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Integrating Forced Migrants in a Union of Diverging Regions: A Policy Assessment

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Abstract

This paper uses a two-country setup of the Eurace@Unibi model to study the economic impact of a sizable level of forced migration into two countries that form a political and currency union. We consider the case in which the origin of migration is outside the union and immigrants exhibit skill levels that are on average considerably lower compared to the skill levels of the domestic labor force in both member states of the union. We assume that these skill gaps constitute a significant hurdle for integrating migrant workers into the labor market. Moreover, we assume that the two countries differ regarding their institutional setting, in particular with respect to the labor market, and they differ regarding the production technology operated by firms in the countries resulting in different levels of productivity and economic activity. In simulation experiments, we examine the effect of different schemes of allocating migrants among the two countries, and analyze the effectiveness and implications of different policy measures aimed at fostering the integration of immigrants into the labor market.

Keywords: Forced Migration, Integration Policies, Core-Periphery
JEL Classification: C63, F22, J61, R11

1 Introduction

The European Union has been facing two major crises in recent years. The first one, the European debt crisis, started in 2008 and developed rapidly into an economic crisis that had significant adverse economic and labor market effects especially in the southern member states of the union. In fact, the recession has interrupted and even reversed the process of economic convergence (see, e.g., Estrada et al., 2013) and the substantial divergence of Northern and Southern European economies in the years following the outburst of the crisis has challenged European institutions and policy makers.[1] The second major crisis, the European refugee crisis, started in 2015 when the European Union experienced an unprecedented influx of forced migrants largely originating from war-torn countries in the Middle East, Southern Asia and Africa. In the peak years 2015/2016, almost 2.5 million refugees arrived in Europe from which 1.4 million eventually sought asylum in the main destination countries Germany, Austria and Sweden.[2] Since most of the migrants arrived from countries such as Syria, Iraq and Afghanistan, the perspective of return is limited, at least in the short term. For this reason, the refugee crisis will be a long-term challenge not only for the major host countries but also for the European Union as a whole.

While there have been several policy responses to the economic crisis especially for the countries of the Eurozone, the European Union has been struggling to find a common strategy to address the refugee crisis. One of the policies proposed by the EU is meant to achieve

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[1] Germany, for example, as the largest northern economy achieved an average annual real growth of GDP per capita of 1.1% between 2008 and 2017, whereas the Italian economy as the largest among the southern members contracted on average by 1.1% per year in the same period. See `http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00115&plugin=1`, accessed April, 16th, 2018.

[2] See `http://ec.europa.eu/eurostat/product?code=migr_asyappctza`, accessed April, 16th, 2018.

a fair allocation of migrants among the member states. This proposal, however, has been met with disapproval by some governments, and since some member states refused to receive any larger amount of refugees, there have been substantial imbalances in the allocation of the immigrants across the union. Eventually, the refugee crisis developed into a political crisis accompanied by the rise of populist and right-wing parties around Europe.

Integrating a sizable number of refugees into host societies is a tremendous challenge, and a rapid and appropriate labor market participation is key for the successful integration and economic assimilation (see, e.g., Zimmermann, 2016). The prospects of immigrants at the labor market are, however, generally weaker than for native workers, where major obstacles are the lack of language proficiency and unclear or not-recognized educational attainments, but also legal barriers and penalties associated with the immigrant status (see, e.g., Kogan, 2011; Dustmann and Fabbri, 2003). For the specific group of forced migrants, who are not selected according to the labor market needs of the host country, the labor market integration is even more challenging than for other groups. At the same time, the general prospects for integration are better if there is a favorable economic climate into which the immigrants arrive. Thus, in light of growing economic imbalances in Europe, it seems questionable whether allocation quotas as proposed by the EU, which include the assignment of a sizable number of refugees to economically struggling regions, are the right strategy to respond to the refugee crisis. And given the considerable resistance against receiving migrants of some member states on the one side, and large incentives for refugees to relocate in regions of economic prosperity on the other side, it seems impossible to enforce these allocation quotas in the first place.

The aim of this paper is to assess the economic implications of a sizable surge of forced migrants into a union of economically diverging states and to analyze the effectiveness of possible policy responses to the migration. In particular, we carry out an agent-based policy analysis in which we contrast a baseline migration scenario where no active policy responses are given and eventually all refugees arrive in the economically leading countries with two policy scenarios. In the first scenario, a refugee allocation policy as pursued by the European Union is considered. The second scenario describes a situation in which all refugees are received by the economically stronger regions and the local governments implement specific policies that foster integration into the labor market. The economic implications of these scenarios are assessed by considering a two-region core-periphery setup of an agent-based macroeconomic model. The core region is economically and technologically at the frontier whereas the periphery lags behind in both dimensions. At the same time, the two regions form a political and economic union but differ in terms of labor market institutions. As we emphasize forced migration, we make specific assumptions on the migrant cohort especially with respect to the size and the skill structure. The migration cohort corresponds to 2% of the regional population and arrives within a short period of time. Furthermore, the cohort is characterized by gaps in terms of average skills compared to the native population in both regions.

We use this agent-based setup to analyze the implications of migration and of the different policy responses for both the high-tech core and low-tech periphery. Besides the effect on the regions, we also analyze the implications of the different scenarios for the immigrants. In particular, we address the following research questions:

1. What are the economic implications of a low-skill migration surge into the core region?
2. How does a 50% allocation quota between the core and the periphery compare to the scenario in which the core region receives all migrants?
3. Can wage subsidies established as an integration policy in the core act as an alternative to allocation quotas?

Our key findings can be summarized as follows. A sizable influx of forced immigrants into the core region reduces the average standard of living and increases inequality. In this case, however, most of the effect is due to persistent income gaps between the migrants and the native population that are caused by a low labor market participation of the immigrants. The native population is less effected by the migration. An allocation policy mitigates the aggregate effects on the core region but introduces similar effects on average real consumption

and inequality in the periphery. In contrast to the situation in the core region, employment of immigrants is higher in the periphery. But their average standard of living is not only substantially lower compared to the native population but also in comparison to the migrants that arrived in the core. Furthermore, a larger participation of low-skill workers affects the capital productivity in the periphery negatively, which increases the technological gap between the core and the periphery in the long run. When instead all immigrants are hosted by the core and this is accompanied by appropriate wage subsidies, the labor market participation of migrants improves and their average standard of living is the highest. This migration scenario, however, introduces negative effects on employment and consumption in the periphery.

Migration in general has been addressed by several streams of the economic literature. While the largest part of the literature addresses issues of voluntary migration, which is mostly driven by labor market opportunities, the economic literature on forced migration is less developed. There are essentially two strands addressing forced migration. The one focuses on the economic implications for the migrants, the other deals with the impact on the destination country and the native population. Methodologically, most studies employ econometric methods using micro-level data. This paper contributes to the existing literature by explicitly modeling and analyzing the case of forced migration within a core-periphery system of economies. Moreover, we follow a theoretical approach which captures macro, distributional and inter-regional effects, and allows to study the implications of different policy alternatives in counter-factual experiments.

The remainder of this paper is organized as follows: In Section 2, we briefly discuss the existing literature on forced migration, in Section 3 we describe our model in detail. In Section 4, we present the setup and the results of our policy experiments. In Section 5, we discuss policy implications and conclude.

2 The Literature on Forced Migration

The major part the migration literature focuses on voluntary migration. Models of voluntary migration typically feature a migration decision. In practically all models of this kind, migration is driven by wage differentials between the source and the host country. A central finding from this strand of literature is that immigrants are not a random sample of the host countries population. Instead, agents decide to migrate, if it is favorable for them. As a result, the skill distribution of immigrants typically differs from the skill distribution of the source countries population (see, e.g., Borjas, 1999). Voluntary migration scenarios however, are significantly different from scenarios of forced migration (e.g. Cortes, 2004). As a result, conclusion drawn from the analysis of voluntary migration models and the corresponding policy suggestions do not necessarily apply to the case of forced migration.

In contrast to the abundance of literature on voluntary migration, the economics literature dealing with forced migration specifically is less developed (see, e.g., Ruiz and Vargas-Silva, 2013, for an overview). One branch of the literature focuses on the impact of displacement on the displaced themselves, in particular on their labor market experience. The analysis is typically based on specific historical events leading to a displacement of certain parts of a countries population. The long-term effects of forced migration have been analyzed by considering groups that have been displaced in the aftermath of world war II. The conclusions drawn from different studies are rather contradictorily: Using data from parts of the population that has been displaced in Finland, Sarvimäki et al. (2009) find that the displacement increased the long-term income of the displaced. In contrast, studies analyzing the displacement of Germans after WWII suggest that the displacement had a negative long-term impact on income of the displaced (Bauer et al., 2013). In addition to the literature on long-term effects of forced migration, there are several papers analyzing the short- and medium-term effects using more recent historical events and data on the economic situation of refugees in several countries. Kondylis (2010) uses data from the displacement after the war in Bosnia and Herzegovina and shows that the displacement negatively affects the labor market outcome of the displaced. In particular, displaced persons exhibited an increased probability of unemployment or dropping out of the labor force. By analyzing data on migrants arriving in Australia, Wooden (1991) finds that employment probabilities

are 20 percentage points lower that employment probabilities of comparable non-refugee migrants. He also finds that a disadvantage for refugees on the labor market persists over time. This result is confirmed by Lundborg (2013), who analyzes the integration of refugees into the Swedish labor market. He finds that unemployment among refugees is very high in the first time after arrival and an permanent employment gap to the non-refugee population persists over the entire lifetime. In addition, he reports that the labor market outcome of refugees from culturally distant countries, such as Iran/Iraq is considerably worse compared to refugees from culturally closer countries (e.g. eastern European countries). In line with this result, Carlsson and Rooth (2007) find experimental evidence that migrants from Muslim countries are discriminated on the Swedish labor market. Del Carpio and Wagner (2015) use recently collected data to explore the situation of Syrian refugees in Turkey. One of their key findings is that 85 percent of Syrian refugees have entered the Turkish labor market, but are almost exclusively employed in the informal sector.

Another branch of the existing literature focuses on the effects of forced migration on host countries and the native population, with again a particular focus on the labor market. Braun and Mahmoud (2014) analyzed the large-scale displacement of Germans from Eastern Europe after world war II. They found that the forced migrants significantly reduced the employment rate of natives. However, this can be regarded as a rather uncommon case, since migrants and natives were speaking the same language and passed the same schooling system. Hence, forced migrants can be described as very close substitutes in this case. Maystadt and Verwimp (2014) find that refugees from Burundi and Rwanda had a positive impact on native households real consumption per capita in Tanzania. However, impact on the host population was heterogeneous with decreasing wages for parts of the native population. Calderón-Mejía and Ibáñez (2015) analyzed internal displacement in Colombia. They distinguish between the impact on the formal and informal labor market. They find that forced migration has the greatest impact on the informal sector, lowering wages significantly. Del Carpio and Wagner (2015) find evidence for large-scale displacement of natives by Syrian refugees in the informal labor market in Turkey. At the same time, they report an increase in formal employment for the native population. A different analysis of the impact of Syrian refugees on the Turkish labor market, conducted by Akgündüz et al. (2015), finds no evidence for considerable effects on the formal labor market. In addition, the study also rules out the possibility that the lack of labor market effects can be explained by a decrease of internal migration.

3 The Model

3.1 Overall Structure

We employ a variant of the agent-based macro model Eurace@Unibi to assess the implications of a sizable influx of forced migrants into a union of states of different economic strength. We opt for an agent-based approach mainly for two reasons. First, agent-based models are well-suited to tackle the heterogeneity of economic agents in a comprehensive way, which we believe is an important aspect for studying the implications of a sizable level of low-skill migration. In fact, heterogeneous firms and households interact on labor and goods markets where the decentralized interaction at the micro level gives rise to the emergence of the aggregate properties of the economic system. Migration, especially if there are substantial differences to the native population, increases the heterogeneity of households which might induce second order effects that cannot be captured by models that do not account thoroughly for heterogeneity. Second, we follow an agent-based approach as it provides a sufficient flexibility to incorporate different and to some extent rather sophisticated policies within the same theoretical framework. This allows to analyze the policy implications of the migration in a comprehensive and consistent manner. For further discussions of the agent-based approach to macroeconomics, the reader is referred to, e.g., Fagiolo and Roventini (2017) and Dawid and Delli Gatti (2018).

A complete description of the Eurace@Unibi model is provided in Dawid et al. (2016). Due to space constraints here no full treatment of the model is given. Rather, we describe only the main aspects of the model, which are crucial for the understanding of the mecha-

nisms driving the policy results discussed below. The description of the model is to some extend identical to the ones given in Dawid et al. (2014, 2018b,a), since the multi-regional setup used here is similar to that underlying these analyses. However, the policy agenda of this paper is quite different from the previous contributions, which focused at the comparison of different variants of cohesion policies. Furthermore, we introduce a minimum wage as an additional labor market institution and adjust the hiring process of firms accordingly, which distinguishes the present model from versions of the model used in previous papers.

The model describes an economy with an investment and a consumption good sector, and a financial, a credit and a labor market in a regional context. The economy consists of two regions each of which has a regional government, and both regions are closely connected in form of an economic and currency union. The two regions are populated by firms, where we distinguish consumption good and capital good firms, households and banks. Furthermore, there is a supra-regional central bank.

A single capital good firm produces vertically differentiated machines that differ in terms of productivity. New vintages of the capital good are developed according to a stochastic arrival time, where the most recent vintage defines the technological frontier as new vintages always improve the productivity of the existing best practice. Consumption good firms use these capital goods together with labor of varying degrees of general and specific skills to produce horizontally differentiated versions of the consumption good. The general skills represent households' educational achievements whereas specific skills are related to the production technology and are acquired on-the-job. The specific skills of the firms' workforce and the productivity of their physical capital stock are linked in a complementary way such that a sufficient level of specific skills is needed to fully exploit the technological advances of high-tech machines in the production process. The consumption good firms can choose from the available set of vintages when investing the physical capital. The choice is driven by the comparison between the prices of the capital vintages and their expected returns for the firm which depends on the skills of the firm's workforce.

Households have idiosyncratic preferences for the product properties of the horizontally differentiated consumption goods, where the market price and the origin of the products are the only product features explicitly modeled. Households are assumed to have a home bias in their purchasing decision and prefer goods offered at lower prices. The consumption goods are sold at local market places called malls, where firms from both regions can store and offer their products and consumers come to buy goods at the posted prices. The pricing rule of consumption good firms is based on profit maximizing considerations relying on estimated demand characteristics obtained from market research activities.

