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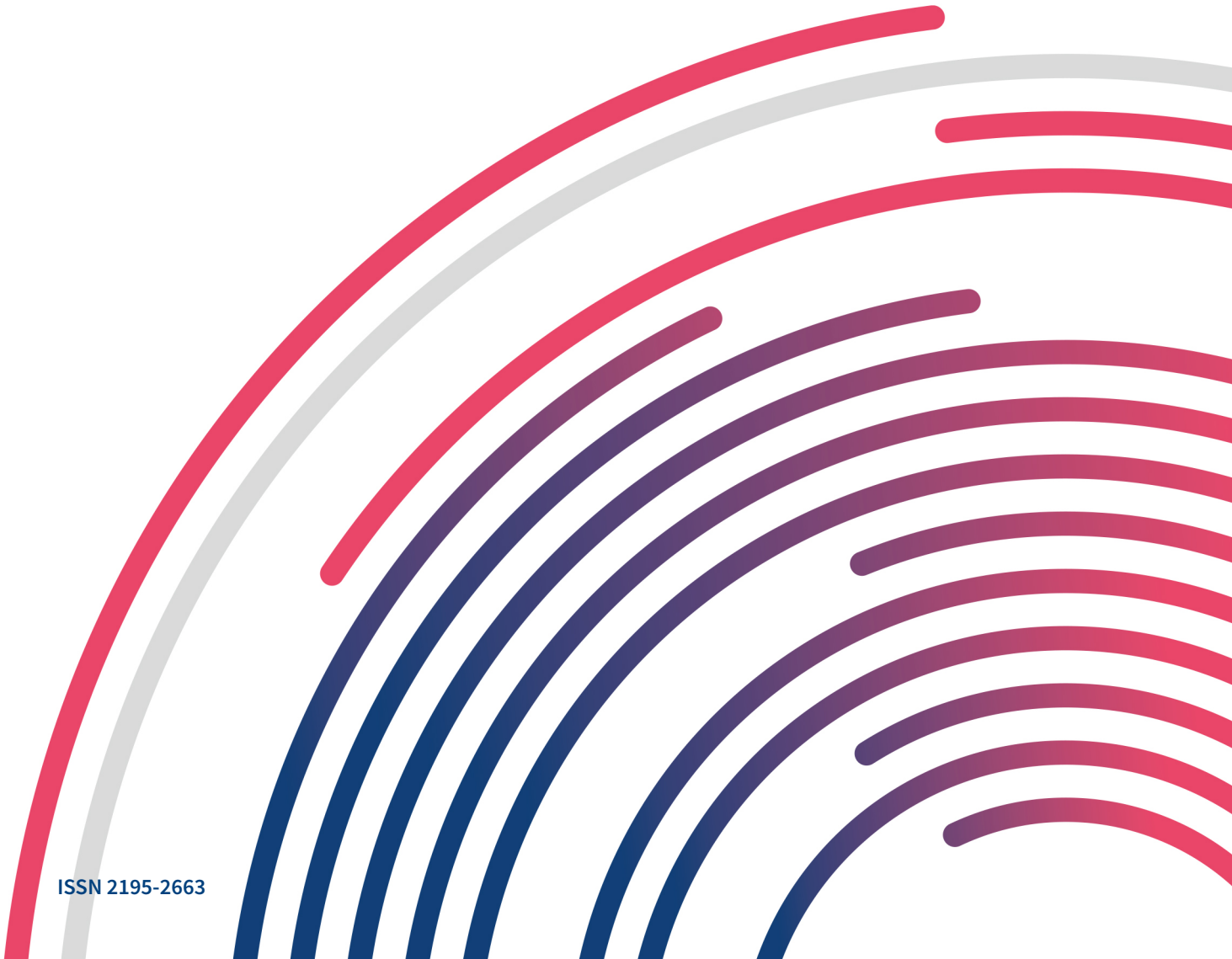
Lucas Guichard, Ignat Stepanok



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International Trade, Intellectual Property Rights and the (Un)employment of Migrants

Lucas Guichard (Luxembourg Institute of Socio-Economic Research: LISER),
Ignat Stepanok (IAB)

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Abstract

We study the effect of trade liberalization and intellectual property rights (IPR) protection on the unemployment rate of migrants relative to non-migrants. We build a North-South trade and growth model with a positive steady state rate of migration. We find that bilateral trade liberalization decreases the relative unemployment rate of migrants when migration is low and increases the relative unemployment rate when the migration rate is high. The results do not rely on assumptions about network effects, the probability to find a job for a migrant is independent of the relative size of the migrant diaspora. IPR protection leads to a higher relative unemployment rate of migrants regardless of the size of migration. We empirically test and confirm the theoretical predictions on trade liberalization and IPR protection using data for 20 OECD (Organisation for Economic Co-operation and Development) countries over the period 2000-2014.

Zusammenfassung

Wir untersuchen die Wirkungen einer Handelsliberalisierung und des Schutzes geistigen Eigentums auf die Arbeitslosenquote von Migrantinnen und Migranten im Vergleich zu Einheimischen im Zielland. Die Analyse stützt sich auf ein Nord-Süd-Handelsmodell mit Wirtschaftswachstum und einer positiven Migrationsrate. Eine bilaterale Handelsliberalisierung führt zu einer niedrigeren Arbeitslosenquote von Migrantinnen und Migranten bei geringer Migration und zu einer höheren Arbeitslosenquote, wenn die Migrationsrate hoch ist. Dieses Ergebnis beruht nicht auf Netzwerkeffekten: Die Wahrscheinlichkeit eine Stelle zu finden ist unabhängig von der Größe der Diaspora. Ebenso führt der Schutz geistigen Eigentums zu einer höheren Arbeitslosenquote von Migrantinnen und Migranten unabhängig von der Größe der Diaspora. Die theoretischen Hypothesen des Modells wurden anhand von Daten aus 20 OECD Ländern in der Periode 2000-2014 empirisch getestet. Die empirischen Ergebnisse bestätigen die theoretischen Vorhersagen des Modells.

JEL

F12, F16, F22, F43, J63, O34

Keywords

Migration, unemployment, trade liberalization, intellectual property rights, North-South trade

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1 Introduction

The labour market performance of migrants in host countries has been extensively studied in the literature. In this paper, we explore theoretically and empirically the connection between the intensity of international trade and the unemployment rate of migrants relative to the one of local-born individuals. More specifically, we look at how bilateral and symmetric trade liberalization affects the relative unemployment rate of migrants in a developed destination country. We also explore the influence of IPR protection, modelled as a lower imitation rate in the developing South. To the best of our knowledge, this paper is the first one to study the effect of trade and of IPR protection on the relative unemployment rate of migrants in a destination country.

Our model is an extension of the North-South growth model in Helpman (1993), with the difference that there is constant migration from the South to the North and steady state unemployment in the North. Unemployment is the result of search and matching frictions in the labor market. Our model features population growth and removes the scale effect property of population size on economic growth present both in Helpman (1993) and in Arnold (2002)[1]. People have heterogeneous abilities and endogenously self-select into education. Both migrants and non-migrants can become skilled, there is a between-country and within-country wage inequality.

We find that trade liberalization can either increase or decrease the relative unemployment rate of migrants, the direction of the effect depends on the relative population size of the host country and on the size of the migration flow. Interestingly, the relative unemployment rate of migrants decreases in a steady state with a lower migration rate. These results do not rely on any assumptions about network effects, the probability to find a job for a migrant is independent of the relative size of the migrant population in the North. Trade affects unemployment through two main channels, the first one is innovation and the well known creative destruction effect, and the second one is through the incentive of individuals to invest in education. The unemployment rates of migrants and natives move in identical directions as a result of trade liberalization, both either increase or decrease. The asymmetry of one reacting stronger than the other however results from the different (endogenous) probabilities for people in the two groups to find a job and also their different incentives to invest in education.

The second exercise we look at is increasing IPR protection. In the model, innovation takes place in the North and there is an imitation process in the South. Patented Northern products

[1] Arnold (2002) develops a North-South model of trade and growth also featuring unemployment but without migration.

can be copied and any firm in any country can start producing them. Increasing IPR protection is described as a lower imitation rate in the South. It leads to a higher relative unemployment rate of migrants, the result does not depend on the level of migration from the South to the North. The driving forces are the imitation and innovation rates and also the incentive of people to invest in education.

