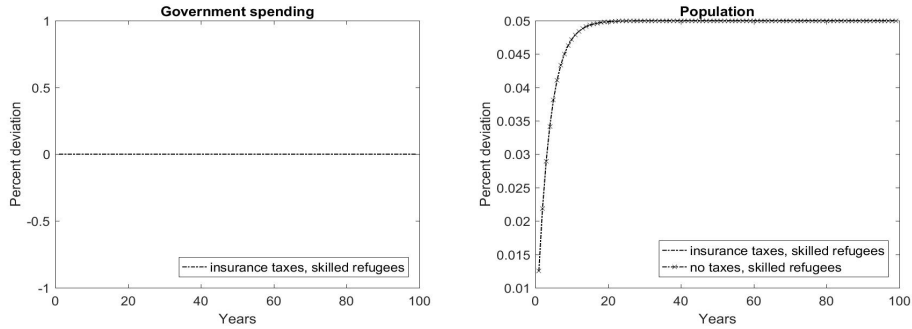


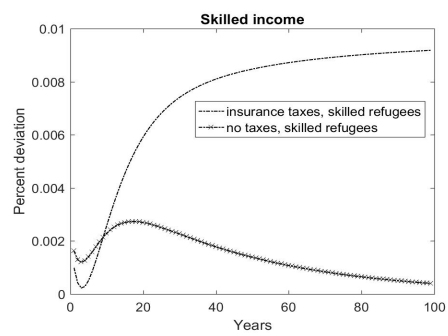
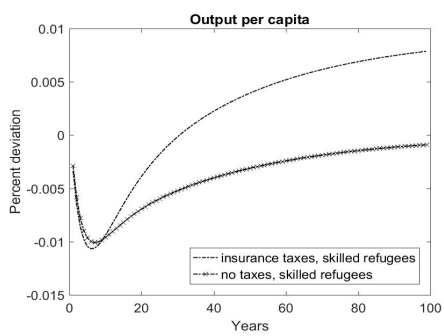
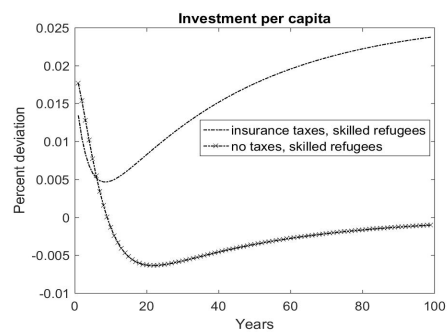
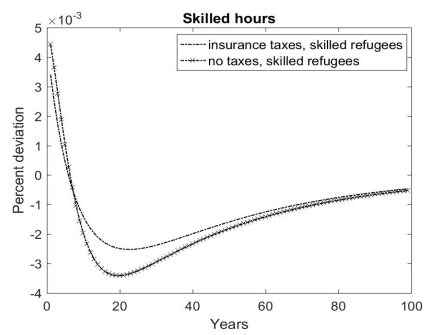
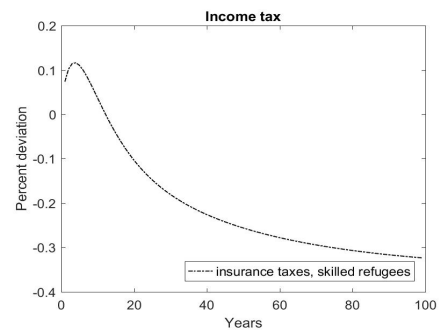
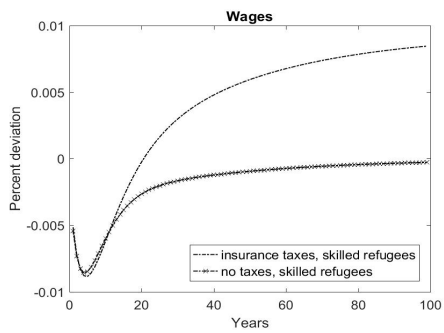
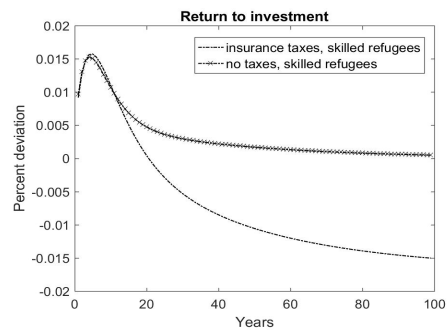
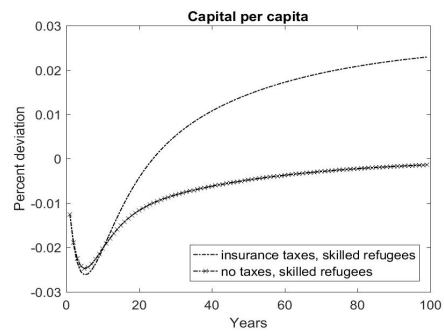