The labor market is described by a two-round search-and-matching procedure where firms post vacancies, households apply to a subset of the firms with job openings, and firms make job offers to workers based on their expected productivity. Finally, applicants that received job offers have to accept/reject. Important determinants of the labor market process are the wage offer and the reservation wage. The wage offer is determined, on the one hand, by the expectation the firm has at the time of hiring about the specific skills of the worker and, on the other hand, by a base wage component that is influenced by the (past) tightness of the labor market and determines the wage per unit of expected productivity. The reservation wage of a job seeker is linked to her last labor income, but depreciates over the spell of unemployment.

Banks collect deposits from households and firms and provide credits to firms. In line with the pecking order theory, firms try to finance their production by internal funds first, and only if these are not sufficient to cover the expected expenses, they apply for loans at the credit market. The interest they have to pay on loans depends on the individual default risk, and the amount of the loans might be restricted by the bank's liquidity and risk exposure. At the financial market, households trade a single asset which is a fund that holds all stocks of the firms in the economy. This asset is used as a vehicle to distribute dividends to the households, where each asset owner receives a share of the total dividends that is consistent with the share of assets she owns. The central bank provides standing facilities for the banks at a given base rate, pays interest on banks' overnight deposits and might provide fiat money to the governments.

There are two types of firm bankruptcy. If a firm is not able to pay its financial com-

mitments, then it declares illiquidity. Insolvency as the second type of bankruptcy occurs when the firm has a negative equity. In both cases, the firm goes out of business, stops all production activities and dismisses all workers. Then it writes off a fraction of its debt and stays inactive for a given period of time. At the end of the idle period, the firm can restart producing with the existing capital stock but has to build up a new workforce.

In each region, there is a local government that collects taxes to finance unemployment benefits or other fiscal policy measures such as transfers or subsidies. Furthermore, each government can establish different social and labor market institutions such as minimum wages and basic security payments. The regional government is assumed to run a balanced budget by adjusting the tax rates in a way that, retrospectively, the tax rates would have balanced the government expenditures over a given time period in the past.

As outlined above, the two regions represent an economic and monetary union fostering the integration of goods, financial and labor markets within a joint currency area. Accordingly, we assume that the consumption good firms have access to the same technologies and they can apply for loans to any bank regardless of their region of origin. Also the consumption good market is global in the sense that each firm can deliver its products to the other region without restrictions. Only for the labor market we assume that, despite market integration from the policy perspective, there are still substantial spatial fractions such that regular labor mobility between the regions is not considered in the model setup used here.[3]

3.2 Agents, Markets, and Decisions

3.2.1 Output Planning and Production

Consumption good producers use physical capital and labor for production. The capital stock of a firm i, $K_{i,t}$ is composed of different vintages of the production technology that differ in terms of productivity. More precisely, suppose $\mathbf{V}_t$ is the set of available vintages at time t, indexed by $v = 1, ..., V_t$, where vintage $v = 1$ represents the oldest vintage with the lowest productivity and $v = V_t$ the current best practice technology. The law of motion of capital implies that the capital stock of vintage v owned by firm i is

$$K^v_{i,t+1} = (1 - \delta)K^v_{i,t} + I^v_{i,t} \tag{1}$$

where δ is the depreciation rate, $I^v_{i,t} \geq 0$ is the gross investment in vintage v and $K_{i,t} \geq 0$.

The workforce of firm i at time t consists of $L_{i,t}$ workers that have an average specific skill level denoted by $B_{i,t}$. In the production process, it is assumed that labor and capital are used in a complementary manner. Moreover, there is a complementarity between the technology and the specific skills of the workers, which limits the usage of better vintages with a high productivity A^v to the level of $B_{i,t}$ if $A^v > B_{i,t}$. Altogether, the production process is represented by an augmented Leontief type production function that is able to capture the vintage structure of capital and the complementarity between physical capital and the specific skills of the workforce. By assuming that the firm uses the vintages contained in its capital stock in descending order starting with vintage $v = V_t$, we can write the augmented Leontief production function to produce output $Q_{i,t}$ by

$$Q_{i,t} = \sum_{v=1}^{V_t} \min \left[K^v_{i,t}, \max \left[0, L_{i,t} - \sum_{k=v+1}^{V_t} K^k_{i,t} \right] \right] \cdot \min \left[A^v, B_{i,t} \right]. \tag{2}$$

Once per period, the firm determines the quantity $\tilde{Q}_{i,t}$ it wants to produce in the upcoming production cycle. The desired output is the sum of the planned delivery volumes $\tilde{D}_{i,r,t}$ to the two local malls in region $r = 1, 2$. The determination of the planned delivery volumes depends on the expected but unknown demand and the inventory stock left over from the previous sales cycle.

[3] In fact, empirical evidences suggest that integration of goods and financial markets in the European Union are well advanced (see European Commission, 2012), whereas the degree of labor market mobility is still low. The European Commission (2011), e.g., reports that in 2010 only 2.8% of working-age European citizen lived in another EU member state.

Since a firm that is not able to serve all the arising demand in a mall faces stock-out costs in form of forgone sales, the production planning of the consumption good firm can be described as a classical inventory problem with stochastic demand and stock-out costs. A standard heuristic put forward in the Operations Management literature prescribes to generate a demand estimation and to replenish the inventory stock up to a level that is consistent with a service level χ (see, e.g., Silver et al., 1998). Following this heuristic, the planned delivery volumes $\tilde{D}_{i,r,t}$ to each mall is determined as the difference between a critical inventory stock $Y_{i,r,t}$ and the current mall stock $\mathcal{S}_{i,r,t}$,

$$\tilde{D}_{i,r,t} = \begin{cases} 0 & \mathcal{S}_{i,r,t} \geq Y_{i,r,t}, \\ Y_{i,r,t} - \mathcal{S}_{i,r,t} & \text{else.} \end{cases} \tag{3}$$

The firm assumes that demand follows a normal distribution and hence the replenishment level can be expressed as the sum of the expected demand and an inventory buffer by

$$Y_{i,r,t} = \hat{D}_{i,r,t} + q_\chi \cdot \sqrt{\hat{\sigma}^2_{\hat{D}i,r,t}}, \tag{4}$$

where $\hat{D}_{i,r,t}$ is the expected demand, $\hat{\sigma}^2_{\hat{D}i,r,t}$ the estimated variance of the demand distribution and q_χ the χ-quantile of the standard Gaussian distribution with mean 0 and variance 1.

Based on the planned output quantity $\tilde{Q}_{i,t}$, the firm determines the input factors and the financial planning. For the input factor requirements, the planned production quantity is related to a critical output level $\hat{Q}_{i,t}$, which is the feasible output if the current capital stock is fully employed. There are two cases with different implications for the capital demand to be purchased at the capital goods market:

1. $\hat{Q}_{i,t} \geq \tilde{Q}_{i,t}$: In that case the desired output can be produced with the current capital stock and no additional investments are necessary. We have $I_{i,t} = 0$ and the labor input is computed by taking the labor productivity of the last month into account:

$$\tilde{L}_{i,t} = \tilde{Q}_{i,t} \cdot \frac{L_{i,t-1}}{Q_{i,t-1}.} \tag{5}$$

2. $\hat{Q}_{i,t} < \tilde{Q}_{i,t}$: Here we have positive investments $I_{i,t} > 0$; the amount depends on the outcome of the vintage choice. If v is the selected vintage, the investment volume is

$$I_{i,t} = \frac{\tilde{Q}_{i,t} - \hat{Q}_{i,t}}{\min\left[A^v, B_{i,t}\right]} \tag{6}$$

and the labor demand becomes

$$\tilde{L}_{i,t} = K_{i,t-1}(1-\delta) + I_{i,t}. \tag{7}$$

Depending on whether the firm's labor demand exceeds or falls short of the current workforce the firm has to either hire additional workers or dismiss redundant workers.

Based on the input requirements, the firm undertakes the financial planning for the production cycle. The total financial needs are determined by the expected expenditures for production, as well as financial commitments such as debt installments and interest payments. The firm tries to cover these payments primarily by internal funds. Only if the internal resources are not sufficient, the firm applies for loans to a commercial bank. If the firm is rationed on the credit market, it tries to rescale the production in order to be able to fund all financial commitments. If this is not possible, the firm goes bankrupt.

3.2.2 Demand Estimation

For the estimation of the demand, we assume an procedure that aims at devising a closed form expression translating observed and unobserved but estimated determinants of demand into an expected value. Similar to Dawid et al. (2018b), we introduce a home bias in the consumption choice of households such that not only the prices but also the product origin is

an explicitly modeled characteristic driving the demand. To estimate the demand function based on these product properties, we rely here on a procedure proposed in Harting (2015). The derivation of this demand function is decomposed in two steps. The first step describes an estimation of the overall development of the local consumption goods markets represented by the growth of the market size. The market size is given by the deflated overall budget of households disposed for consumption, where we assume that this can ex post be observed by the firms. They use previous realizations to predict the market development by estimating an expected growth rate $\hat{g}$.

In the second step of the procedure, the firm estimates its market share for any possible price choice. More precisely, the firm estimates the choice probability of a representative consumer regarding its product and uses this probability as a proxy for its market share. The estimation is based on simulated purchase surveys for which the firm draws a representative sample of households. Then, it presents the sampled households a set of goods from both regions at different prices and asks the participating households to simulate their purchase decision on this set of goods. Based on the outcome of this simulation, the firm estimates a discrete choice model that incorporates the prices as well as the origin of the presented goods as explicit determinants for the purchasing decision. As a result, the firm obtains two estimators, one for the price sensitivity of households and the other for the home bias, which can then be plugged in a discrete choice model incorporating the actual range of goods provided at the consumption goods market. By using (expectations of) the prices of its competitors, the firm can finally compute its expected market share from this choice model.

3.2.3 Pricing

Consumption good firms set the price of their products once per year. This relatively long period between two price changes of an individual firm is consistent with survey data for US firms (Blinder, 1991) and for firms located in the Euro area (Fabiani et al., 2006).

The price setting is based on an elaborate analysis of potential profits. To this end, the firm defines a set of candidate prices $\tilde{\mathbf{P}}$ that is drawn from an interval around its previous price p_{it-1}. For each of the candidate prices, it computes the expected demand for the next pricing period. The price vector of firm's competitors is thereby adjusted on a monthly base according to adaptive inflation expectations. Based on the demand scheme as well as the capital stock and workforce at the time of the price setting, the firm estimates the input factor and financing requirements over the validity of the price, which eventually allows to estimate the expected profit stream associated with each price. Suppose, $\hat{\pi}_{i,t+\tau}$ is the expected profit associated with candidate price $\tilde{p}$ in the τth period of the planning horizon given the expectation on demand and inflation as well as costs and firm's productivity, then the present value of the profit stream is

$$\hat{\Pi}_t = \sum_{\tau=0}^{11} \frac{1}{(1+\delta)^\tau} \cdot \hat{\pi}_{i,t+\tau}. \tag{8}$$

The firm selects the price which yields the highest discounted profit $\hat{\Pi}_t$:

$$p_{i,t+\tau} = \arg\max_{\tilde{p} \in \tilde{\mathbf{P}}} \hat{\Pi}_t, \forall \tau = 0, ..., 11. \tag{9}$$

Thus, the firm seeks the profit maximizing price taking into account the trade-off between price, sales and costs.

3.2.4 Skill Dynamics

Workers are characterized by two dimensions of human capital endowments. The first dimension is the general skill level which can be interpreted as the formal qualification and those abilities that a worker has obtained during schooling and professional education. We define n skill categories $b_h^{gen} \in \{1, ..., n\}$ representing different levels of educational achievements. Each household is associated to one of these skill groups, where household h is said to be better qualified than household k if $b_h^{gen} > b_k^{gen}$.

Specific skills are the second dimension of human capital. They are technology related and measured in terms of productivity. They can be interpreted as competences and the experience a worker has collected while working with a certain production technology. The underlying assumption of learning-by-doing is thereby supported by empirical evidences. Bahk and Gort (1993), e.g., found a significant effect of learning-by-doing on output of 15 industries, where the learning appeared to be strongly related to embodied technological change of physical capital.

The learning process and hence the speed of acquiring specific skills depends on the general skill level of the worker. Suppose the machines used by h's employer i at time t have an average productivity of A_{it}, then the specific skills of worker h evolve according to

$$b_{h,t+1} = b_{h,t} + \chi(b_h^{gen}) \cdot \max[0, A_{i,t} - b_{h,t}]. \tag{10}$$

The function χ is thereby increasing in b^{gen}. Note that the generation of new technologies is assumed to be a cumulative process. This implies that specific skills are transferable between vintages, even from old to new technologies. Furthermore, general skills of individual workers are observable by firms in the hiring process. Specific skills, in contrast, are not observable at the individual level but average values for the different general skill groups can be measured at the firm level.

3.2.5 Technological Change

The supply of the capital goods and the process of technological change is modeled in a stylized way. We recur to a single capital good producer that offers different vintages of the capital good $v = 1, ..., V_t$ that have distinct productivities A^v. Alternatively, our representation of the supply of capital goods can be interpreted as a reduced form market with monopolistic competition structure, where each vintage is offered by a single firm, which uses the pricing rule described below.

New vintages become available over time following a stochastic process. Every period with a probability $\mathbb{P}[\text{Innovation}] > 0$ there is a successful innovation of a new vintage $V_t + 1$. The productivity as the key characteristic of the technology is increased from the previous best practice by $\Delta q^{inv} > 0$. Thus the new frontier technology features a productivity level of

$$A^{V+1} = (1 + \Delta q^{inv}) \cdot A^V. \tag{11}$$

To keep the description of this sector as simple as possible, no explicit representation of the production process and of the needed input factors is introduced. To account for the cost dynamics, that might eventually influence capital goods prices, it is assumed that the main factor of production costs is the wage bill and, since wages increase on average with the same rate as productivity grows, the growth rate of productivity is used as a proxy for the increase in production costs of the capital goods.

The pricing of the vintages $p_{v,t}$ is modeled as a combination of cost-based p_t^{cost} and value-based prices $p_{v,t}^{value}$ (see, e.g., Nagle et al., 2011):

$$p_{v,t} = (1 - \lambda) p_t^{cost} + \lambda p_{v,t}^{value}. \tag{12}$$

Due to our assumption above, p_t^{cost} increases with the average productivity of the economy. For the value-based price component, the discounted productivities for each vintage are calculated for a reference firm that employs workers whose human capital is equal to the average of the economy. The value-based part $p_{v,t}^{value}$ is proportional to this estimated effective productivity of the vintage. The motivation for this rule is that the capital good producer tries to estimate the value of each vintage, in terms of effective productivity, for its average customer. Furthermore, it is assumed that the capital good producer is able to deliver any demanded quantity of any vintage.