The theory finds support in the data using information from 20 OECD countries for a period of 15 years between 2000 and 2014. The dependent variable in our empirical analysis is the unemployment rate of foreign-born individuals relative to the unemployment rate of local-born people in the Northern countries. We build a standard openness measure as in Alcala/Ciccone (2004) using trade of each OECD country with the largest economies that can be described as the South[2]. We interact the openness measure with the share of foreign-born population in the OECD countries in order to be able to test the theoretical predictions. We find that a small share of foreign-born population is conducive of more trade going hand in hand with lower relative unemployment of migrants in the North. A large share of foreign-born individuals in an OECD country, on the other hand, implies that more trade is connected with higher relative unemployment.

In addition to the trade result, we are able to test the prediction of the theory on how IPR protection affects the relative unemployment rate of migrants. We use an already known IPR protection index described in Park (2008). The higher the value, the more protected are IPR in a given country. For each Northern country, we compile an IPR exposure index that takes into consideration how much it trades with the South as well as the individual Southern countries' IPR indexes weighted by how much the OECD country trades with the particular Southern country. The implicit assumption is that trading more with a country with lower IPR protection standards increases the chance that Northern patented products get imitated. We show that a higher value of the IPR exposure index, in other words a lower exposure to imitation abroad, implies a higher relative unemployment rate of migrants in the North. The result coincides with the prediction of our theoretical model.

There is extensive evidence by now that trade leads to restructuring of the economy and redistribution of resources. There are gains to be made but there are also disadvantaged groups. Comparisons along the lines of high-skilled versus low-skilled people have been a frequent topic of study. Labor market outcomes for migrants versus non-migrants on the other hand have been less studied in the context of international trade despite the fact that migrants are frequently a sizeable group. For the period 2000-2014, foreign-born population in Australia for instance has been on average 25 percent of total population, in Germany slightly over 12 percent, in the USA also 12 percent. The unemployment rate of the foreign-born population relative to the one of natives varies in the OECD data that we use between 0.71 for Italy in 2003 and 3.2 for Norway in 2009. Migration has been a topic that has moved

[2] Our South is comprised of 20 countries, we describe those in detail in section four.

and will do so in the future a number of political campaigns and developments. While in this paper we do not focus on the reasons for migration[3], we are interested in the integration of migrants and more specifically in their unemployment rates at destination. This has implications for within-country redistributive institutions and generally for the answer to the question what are the costs of globalization.

A number of papers report a connection between international trade and unemployment, Hasan et al. (2012) look at urban unemployment in India. Dutt/Mitra/Ranjan (2009) and Felbermayr/Prat/Schmerer (2011b) use cross-country data and provide evidence that more openness leads to lower unemployment. The theory trade literature has also been paying increasing attention to labor market issues. Sener (2001) studies symmetric countries in a growth-theoretic setting. Helpman/Itskhoki (2010) and Felbermayr/Prat/Schmerer (2011a) analyze unemployment in the context of heterogeneous firms. The list of papers is long, models with asymmetric countries are however relatively scarce, exceptions being the Hekscher-Ohlin model in Davidson/Martin/Matusz (1999) and Arnold (2002).

Many papers have studied the labour market performance of migrants in host economies. In the context of immigration to the US, Card (2005) shows that among men, immigrants are only slightly less likely to work than the natives, while the immigrant gap in the probability of working is larger among women. The pattern reverses for second generation immigrants (defined as people born in the US with at least one foreign-born parent) who are found to be more likely to work compared to members of third and higher generations (defined as people whose parents were born in the US).

Dustmann/Frattini (2011) suggest a general overview of immigrant-native employment gaps in 15 European countries. Their findings show that immigrants in Central and Northern Europe face important disadvantages relative to natives, which are reflected in an employment gap that ranges from 8 to 15 percentage points. In Southern European countries (Italy, Spain and Portugal) as well as in Ireland and the UK, the employment differential is smaller and varies between 0 and 6 percentage points.

In a comparative study based on three European countries (i.e., France, Germany and the UK), Algan et al. (2010) document that most immigrant groups have significantly lower employment rates than their native counterparts. This conclusion holds for all three destination countries and after controlling for education, potential experience, and regional allocation. Focusing on Spain, Amuedo-Durantes/De La Rica (2007) find that the immigrant-native employment gap amounts to 15 percentage points for men and 4 percentage points for women

[3] The connection between trade and migration has been the topic of many studies, in our model trade openness and the migration rate are both exogenous variables. The migration rate can of course be endogenized, but since it is not the focus of our study we have tried to keep the model as parsimonious as possible and have left it exogenous.

during the first year in the host country. The observed gap varies notably depending on the origin country and decreases with time spent at destination.

Naghavi/Strozzi (2015) focus on the role of migration for the relation between IPR protection and innovation in developing countries. They find that migration is an additional channel for knowledge transfer and increases innovation in developing countries provided that there is a sufficiently strong level of IPR protection there.

In the next section we develop the model, in section three we discuss the steady state, section four lays out the empirical estimation and section five concludes.

2 The Model

We build an asymmetric country model with an innovating North trading with an imitating South, an exogenous share of the Southern population migrates from the South to the North at every point in time. The model features positive migration in steady state. People are endowed with heterogeneous abilities, production in both the North and in the South is done with low-skill work, research and development (R&D) in the North is done with high-skill work. The productivity of high-skill work depends on individual ability, the productivity of low-skill work does not. Both Northern-born individuals but also migrants make a decision whether to invest in education and forego wages for a period of time in order to become high-skilled. There are two threshold abilities in the North, one for local-born and one for migrants, which separate high-skilled from low-skilled individuals. Since there is no R&D in the South and everyone works in production, individual skill level is irrelevant and all people remain low-skilled. The process of imitating Northern products in the South is exogenous and costless and does not require any investment in R&D in the South.

The skilled R&D workers in the North are never unemployed[4]. The low-skilled people in the North either work in production or are at times unemployed. As already mentioned, there is no unemployment in the South.

[4] This is a reasonable simplification, which can be relaxed. The ratio between the unemployment rates of less educated to highly educated individuals in the US for the period 1971-1974 was 3.1 increasing to 4.7 in 1983-1986 and declining to 3.9 in 1991 according to Nickell/Bell (1995).

2.1 Consumers

The number of people born in the North until time t is L_{Nt} and in the South L_{St}, both groups grow at the exogenous rate n. Let the number of people who have migrated from the South to the North up to time t be L_{Mt}. The total number of individuals in the North at time t will therefore be $L_{Nt} + L_{Mt}$ and in the South $L_{St} - L_{Mt}$. There is an infinite number of households, each with its own ability θ. It is important to note that households redistribute income internally and any member receives the same amount for consumption expenditure regardless of whether they work or not. Households in the North consist of either only Northern-born members or only migrants. The ability is uniformly distributed across households and is within the range $\theta \in [0, 1]$. Household members are identical in terms of their ability. The intertemporal utility of an entire household with ability θ from period $t = 0$ onwards is defined as $U_{i\theta} \equiv \int_0^\infty e^{-(\rho-n)t} log(y_{i\theta t}) dt$, where $i \in \{N, S\}$ stands for the two regions North and South and the time discount factor ρ is identical for all individuals in both countries. The static utility of a single consumer at time t is defined by

$$log(y_{i\theta t}) \equiv \int_0^1 log\left(\sum_j \lambda^j d_{i\theta}(j, \omega, t)\right) d\omega$$

and also depends on the ability level of the individual. Consumers choose from an infinite number of product varieties exogenously set at mass one, the parameter j is a positive integer and shows the level of a product's quality. The amount of quality j of product ω consumed at time t by an individual with an ability θ is denoted by $d_{i\theta}(j, \omega, t)$, while $\lambda > 1$ is the step size of innovation and measures the perceived quality difference between an old and a new version of the same product.

Optimization is standard and results in people consuming only the product, which gives them the lowest quality-adjusted price $p(j, \omega, t)/\lambda^j$ within a variety ω. We assume that if two firms provide two different quality levels at the same quality-adjusted price, people prefer to consume the product with higher quality. When people choose between product varieties, an individual's demand equals $d_{i\theta}(\omega, t) = E_{i\theta t}/p(\omega, t)$ with $E_{i\theta t}$ being per capita consumption expenditure of a person with ability θ in country i. We drop j from the notation from now on, because the discussion will be focused on that product quality level, which gives the lowest quality-adjusted price.