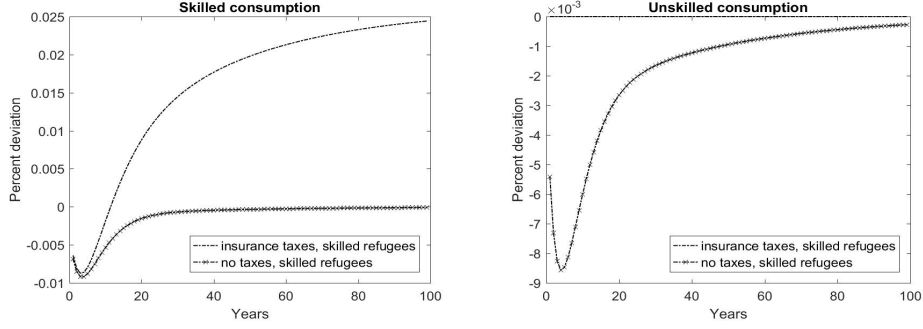
We now consider a migration shock with skilled refugees that invest in the host country and compare the scenarios with and without welfare system. In case skilled refugees invest, the substitutional effect of tax rate changes on skilled income is stronger than the income effect. If skilled agents have to pay taxes, the increase of skilled hours in the first year after the shock is less strong which reduces skilled after tax income even more. The percentage deviation of investment per capita is thus lower in the first years which has a slightly negative effect on capital and output per capita. On the other hand the stronger decrease of after tax income of skilled agents leads to a temporary further increase of income tax.

On the medium term the substitutional effect of decreasing taxes induces a higher percentage change of skilled hours in a welfare state. This has a strong positive effect on skilled income and investment per capita in the long run. Consequently the impact of the welfare system on capital and output per capita is strongly positive on the long term.

The welfare system barely affects income differences in this scenario but it is strongly welfare improving for both labour groups.