It should be noted that not explicitly modeling the hiring and firing decisions of the capital goods producer has two main implications. First, there are no wage payments from the capital goods producer to households. However, in order to close the model, all revenues of the capital goods producer are channeled back to the households through dividends on the index bonds. Second, the capital goods producer is never rationed on its input markets, in

particular on the labor market. The qualitative implication of explicitly capturing the capital goods producer's hiring process would be that in periods when labor market tightness is high there would be a relatively high probability that the capital goods producer is rationed on the labor market. Being rationed the firm would not be able to deliver the full amount of capital goods that is demanded by the consumption goods producers. This would slow down the expansion of these consumption good producers relative to their plans. Such a qualitative effect is already present in the model since consumption good producers need to hire labor themselves whenever they want to expand their production. Through this channel a tight labor market has already a hampering effect on firms' expansion and potential rationing of the capital goods producer would not add a qualitatively different effect.

3.2.6 Investment and Vintage Choice

If consumption good producers have a target output level which cannot be produced with their current capital stock, they acquire new capital. To this end, a consumption goods firm has to choose from the set of available vintages. Here, the complementarity between specific skills and technology plays an important role: due to the inertia of the specific skill adaptation, the effective productivity of a vintage with $A^v > B_{i,t}$ is initially below its quality. It converges to A^v over time as the specific skills of workers at the firm catch up to the quality of the vintage. Therefore, the firm computes a discounted sum of estimated effective productivities over a fixed time horizon S,

$$\hat{\mathcal{A}}^v_{i,t} = \sum_{s=0}^{S} \frac{1}{(1+\rho)^s} \min[A^v, \hat{B}_{i,t+s}]. \tag{13}$$

The specific skill evolution is estimated for each time step within $[t, t+S]$ using an expression analog to (10),

$$\hat{B}_{i,t+s+1} = \hat{B}_{i,t+s} + \chi(B^{gen}_{i,t}) \cdot \max[A^v - \hat{B}_{i,t+s}, 0], \tag{14}$$

where the firm inserts its average general level $B^{gen}_{i,t}$ and specific skill values $\hat{B}_{i,t+s+1}$. A logit choice model based on the ratio of the estimated effective productivity and price for each available vintage determines which vintage is ordered, where the probability to choose vintage v is given by

$$\mathbb{P}[\ i \text{ selects } v] = \frac{\exp\left(\gamma^v \log\left(\frac{\hat{\mathcal{A}}^v_{i,t}}{p^v_t}\right)\right)}{\sum_{u=1}^{V} \exp\left(\gamma^v \log\left(\frac{\hat{\mathcal{A}}^u_{i,t}}{p^u_t}\right)\right)}. \tag{15}$$

Hence, in this formulation, the current average level of specific skills of a firm and the expected speed by which the workers are able to adjust their skills, captured by the average general skills, play a key role to determine in which vintage the firm will invest.

Capital goods are produced on demand, and as consumption goods producers may find it more suitable for their production plans not to employ the latest vintages, the capital good producer keeps on delivering also older vintages as the technology frontier grows. Note, that the way we model the capital good producer it is a proxy for a more differentiated market with different firms supplying different vintages. In this sense, we capture vertical differentiation in the supply of capital goods.

3.2.7 Labor Market Interaction

If the current workforce of a firm is not sufficient to produce its target output, the firm posts vacancies for production workers. The wage it offers has two constituent parts. The first part is the market driven base wage $w^{base}_{i,t}$. The base wage is paid per unit of (expected) specific skills of the worker. If the firm cannot fill its vacancies and the number of unfilled vacancies exceeds some threshold $\overline{v} > 0$ the firm raises the base wage offer by a fraction φ to attract more workers, i.e.

$$w^{base}_{i,t+1} = (1+\varphi) w^{base}_{i,t}. \tag{16}$$

The second part of the wage offer is related to an applicant's expected level of specific skills. Since the specific skills represent the (maximal) productivity of the employees, the wage $w_{i,t}$ is higher for higher (expected) specific skills. Because only the general skills but not the specific skill level of a job applicant are observable, firms use the average specific skills of employees belonging to the same skill group to estimate the applicant's specific skill level and determine a skill-group specific wage offer

$$\tilde{w}^O_{i,g,t} = w^{base}_{i,t} \times \min[A_{i,t}, \bar{B}_{i,g,t-1}], \tag{17}$$

where $\bar{B}_{i,g,t-1}$ are the average specific skills of all employees of skill group g in the firm. A firm can observe the specific skill levels of all its current employees, however this information will not be transferred to a competitor in case a worker applies there.

There is, however, the possibility that the regional government establishes a general minimum wage $\omega^M_{r,t}$. In this case, the firm is obliged to pay at least a wage that corresponds to the minimum wage. Consequently, the actual wage offer $w^O_{i,g,t}$ is limited downwards by the minimum wage such that

$$w^O_{i,g,t} = \max[\omega^M_{r,t}, \tilde{w}^O_{i,g,t}]. \tag{18}$$

A job-seeking worker considers the wage offers posted by a random sample of searching firms in the worker's region and compares them with her reservation wage $w^R_{h,t}$. A worker h only applies to firm i if it makes a wage offer $w^O_{i,t} > w^R_{h,t}$. The level of the reservation wage is determined by the current wage if the worker is employed, and in case of an unemployed worker by her previous wage, where the reservation wage declines with the duration of unemployment. The reservation wage never falls below the level of unemployment benefits.

Each application of a job-seeker has to pass through a two-step hiring procedure. In a first step, firms screen the applicants with respect to specific criteria and filter out those candidates that do not match certain requirements. The decision on who will pass the first stage is based on a bunch of characteristics that are summarized in a score $\mathcal{S}_{h,t}$. Two of the characteristics that constitute the score are modeled explicitly and represent properties that are shared by all members of the same skill group. The first of these explicit factors is based on the assumption that each firm tries to avoid hiring workers for which the wage is much higher than the additional revenue each of these workers is expected to generate. Therefore, we define a measure for the expected contribution of a worker that is given by

$$co_{i,g,t} = \frac{P_{i,t} \cdot \min[A_{i,t}, \bar{B}_{i,g,t-1}]}{w^O_{i,g,t}} - 1, \tag{19}$$

where a larger expected contribution has a positive effect on an applicant's chance to get shortlisted. Note that, as long as the minimum wage is not binding for any skill group, $co_{i,g,t}$ is the same for all skill groups and is therefore not associated with a skill bias. If, however, the minimum wage is binding for a skill group, then the expected contribution of an applicant of this skill group decreases and the probability to be shortlisted falls compared to applicants of the other skill groups. For the second explicitly modeled criterion, the firm assesses the expected deviation of an applicant's productivity $\bar{B}_{i,g,t-1}$ from the firm-wide level of specific skills $B_{i,t-1}$,

$$bg_{i,g,t} = \frac{\bar{B}_{i,g,t-1}}{B_{i,t-1}} - 1. \tag{20}$$

The rationale for this criterion is that the average specific skills $B_{i,t-1}$ of all workers is used in the production and price planning, and large gaps between the overall average $\bar{B}_{i,t-1}$ and the average of a single skill group $\bar{B}_{i,g,t-1}$ imply that the firm cannot meet its plans if too many workers of this group are hired at the same time. Consequently, a higher $bg_{i,g,t}$ increases the chance to pass the first stage of the hiring process. Note that this criterion has a skill bias that is the stronger the larger the skill gap is between the average specific skills of particular skill group g and the average specific skill level of the firm. Besides these group-specific characteristics, we assume idiosyncratic properties of the applicants that influence the score and are not explicitly modeled. Instead, they are captured by a random variable $\varepsilon_{h,t}$ such that the score of an applicant h is given by

$$\mathcal{S}_{h,t} = \gamma^{co} \cdot co_{i,g,t} + \gamma^B \cdot bg_{i,g,t} + \varepsilon_{h,t}, \tag{21}$$

where $\gamma^{co}, \gamma^{B} > 0$ are parameters indicating the importance of the two explicit factors. Applying the standard assumptions for the distribution of $\varepsilon_{h,t}$, we can model the decision making whether applicant h with skill level g is shortlisted by means of a logit model. The probability to be shortlisted is then given by

$$\mathbb{P}(i \text{ pre-selects } h) = \frac{\exp(\gamma^{co} \cdot co_{i,g,t} + \gamma^{B} \cdot bg_{i,g,t})}{1 + \exp(\gamma^{co} \cdot co_{i,g,t} + \gamma^{B} \cdot bg_{i,g,t})}. \tag{22}$$

In the second step of the hiring procedure, the firm chooses from the set of shortlisted applicants $\mathbb{A}_{i,t}$ the workers to make a job offer. If there are more applicants than vacancies to fill (i.e. $\tilde{L}_{i,t} < |\mathbb{A}_{i,t}|$), then the firm prefers to hire workers with higher general skills such that a shortlisted applicant with high general skills is more likely to receive a job offer than an applicant with a low general skill. Again, the probability that firm i chooses worker h from the short list $\mathbb{A}_{i,t}$ is a logit model with

$$\mathbb{P}(i \text{ selects } h) = \frac{\exp(\gamma^{gen} b_h^{gen})}{\sum_{a \in \mathbb{A}_{i,t}} \exp(\gamma^{gen} b_a^{gen})}. \tag{23}$$

Finally, the workers collect the job offers and have to decide to accept or reject them. If a worker receives more than one job offer, then she accepts the job offer with the highest wage. It should be noted that this mechanism implies that workers and/or firms can be rationed on the labor market. In this case, there is a second round of this matching process in each period. If after the second round any vacancy is not filled, it will remain unfilled for the upcoming production cycle. Similarly, if an unemployed worker does not get a job offer, she stays unemployed.

In case the workforce of a firm is too large relative to its target output level, the firm adjusts its number of workers. Dismissed workers are selected according to their general skill level, where we assume that low-skill workers are dismissed first. Additionally, there is a small probability for each worker-employee match to be separated in each period. This should capture job separations due to reasons not explicitly modeled.

3.2.8 Consumption Goods Market Interaction

The consumption goods market is modeled as a decentralized goods market. Each local market is represented by a mall at which the consumption goods producers can offer and sell their products to their customers. While firms are free to serve all malls regardless their spatial proximity, households always choose the mall which is located in their region.

Households go shopping once a week and try to spend their entire weekly consumption budget for one good. The consumption budget is determined using a (piecewise) linear consumption rule according to the buffer-stock approach (see Carroll, 1997; Allen and Carroll, 2001). In particular, we assume that the consumption budget is

$$C_{h,t}^{exp} = I_{h,t}^{Mean} + \kappa(W_{h,t} - \Phi \cdot I_{h,t}^{Mean}) \tag{24}$$

where $I_{h,t}^{Mean}$ is the mean individual income of an agent over the last T periods and the parameter Φ is a target wealth/income ratio. The parameter κ indicates how sensitive consumption reacts to deviations from the target level.

At the beginning of their shopping procedure households gather information about the prices of all available goods at the mall, but they get no information about the actually available quantities. The decision which good to buy is described using a logit-choice model. Specifically, we have

$$\mathbb{P}(h \text{ selects } i) = \frac{\exp(-\gamma^{C} v_h(p_{i,t}) + \gamma^{h} I_{i,h})}{\sum_{i'} \exp(-\gamma^{C} v_h(p_{i',t}) + \gamma^{h} I_{i',h})}, \tag{25}$$

where $v_h(p_{i,t})$ is the value of a product that is affected by its price and $I_{i',h}$ is an indicator that is 1 if firm i and household h stem from the same region. Thus, we assume two factors influencing the consumers choice function. These two parameters govern on the one hand the price sensitivity of consumers (γ^{C}) and therefore the intensity of competition between the

consumption good producers, and the relative preference of households for goods produced in their home region as opposed to the foreign region (γ^h). The latter is intended to foster the reproduction of stylized facts concerning the fraction of local consumption and can be seen as a representation of differences in taste. Furthermore, there is empirical evidence suggesting a home bias in consumers choice, at least for developed countries, which can be explained by the concept of consumer ethnocentrism (see, e.g., Balabanis and Diamantopoulos, 2004; Watson and Wright, 2000). The term consumer ethnocentrism has been introduced by Shimp and Sharma (1987) to represent the responsibility and morality of purchasing foreign-made products and the loyalty of consumers to products manufactured in their home country.[4]

The consumption requests for the different goods are collected by the mall and, if the total demand for one good exceeds its mall inventory level then the mall has to ration the demand. In this case the mall sets a rationing quota corresponding to the percentage of the total demand that can be satisfied with the available goods. Each household receives the indicated percentage of the requested consumption good.

After the shopping activity, rationed households may still have parts of their consumption budget available. Those households have the opportunity to spend the remaining budget for another good in a second shopping loop. In this case the shopping process is repeated as described above.

The production of the consumption goods firm follows a fixed time schedule with fixed production and delivery dates. Even if the mall stock is completely sold out it can only be refilled at the fixed delivery date. Consequently, all the demand that exceeds the expected value of the monthly sales plus the additional buffer cannot be satisfied.

3.2.9 The Government

In each region there is a local government which determines the extent of social and labor market institutions. The governments have redistributional functions by collecting taxes and using tax revenues to finance transfers. A worker who becomes unemployed receives an unemployment benefit that is relative to her last earned wage, where the replacement rate is ub_r. This compensation payment stays constant over the spell of the joblessness until the worker finds a new employment. However, the government defines a basic security standard which sets a minimum level for the benefits. This level is adjusted over time and is a fraction bs_r of the average wage in the region. Finally, the government can set a minimum wage $\omega^M_{r,t}$ that is also a percentage m_r of the regional mean wage, where $bs_r < m_r$ holds.

It is assumed that the regional governments run balanced budgets. To do so, they adjust the tax rates in a way that, retrospectively, the tax rates would have balanced the government expenditures of a given period of length T^G. More precisely, suppose $G_{r,t-\tau}$ are the governmental expenditures period $t-\tau$ and $Y^G_{r,t-\tau}$ is the tax base from the same period. Then we assume that the tax rate in t is determined according to

$$tax_{r,t} = \frac{\sum_{\tau=1}^{T^G} G_{r,t-\tau}}{\sum_{\tau=1}^{T^G} Y^G_{r,t-\tau}}. \tag{26}$$

The tax base in $t-\tau$ is derived from the tax revenue $TR_{r,t-\tau}$ of this period by computing the following expression:

$$Y^G_{r,t-\tau} = \frac{TR_{r,t-\tau}}{tax_{r,t-\tau}}. \tag{27}$$

In the policy analysis, we additionally assume that the governments can potentially introduce wage subsidies to foster the integration of migrants into the labor market. In this case, the subsides contribute to the governmental expenditures $G_{r,t}$.

[4]The French, German and Italian market for new cars in 2015 can serve as an example that illustrates the concept of a home bias. While French car manufacturers such as Renault, Citroen and Peugeot achieve a total market share of 56% at their domestic market, German brands such as VW, Mercedes, Audi and BMW dominate the German market for new cars with a total market share of more than 60%. The Italian market is more open for foreign brands but the local producer Fiat is the undisputed market leader with a market share of about 20%.