Let E_{Nt} be average per capita consumption expenditure in the North and E_{St} in the South. The last step of consumer optimization deals with allocating expenditure over time. In the North, the allocation follows the usual Euler equation $\dot{E}_{it}/E_{it} = r_{it} - \rho$, with r_{it} being the real interest rate. In order to have a balanced growth equilibrium we solve for a steady state in which $r_{Nt} = \rho$. Southerners do not save, which means that their average consumption

expenditure E_{St} equals wages and is also constant in steady state. We use consumption expenditure in the South to be the numeraire in the model. This implies that the wage in the South is also equal to one $w_S = E_{St} = 1$.

There is no unemployment in the South and the only activity for workers there is production. We assume that production in both countries is a low-skill activity and is not influenced by the individual ability. In this case, individual and average per capita consumption expenditure in the South are the same. The picture in the North is different, R&D is done with high-skill labor and the productivity there depends on the individual ability level. To complement the optimization problem of households, we need to describe if and how households in the North decide to invest in education in order for their members to become high-skilled.

2.2 The Decision to Invest in Becoming Skilled

2.2.1 Northern-born individuals

Each household will choose to invest in education of its newly-born members at time t as long as the following inequality holds:

$$\int_{t+T}^{\infty} e^{-r(s-t)}\theta_k w_H ds > Z_t. \tag{2.1}$$

The left-hand side of the inequality describes the present discounted value of choosing to be skilled at the time before having acquired the necessary education. It takes an exogenous period T for a Northern-born person to become skilled and the cost to education or skill acquisition is the forgone low-skill wage w_L for the period. Note that this is the low-skill wage in the North and differs from the wage in the South $w_S = 1$, which is also given for low-skill work. Northern high-skilled workers are never unemployed, $\theta_k w_H$ is the Northern high-skill wage and is proportionate to the ability level of the individual worker k.

The right-hand side of the inequality describes the value of an unemployed individual born in the North. The value Z_t can be described by the following equation $rZ_t = 0 + \beta_N(V_t - Z_t)$, meaning that the return from being unemployed equals a stream of income while unemployed, which in this case is normalized to zero, plus the probability of becoming employed β_N times the difference between the value of being employed and the value of being unemployed. The value of being low-skilled and employed for a Northern-born person can be described by the following equation $rV_t = w_L + (I_M + I)\,(Z_t - V_t)$, where as previously mentioned w_L is the low-skill wage and with probability $I_M + I$ the employer goes out of business

and the employee loses her or his job. I_M is the instantaneous probability that the product of the employer's firm is imitated and I is the instantaneous probability that innovation takes place and another firm with a better quality version of the same product variety takes over the entire market. Those probabilities will be described further below in more detail.

To summarize, the inequality in (2.1) states that a household will choose to educate its members as long as the present value of future earnings of a skilled worker is higher than the present value of future expected earnings of a low-skilled currently unemployed person. Suppose that a household chooses not to educate a given person when they are born. Then, the above inequality does not hold and the person remains low-skilled. Given that $V_t > Z_t$, it follows that when the low-skilled individual becomes employed, there is even a lower incentive to invest in education and make her or him high-skilled. This means that the household would have no incentive to educate its working members if it already chose not to educate them when they were unemployed. Suppose however that the inequality above holds and the person becomes or is on the way of becoming skilled. We assume no on the job search or search during training. Every individual leaving an activity, a job or education, remains unemployed for a positive period of time. Given this, a skilled person or a person in education to become skilled, would have no incentive to pose as low-skilled and become unemployed with the idea to take up a job as low-skilled.

To find the share of skilled workers within the Northern-born population, we set (2.1) to be an equality, meaning that the threshold θ_H separating high-skilled from low-skilled individuals is

$$\theta_H = e^{rT} \frac{w_L}{w_H} \frac{\beta_N}{r + I_M + I + \beta_N}. \tag{2.2}$$

All people with abilities $\theta_k \in [0, \theta_H)$ belong to the low-skilled group and with abilities $\theta_k \in [\theta_H, 1]$ to the high-skilled group. The threshold ability level depends on the relative wage in the North, on the probabilities to find β_N and lose $I_M + I$ a job and on the duration of education T. The number of low-skilled people who are born in the North equals

$$L_{Lt} = \theta_H L_{Nt}.$$

Keep in mind that this is different from the total number of low-skilled people in the North, since some migrants coming from the South are also low-skilled. The number of high-skilled people is

$$L_{Ht} = \int_{-\infty}^{t-T} n(1-\theta_H) L_{Ns} ds = (1-\theta_H) e^{-nT} L_{Nt}. \tag{2.3}$$

Subtracting from the number of Northern-born people the low-skilled does not produce the number of the high-skilled individuals, since some people are always in education and it

takes time before they become high-skilled, therefore $L_{Lt} + L_{Ht} \neq L_{Nt}$. The units of human capital supplied by Northern-born individuals at any point in time are

$$H_t = \frac{\theta_H + 1}{2} L_{Ht},$$

or namely the average ability of a trained skilled worker times the number of skilled workers. Given that the range of ability of skilled workers is $\theta_k \in [\theta_H, 1]$, and that it is uniformly distributed, then the average ability of skilled workers is $\frac{\theta_H+1}{2}$.

2.2.2 Migrants

Migrants can also invest in education, the only difference to the Northern-born population is that it takes them longer to become skilled, $T_M > T$. The assumption is plausible given that migrants do not speak the language of a different country as well as the people born there. Here it is important to point out that the migrants have the same ability distribution as the people who remain in the South, which is also the same ability distribution of Northern-born people. This implies that migration is truly random and is not based on some sort of self-selection. This is of course a strong assumption, but aims to make the current setup as simple as possible.[5]

Migrants decide to invest in education if the following holds

$$\int_{t+T_M}^{\infty} e^{-r(s-t)} \theta_k w_H ds > Z_{Mt}, \tag{2.4}$$

where Z_{Mt} describes the value of an unemployed migrant. The value of an unemployed (low-skilled) migrant should fit the equality $rZ_{Mt} = 0 + \beta_M(V_{Mt} - Z_{Mt})$, where the value of leisure is zero and V_{Mt} is the value of an employed low-skilled migrant and β_M is the instantaneous probability for a migrant to find a job in production in the North. The value of being employed for a migrant is such that $rV_{Mt} = w_L + (I_M + I)(Z_{Mt} - V_{Mt})$. It equals the low-skill wage plus the probability that the person loses her or his job $I_M + I$ and returns to the value Z_{Mt}.

To find the threshold ability of a migrant θ_{MH} that separates those who invest in education from the ones who do not, we set (2.4) to be an equality. Solving yields

$$\theta_{MH} = e^{rT_M} \frac{w_L}{w_H} \frac{\beta_M}{r + I_M + I + \beta_M}. \tag{2.5}$$

All migrants with abilities $\theta \in [0, \theta_{MH})$ belong to the low-skilled group, whereas migrants with abilities within the range $\theta \in [\theta_{MH}, 1]$ are part of the high-skilled individuals. The num-

[5] Looking at self-selection into migration and endogenizing the migration decision in the current setup could be a potential subject of a future extension.

ber of low-skilled migrants equals

$$L_{MLt} = \theta_{MH} L_{Mt}.$$

The number of high-skilled migrants equals

$$L_{MHt} = \int_{-\infty}^{t-T_M} n(1-\theta_{MH}) L_{Ms} ds = (1-\theta_{MH}) e^{-nT_M} L_{Mt}. \tag{2.6}$$

The high-skilled migrants contribute to the total amount of units of human capital in the North by

$$H_{Mt} = \frac{\theta_{MH}+1}{2} L_{MHt}$$

units, where $\frac{\theta_{MH}+1}{2}$ is the average ability of a skilled migrant.

2.3 Firms

Northern firms, both existing quality leaders but also follower firms, invest in improving existing products. When successful to discover a better quality of a given product, the innovator announces the necessary vacancies and when successful in finding workers, takes over the market as a monopolist. Market leaders do not have an incentive to improve on their own products because they would be replacing themselves, they do however have an incentive to improve on other incumbents' products. We will for simplicity refer to innovating firms as followers because even market leaders for a given product ω are followers when it comes to innovating on another product variety.