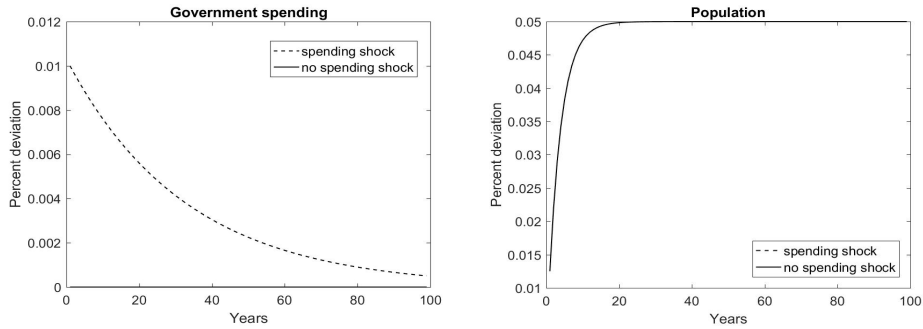


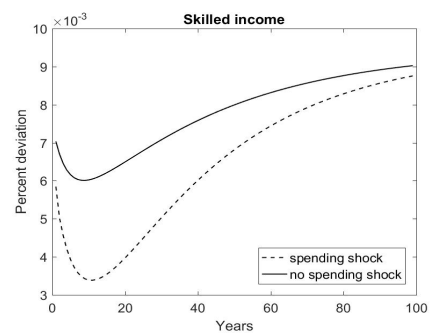
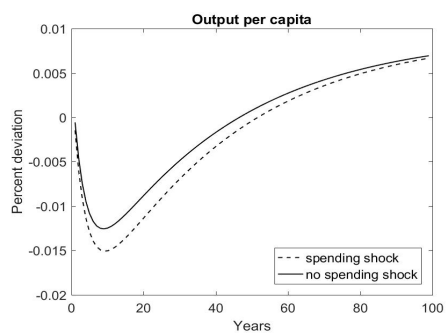
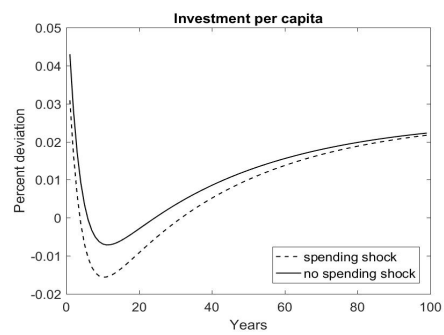
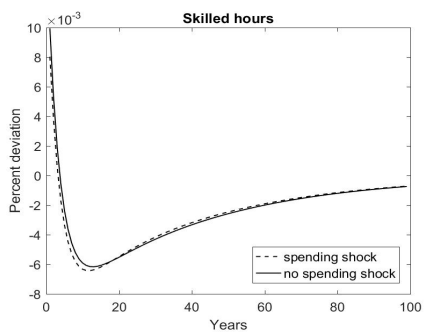
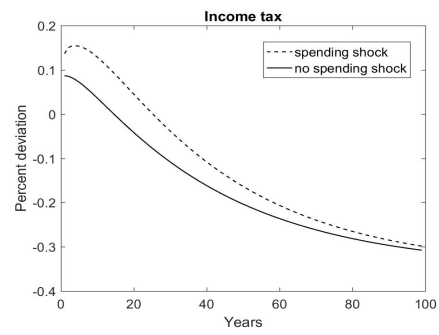
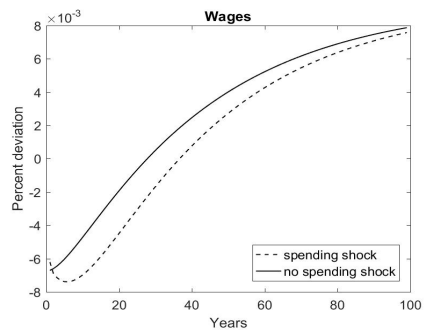
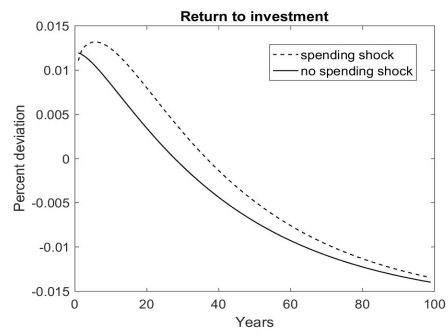
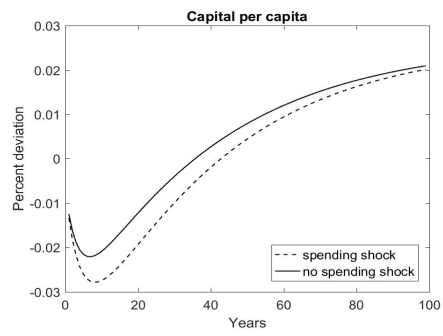
Comparing both scenarios we deduce that the effects of a welfare state on the behaviour of skilled natives differ depending on their expectations about the refugees. Although the income effect of taxes compensates the substitutional effect when natives expect low-skilled refugees, the substitutional effect dominates and governs the behaviour of skilled natives if they expect skilled refugees with investment incentives.

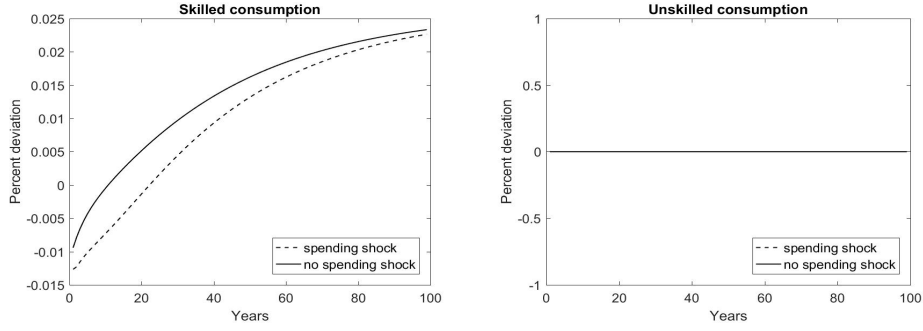
4.5 Simultaneous migration and government spending shock

We consider now a simultaneous migration and government spending shock. A rise of integration costs and thus of government spending is financed by a stronger increase of income tax in the welfare state. We first compare a welfare system with government spending shock to a welfare system without demand shock for the case of low-skilled immigration. In this scenario the substitutional and income effect of increasing taxes on skilled income again compensate each other. Consequently the percentage change of skilled hours marginally changes for a demand shock. The effects are thus similar to the effects of a welfare state without government spending shock. However the loss of skilled after tax income still has a negative impact on investment per capita, capital and output per capita.