3.3 Parametrization, Initialization and Validation

For the policy analysis we use a standard parameter constellation for a two-region setup of the Eurace@Unibi model that is to a large extent identical with the parameter setup used in Dawid et al. (2018a,b). The strategy applied to identify this setup followed an approach that combines the use of empirically grounded parameter values, when possible, retrieved from the literature with calibrated parameter values that are chosen to reflect empirical evidence and to reproduce a large set do stylized facts. The list of stylized facts that have been reproduced by the standard two-region setup of the Eurace@Unibi model includes persistent growth, low positive inflation and a number of important business cycle properties: persistent fluctuations of output; pro-cyclical movement of employment, consumption and investment, where relative sizes of amplitudes qualitatively match those reported e.g. in Stock and Watson (1999), counter-cyclical movement of wages and firm mark-ups. On the industry level the model generates persistent heterogeneity in firm-size, profit rates, productivity and prices in accordance with empirical observations reported e.g. in Dosi et al. (1997). Also labor market regularities, like the Beveridge and Phillips curve, are reproduced by the model with this benchmark parameter constellation. The reader is referred to Dawid et al. (2018a) for a more detailed overview of the reproduced stylized facts. A table with the list of parameter values used in the simulations underlying this paper are provided in the Appendix.

The agent population is assumed to be essentially homogeneous within each region at the outset of the simulation. Firms located in the same region have identical assets (a capital stock of the same size and quality, and the same amount of liquidity) and liabilities, and there are no established worker-employer matches. Fellow citizen own the same wealth and are endowed with the same specific skills. Distributions of these variables among agents evolve endogenously over the simulation. There is only one exception for the general skills of households. Within the regional population the general skills are heterogeneous from the start following an exogenous distribution. Note that across regions we allow for differences with respect to specific variables in order to set up regions with specified properties. As discussed in the next section, here we assume inter-regional heterogeneity for the initial specific skills of workers and the initial capital productivity of firms.

Finally, as outlined in Section 3.2.5, the growth of the technological frontier in the capital goods sector is purely stochastic. Since the actual trajectory of the frontier has considerable implications for the growth path of the economy, there might be spurious growth effects stemming from stochastic differences in the dynamic of the technological frontier between runs. To avoid that these growth effects distort the results of the policy analysis, we use an identical realization of the stochastic process governing the emergence of new vintages in all considered simulation runs.

4 The Policy Experiment

4.1 The Experimental Setup

We consider a two-region setup of the model with a more advanced core region and a periphery that is economically less developed. In particular, we assume that firms in Region 1 have a physical capital stock with an initial productivity that is 50% higher compared to the capital stock of firms in Region 2 and workers have an equivalently higher initial level of specific skill. The population of both regions has the same size and we also assume that the human capital endowment in terms of general skills is identical, where 50% of the population have a high general skill level and 50% of the population feature a low one. Moreover, the two regions differ in terms of their labor market institutions. While a minimum wage is implemented in the high-tech core that is 55% of the average regional wage, there is no minimum wage in the periphery. Similarly, the social security system is more generous in the high-tech region. The characteristics of the two regions are summarized in Table 1. Although having a different institutional setting, the two regions are assumed to form a political and economic union in a common currency area.

We assume that this union of states experiences a sizable influx of immigrants within

Table 1: Initialization of capital stock, skills, size of regions and institutions.

	Region 1 (Core)	Region 2 (Periphery)
Number of households/firms	8000/400	8000/400
Initial quality of capital stock (at $t = 0$)	1.5	1.0
Initial level of specific skills (at $t = 0$)	1.5	1.0
Skill distribution (high/low)	0.5/0.5	0.5/0.5
Minimum wage (pct. of average wage)	0.55	none
Replacement rate (pct. of last wage)	0.65	0.45
Basic security benefits (pct. of average wage)	0.33	0.15

Table 2: Characteristics of the migration cohort.

Number of households	160
Initial level of specific skills (at $t = T^M$)	0.35
Skill distribution (high/low)	0.28 / 0.72

a short period of time. The focus here is on the broad category of humanitarian migrants that includes asylum seekers and persons asking for international protection regardless of whether some sort of protection will eventually be granted.[5] The forced migrants are thereby assumed to come from countries outside the union of the two states where the perspective of return is limited. For this reason, we abstain from incorporating return migration in our analysis.

For the sake of illustration, there is a single cohort of migrants that arrives at a specific point in time T^M. The size of the cohort is chosen such that it represents 2% of the population of either of the two states. The characteristics of the migrant cohort is summarized in Table 2. In particular, we assume that the skill structure of the refugee population differs from the skill profile of the resident population. On the one hand, there is a gap in terms of specific skills to the technologies operated in both locations. This implies that the immigrants may lack technology-related experiences to work efficiently with the production technologies employed by the firms in the destination countries. This gap, however, can be closed over time by collecting experiences on-the-job. On the other hand, we assume that the immigrants have on average lower educational achievements compared to the native population where, in accordance with recent evidences of humanitarian immigrants arriving in Germany, the share of low skilled individuals in the migration cohort is substantially larger compared to the native population.[6]

There is empirical evidence that immigrants cannot fully transfer their human capital to their destination country. As a result, immigrants are often integrated in segments of the labor market that do not correspond to their formal educational level. Dustmann et al. (2012) show that in Great Britain migrants downgrade considerably upon arrival and, even if formally better educated, they compete with workers at the lower end of the wage distribution. Eckstein and Weiss (2004) illustrate that, upon arrival, immigrants from the former USSR to Israel receive no return for imported human capital in terms of schooling

[5]This type of immigrants has to be distinguished from a controlled labor immigration of typically high skilled workers for which candidates have to apply for a work visa before entering the destination country.

[6]In fact, findings of a special survey of the German Socio-Economic Panel (SOEP) among refugees who entered Germany between January 1, 2013 and January 31, 2016 and who applied for asylum show substantial differences in the educational profile compared to the German population. While the share of immigrants that completed secondary school is similar to that of the German population, one can find much more individuals in the lower end of the educational spectrum (no schooling or only primary school) and less in the middle part (completed middle school) compared to the German population. Similarly, while 13% of the refugees reported to hold a university degree and another 18% received some sort of on-the-job training and vocational training, 21% of the German population have university degree and 59% have vocational training qualifications (see Brücker et al., 2016).

Table 3: Overview of skill categories.

	Native population	Immigrants
Skill group 1	–	low
Skill group 2	low	high
Skill group 3	high	–

and experience. The price for skills obtained abroad increases over time, but a large gap remains between the compensation that immigrants and natives obtain in the labor market. Eckstein and Weiss (2004) estimate the long-run return on schooling to be 6.9% for natives whereas the return on schooling obtained abroad is only 2.7%. A similar result is reported in Friedberg (2000), who additionally shows that, in the context of the Israeli labor market, foreign education obtained in Western countries (e.g. USA or Western Europe) is similarly compensated as domestic education, but there are substantial gaps in terms of return on schooling obtained in many African and Asian countries. These patterns might reflect differences in school quality and vocational training across different regions of origin. Since there are also other obstacles that prevent immigrants to make use of their educational background to its full potential such as a possible lack of complementary skills like language or social norms, we assume that immigrants and domestic workers that formally have the same educational achievements do not fall in the same "effective" skill category (Dustmann et al., 2012). Rather, we assume that high skill migrants are downgraded upon arrival and get integrated in the low skill segment of the labor market. In the same manner, low skill members of the migration cohort form a separate labor market segment at the lower end of the general skill spectrum. In particular, we define general skill group 1 as the category including all low-skill immigrants, whereas skill group 2 contains high-skill immigrants and low skill native workers. Finally, skill group 3 includes all high-skilled native households (see Table 3 for an overview).

In our policy analysis we first contrast a baseline scenario without migration with a scenario in which migration occurs but no active policy response is given. The narrative of this migration scenario is that the refugees arrive in the periphery country but then try to relocate as soon as possible in the core country with its higher social standards. This assumption is consistent with evidences showing that asylum seekers, to some extent, choose particular destination countries based on historical, economic and reputational factors (see, e.g., McAuliffe and Jayasuriya, 2016). Accordingly, we consider a situation in which all immigrants settle down in the high-tech core region.[7]

In a second step we compare this migration scenario with two policy scenarios. In the first policy treatment, we assume that the member states of the union agree on a refugee allocation and resettlement quota, which implies that a share of the cohort will be hosted by Region 2. Note that this policy mimics in a stylized way the plan pursued by the European Union to implement an allocation scheme for forced migrants among the member states. An alternative interpretation of this policy treatment is that the core region passes more restrictive asylum legislations and/or installs border controls that reduce the inflow into Region 1 substantially. Since we assume that forced migrants enter the union in the periphery, this implies that a share of the cohort would have to stay in Region 2.

As an alternative policy scenario we consider a situation in which all refugees are taken in by the high-tech country, but in contrast to the migration scenario described above, the local government implements active labor market policies to foster the integration process of low skill immigrants. The intention of these policies are to compensate the unfavorable wage productivity ratios that are caused by paying the minimum wage. The different scenarios are summarized in Table 4.

In the following Monte Carlo experiments, we conduct simulation runs encompassing

[7] A survey of the International Organization for Migration (IOM) among Iraqis who left the country in 2015 and lived in Europe at the time when the interviews were conducted indicates that Germany was chosen as the intended destination at the time of departure by 47%, Finland by 14% and Sweden by 10% (see International Organization for Migration, 2016).

Table 4: Overview of the considered migration and policy scenarios.

Scenario	Properties
Migration	• Migration only to Region 1 • No active policy response
Allocation Policy	• 50% allocation quota, i.e. equal allocation of immigrants among Region 1 and 2
Integration Policy	• Migration only to Region 1 • Active policy response of the government in Region 1; implementing integration policies to support labor market participation of low-skill immigrants

850 months. However, as we start the simulations with almost completely homogeneous populations, it takes not only a considerable number of iterations until empirically plausible distributions have emerged but it also takes time until transient effects have disappeared that might distort the analysis of simulation outcomes. Therefore, we cut off the first 600 months and consider in the following sections only 250 months from 601 to 850 that follow this transient phase. Any experimental treatment is applied after month 600, in particular, we use $T^M = 624$ as the migration period. Thus, we analyze the implications of the inflow of forced migrants and of the different policy treatments over a time horizon of about 18 years. We do not consider a longer time horizon since we abstain from considering demographic long-term effects of the migration, which cannot be addressed with the current model setup.

For each of the considered scenarios 100 batch runs are conducted. In order to statistically assess the impact of migration and the policy treatments, we estimate dynamic effects using penalized spline methods (see Kauermann et al., 2009). To this end, the time series are pooled and the effects are evaluated by estimating equation

$$Y_{t,s,i} = s(t) + I_{[\mathbb{M}=1]} \cdot s_{\mathbb{M}}(t) + I_{[\mathbb{M}=1\&\mathbb{P}=p]} \cdot s_{\mathbb{P}}(t) + \eta_i^0 + \eta_i^1 t + \varepsilon_{t,s,i}, \tag{28}$$

where $Y_{t,s,i}$ is the outcome variable at iteration t, for scenario s, and run i. The baseline spline is $s(t)$ to which the dynamic migration effect captured by $s_{\mathbb{M}}(t)$ and the dynamic effect of a policy treatment p captured by $s_{\mathbb{P}}(t)$ are added with dummy variables I indicating whether the influx into the union takes place and, if this is the case, one of the policy treatments is applied. The linear term involving η_i^0 and η_i^1 captures run specific random effects and $\varepsilon_{t,s,i}$ is the error term. Whenever we illustrate dynamic effects in the following sections, we will plot a spline plus the estimated confidence bands, where the latter is to illustrate the significance of the effects. A spline captures the additive change of Y induced by the treatment. In that sense, spline $s_{\mathbb{M}}(t)$ estimates the additional effect of migration compared to the baseline without migration, whereas spline $s_{\mathbb{P}}(t)$ captures the additive effect of policy p in comparison to the migration scenario.

4.2 The Benchmark without Migration

We commence the discussion of our results with Figure 1 which shows for the two regions the evolution of some key macroeconomic variables in the absence of migration. Panel (a) of this figure plots the time series of total output for the core region (black line) and the periphery (red line). Total output shows a positive trend in both regions but, although the populations have the same size, the level in Region 1 is substantially higher compared to that of Region 2. Moreover, as time evolves, there is a clear divergence which indicates that average economic growth in the core exceeds the average growth rate in the periphery. The evolution of regional outputs is mirrored in panel (b), which depicts the time series of the average productivities in Region 1 and 2. Again, both regions are characterized by persistent productivity growth, but there is a gap between the two regions that increases over time. In fact, the productivity ratio between Region 1 and 2 increases from 1.5 at $t = 600$ to a level of 1.65 at the end of the considered time horizon ($t = 850$). Since we initialized the

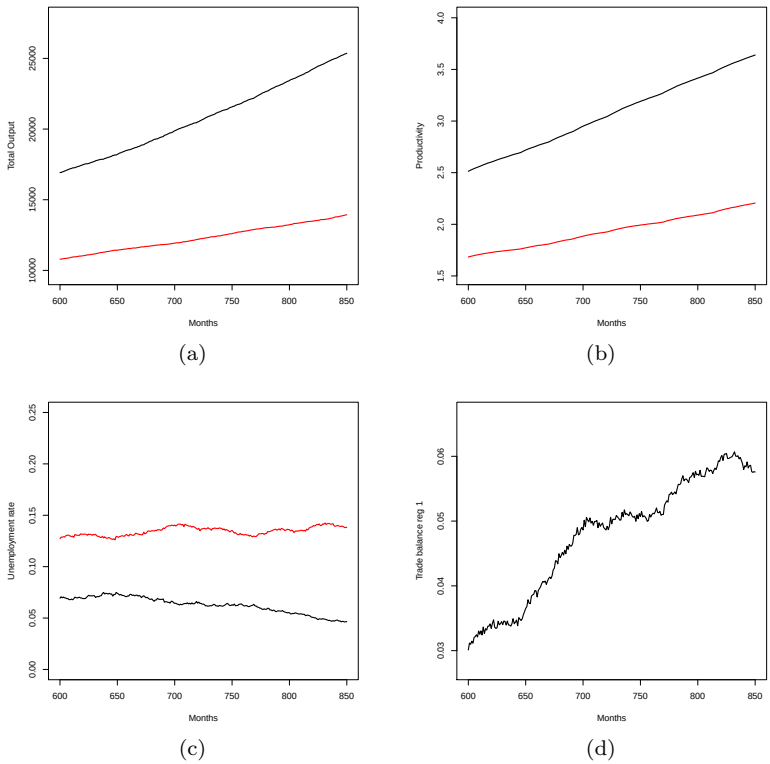


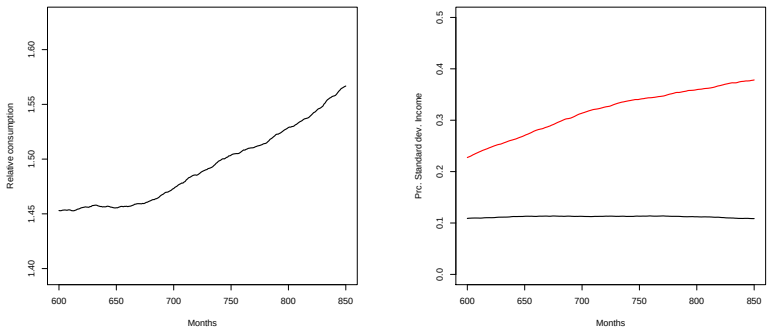
Figure 1: Panel (a): total output in Region 1 (black) and Region 2 (red); panel (b): productivity in Region 1 (black) and Region 2 (red); panel (c): employment rate in Region 1 (black) and Region 2 (red); panel (d): trade surplus quota of Region 1 with Region 2.

two regions with a productivity gap of 1.5, this illustrates that the initial technology gap between the two regions is never closed.