We assume that high-skilled labor and more specifically human capital is the only input to the R&D process. Because by assumption high-skilled people are never unemployed, follower firms doing R&D do not have to wait to find and hire researchers in order to start innovating. Let $I_i(\omega, t)$ be the instantaneous arrival rate of knowing how to produce the higher quality of product ω, the subscript i here denotes the innovating firm. The arrival rate depends on the human capital input to R&D in the following way:

$$I_i(\omega, t) = a_I \frac{h_i(\omega, t)}{X(\omega, t)}. \tag{2.7}$$

What matters for the productivity of the innovation process is not only the units of time of high-skilled labor but also the ability of the workers involved, those two aspects are combined in the human capital variable $h_i(\omega, t)$. The scale parameter $a_I > 0$ is exogenous. The way the parameter $X(\omega, t)$ evolves over time determines which type of a growth model we are

working with. $X(\omega, t)$ grows, to show that with time it becomes more difficult to do R&D and is instrumental in removing the scale effect of population size, which was characteristic for earlier endogenous growth models. To maintain a constant success rate of discovery $I_i(\omega, t)$, the amount of human capital dedicated by each firm to innovation has to increase at the same rate as R&D difficulty $X(\omega, t)$.

We aggregate the efforts of individual firms and write the instantaneous probability at which a product variety is improved as $I(\omega, t) = \sum_i I_i(\omega, t)$ and the amount of human capital invested by all firms trying to improve on ω as $h(\omega, t) = \sum_i h_i(\omega, t)$. The number of firms i trying to improve on a single variety ω remains indeterminate as is standard in the literature, the innovation rate $I(\omega, t)$ is assumed to be identical across product varieties but also independently distributed across time and firms. We can therefore drop ω from $X(\omega, t)$ and $I(\omega, t)$ when we describe the steady state.

Importantly, once a product quality is discovered, we assume that the lower quality level of the same product becomes common knowledge and can be produced both in the North and in the South by any firm. There is no innovation in the South, there is however costless imitation occurring at the exogenous rate I_M. Imitation starts to be a risk for the best available quality of a given variety immediately after it gets discovered and before it starts to be produced in the North. Once a product is imitated, its production moves to the South provided that the wage in the South plus transportation costs are lower than the production wage in the North, which we assume holds. As a result of this setup, the North produces only state-of-the-art products, whereas the South produces only imitated products or products which are one step below the state of the art, while a patent holder in the North waits to hire workers in order to start producing the state of the art there.

The production function is linear and one unit of low-skilled labor is required to produce one unit of any good both in the North and in the South. Quality leaders in the North set prices to keep competitors out of business, they can therefore charge only λ times what the most viable competitor can offer for the one-quality-step-lower-version of the same product. A competitive fringe firm from the North would price at marginal cost, which would be the Northern low-skilled wage w_L. A Southern competitive fringe firm would price at τw_S in the North, where $\tau \geq 1$ is an iceberg trade cost and $w_S = 1$ is the wage in the South. For Southern firms to be competitive on the Northern market for imitated products, the following must hold $\tau < w_L$, which means that a Southern imitator can sell at a lower price on the Northern market compared to a Northern firm also selling at marginal cost, we assume this holds. It follows therefore that, when it comes to non-imitated products, it is the Southern firms that are the viable threat point for Northern quality leaders. This means that the price of a Northern producer will be $p_{NN} = \lambda\tau$ in the North and $p_{NS} = \lambda$ in the South.

The profit of a Northern firm therefore amounts to

$$\pi_{Nt} = (p_{NN} - w_L)d_{NNt}\left(L_{Nt} + L_{Mt}\right) + (p_{NS} - \tau w_L)d_{NSt}\left(L_{St} - L_{Mt}\right).$$

It is the markup times demand for a Northern product in the North $d_{NNt}\left(L_{Nt} + L_{Mt}\right)$ plus the markup in the South times demand for the product in the South $d_{NSt}\left(L_{St} - L_{Mt}\right)$. We previously described demand in the North as being dependent on the individual ability of a consumer θ, since demand is a function of consumption expenditure, which in turn depends on the ability of the spending person. The variables d_{NNt} and d_{NSt} denote average per-capita demand for Northern goods in the North and in the South. Given that there are only low-skilled jobs in the South, individual and average per-capita demand in the South are identical.

For the markups of Northern firms selling in the South to be positive, $\lambda > \tau w_L$ must hold. Combining this inequality with the one ensuring that Southern competitive fringe firms can be competitive on the Northern market yields the range for the Northern low-skill wage

$$\frac{\lambda}{\tau} > w_L > \tau. \tag{2.8}$$

We solve for an equilibrium where those two inequalities hold.

Southern producers price at marginal cost and set their price in the South at $p_{SS} = 1$ and in the North at $p_{SN} = \tau$, their profits are therefore zero.

Northern consumers save in a market aggregate asset that contains all innovating and producing Northern firms, which yields the riskless real interest rate r. Investing in a follower firm doing R&D should in expectation yield r, the value of such a follower should therefore satisfy the following equation

$$rv_F(j) = \underset{h_i}{argmax} - h_i(\omega, t)w_H + I_i v_{FN}(j+1) + \dot{v}_F(j). \tag{2.9}$$

We are omitting the subscript t from the value functions for brevity. Firm i invests in R&D $h_i(\omega, t)$ units of human capital, which has the per unit price w_H. The follower has success with probability I_i and becomes a leader looking for workers with value v_{FN}.

$$rv_{FN}(j) = z_t\left(v_N(j) - v_{FN}(j)\right) - \left(I + I_M\right)v_{FN}(j) + \dot{v}_{FN}(j). \tag{2.10}$$

With the instantaneous probability z_t the patent holder finds workers and becomes a producer with value $v_N(j)$. We set the cost for announcing a vacancy at zero, this is a standard approach in growth models with search and matching frictions like the ones in Aghion/Howitt (1994), Sener (2001) and Mortensen (2005). Innovation and imitation start to be a risk immediately after a product is discovered. If innovation or imitation take place, the patent holding

firm loses its value.

The return from investing in a Northern producing leader equals the stream of profits minus the probability I that a better quality of the same product is discovered, and minus the probability I_M that the product is imitated. In both cases, the Northern leader stops producing because the product version becomes common knowledge and production moves to the South. In addition, one should take into consideration the fact that the value of a Northern leader grows at the population growth rate $\dot{v}_N/v_N = n$. With this in mind, we can write the return from investing in a Northern leader as

$$rv_N(j) = \pi_{Nt} - (I + I_M)v_N(j) + \dot{v}_N(j). \tag{2.11}$$

The value of a market leader is independent of the quality level j, which follows from the Cobb-Douglas utility function[6]. Free market entry means that any firm can become a follower and do R&D. This means that the value of a follower is zero $v_F(j) = 0$, which we use in (2.9). Solving for $v_{FN}(j)$ in (2.9) and using that in (2.10) allows us to find an expression for $v_N(j)$. We then combine this expression with a second expression for $v_N(j)$ from (2.11) and arrive at the Northern R&D equation

$$z_t \frac{\pi_{Nt}}{(r + I + I_M - n)(r + z_t + I + I_M - n)} = \frac{X_t}{a_I} w_H. \tag{2.12}$$

This is one of the main equations in the model that will help us solve for a steady state equilibrium. Its basic intuition is to show that higher profits (left-hand side of the equation) create a higher incentive for firms to invest in innovation and therefore translate into a higher R&D difficulty in the economy (right-hand side of the equation).

As already mentioned, the total mass of goods in the world equals unity. Some of them are produced by quality leaders in the North, those are of mass n_N, and some by competitive fringe firms in the South, those are of mass n_S. Any product that is imitated moves for production to the South, any product on which there is an innovation also moves to the South for production until the Northern innovator finds workers. The flow of firms from the North to the South should equal the reverse flow in steady state $(I_M + I)\, n_N = z_t n_Z$. The mass n_Z are products that have faced innovation, are produced in the South at one quality step below the state-of-the-art while a patent holder of the highest quality in the North looks for workers. The inflow and outflow from the mass of n_Z products have to be also equal in order to have a constant value for n_Z in steady state, which means that $(z_t + I_M)\, n_Z = I n_N + I\,(n_S - n_Z)$. Combining the last two expressions with $n_N + n_S = 1$ allows us to find the values $n_N = \frac{z_t}{I_M + I} \frac{I}{z_t + I_M + I}$ and $n_S = \frac{I_M z_t + (I_M + I)^2}{(I_M + I)(z_t + I_M + I)}$.