The major percentage change differences between both scenarios for income before tax of skilled natives slightly reduce income differences between the high-skilled and the low-skilled labour groups in the short run.

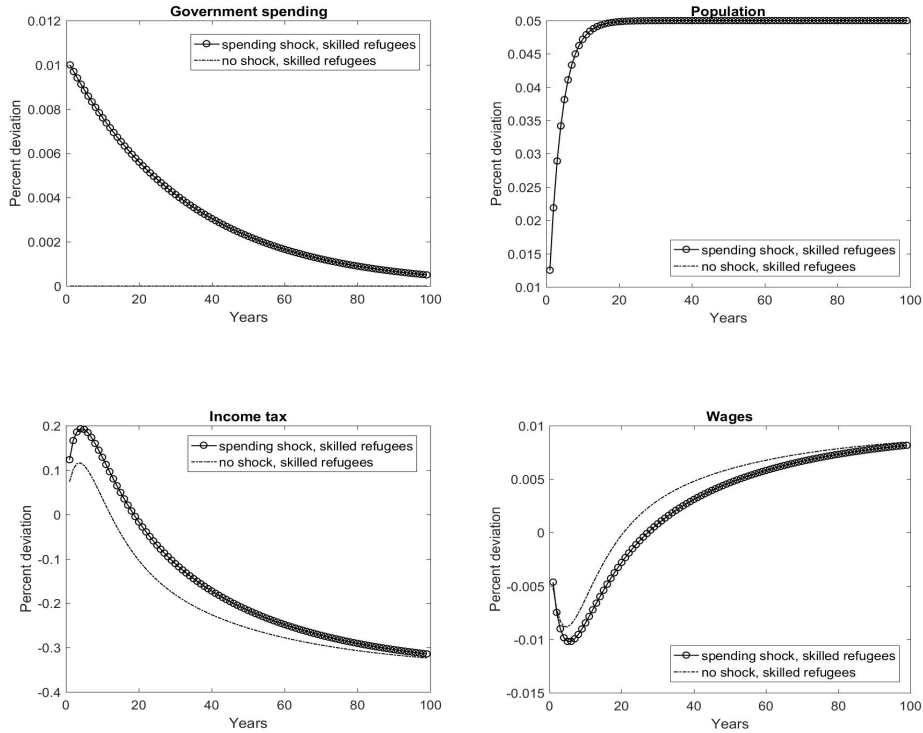


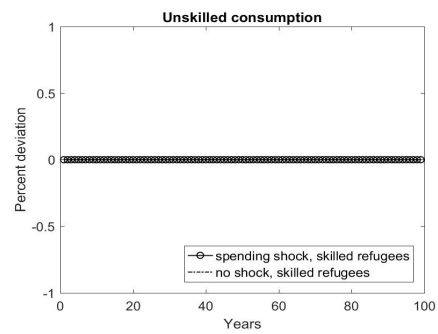
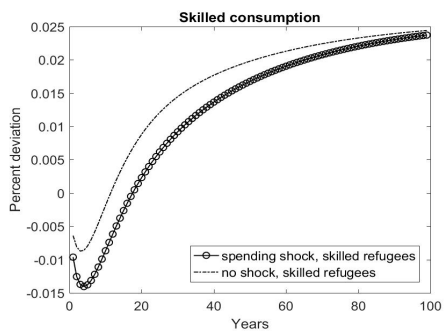
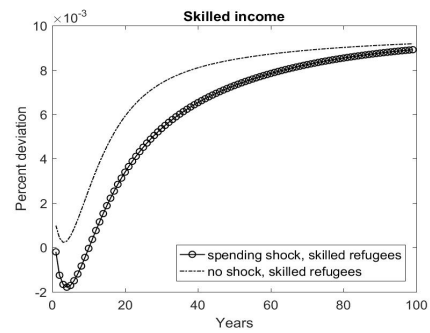
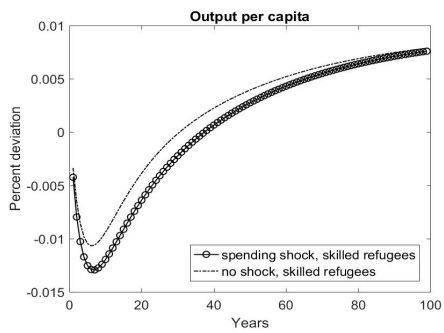
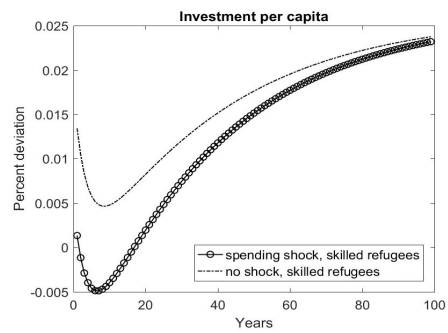
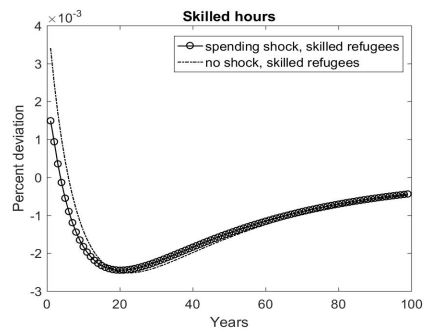
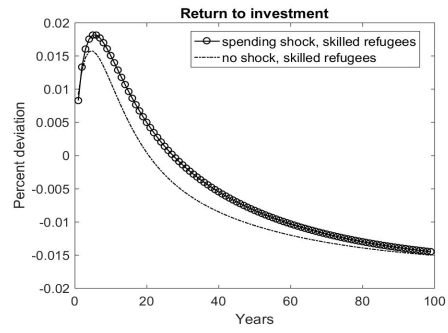
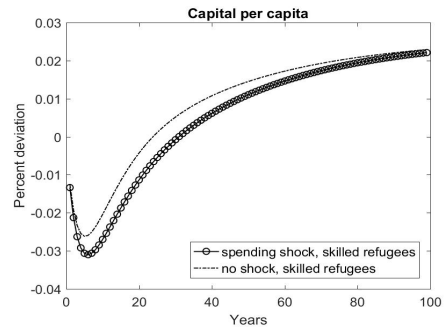




Now we focus again on the migration shock with skilled refugees who invest. The following pictures show the differences of effects between the welfare system with and without government spending shock. As in 4.4, the substitutional effect of increasing taxes dominates the income effect on skilled income. The impact of the government spending shock is similar to the differences of effects in a state with and without welfare system described in 4.4.

Interestingly, although income differences fairly decreased in the presence of a government spending shock for low-skilled immigration, in this scenario the demand shock has no effect on the differences between skilled and low-skilled income.