In panel (c) of Figure 1 we show the evolution of the regional unemployment rates. Here, it becomes apparent that Region 2 is not only lagging behind Region 1 in technological terms, but this region is also characterized by a substantially higher unemployment. Moreover, one can see that Region 1 is able to reduce the unemployment rate in the considered time phase whereas Region 2 records a slight increase in the level of unemployment. The better economic performance of Region 1 can also be seen from panel (d), which shows the trade balance between the two regions from the perspective of Region 1. Apparently, since the trade surplus of Region 1 increases over the course of time, the core improves its competitiveness at an expense of the periphery.

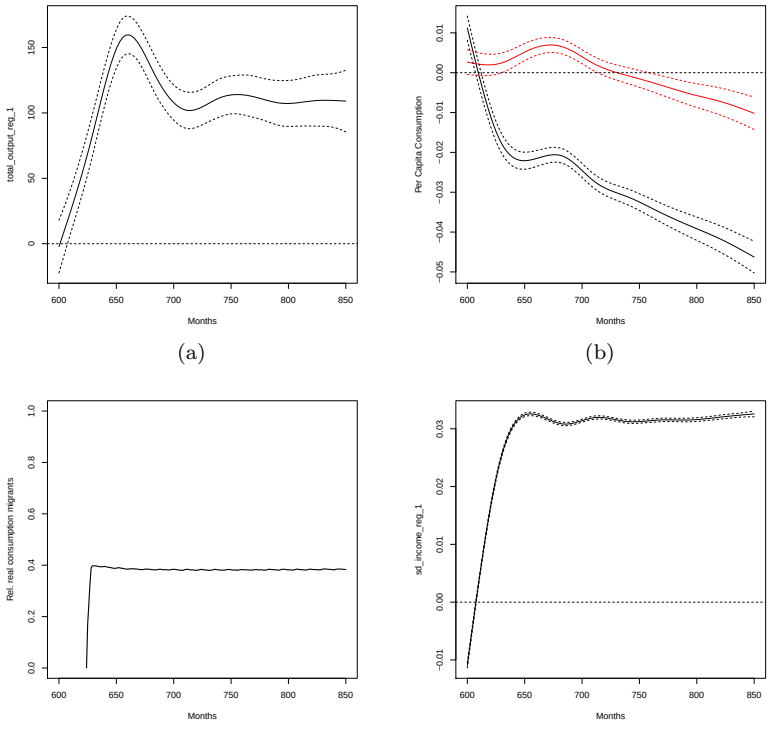
The diverging economic development in the two regions implies substantial effects on the relative standard of living. In the following, we use the average real consumption per capita of the population as indicator for the regional standard of living; from Figure 2 (a), which illustrates the consumption per capita in Region 1 relative to Region 2, one can see that the periphery region falls behind the core region also in terms of relative standard of living. From the perspective of the periphery, this situation is further aggravated by the fact that the standard of living is also more unequally distributed than in the core. This can be seen from panel (b) plotting the time series of income inequality. Apparently, income inequality is higher and increasing in the periphery, whereas in the core region the level of inequality stays constant at a lower level.

Altogether, the baseline scenario describes a situation in which the core and the periphery diverge substantially in economic and social terms. Note that, to some extent, the baseline scenario mimics in a highly stylized way the situation in which the European Union was at the outset of the European refugee crisis in 2014, which was characterized by asymmetrical relations between the economically stronger core countries (e.g. Germany, Austria, Netherlands, and Finland) and those of the periphery (e.g. Greece, Portugal, Spain, Italy).



(a) (b)

Figure 2: Panel (a): relative consumption in Region 1; panel (b): income inequality measured as percentage standard deviation of the income distribution in Region 1 (black) and Region 2 (red).



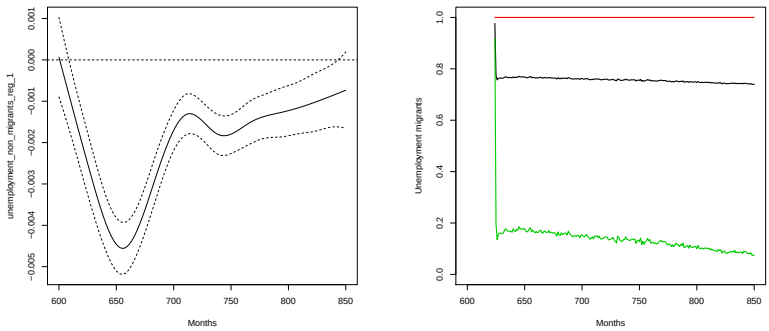
(a) (b)

(a) (b)

Figure 3: Spline smoothed migration effects on total output in Region 1 (a), per capita consumption (b, black line) and per capita consumption of the native population (b, red line) in Region 1. Panel c: ratio of the per capita consumption of migrants and natives in Region 1. Panel d: migration effect on inequality measured in Region 1 as percentage standard deviation of the income distribution.

4.3 The Implications of Migration to the Core Region

We proceed by discussing the implications of our first migration scenario in which the immigrant influx is only into the economically more advanced Region 1 and where no active policy reaction is given. In order to elicit the comparative migration effect in terms of quantitative size and statistical significance, we plot in Figure 3 (a) the dynamic effect on the time series of total output using splines. The time series has to be read as the absolute effect of immigration on the level of total output. The spline in panel (a) illustrates that the output



(a) (b)

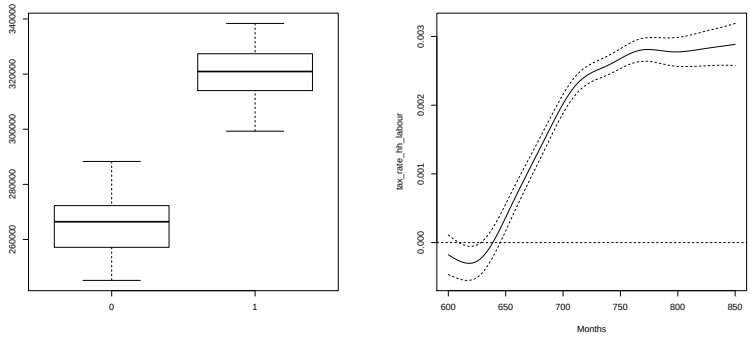
Figure 4: panel (a): spline smoothed migration effect on the unemployment rate of natives in Region 1. Panel (b): total unemployment rate of migrants (black line) and of low-skill (red line) and high-skill migrants (green line).

trajectory is shifted upwards, which on the one hand means that migration leads to more output in that region, but on the other hand suggests that there is only a temporary but no persistent effect on economic growth. In per capita terms not shown here, the output level declines which implies that total output does not change proportionally to the population.

A similar observation can be made for per capita consumption (panel b); when taking the larger population into account, the considered migration into the core is associated with a reduction of the average real consumption of all households (black line). If the effect on real consumption per capita is, however, decomposed into the contribution of the native population and immigrants, then one can see that the consequences of migration for the native population are less pronounced as for the full population. In fact, from the red line in panel (b) depicting the effect on the consumption per capita of the native population, one can see that the losses in real consumption per capital are only one fourth of the total effect, which suggests that three fourth must stem from the migration cohort. Indeed, there is a persistent gap in terms of real consumption between the native population and the immigrants. On average, immigrants only consume 40% of the consumption of an average native household (panel c). At the same time, there is an increase in income inequality (panel d), where the effect on real consumption suggests that the rise in inequality is mainly driven by large and persistent income gaps of immigrants in comparison to the native population.

What stands behind these observations? In order to get an understanding of the underlying mechanisms, one has to consider the implications of the considered inflow of migrants on the labor market. In Figure 4 we illustrate the labor market performance of the native population and the migration cohort. The unemployment of the native population, which was already low in the baseline scenario, decreases even further (panel a), where in the short term there is a reduction of the unemployment rate of about 0.3 percentage points. In the long run, however, this positive effect becomes smaller and almost disappears. For the migration cohort, panel (b) shows a complete different picture. Despite the absence of legal barriers to enter the labor market by assumption, more than 70% of the immigrants remain unemployed over the whole considered time horizon (black line). The red and the green line in panel (b) decompose the unemployment rate of migrants into rates by skill groups. Here one can clearly see that unemployment mainly persists among low skilled migrants (red line), whereas high skilled migrants are much more successful in participating in the labor market (green line).

How can this observation be explained? As pointed out in Section 4.1, we assume that migrants experience a skill downgrade upon arrival. More precisely, the effective skill level of high skill migrants corresponds to the low skill category of native workers (skill group 2). As a consequence, these workers enter the low skill segment of the labor market and the labor market performance of this group is identical with that of native low skill workers. For the less qualified migrants, the skill downgrade implies that they form a new skill category at



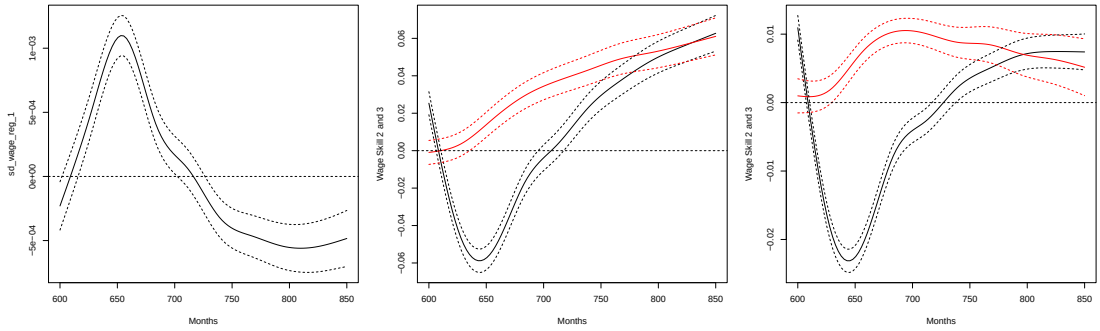
(a) (b)

Figure 5: Panel (a): comparison of the discounted sum of total governmental spendings in Region 1 for transfers between the baseline scenario without migration (left boxplot) and the migration scenario (right boxplot); panel (b): spline-smoothed migration effect on the tax rates in Region 1.

the labor market (skill group 1). When applying for a job, the firms expect the specific skill level of these applicants to correspond to the initial level of 0.35 the migrants have at arrival. Since there is a minimum wage of 55% of the average wage in the core region, the wage a firm would have to pay for low skilled migrants is too high compared to the productivity these workers are expected to yield, such that the likelihood to hire them is almost zero (compare Section 3.2.7). Thus, the combination of productivity gaps and minimum wages is the major obstacle for the labor market integration of the migrants.

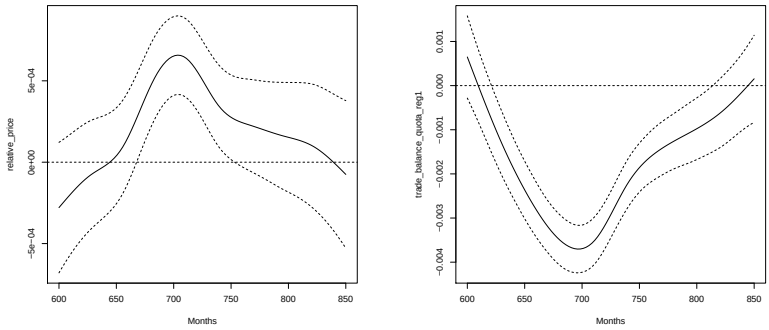
Due to their low labor market performance, low-skill migrants remain recipients of benefits at the basic security level. This explains the persistent gap in terms of real consumption per capita between the natives and migrants described above and also explains the rise in income inequality in the core. But the high and persistent unemployment of migrants has also negative implications for the public finances in Region 1. Figure 5 (a) depicts boxplots showing the discounted and deflated sum of the total social expenses for transfers and unemployment benefits in the core region among the 100 batch runs in the baseline scenario without migration (left boxplot) and the migration scenario under consideration (right boxplot). Apparently, the total transfer payments are considerable higher in the presence of migration, which means that the additional transfers for the migrants are not compensated by the higher employment of native workers. Panel (b) shows the spline-smoothed effect on the tax rate in Region 1. In order to finance the higher transfer payments and to keep a balanced budget, the government has to increase the tax rate over time. Eventually, rising taxes have a negative effect on the native households by reducing their net income.

Now we turn to the implications on the wage structure. Figure 6 (a) shows the effect on wage inequality that only takes the labor income of employed households into account. Apparently, in the short term, there is an increasing effect on the level of wage inequality that turns into a slight decreasing effect in the long run. In panel (b) of this figure, we plot the effects on the average nominal wage of skill group 2, which captures the low skilled natives and high skilled migrants (black line) and on the average nominal wage of skill group 3 representing the high skilled natives (red line). Both lines point out that there are ambiguous wage effects. While there is a wage-enhancing effect for high skill natives throughout the whole time horizon, immigration initially depresses wages for low skill native workers. This pattern is consistent with the results obtained in Dustmann et al. (2012), who demonstrate that, when migrants downgrade upon arrival, there are decreasing wages in the lower part of the wage distributions and slightly increasing wages in the upper part. In the long term, however, we can observe a positive effect on wages also for skill group 2. Note that decreasing wages for workers of skill-group 2 are because the integration of high skilled immigrants that arrive with low specific skills leads to a short-term drop in the expected specific skills of the whole skill group 2, which in turn affects the skill group specific wage offers posted by firms (compare Expression 17 in Section 3.2.7). In panel (c) we depict the



(a) (b) (c)

Figure 6: Panel (a): spline-smoothed migration effect on the inequality of wages in Region 1; panel (b): spline-smoothed migration effect on average nominal wages of skill-group 2 (black line) and of skill group 3 (red line) in Region 1; panel (c): spline-smoothed migration effect on average real wages of skill-group 2 (black line) and skill group 3 (red line) in Region 1.