[6] A more general CES utility function would have resulted in demand for a product being dependent on its quality level relative to the average quality of all products available on the market.

2.4 Migration and the Labor Markets

In this section, we describe the functioning of the labor markets in the North and in the South. We know that L_{Mt} is the number of migrants who have moved to the North up until time t. This group of people grows in time, since in steady state we have a constant share of the people living in the South who migrate. $\dot{L}_{Mt} = (L_{St} - L_{Mt})\, m_t$ describes this change in the stock of migrants in the North, it equals the number of people migrating from the South to the North at any given point in time, where m is the individual probability of moving to the North and $L_{St} - L_{Mt}$ is the number of people who live in the South. Migration from the South to the North is costless and the migration rate m_t is exogenous. In order to have a balanced growth equilibrium, the growth rate of the group of migrants in the North should be equal to the growth rate of Northern and Southern born individuals n. The following should therefore hold $\frac{\dot{L}_{Mt}}{L_{Mt}} = n = \frac{L_{St} - L_{Mt}}{L_{Mt}} m_t$. It follows that m should be a constant and equals

$$m = n \frac{L_{Mt}}{L_{St} - L_{Mt}}.$$

The market for skilled workers in the North is balanced between the needs of the R&D industry and the number of people who decide to invest in education, both Northern-born and migrants. As mentioned earlier, high-skilled workers are never unemployed. The supply of human capital depends on the number of skilled workers and on their average ability $H_{Mt} + H_t = \frac{\theta_{MH}+1}{2} L_{MHt} + \frac{\theta_H+1}{2} L_{Ht}$. Demand is based on the needs of all innovating firms in the North $\int_0^1 h(\omega, t) d\omega$. Setting the supply to be equal to demand, also substituting for L_{Ht} from (2.3), for L_{MHt} from (2.6) and for $h(\omega, t)$ from (2.7), we obtain

$$\frac{\theta_{MH}+1}{2}(1-\theta_{MH}) e^{-nT_M} L_{Mt} + \frac{\theta_H+1}{2}(1-\theta_H) e^{-nT} L_{Nt} = \frac{I}{a_I} x L_{Nt}.$$

The new parameter $x \equiv X_t / L_{Nt}$ represents relative R&D difficulty, which is a combination of R&D difficulty X_t and population size, and is roughly indicative of how innovative an economy is. R&D difficulty and population size grow at the same rate in equilibrium and relative R&D difficulty x is a constant variable in steady state. Rearranging and dividing by L_{Nt} yields the Northern high-skill labor market equation:

$$\frac{1-\theta_{MH}^2}{2} e^{-nT_M} \frac{L_{Mt}}{L_{Nt}} + \frac{1-\theta_H^2}{2} e^{-nT} = \frac{I}{a_I} x. \tag{2.13}$$

The equation conveys the idea that a higher R&D difficulty x requires in equilibrium more resources, in our case human capital. A higher x on the right-hand side is accompanied by lower θ_{MH} and θ_H on the left-hand side. The lower threshold ability values for migrants and non-migrants mean that more people from the two groups choose to invest in education.

The labor market for low-skilled individuals is somewhat more involving, at least because people go through periods of unemployment and bargain for their wage. Northern-born workers find a job with an instantaneous probability $\beta_N > 0$ and migrant workers with probability $\beta_M > 0$, both parameters are endogenous. The group of unemployed people who are born in the North follows the dynamic:

$$\dot{U}_{Lt} = \theta_H n L_{Nt} + (I_M + I)\,\xi n_N D_{Nt} - \beta_N U_{Lt}, \tag{2.14}$$

where $\xi \equiv \frac{(1-u_L)L_{Lt}}{(1-u_L)L_{Lt}+(1-u_M)L_{MLt}}$ is the share of Northern-born workers in the total low-skilled working population in the North. This is the same as the share of Northern-born people who are active within a single firm. We define $D_{Nt} \equiv d_{NNt}\,(L_{Nt} + L_{Mt}) + \tau d_{NSt}\,(L_{St} - L_{Mt})$ to be the demand for low-skilled labor of each producing Northern firm. This is different from the amount of the variety consumed in the world due to the presence of the iceberg trade cost $\tau \geq 1$.

On the left-hand side of equation (2.14) we have the change in the number of Northern-born (low-skilled) unemployed people in the North. The right-hand side starts by taking into consideration the fact that all newly-born members of households who are low-skilled are first unemployed. Further, all Northern firms whose products face imitation or innovation go out of business and their workers lose their jobs. Each firm employs also migrants, their movement into and out of unemployment is considered below in equation (2.15). The number of local-born unemployed individuals in the North U_{Lt} is reduced at the rate at which people find a job β_N.

The evolution in the number of unemployed migrants is described by the following equation:

$$\dot{U}_{Mt} = \theta_{MH} m\,(L_{St} - L_{Mt}) + (I_M + I)\,(1 - \xi)\,n_N D_{Nt} - \beta_M U_{Mt}. \tag{2.15}$$

The population of Southerners in the North grows because of newcomers from the South, those who do not invest in education are initially unemployed. A share $1 - \xi$ of all workers in Northern firms are migrants, those firms that go out of business therefore contribute to the total number of unemployed migrants. At the rate β_M unemployed migrants find a job, which reduces their total number U_{Mt}.

All employed low-skilled workers are involved in production:

$$(1 - u_L)L_{Lt} + (1 - u_{ML})L_{MLt} = n_N D_{Nt}. \tag{2.16}$$

We use $u_L = U_{Lt}/L_{Lt}$ to denote the unemployment rate of Northern-born low-skilled people and $u_{ML} = U_{Mt}/L_{MLt}$ the unemployment rate of low-skilled migrants. We combine the Northern unemployment equation (2.14) with the labor equation (2.16) and obtain the rate

of unemployment for low-skilled Northern-born individuals:

$$u_L = \frac{U_{Lt}}{L_{Lt}} = \frac{n + I_M + I}{n + I_M + I + \beta_N}. \tag{2.17}$$

The above expression shows that the unemployment rate in question increases in the population growth rate n, in the innovation rate I and in the imitation rate I_M, it decreases in the rate at which Northern workers find a job β_N. The creative destruction effect through the innovation rate I plays an important role in determining the unemployment rate. More innovation, which corresponds to higher growth, leads to higher unemployment of the low-skilled workers in the model. Studies like Pissarides/Vallanti (2007) show a negative correlation between growth and unemployment without making a distinction between skilled and low-skilled workers. Moreno-Galbis (2012) on the other hand shows in a model with high- and low-skill workers that while the high-skilled ones benefit from growth (a stronger capitalization effect), the low-skilled workers are faced with higher unemployment when growth accelerates (a stronger creative destruction effect).

Ultimately, we are interested in the unemployment rate of low-skilled Northern-born people as a share of all Northern-born people in the labor force, which means excluding those who are in education:

$$u_N = \frac{U_{Lt}}{L_{Lt} + L_{Ht}} = \frac{L_{Lt}}{L_{Lt} + L_{Ht}} u_L.$$

We also transform the unemployment equation for migrants (2.15) and combine it with the Northern labor equation (2.16), to obtain

$$u_{ML} = \frac{U_{Mt}}{L_{MLt}} = \frac{n + I_M + I}{n + I_M + I + \beta_M}. \tag{2.18}$$

The unemployment rate of low-skilled migrants increases in the population growth rate n, in the innovation rate I and in the imitation rate I_M, it decreases in the rate at which people from this group find a job β_M. We are interested in the unemployment rate of low-skilled migrants as a share of all migrants who are in the labor force in the North, this means including those migrants that have completed their education and work in the R&D sector:

$$u_M = \frac{U_{Mt}}{L_{MLt} + L_{MHt}} = \frac{L_{MLt}}{L_{MLt} + L_{MHt}} u_{ML}.$$

In this paper we look at the effect of a change in the iceberg trade cost τ, and subsequently of a change in the imitation rate in the South I_M, on u_M/u_N.