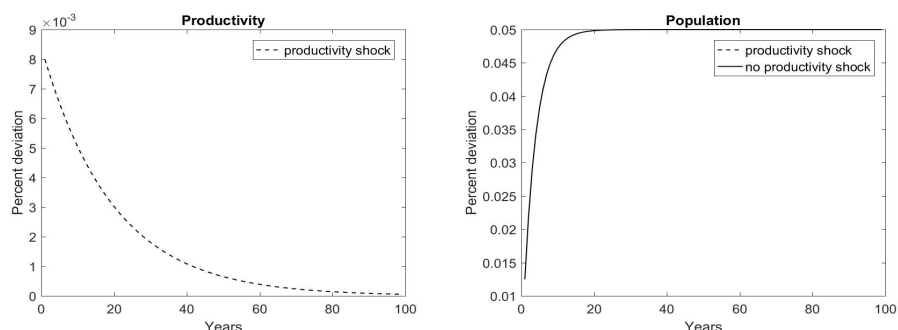


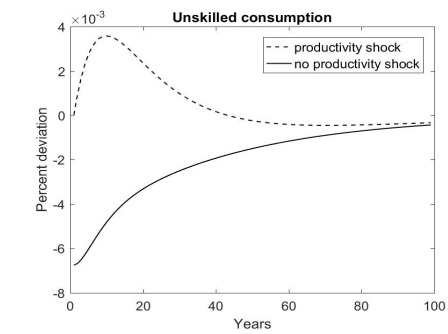
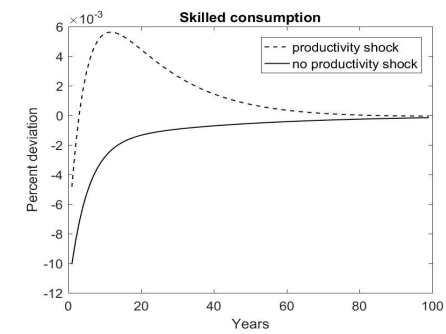
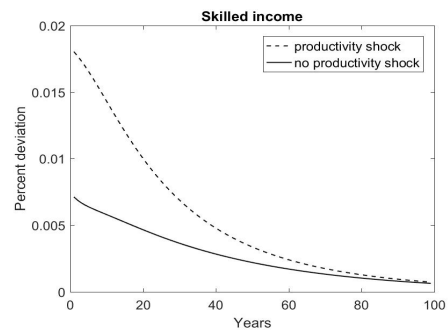
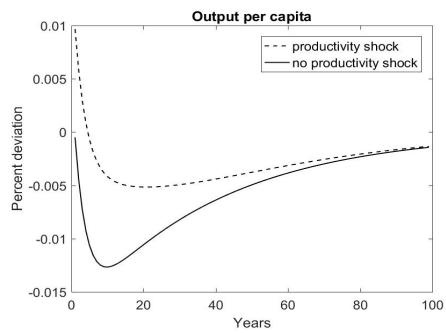
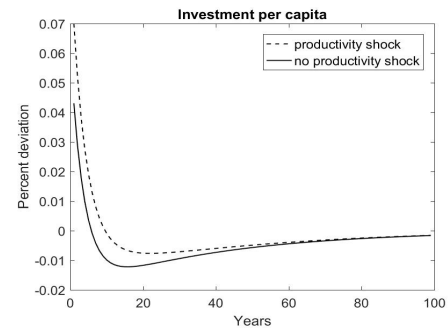
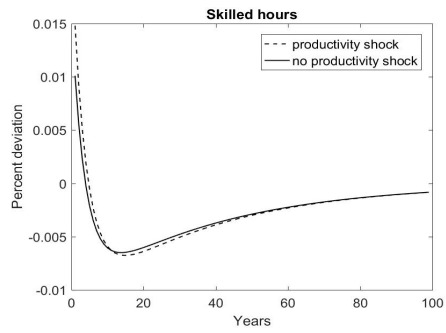
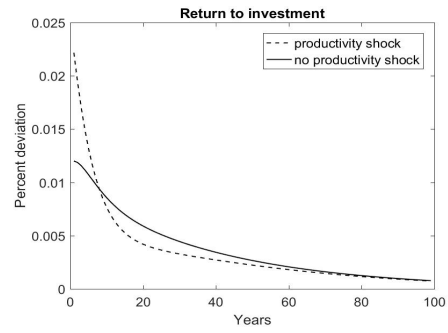
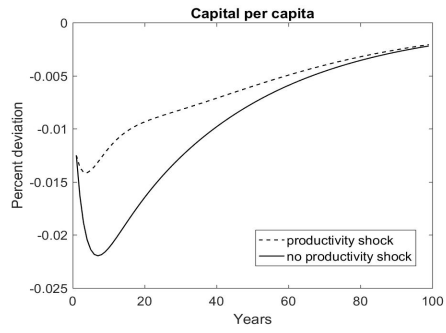
In the presence of a government spending shock, the substitutional effect of taxes again controls the working and investment decisions of skilled natives if they expect skilled refugees, whereas the shock has no effect on the working behaviour dynamics of skilled natives if refugees are all low-skilled. Furthermore the impact of a demand shock on income difference also depends on the expectations of natives about the refugees. The spending shock reduces income differences between the labour groups in the short run for a low-skilled migration shock whereas it has no impact in the presence of skilled refugees.

4.6 Simultaneous migration and technology shock

In this section we analyse the effects of a simultaneous migration and technology shock. The following pictures show the differences between a low-skilled migration shock only and a migration shock combined with a technology shock in the same year.