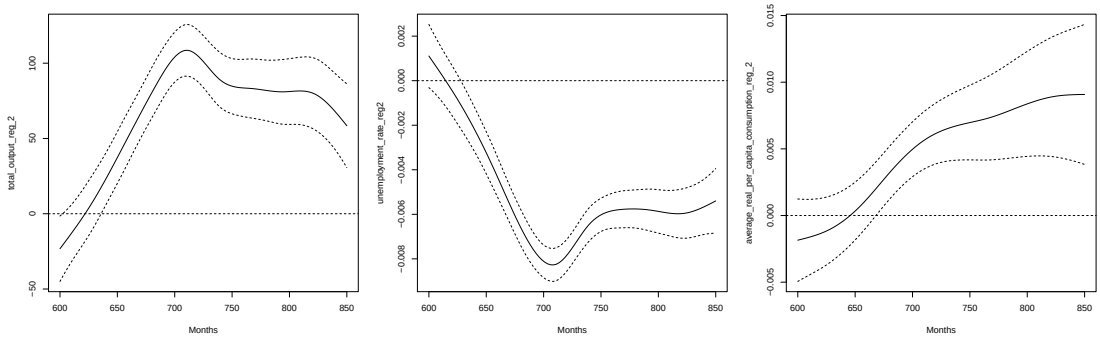
(a) (b)

Figure 7: Spline smoothed effects of migration on the average price of firms in Region 1 relative to the average price of firms in Region 2 (a) and the trade surplus of Region 1 (b).

wage effects of migration in real terms. Here, one can see that qualitatively the long-term impact differ from the effects on nominal wages; in particular, the positive effect for both skill groups declines in the long term which suggests that migration to the core has an inflation fostering effect that is mainly driven by higher labor cost. Hence, in real terms, there are hardly any persistent effects on the labor income of native households. The gains in nominal terms are largely offset by higher inflation. The rising inflation together with the fiscal response to increase the tax rates explains why there is eventually a negative effect on the real consumption of the native population as observed in Figure 3 (b).

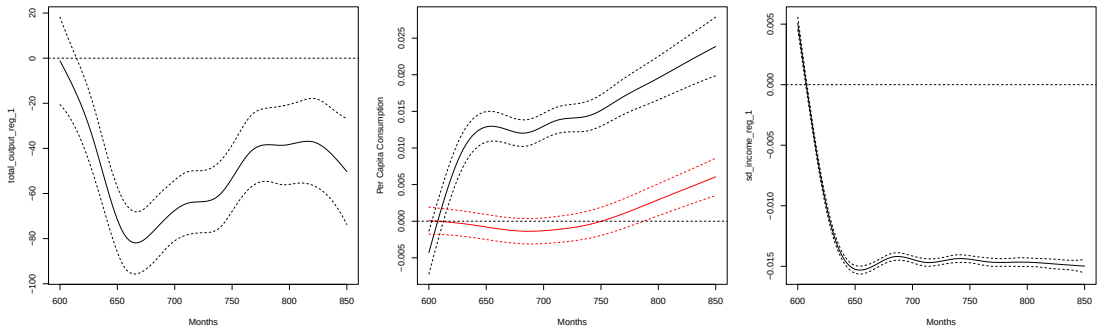
So far, we have only considered the isolated effects of migration on the core region. Since Region 1 is closely connected to the economically lagging Region 2, it is also worth considering the implications for the economic performance of Region 2, which is not the primary destination of immigrants. Figure 7 (a) depicts the estimated effect on the relative prices of firms located in Region 1 compared to those firms from Region 2. One can see that the relative prices increases from the perspective of Region 1, which means that the commodities produced in the core become more expensive relative to the products from Region 2. Thus, the core forfeits some of its competitive advantage in response to immigration. This process is mainly cost-driven as in the context of a tight labor market close to full employment, the recruitment of new employees to expand output becomes difficult placing upward pressure on wages that eventually drive up unit labor costs. In panel (b) of Figure 7, one can see that the declining competitiveness also leads to a reduction of the trade surplus of Region 1.

In Region 2, the influx of immigrants to the core induces a higher output level compared to the baseline scenario (see Figure 8 a). This output enhancing effect is partly driven by



(a) (b) (c)

Figure 8: Spline smoothed effects of migration on total output (a), the unemployment rate (b) and the per capita real consumption (c) in Region 2.



(a) (b) (c)

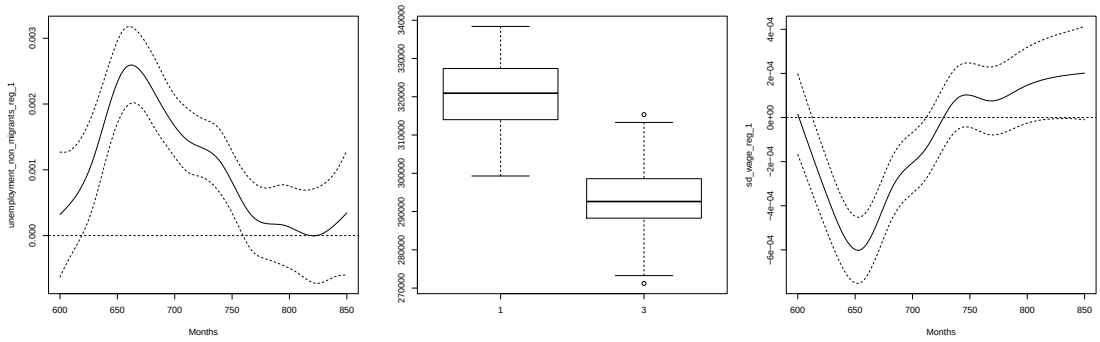
Figure 9: Spline smoothed policy effects of the allocation quota on total output in Region 1 (a), per capita consumption in Region 1 for the full population (black line) and the native population (red line) (b) and inequality measured as percentage standard deviation of the income distribution (c) in Region 1.

a higher demand in Region 1 that results in more exports from the periphery to the core but it is also partly driven by the change in relative competitiveness that makes products of Region 2 more attractive. The higher level of economic activities improves the employment (panel b) and the standard of living (panel c) in the periphery such that in economic terms Region 2 benefits from migration to Region 1.

4.4 The Implications of a Migration Allocation Quota

We now turn to our first policy scenario in which we assume that the migrants are equally allocated among the two regions. In particular, a scenario is considered in which both states agree on an allocation quota of 50% with random assignment of migrants to regions, which means there is no pre-selection of individuals by one of the states according to, e.g., the general skill level. Note that we consider this scenario as one of the possible policy responses. Therefore, we compare the outcomes of this policy treatment to the migration scenario discussed in the previous subsection in which all immigrants settled down in the core region.

What are the economic implications of the allocation quota on the core region? In Figure 9 we depict the effects of this policy treatment on total output, per capita consumption and income inequality. Regarding the time series of total output, one can observe a slightly negative effect which is, however, quantitatively smaller than the positive effect induced in the migration scenario without active policy response (compare Figure 3). Thus, the overall output effect compared to the no-migration benchmark is still positive. For the effects on



(a) (b) (c)

Figure 10: panel (a): spline smoothed policy effects of the allocation quota on the unemployment rate of native households in Region 1. Panel (b) comparison of the discounted sum of total governmental spendings in Region 1 for transfers between the no-policy scenario (left boxplot) and the allocation policy (right boxplot). Panel (c): spline smoothed policy effect on the inequality of wages in Region 1.

per capita consumption of the total population and natives as well as the effect on inequality, one can see that implementing the allocation quota also mitigates the original effects of migration. In all these cases, the policy seems to halve the strength of the migration effects, which is consistent with our assumption that the allocation quota reduces the inflow into Region 1 by 50%.

Similarly, the policy treatment reduces the weak positive employment effects for native workers in Region 1 (Figure 10 a). At the same time, there is no significant effect on the level of unemployment among immigrants, which underlines that reducing the inflow of migrants into the core region does not improve the perspectives of low-skilled migrants to integrate in the labor market. Nevertheless, migration at a lower scale implies a substantial reduction of governmental spendings for social transfers, as evidenced by panel (b) of Figure 10, which compares the deflated, discounted expenditures for social transfer spent by the local government in Region 1 for the two migration scenarios. Moreover, the lower size of the arriving migration cohort also reduces the extent of the effect that migration has on the inequality of wages (panel c).

While the policy mitigates the effects of migration in the core, what are the consequences of an equal allocation for the periphery? In terms of total output, Figure 11 (a) demonstrates that the additional effect is in general very weak but positive in the short and negative in the long run, which means that the positive effect on total output in Region 2 that could be observed in the migration scenario without allocation quota largely persists. Regarding the effects on income inequality and per capita consumption of the full population, the effects on Region 2 are similar to those observed for Region 1 in the pure migration scenario. In fact, there is an increases of income inequality in the periphery (panel b) whereas the average standard of living of the population declines (panel c, black line).

Considering the consumption effects for natives and migrants separately, one can see that there is a negative effect on the native population that is, however, weaker than the effect on the average consumption of all households (panel c, red line). For migrants, panel (d) of this figure shows again a considerable gap in terms of real consumption per capita compared to the native population that narrows only slightly over time. It is worth noting that the size of the gap is larger compared to the gap that could be observed in the core region (compare Figure 3 c). As this implies that also the absolute per capita consumption of migrants is larger in the core region, there are strong incentives for immigrants that have been assigned to the periphery to eventually relocate in the core. Form this perspective, the allocation policy might be difficult to be enforced at least in the medium and long run.

This finding is remarkable given the observation that the labor market participation of immigrants is much higher in the periphery. In fact, while the allocation policy leads to a slightly rising unemployment among native workers (Figure 12 a), one can see that the

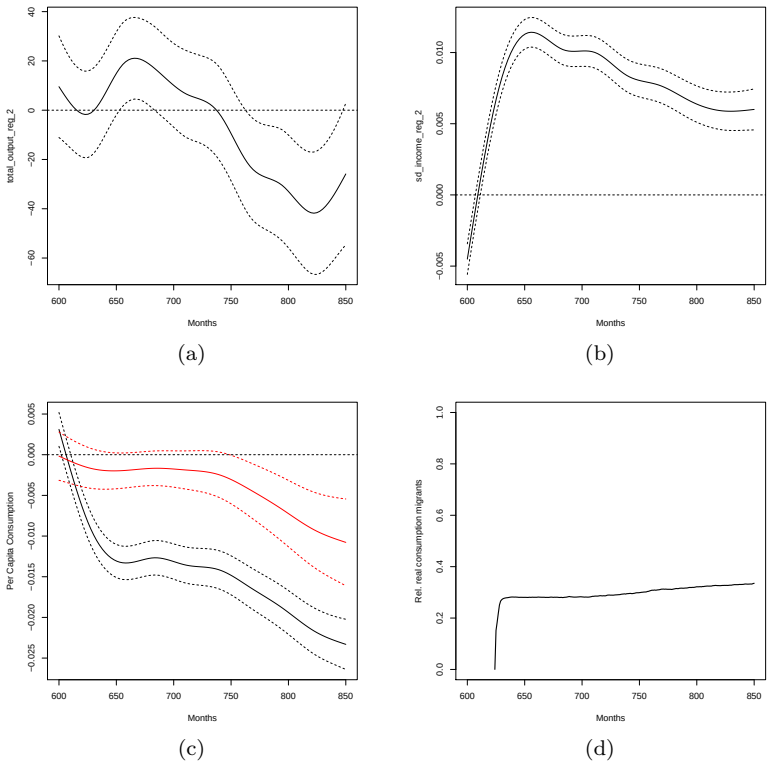


Figure 11: Spline smoothed policy effects on total output (a), inequality measured as percentage standard deviation of the income distribution (b) and per capita consumption (black line) and per capita consumption of the native population (red line) in Region 2 (c). Panel d: ratio of the per capita consumption of migrants and natives in Region 2.

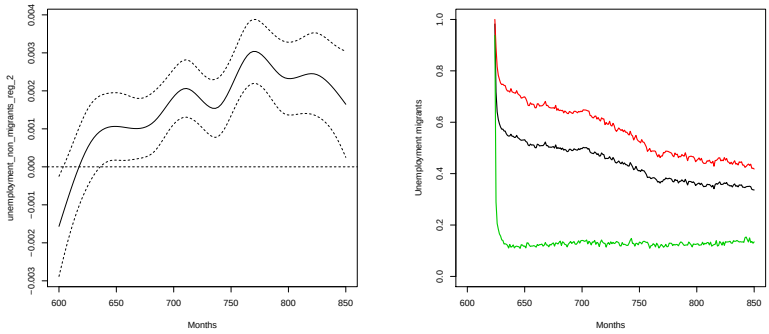
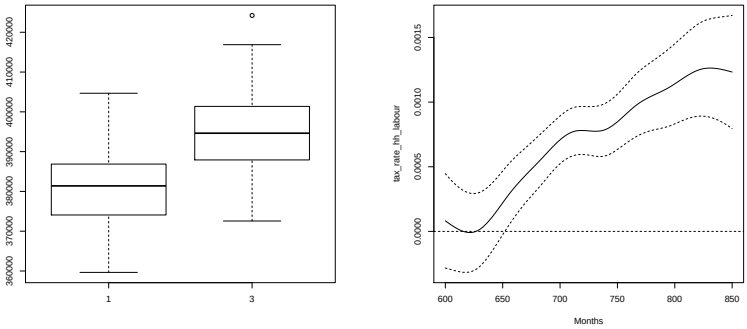


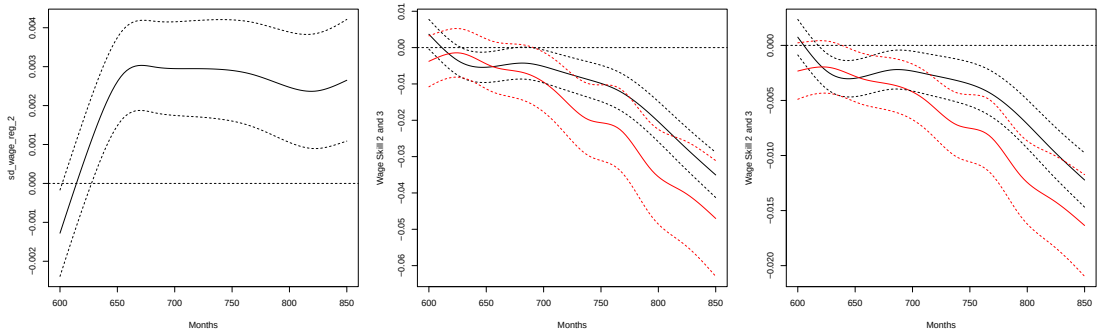
Figure 12: panel (a): spline smoothed migration effect on the unemployment rate of natives in Region 2. Panel (b): total unemployment rate of migrants (black line) and of low-skill (red line) and high-skill migrants (green line).

unemployment rate of migrants is considerable lower compared the level that emerges in the core region (panel b, black line). The reason can be seen from the red and green line in panel (b) that depict the unemployment rate for low-skill (red line) and high-skill immigrants (green line). Apparently, the labor market integration of low-skill immigrants is much more successful in the periphery as the level falls from about 70% to around 40% in the course of time. Recall that in the core region almost all low-skill migrants remained unemployed. For high-skill immigrants, panel (d) demonstrates that there is essentially no difference in terms of labor market participation compared to the native population. Nevertheless, despite a higher employment among migrants, the reception of immigrants in the periphery leads to



(a) (b)

Figure 13: Panel (a): Comparison of the discounted sum of total governmental spendings in Region 2 for transfers between the no-policy scenario (left boxplot) and the allocation policy (right boxplot); panel (b): spline smoothed policy effects of the allocation quota on the tax rates in Region 1.