To complete the description of the labor markets, we need to write out the Southern labor equation. There is no unemployment in the South, there is also no innovation, imitation is

costless and does not take up resources. This implies that all employed workers are active in production:

$$L_{St} - L_{Mt} = n_S D_S, \tag{2.19}$$

where $D_S \equiv d_{SSt}\left(L_{St} - L_{Mt}\right) + \tau d_{SNt}\left(L_{Nt} + L_{Mt}\right)$ is demand for labor by an individual Southern competitive fringe firm. Since one unit of labor is needed to produce one unit of a good, this is also the amount of goods needed to be produced in order to cover demand for that good in the world. Again, keep in mind that some of the goods transported from the South to the North are lost on the way due to the iceberg trade cost $\tau > 1$.

2.5 Wage Bargaining

We finally need to introduce the wage bargaining process between firms and low-skilled workers in the North. We use the bargaining approach proposed in Binmore/Rubinstein/Wolinsky (1986), where parties do not search while negotiating. The outside option for a firm is zero and for a worker the value of leisure, instead of the value of unemployed search. The value of leisure in our model is normalized to zero. The bargaining problem between firms and low-skilled workers can be written as

$$w_L = \underset{w_L}{argmax} \left\{ \left(\frac{\left(p_{NN} - w_L\right) d_{NNt}\left(L_{Nt} + L_{Mt}\right) + \left(p_{NS} - \tau w_L\right) d_{NSt}\left(L_{St} - L_{Mt}\right)}{d_{NNt}\left(L_{Nt} + L_{Mt}\right) + d_{NSt}\left(L_{St} - L_{Mt}\right)} \right)^{\gamma} w_L^{1-\gamma} \right\},$$

where $1 > \gamma > 0$ is the bargaining power of firms and $1 - \gamma$ the bargaining power of future workers. In essence, the first large bracket raised to the power of γ expresses a weighted world markup of a Northern patent holding producer. Solving yields the low-skill wage in the North

$$w_L = (1 - \gamma)\, \lambda \tau \frac{E_N L + 1}{E_N L + \tau^2}, \tag{2.20}$$

where $L \equiv \left(L_{Nt} + L_{Mt}\right) / \left(L_{St} - L_{Mt}\right)$.

The matching function for Northern-born individuals is of a standard form and equals $m_{Lt}\left(U_{Lt}, V_{Lt}\right) \equiv \phi_L U_{Lt}^{\varepsilon} V_{Lt}^{1-\varepsilon}$. The elasticity of the function is defined by $1 > \varepsilon > 0$ and the efficiency of the matching process is determined by the scale parameter, V_{Lt} is the number of vacancies for local-born individuals open at time t. The probability to find a local-born worker for a vacancy equals $z_{Lt} = m_{Lt}/V_{Lt}$. The matching function for migrants equals $m_{Mt}\left(U_{Mt}, V_{Mt}\right) \equiv \phi_M U_{Mt}^{\varepsilon} V_{Mt}^{1-\varepsilon}$. The efficiency scale parameter of the migrants' matching function is $\phi_M < \phi_L$, which we assume is lower than the one for Northern born individuals. This is a reasonable assumption, which implies that everything else equal (number of unem-

ployed individuals and number of vacancies), it takes longer for a migrant to find a job. The probability to fill a vacancy with a migrant is $z_{Mt} = m_{Mt}/V_{Mt}$. In equilibrium, firms will announce vacancies within the two pools of unemployed individuals, the one for people born in the North and the other for migrants, in such amounts that $z_{Lt} = z_{Mt} = z_t$.

The probability for a non-migrant to find a job is $\beta_N = m_{Lt}/U_{Lt}$. Substituting for $m_{Lt} = z_t V_{Lt}$ and then substituting for V_{Lt}/U_{Lt} using the definition of the matching function for non-migrants helps us arrive at $\beta_N = z_t^{1-1/\varepsilon}\phi_L^{1/\varepsilon}$. Similarly, we can express $\beta_M = z_t^{1-1/\varepsilon}\phi_M^{1/\varepsilon}$. What is notable in the last two expressions is that despite the fact that the probability to fill a vacancy is identical when searching within either of the two groups, migrants and non-migrants, the probabilities to find work for the individuals from the two groups are not identical. With the expressions for β_N and β_M and the low-skilled wage equation (2.20), we have all ingredients to solve for the steady state.

3 The Steady State

In this section, we provide a solution for a steady state equilibrium in a growth model where policy variables have a permanent effect on growth (PEG), in other words a fully-endogenous growth model. We look at two comparative statics exercises, trade liberalization ($\tau \downarrow$) and increasing the level of IPR protection represented by a lower imitation rate ($I_M \downarrow$) in the South.

The PEG model is defined by an evolution of R&D difficulty, which depends on population size $X_t = \mu L_{Nt}$ with $\mu > 0$ being an exogenous parameter. A higher number of people born in the North means higher R&D difficulty and therefore a more expensive R&D process if firms want to keep the innovation rate in equation (2.7) constant. One could also define the evolution of R&D difficulty to be a function of world population or Southern population, instead of a function of L_{Nt}, but this would not make a qualitative difference to the results, since the population values are proportionate. The evolution of R&D difficulty can be interpreted as higher costs for innovating firms if they want their products to appeal to a larger group of people. Bloom et al. (2020) provide recent evidence of the idea that research becomes more difficult with time and innovations require an ever increasing number of researchers.

The early endogenous growth models had the property that the size of population would influence the economic growth rate. Evidence presented by Jones (1995a) however showed that this scale property is not empirically plausible. As a result, many later growth models removed the scale property by allowing for population growth and making R&D increasingly

difficult (see Segerstrom 1998). From the above R&D difficulty expression $X_t = \mu L_{Nt}$, one can immediately pin down relative R&D difficulty $x \equiv X_t/L_{Nt} = \mu$. The unknown variables in the model are $E_N, I, u_L, u_M, w_L, w_H, \theta_H, \theta_{MH}$ and z_t and we use the following equations to solve for them: (2.2), (2.5), (2.12), (2.13), (2.16), (2.17), (2.18), (2.19) and (2.20). The probabilities for Northern-born individuals β_N and for migrants β_M to find work are expressed in terms of z_t and the exogenous efficiency parameters of the two matching functions.

We solve the model numerically and use the following parameter values: the iceberg trade cost ranges from $\tau = 1.3$ to $\tau = 1$, with the latter value corresponding to the case of free trade. Tariff-equivalent trade costs between the US and Mexico in 2000 are estimated at 33 percent in Novy (2013). We set the relative size of the population born in the South to be $L_{St}/L_{Nt} = 2$. Note that this is not the relative size of the populations in the two regions, since there is migration from the South to the North. The rate of migration is set first at $m = 0.0001$, subsequently at $m = 0.001$ and finally at $m = 0.01$. Those choices for the migration rate generate a share of foreign-born population in the North of 1 percent for the low migration rate, 9.5 percent for the intermediate value of m and 41.6 percent for the high migration rate.[7] These percentage shares are within the bounds of what we observe in the data for the 20 OECD countries with a lowest value from the sample for Finland at 2.63 percent in 2000 and 43.75 percent for Luxembourg in 2013[8]. Our first policy experiment is the change in the iceberg trade cost, and we use the different rates of migration to explore whether the change in the iceberg trade costs leads to different results for different migration rates.

An imitation rate of $I_M = 0.01$ means that it takes in expectation 100 units of time before a product is imitated and moves for production to the South, if the interval between $t = 0$ and $t = 1$ is set to be a unit of time. We work with $T = 4$, which means that it takes 4 units of time for an individual born in the North to educate herself or himself in order to become highly skilled. A migrant on the other hand needs to invest slightly more time in education to become skilled, $T_M = 5$. The inequality $T_M > T$ is reasonable if one accounts for the time to learn a language in a foreign country, education takes on average longer for migrants. The choice of T and T_M is mostly important for the difference between the high-skilled and the low-skilled wage in the North w_H/w_L.