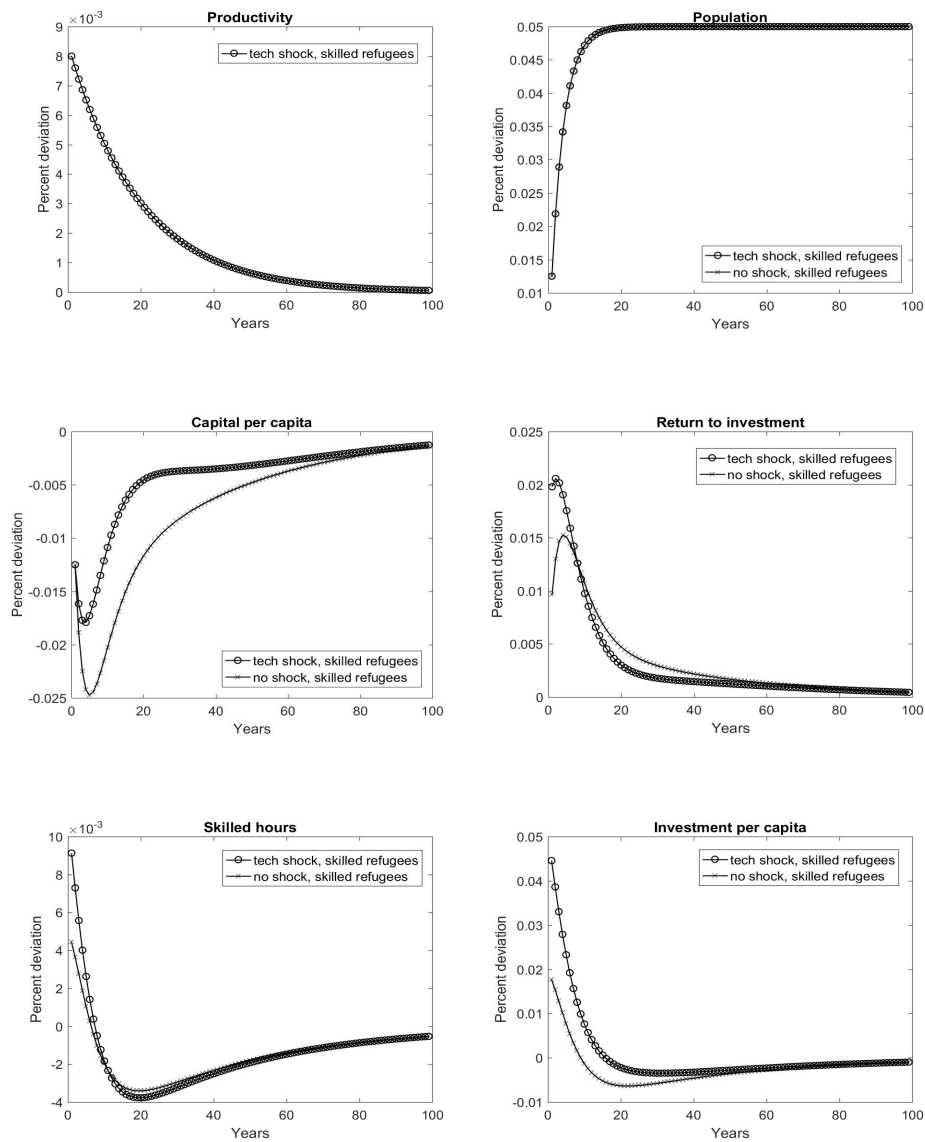
A positive productivity shock intensifies the positive effect of labour and capital on output. Skilled natives thus have higher work and investment incentives which explains the intensified increase of skilled hours and investment per capita in the presence of a technology shock. The resulting positive impact on output per capita and income is strongly welfare-improving for both skilled natives and unskilled agents. However the differences in income are slightly larger compared to baseline case in the first years after the shock.