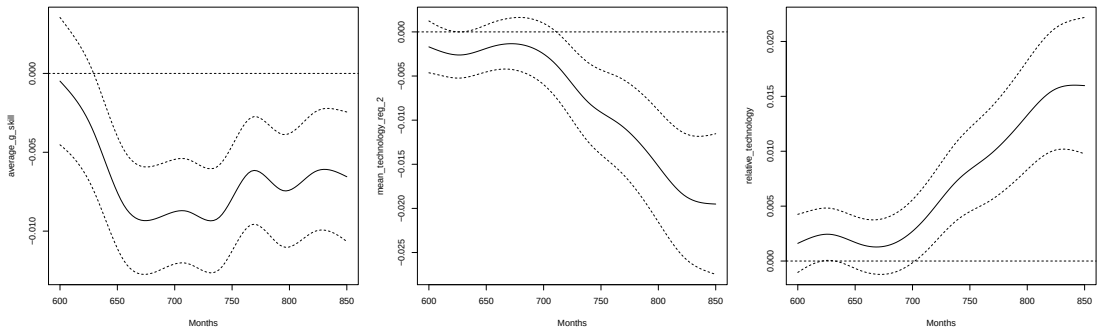
(a) (b) (c)

Figure 14: Panel (a): spline-smoothed policy effect of the allocation quota on the inequality of wages in Region 2; panel (b): spline-smoothed policy effect of the allocation quota on average nominal wages of skill-group 2 (black line) and of skill group 3 s (red line) in Region 2; panel (c): spline-smoothed policy effect of the allocation quota on average real wages of skill-group 2 (black line) and skill group 3 (red line) in Region 2.

a higher level of transfer payments and eventually, as a fiscal response, to higher tax rates (see Figure 13).

The main reason why the labor market integration of low-skill migrants is more successful in the periphery lies in the different extent to which labor market institutions are implemented in the two countries. As pointed out above, in the core region, the minimum wage acts as an insurmountable hurdle that prevents labor market participation of low-skill immigrants. In the periphery, however, we assume that there is no institutional minimum wage such that firms can offer wages that correspond to the expected productivity of these applicants. And since the level of the basic security benefits and therefore the reservation wages of low-skill immigrants are relatively low, they are more willing to accept low-paid jobs which allows them to get integrated into the labor market. In the medium and long run, the labor market participation enables the group of low-skill migrants to collect experiences on-the-job, such that there is a narrowing of the gap in terms of specific skills which eventually implies a narrowing of the wage gap. Nevertheless, the integration of migrants on lower wages imply a persistent rise in the wage inequality as evidenced by panel (a) of Figure 14.

The remaining panels of Figure 14 show the migration effect on the average wages of skill group 2 and 3 in nominal terms (panel b) and real terms (panel c). In contrast to our findings in Section 4.3 capturing migration to the core, one can see that in the periphery



(a) (b) (c)

Figure 15: Spline-smoothed policy effect of the allocation quota on the average general skills of firms in Region 2 (a), the average capital productivity in Region 2 (b) and the relative productivity level of firms in Region 1 in comparison to firms in Region 2 (c).

wages of low- and high-skill natives get persistently depressed in response to migration. An explanation for these negative effects can be found in second-order effects of the considered low-skill migration that arise through the interplay of skill and productivity dynamics in the interaction of households and firms. More precisely, since there is a higher participation of low-skill immigrants in the workforce, the average general skills of firms decline as illustrated in Figure 15 (a). Because firms with a larger share of low-skilled workers expect a lower adjustment speed of the workforce in the context of acquiring specific skills, these firms have less incentives to invest in more recent technologies (see Section 3.2.6 for more details on firm's vintage choice). Thus, the change in the skill structure caused by integrating low-skill immigrants into the labor market feeds back on the vintage choice, which in turn affects the diffusion speed of advanced technologies in the periphery. As a result, there is a negative effect on the average productivity of the capital stock in Region 2, which is evidenced in Figure 15 (b). Since wages are linked to the productivity, this will eventually depress the wages in that region.

Thus, the integration of the forced migrants in the labor market of the periphery lowers the nominal and real wage level which eventually contributes to the negative effect on real consumption of native households in the periphery (compare Figure 11 c). At the same time, it enlarges the already existing technological gaps of the periphery to the core (see Figure 15 c) which may hamper the periphery's prospects for technological and economic catch-up.

4.5 The Effect of Integration Policies

Now we contrast the results of the allocation policy with our second policy scenario. The starting point is similar to the pure migration scenario in Section 4.3 in which the full cohort of immigrants is received by the core region. But in contrast to the previous scenario, we now assume that the local government implements active policy measures that are supposed to foster the integration of low-skill migrants into the labor market. We focus here on wage subsidies to the private sector. The reason for emphasizing this active labor market policy is that empirical evidences illustrate the effectiveness of wage subsidies to foster labor market participation of immigrants. In fact, using rich administrative data from Denmark, Clausen et al. (2009) show that wage subsidies are the most effective programs in improving the likelihood of newly arrived immigrants to find regular jobs.

In the preceding discussion we identified the combination of the presence of a minimum wage and substantial gaps in terms of specific skills as one of the main obstacles for low-skill immigrants to participate in the labor market of the core. In order to overcome these hurdles, it is assumed that the government grants wage subsidies to firms when hiring low-skill immigrants that would be too costly otherwise. More technically, the wage subsidies compensate the difference between the minimum wage $\omega_{r,t}^{M}$ and the wage offer $\tilde{w}_{i,1,t}^{O}$ that

Table 5: Overview of the two variants of the active labor market policy.

Untargeted wage subsidies	Targeted wage subsidies
• All firms in Region 1 qualify for the subsidies	• Only the high-tech firms in Region 1 are eligible to receive wage subsidies.
• The wage subsidy is conditioned on hiring workers of skill group 1	
• The size of the subsidy corresponds to the gap between the minimum wage $\omega_{r,t}^{M}$ and the productivity-consistent wage $\tilde{w}_{i,1,t}^{O}$	

would take the expected productivity of the worker into account. An eligible firm that hires a single migrant with skill level 1 receives a monthly subsidy for that worker that is a percentage $\omega_{i,t}^{S}$ of the current minimum wage that the firm has to pay. The subsidy rate is determined according to

$$\omega_{i,t}^{S} = \max\left[1 - \frac{\tilde{w}_{i,1,t}^{O}}{\omega_{r,t}^{M}}, 0\right], \tag{29}$$

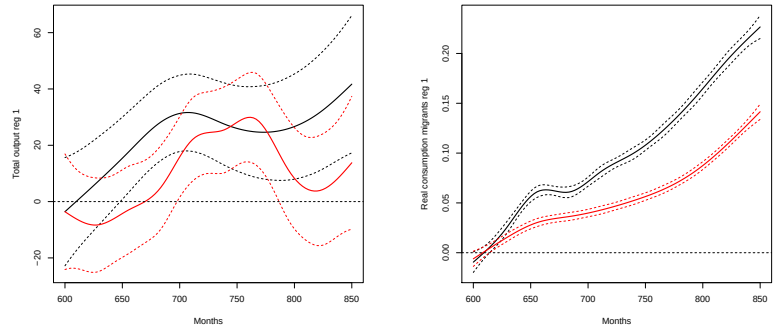
where the productivity-consistent wage offer would be $\tilde{w}_{i,1,t}^{O} = w_{i,t}^{base} \cdot \min[A_{i,t}, \bar{B}_{i,1,t-1}]$ (compare Section 3.2.7).

In the following, we distinguish two variants of this policy. In the first policy case, all firms in the core region are eligible to apply for subsidies (hereafter untargeted policy). Whereas in the second case, which we will refer to as the targeted policy, only high-tech firms are allowed to receive wage subsidies. A firm is thereby classified as a high-tech if the productivity of the used capital stock $A_{i,t}$ is above the median productivity of all firms in the region. As we will see below, given the persistent heterogeneity of firms with respect to productivity, there can be different implications when low-tech firms are excluded as possible recipients of the wage subsidy. The properties of the two policy variants are summarized in Table 5.

We start discussing the implications of the wage subsidy policies by considering the dynamic effects on total output and per capita consumption in Region 1. Figure 16 (a) illustrates that implementing both types of wage subsidies leads to a weak positive output effect. Similarly, there is a positive impact on per capital consumption, which is mainly driven by a strong increase in consumption per capita of migrants (panel b). Hence, the subsidies narrow the gap in terms of standard of living between the native population and the migrants. It is thereby worth noting that the catching up is not on the expense of the average native household as almost no effect on the native per capita consumption can be found.

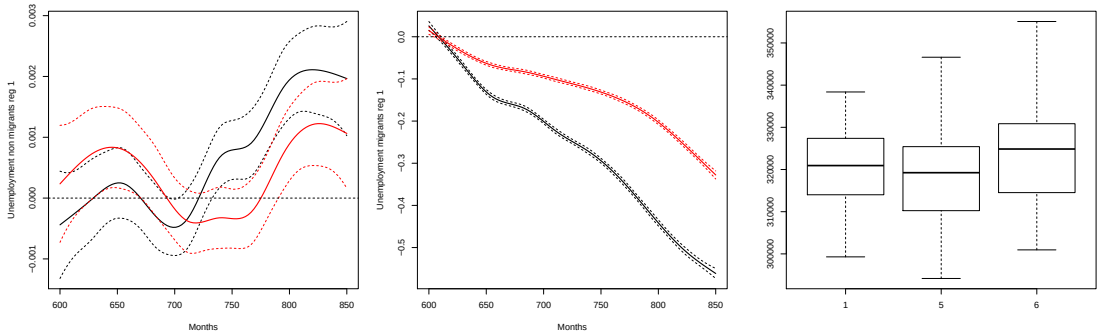
In Figure 17 we depict the implications on employment, where for native workers there are almost no changes in response to the policy. Only in the long run, there is a weak increase in unemployment (panel a). Considering the dynamic policy effects on the unemployment rate of immigrants in panel (b), one can see that both policies lead to a higher labor market participation where the process of unemployment reduction is more effective for the untargeted policy. This suggests that wage subsidies are effective tools to foster the labor market integration where the higher employment of the migrants does not lead to strong crowding-out effects. If only the effectiveness with respect to the policy's primary goal is evaluated, then one can conclude that the untargeted policy performs better compared to the targeted policy.

In fiscal terms, there are no significantly higher governmental expenditures not only between the two policies but also compared to the no-policy migration scenario (see Figure 17 c). In that sense, the additional expenses for the subsidies are compensated by lower spendings for transfers. Note that the need to subsidize wages to get low-skill immigrants employed declines over time with a narrowing gap in terms of specific skills. Since



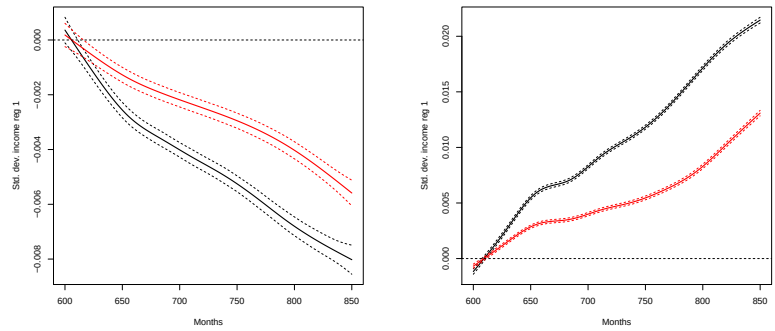
(a) (b)

Figure 16: Spline-smoothed policy effects of wage subsidies on total output (panel a) and per capita consumption of immigrants (panel b) in Region 1; color code: black – untargeted policy; red – targeted policy.



(a) (b) (c)

Figure 17: Spline-smoothed policy effects of wage subsidies on unemployment of native workers (panel a) and migrant workers (panel b) in Region 1; color code: black – untargeted policy; red – targeted policy. Panel (c): Comparison of the discounted sum of total governmental spendings for transfers and subsidies between the no-policy scenario (left boxplot), the untargeted wage subsidy (middle boxplot) and the targeted wage subsidy (right boxplot).



(a) (b)

Figure 18: Spline-smoothed policy effects of wage subsidies on income inequality (a) and wage inequality (b) in Region 1; color code: black – untargeted policy; red – targeted policy.

the employment effect is persistent, the wage subsidy policies will eventually dominate the no-policy scenario in terms of fiscal implications when considering a longer time horizon.