The R&D parameters $a_I = 1$ and $\mu = 8$ are chosen with the idea to arrive at a steady state growth rate reasonably close to 2 percent per unit of time, or per year if we denote the unit to be equal to a year. The population growth rate $n = 0.018$ is taken from Kremer (1993), the number corresponds to the world population growth rate in the 1980s. The efficiency

[7] The ratio of the North to South labor force equals $(L_{Lt} + L_{Ht} + L_{LHt} + L_{MHt}) / (L_{St} - L_{Mt})$. The numerator excludes locals and migrants who are in education. For the migration rate of $m = 0.0001$ the ratio is 50 percent. For comparison, looking at data from World Bank, World Development Indicators (2017a) and dividing the labor force of high-income countries by the labor force of upper middle-income countries in 2017 yields 0.44.

[8] In the OECD data Italy's share of foreign-born population is recorded at 0 percent for the years 2004-2007, while it is 3.9 percent in 2001 and 9.7 in 2009.

parameter of the matching function of migrants is set at $\phi_M = 0.7$ and at $\phi_L = 1$ for locals. These parameters imply that everything else equal, non-migrants find a job quicker. This is a reasonable assumption given the usual language and potential administrative barriers for migrants before they can fully access the labor market of the host country.[9] The wage bargaining parameter γ is set at 0.3, which is chosen to ensure that the inequalities in (2.8) hold. The value given to the parameter determining the elasticity of the matching functions is $\varepsilon = 0.5$. The rate at which people discount the future is $\rho = 0.04$, the choice determines the real interest rate in the model and follows the real interest rate in McGrattan/Prescott (2005). Finally, we set the step size of innovation at $\lambda = 2$. Looking at the resulting low-skill wage w_L in Table 1 on trade liberalization, we can calculate the markups of Northern producers from selling in the North $(\lambda\tau - w_L)/w_L$. The numbers range between 42 and 96 percent, which is in line with the markup estimations in Morrison (1990).

Table 1: The effect of trade liberalization

	$m = 0.0001$		$m = 0.001$		$m = 0.01$	
	$\tau = 1.3$	$\tau = 1$	$\tau = 1.3$	$\tau = 1$	$\tau = 1.3$	$\tau = 1$
I	0.0150	0.0153	0.0172	0.0174	0.0328	0.0325
g	0.0104	0.0106	0.0119	0.0120	0.0227	0.0225
u_M/u_N	2.1054	2.1034	2.1014	2.0996	2.0096	2.0276
u_N	0.0028	0.0032	0.0036	0.0039	0.0199	0.0166
u_M	0.0060	0.0067	0.0075	0.0081	0.0400	0.0337
β_N	13.1376	11.7571	10.8467	10.0341	2.4644	2.9450
β_M	6.4374	5.7610	5.3149	4.9167	1.2076	1.4431
E_N	1.6221	1.7148	1.6363	1.6997	1.6948	1.5918
w_H	1.7882	1.8993	1.8399	1.9169	2.0915	1.9604
w_L	1.3206	1.4000	1.3451	1.4000	1.5021	1.4000
θ_H	0.8624	0.8602	0.8527	0.8513	0.8154	0.8152
θ_{MH}	0.8939	0.8902	0.8818	0.8800	0.8209	0.8251
n_N	0.4519	0.4657	0.4884	0.4979	0.6932	0.6797
n_S	0.5481	0.5343	0.5116	0.5021	0.3068	0.3203
Share of migrants in %	1.0	1.0	9.5	9.5	41.6	41.6

Source: own calculations.

We summarize the results in Table 1, where columns two and three focus on the case of low migration $m = 0.0001$, columns three and four on intermediate migration $m = 0.001$, and columns six and seven on high migration $m = 0.01$.

Trade liberalization $\tau \downarrow$ decreases the relative unemployment rate of migrants $u_M/u_N \downarrow$ for the case of low ($m = 0.0001$) and intermediate migration flows ($m = 0.001$), whereas it increases the relative unemployment rate for the case of high migration ($m = 0.01$). A driving force for the unemployment rates of Northern-born and migrant workers is the innova-

[9] Using German data, Uhlendorff/Zimmermann (2014) report that male migrants take longer time to find jobs, Frijters/Schields/Price (2005) find that male migrants in the UK have more difficulty finding a job.

tion rate. It acts through two channels, first it increases both unemployment rates u_N and u_M through the creative destruction effect. Firms replace each other when innovation takes place. Higher innovation means that people lose their job more often. Second, the innovation rate affects both unemployment rates also through the change in the share of high-skilled people as a share of all individuals who are part of the labor force, the education effect. More people who invest in education means that fewer are subject to unemployment. A higher innovation rate is accompanied with an increase in the share of people who choose to become highly skilled. Remember that it is only low-skilled workers who work in production who are subject to unemployment.[10]

Given that the probability to find a job is higher for local-born people $\beta_N > \beta_M$, it is possible to show that the relative unemployment rate u_M/u_N of migrants decreases with an increase in the innovation rate I and increases when the innovation rate decreases. This is the creative destruction effect and can be seen in Table 1 above. The education effect works in the same direction, a higher innovation rate incentivises more migrants to become skilled relative to non-migrants. The question is then how trade liberalization affects the innovation rate and what is the role of the migration rate in determining the relation between τ and I.

Lower trade costs increase the threat of Southern competition and force Northern firms to sell at lower markups in the North. Their business in the North suffers from lower trade costs whereas their business in the South gains. The markup for selling in the South increases, since shipping there becomes cheaper. Low migration means a relatively larger South, which in turn implies that trade liberalization will more likely increase the profits of patent-holding Northern firms. This increases the incentive for follower firms to invest in R&D and increases the innovation rate. Trade liberalization $\tau \downarrow$ increases innovation $I \uparrow$ when the South is relatively large, which is the case when the migration rate is low. The higher innovation rate translates into a lower relative unemployment rate $u_M/u_N \downarrow$.

When migration is high, then the North is relatively larger. Trade liberalization $\tau \downarrow$ decreases profits of Northern patent-holding firms and the innovation rate decreases $I \downarrow$. This in turn increases the relative unemployment rate $u_M/u_N \uparrow$.

We also explore the effect of stronger IPR protection, which in the model corresponds to a decrease in the exogenous imitation rate I_M. The results from the numerical simulation are described in Table 2, calculations are made for the case of free trade $\tau = 1$. As expected, the innovation rate I decreases with the decrease in I_M. We know from Helpman (1993) that in this type of a model lower imitation $I_M \downarrow$ is accompanied with a lower innovation rate $I \downarrow$. There are exceptions if one introduces labor market frictions as shown in Arnold (2002)

[10] We can extend the model to a setting where skilled workers in the North are also subject to unemployment. As long as they have a lower unemployment rate, which seems to be the empirically relevant case (see Nickell/Bell 1995), we expect our results to hold.

or costly foreign direct investment as in Dinopoulos/Segerstrom (2010). The Arnold (2002) result relies in addition on a more general CES utility function. In our model, we do have the labor market frictions, but the fact that we employ the special case of a Cobb-Douglas utility function leads to the result that the labor market frictions do not influence the sign of the relation between I_M and I.

A lower imitation rate means that fewer varieties are produced in the South, production moves to the North and labor dedicated to R&D decreases, hence also the lower innovation rate. The greater demand for labor in the North translates into lower unemployment rates. The fact that fewer workers are active in the R&D sector and are high-skilled acts in the opposite direction on the unemployment rate of people in the North, but this effect is weaker.

Table 2: The effect of IPR protection

	$m = 0.0001$		$m = 0.001$		$m = 0.01$	
	$I_M = 0.02$	$I_M = 0.01$	$I_M = 0.02$	$I_M = 0.01$	$I_M = 0.02$	$I_M = 0.01$
I	0.0192	0.0153	0.0214	0.0174	0.0366	0.0325
g	0.0133	0.0106	0.0148	0.0120	0.0253	0.0225
u_M/u_N	2.0088	2.1034	1.9786	2.0996	1.5674	2.0276
u_N	0.0200	0.0032	0.0255	0.0039	0.1241	0.0166
u_M	0.0401	0.0067	0.0505	0.0081	0.1945	0.0337
β_N	2.3244	11.7571	1.8645	10.0341	0.4334	2.9450
β_M	1.1390	5.7610	0.9136	4.9167	0.2124	1.4431
E_N	1.6016	1.7148	1.5786	1.6997	1.2824	1.5918
w_H	1.9360	1.8993	1.9267	1.9169	1.6082	1.9604
w_L	1.4000	1.4000	1.4000	1.4000	1.4000	1.4000
θ_H	0.8207	0.8602	0.8170	0.8513	0.8354	0.8152
θ_{MH}	0.8258	0.8902	0.8149	0.8800	0.7309	0.8251
n_N	0.4488	0.4657	0.4794	0.4979	0.6310	0.6797
n_S	0.5512	0.5343	0.5206	0.5021	0.3690	0.3203
Share of migrants in %	1.0	1.0	9.5	9.5	41.6	41.6

Source: own calculations.