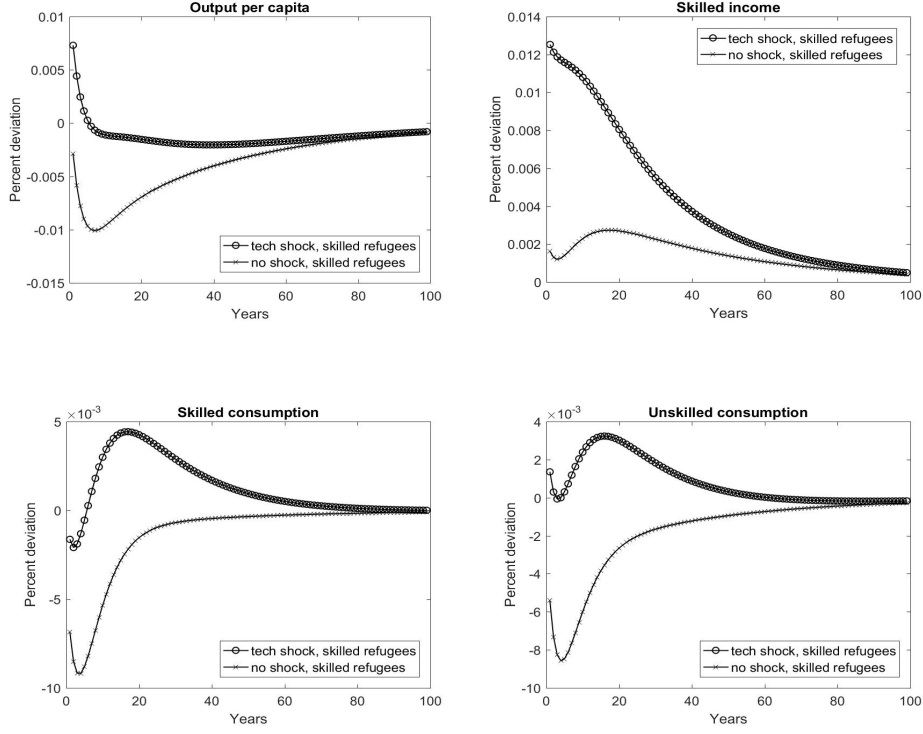




We then simulate the technology combined with a migration shock including a percentage of skilled refugees who invest. The effects on working and investment behaviour of skilled agents are similar to the case before, which also induces higher income differences in the short run in case of a technology shock.

Consequently the reaction dynamics of skilled natives to a technology don't change depending on their expectations about skills and behaviour of refugees.





In the presence of a simultaneous migration and technology shock, the impact of the productivity on the behaviour dynamics of skilled natives does not depend on their expectations about refugees. Moreover income differences are slightly intensified by the shock whether natives expect only low-skilled or a percentage of high-skilled refugees.

5 Conclusion

We quantified the dynamic effects of a migration inflow to the host country in a business cycle model for the refugee inflow to Germany in 2015. We differentiated between low-skilled refugees, skilled refugees without saving incentives and skilled refugees who behave like skilled natives and save a percentage of their income. For the calibration of the model we used recent data for the German economy and already available data about the refugee inflow in 2015.

The comparison of these three scenarios shows that different productivities of refugees only change the level of the adjustment path of the economic variables, whereas investment incentives of refugees alters the behaviour dynamics of skilled natives and therefore the dynamics of the adjustment path. In all scenarios of the baseline case the migration shock has a positive effect on skilled income though the impact on unskilled income is negative. As a result income differences in the population are intensified with the inflow of refugees.

We further analysed these findings by including a welfare system with government spending shock in a. Our results further show us that the dynamics of the effects depend on the skill composition of refugees. If refugees are low-skilled the behaviour dynamics of skilled natives do not change with the increase of taxes whereas the substitutional effect of taxes on income dominates if some refugees are skilled and invest, which has a negative effect on skilled working hours. This also has an effect on differences of income before tax. While the demand shock slightly reduces income differences in the short run for unskilled labour inflow, the differences in income before tax do not change if a percentage of refugees behave like skilled natives. first scenario and a technology shock in a second scenario. Nevertheless the migration shock is still welfare improving for skilled natives while unskilled natives do not suffer from the unskilled labour inflow due to insurances taxes that keep their after tax income constant even though their wages fall. In case of a positive supply shock, higher productivity has a positive effect on labour supply and investment of skilled natives. The dynamics of the effects are similar for all skill compositions of refugees. Skilled and unskilled income both rise but the positive technology shock fairly raises the income differences before tax in both scenarios.

The results of our theoretical model therefore clarify that the skill composition of a migration shock plays a sensible role for the behaviour of skilled natives and the analysis of the macroeconomic effects.

So far we have however assumed that skilled and unskilled labour are perfectly substitutable. Adding a parameter for the inverse of the elasticity of substitution which is greater than zero would catch the fact that unskilled refugees compete with unskilled natives while skilled refugees compete with skilled natives in the labour market. This will probably have an even more important effect on the dynamics of the macroeconomic variables.

Considering the importance of remittances in the migration literature, it is also possible to include an upper bound for consumption and savings of refugees such that a part of their income is used for remittances to the home country and does not appear in the local economy any more. Such a bound will likely only affect the level of the economic variables but not the dynamics.

As we have focused here only on the refugee inflow, we have reasonably omitted an inflow of capital assets to the host country and considered a relatively low share of skilled labour inflow. Our model could be extended so as to consider the general migration features of the German economy. The German industry attracts an important amount of migrants from European countries who have similar skills to natives and import capital assets. An adaptation of the model to this scenario will probably substantially alter the observed effects above.

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