What are the effects of wage subsidies on inequality? In Figure 18 (a), we plot the effect

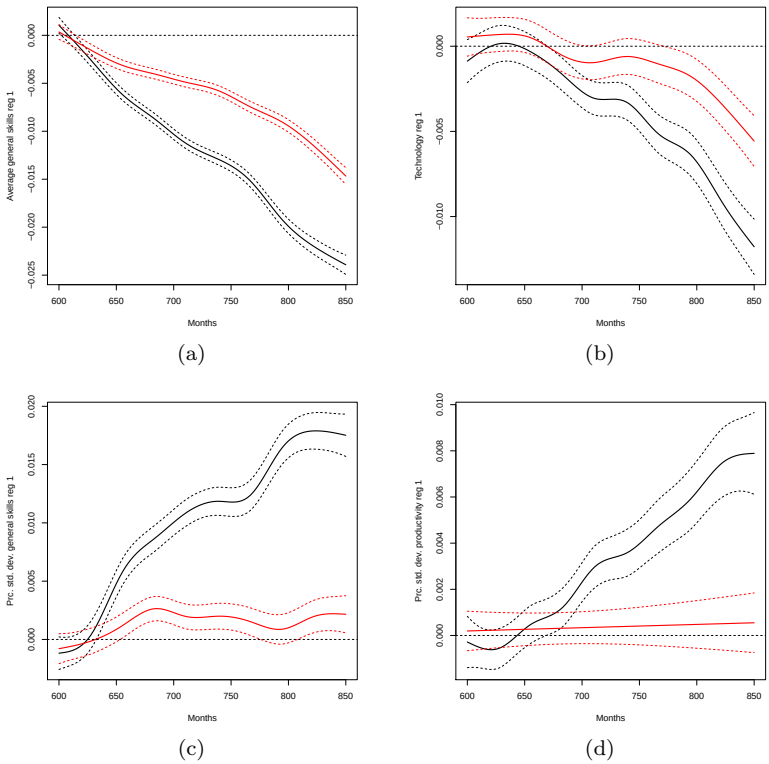
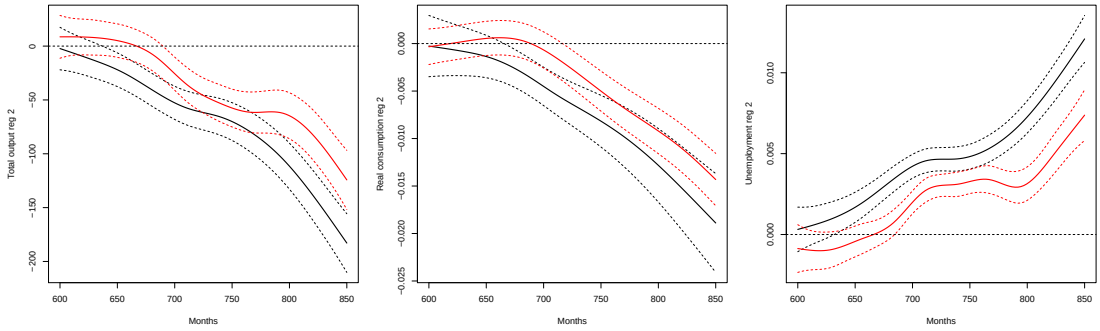


Figure 19: Spline-smoothed policy effects of wage subsidies on the average general skills in firms (a), average capital productivity of firms (b), the heterogeneity of the general skill distribution among firms (c) and the heterogeneity of firm productivity (d) in Region 1; color code: black – untargeted policy; red – targeted policy.

of the two policy variants on income inequality. Consistently with the positive effect on migrant employment, both policies lead to a decline in terms of income inequality. The effect is stronger for the untargeted policy, which one would intuitively expect as this policy also leads to a stronger reduction of unemployment among immigrants. Quite the opposite picture can be observed when looking at the implications on wage inequality (panel b). Here one can see that the better integration of immigrants leads to an increase in terms of wage inequality, where the effect is stronger for the untargeted policy. The reason why both policies lead to a higher wage inequality can be seen from the fact that low-skill immigrants get integrated in the lower part of the wage spectrum. Therefore, if there is a higher participation, a larger mass of workers is at the low end of the wage distribution which, given the original wage structure, leads to an overall increase of wage inequality.

The integration of a larger share of low-skill workers into the labor market has also implications on the average quality of the human capital employed by the firms and, therefore, on the speed with which new technologies diffuse into the core region. In panel (a) of Figure 19 we illustrate the impact of the two policy variants on the average general skill level of firms in Region 1. In fact, labor market integration leads to a decline in terms of the average quality of human capital, where again the effect is stronger for the untargeted policy. At the same time, decreasing general skills of the workers influence the vintage choice such that firms in the core region become on average less productive (panel b) – although the effect is in relative terms small, at least for the size of the considered migrant cohort. Again, the effect of targeted wage subsides is less pronounced compared to the untargeted policy, which suggests a possible conflict of goals between the participation of low-skill immigrants and the speed of technological progress in the economy.

The lower panels of Figure 19 illustrate another important difference between the two variants of wages subsidies. These panels plot policy effects on the heterogeneity of firms with respect to the average general skills (panel c) and capital productivity (panel d). One can see



(a) (b) (c)

Figure 20: Spline-smoothed policy effects of wage subsidies on total output (a) and per capita consumption (b) and the unemployment rate (c) in Region 2; color code: black – untargeted policy; red – targeted policy.

that untargeted wage subsidies imply an increasing heterogeneity of firms in both dimensions, whereas in case of targeted wage subsidies there is essentially no rise in heterogeneity.

Why does the heterogeneity increase only under the targeted wage subsidies? In case of the untargeted policy, low-skill migrants are hired more frequently by low-tech firms as for them the gap between the own productivity and the expected specific skills is closer, which increases the chances for a successful matching. As a result, the average general skill level of these firms declines the most, which feeds back on the productivity of the low-tech firms trough the vintage choice thereby reinforcing the incentives for these firms to hire low-skill migrants. Overall, the consequence is a larger polarization among firms with respect to the allocation of skilled workers, where especially low-skilled migrants are employed by firms located at the lower end of the productivity distribution. At the same time, through the channel of the endogenous vintage choice, the skill polarization leads to a larger heterogeneity with respect productivity, which contributes to the rising wage inequality under the untargeted policy already illustrated above. Clearly, this mechanism is prevented if only high-tech firms qualify for the subsidies.

Having discussed the effects in the core region, we finally turn to the implications of the wage subsidy policies on the periphery. Figure 20 (a) plots the effects of the two variants of the policy on the level of total output in Region 2, which is for both policies negative but in case of the untargeted policy the size of the effect is stronger. A similar picture emerges for the dynamic effect on per capita consumption plotted in panel (b). Thus, the implications of wage subsidies for the periphery are negative in terms of both indicators, economic activity and standard of living. Accordingly, there is also an increase in the unemployment rate (panel c). These negative effects can be traced back to the increased labor supply in the core region, which reduces the upward pressure on wages and mitigates the cost-driven loss of competitiveness from the perspective of the core as observed in the no-policy migration scenario. At the same time, due to the growing labor force, a larger share of the emerging demand generated by the immigrants can be satisfied by domestic production.

5 Discussion and Conclusions

In 2015/2016, the European Union experienced an inflow of 2.5 million refugees from war-torn countries, from which 1.4 moved to the main destinations countries Germany, Austria and Sweden. Although the number of new arrivals has been decreasing following the implementation of border controls, the closure of the so-called Balkan route and the EU-Turkey refugee agreement of March 2016, the European Union is still struggling to find a consensus on how to cope with the refugee crisis. In this respect, a highly controversial issue concerns the allocation of immigrants where the disruptive force of this question on the political cohesion of the union is clearly illustrated by the concentration of refugees among a few member states on the one side and the publicly expressed resistance of other members to receive

forced migrants on the other side.

Besides this political dispute and the fact that some countries, due to their geographical location, have no choice but to take refugees at least in the short term, the question of an adequate and fair refugee allocation between the member states can also be addressed in the context of the persistent economic and social divide in Europe. In fact, the northern core and the southern periphery have been diverging in the last decade thereby enlarging already existing gaps not only in economic terms but also in terms of standard of living. Hence, it can be argued that these regions might bring different preconditions to cope with a sizable migrant influx such that economically stronger member states might take over a higher part in receiving immigrants.

In light of these considerations, the goal of this paper was to address research questions related to forced migration into a union of economically diverging states. More precisely, we used an agent-based macroeconomic model to study the economic implications of a sizable surge of forced immigrants into a union with a core-periphery structure. Thereby, we assessed the effectiveness of potential policy responses to tackle the consequences of that migrant influx. As forced migration has been emphasized, we imposed specific assumptions on the migrant cohort especially with respect to their human capital endowment that are in line with evidences found for the recent immigrants to Germany. In particular, we assumed that more individuals are located at the lower part of the skill distribution compared to the native population and, due to skill downgrades upon arrival, particularly low-skill migrants have lower chances to get integrated in the labor market. Furthermore, we assumed that immigrants have clear preferences to locate in the core region. This implies that most of the arriving migrants would eventually establish in the core if the flows within the union are not actively managed.

Accordingly, in our policy experiments, we first considered a migration scenario in which all refugees are received by the core country. Then we contrasted this scenario by analyzing possible policy responses. In a first experiment we considered allocation schemes between the member states of the union, in a second we implemented active labor market policies aiming at a better integration of migrants in the labor market of the core region. We considered the effects of migration and the policy responses on different economic and welfare indicators thereby focusing on total output, the average standard of living and income inequality. Moreover, we analyzed the implications for the native population as well as for the migrant cohort.

In our first scenario we found that there is a positive effect on total output in the core, while the standard of living declines. However, distributional effects reveal that the effect on the native population is weak. At the same time, there is a persistent gap in terms of real consumption between natives and immigrants. This can be explained by the labor market performance of migrants, where especially low-skill migrants face serious difficulties to get integrated in the labor market. In the periphery region, which is not directly affected by the inflow, one can observe positive employment and output effects.

In the allocation quota scenario we found that the effects on the core region observed in the first scenario are mitigated while there is no effect on the labor market participation of immigrants. For the periphery, one can observe a decline in consumption per capita and a rise in inequality. However, there is a higher employment of immigrants compared to the core, which can be traced back to the specific labor market institutions in that region. At the same time, the average standard of living of migrants is substantially lower not only in comparison to the native population but also compared to the migrants that arrived in the core. Moreover, the higher employment of immigrants leads to a reduction in the average general skill composition of the region's labor force. As a consequence, firms have less incentives to invest in more advanced technologies which in turn affects the average capital productivity in that region. Eventually, there is a growing technological gap between the core and the periphery which fosters the divergence of the two regions.

In our third scenario we considered two subsidy schemes implemented in the core region under which firms can apply for wage subsidies if the skill gaps of migrant workers make them too expensive compared to native workers. The two policies differ from each other in terms of which firms qualify for the subsidies. In case of the targeted policy, only high-tech firms are eligible for the subsidies. In contrast, the untargeted subsidies are paid to any

firm located in the core. We found that both policies have almost no effect on total output and average consumption per capita of native households but one can see a clear positive effect on the consumption of migrants. In fact, the subsidy policies mitigate obstacles for the labor market integration of migrants resulting in a much higher employment level and therefore in a higher average consumption of migrants compared to the case without integration policies. Moreover, both policies reduce overall income inequality in the core region. However, considering labor income only, the policies increase the level of wage inequality. Comparing the impacts of both policies, one can see that the integration process is more effective in case of the untargeted subsidies, which induces a stronger effect of the untargeted policy on both types of inequality. At the same time, the untargeted policy increases the firm heterogeneity with respect to productivity. This is because migrants are mostly hired by low-tech firms which then have less incentives to invest in more advanced technologies. Thus, the policy induces a stronger productivity polarization of firms, which amplifies the effect on wage inequality. The downside of both policies is a negative effect on output, employment and consumption in the periphery region.

To put these findings into perspective, let us relate them to the question how the policy makers in the union should jointly respond to the refugee crisis. Our simulation exercises suggest that an equal allocation quota is not an appropriate policy response. The main reason for this finding is that the economic conditions together with the institutional setting in the periphery allow only a minimum standard of living for immigrants. We observed large and persistent gaps in terms of per capita consumption of migrants compared to native households, which can be considered as a serious threat to the social cohesion in the periphery. At the same time, there are also substantial gaps compared to the migrants that arrived in the core. Since the differences in standard of living of immigrants between the regions provide strong incentives to relocate to the core, it seems questionable if the policy is sustainable in the long run. Furthermore, the allocation quota has also negative effects on some economic indicators in the periphery. The integration of low-skill migrants in the labor market of the periphery enlarges the technological gap to the core. In addition, there is a decline of the average real consumption of the native households in the periphery, which is, however, for the considered size of the migration cohort still small .

Thus, allowing a larger share of the immigrants to arrive in the core seems to be a better approach to deal with the migration, but only if the reception is accompanied by active labor market policies. Our simulations show that receiving all refugees in the core has only minor effects on the native population, whereas the implications for the refugees depend very much on whether or not the government implements active labor market policies that support the integration of refugees in the labor market. If those policies are in place, there is high labor market participation of migrants leading to a steady catch-up of the standard of living. The negative economic effect on output and employment induced by the policy in the periphery must be considered as the price for relieving this region from the direct social costs of migration.

However, the clustering of low-skill immigrants in firms located at the lower end of the productivity distribution illustrates the risk of the wage subsidies to establish a labor market segment in which low-skill migrants only work for non-competitive firms with a very low productivity that only survive because of the subsidies. Besides the distortions those firms introduce into the economy, this also hampers the integration of refugees in the regular labor market as the they cannot build up sufficient specific skills while working for these low-tech firms. By excluding low-tech firms from receiving these wage subsidies, the government can prevent the establishment of such a labor market segment. As such a directed policy reduces the speed of the integration process, there is a trade-off between a rapid catch-up of migrant's standard of living and avoiding the clustering of low-skill migrants in low-tech firms.

To conclude, our simulation exercises suggest that the humanitarian act of receiving a sizable number of forced migrants is in any case associated with social costs for the host society. Regardless of whether all refugees are received by the core region or are equally allocated among the core and the periphery, there is a reduction of real per capita consumption and more inequality in the destination countries. However, at least for the size of the migration influx considered here, the direct economic costs for the native population are low

and for the core region almost negligible. In fact, the decline in per capita real consumption is largely caused by a lower consumption level of migrants. Nevertheless, the persistent gaps in terms of the standard of living between natives and migrants can be a serious threat to the social cohesion in the host societies. Thus, this problem should be addressed with priority in order to avoid the rise of social conflicts in the future. In this sense, a scenario in which the economically stronger core members of the union receive a larger share of the arriving refugees accompanied by appropriate integration policies seems to be the most promising approach.

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Table 6: Values of selected parameters.

Parameter	Description	Value
T^G	Government time horizon in months	72
δ	Capital depreciation rate	0.01
χ	Stock-out probability production planning	0.2
Δq^{inv}	Growth of the frontier	0.05
γ^C	Intensity of consumer choice: price	16.0
γ^L	Intensity of consumer choice: home bias	1.0
Φ	Target wealth-income ratio	16.66
κ	Adjustment wealth-income ratio	0.01
ρ	Discount rate (monthly)	0.005
S	Firm time horizon in months	24
γ^v	Intensity of choice: vintage choice	3.0
λ	Bargaining power of the capital goods producer	0.5
φ	Wage update	0.005
$\overline{v}$	Number of unfilled vacancies triggering wage update	2
ψ	Wage reservation update	0.01
γ^{gen}	Intensity of choice: general skills	0.5
γ^{co}	Intensity of choice: worker's expected contribution	13.0
γ^B	Intensity of choice: expected productivity gap	10.0
T^M	Migration period (months after outset)	624
$\chi(b_h^{gen}=1)$	Specific skills adaptation speed for low-skilled migrants	0.005
$\chi(b_h^{gen}=2)$	Specific skills adaptation speed for high-skilled migrants/low-skilled natives	0.0125
$\chi(b_h^{gen}=3)$	Specific skills adaptation speed for high-skilled natives	0.03703

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