The lower imitation and innovation rates lead to a lower turnover rate of firms (the creative destruction effect) and through that to lower unemployment rates of both locals and migrants. The relative unemployment rate of migrants increases in all instances with low, intermediate and high migration rates. This happens due to the different probabilities for local-born individuals and migrants to find a job. The parameter relation $\phi_L > \phi_{ML}$ implies a higher probability for local-born people to find a job $\beta_N > \beta_M$, this in turn drives the increase in the relative unemployment rate of migrants with the change in I and I_M. The lower innovation rate reduces the share of skilled migrants and non-migrants thus also making more of them subject to potential unemployment. The reduction is bigger for non-migrants however thus reinforcing the increase in the relative unemployment rate.

3.1 Empirical Estimation

In this section, we evaluate empirically the predictions derived from the theoretical framework about the effects of trade openness and IPR protection. The empirical strategy is based on the specifications previously used in the literature, especially in Felbermayr/Prat/Schmerer (2011b) and Stepanok (2018). Contrary to Felbermayr/Prat/Schmerer (2011b), we are providing supporting evidence through correlations rather than aiming to show causality.

We use a modified version of existing empirical models, whereby the estimated equation can be written as:

$$\begin{aligned} u_{it} &= \alpha + \beta_1 O_{it} + \beta_2 [O_{it} \times FP_{it}] + \beta_3 \Pi_{it} + \beta_4 FP_{it} + \beta_5 WD_{it} + \beta_6 EPL_{it} \\ &\quad + \beta_7 UD_{it} + \beta_8 PMR_{it} + \beta_9 OG_{it} + \beta_{10} C_{it} + \beta_{11} GDP_{it} + \upsilon_t + \gamma_i + \varepsilon_{it}. \end{aligned} \tag{3.1}$$

The first difference lies in the dependent variable u_{it}. We use the unemployment rate of foreign-born individuals aged 15 to 64, relative to the one specific to the native population. A number above one would imply that the unemployment rate of migrants is higher than the counterpart for local-born individuals. Second, our measure for openness O_{it} is the real trade openness with respect to the South, implying that we only include trade between a given developed country i located in the North, and some of its main developing trading partners considered in the South.[11]. We build the openness variable based on two definitions for trade, i.e. taking into account trade in goods only and, separately, trade in goods and services, and we report the results for specifications with each measure. Third, the equation is augmented with an interaction term between trade openness O_{it} and the share of foreign-born individuals FP_{it} in the population of Northern country i at time t. Finally, we run an extended specification where we add a variable reflecting the exposure of a given OECD country with respect to imitation in the South. This new covariate is built from the index of patent protection rights developed by Park (2008).[12] The Park index takes a larger value if the level of IPR protection in a given country is high. We combine the IPR protection and trade in goods to derive the following exposure index:

[11] The North is defined by the following countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK, and USA. The set of countries encompassed in the South are: Algeria, Argentina, Bangladesh, Brazil, China, Egypt, India, Indonesia, Iran, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Philippines, South Africa, Thailand, Tunisia, Venezuela, and Vietnam. In the baseline analysis, China does not include data for Hong Kong and Macao. Adding trade information for these two regions when building the openness variable does not qualitatively change our results. The same occurs when adding data on IPR for Hong Kong, whereas no data on IPR protection is available for Macao.

[12] We rely on an extension of the data until 2015 published by the author and available at http://fs2.american.edu/wgp/www/.

$$\Pi_{it} = \ln \left(\sum_{j} \frac{EXP_{ijt} + IMP_{ijt}}{T_{Sit}} IPR_{jt} \frac{T_{Wit}}{T_{Sit}} \right),$$

where EXP_{ijt} are the exports from Northern country i to the Southern country j at time t and, respectively, IMP_{ijt} corresponds to the imports from j into i. The sum of bilateral exports and imports is divided by total trade T_{Sit} with the South for the given Northern country i. This creates a weight for each country located in the South. We then multiply the weight with the value for country j from the Park index for the protection of intellectual property rights IPR_{jt}. In other words, the more a Northern country trades with a given Southern country with high IPR standards, the lower the exposure to imitation will be for that specific developed country. We sum the weighted IPR values over all developing countries that the Northern country trades with[13] and divide the sum by the share of trade with the South in total trade with the world T_{Wit}. In the above equation, the last step is equivalently written as multiplying the sum by T_{Wit}/T_{Sit}. Intuitively, this implies that trading more with the South reduces the value of our IPR exposure index Π_{it}, leading to higher exposure to imitation for country i.

Beyond the above innovations, we control for standard characteristics that could potentially influence the dependent variable, mainly relying on the explanatory variables already used in the literature. Among these covariates, WD_{it} is a wage distortion index built as the sum of the average wage tax burden and an average replacement rate (social benefits if unemployed) to represent the "total fiscal burden imposed on the worker" (Felbermayr/Prat/Schmerer 2011b). EPL_{it} refers to employment protection legislation, UD_{it} stands for union density, C_{it} corresponds to an index of corporatism, PMR_{it} reflects product market regulation, OG_{it} is the output gap, and GDP_{it} is the logarithm of GDP converted to 2011 dollars using purchasing parity rates.[14] Country fixed effects γ_i are added to purge the estimates from unobserved and time-invariant country-specific heterogeneity. We avoid business cycle effects by grouping the data and taking averaged for three four-year periods and one three-year period that are accounted for through the period dummies υ_t. Finally, ε_{it} is the error term.

As far as the data sources are concerned, most of the explanatory variables are obtained from information published by the OECD. Exceptions are (*i*) real trade openness, which is derived from combining data (as in Alcala/Ciccone 2004) from COMTRADE with real GDP converted to international dollars using purchasing power parity rates from the World Bank International Comparison Program database, (*ii*) the index of corporatism that is extracted from

[13] The weights add up to one, i.e. $\sum_j \frac{EXP_{ijt}+IMP_{ijt}}{T_{Sit}} = 1$.

[14] We use the same GDP to compute the openness measure. It is included in the set of controls in order to take into account the size of the host economy. The results are robust if we rely on population data instead of GDP.

Jahn (2016), which relies on information collected across countries and over time by Visser (2016).[15], and (*iii*) the IPR index from Park (2008) previously discussed in this section. The availability of data largely determines the time range (2000-2014) of the empirical investigation. In particular, the analysis cannot be carried out before 2000, as the unemployment rate of foreign-born individuals is not available from the OECD.

The empirical strategy is based on standard panel data econometrics.[16] The results are presented in Table 3, where the coefficients were obtained from the estimation of (3.1) with fixed effects, given that the Hausman test indicates that the fixed effects model should be preferred to the random effects model.[17]. Columns (1) and (2) display the results from using the openness measure based on trade in goods and services, whereas the last two columns of Table 3 depict the findings derived with the openness variable built with trade in goods only. Moreover, columns (2) and (4) refer to the extended specification, where we add the IPR exposure index in the list of covariates to show the effects of both trade openness and exposure to imitation on the relative unemployment rate.

The theoretical predictions suggest that trade liberalization would be associated with a decrease of the relative unemployment rate of migrants in case of low migration from the South to the North. The effect is expected to reverse in the context of high migration from the South to the North, leading to an increase in the relative unemployment rate of foreign-born individuals following trade liberalization. In terms of coefficients involved in the empirical specification, the predictions are analyzed through the estimates associated to the parameters β_1 and β_2. More specifically, we expect the total effect of trade openness, i.e. $\beta_1 + \beta_2$, to have a negative sign when the foreign-born population in country i is rather small, while the joint estimate should turn positive with large size of the migrant population.

Turning to the results, the signs on the coefficients of interest associated to the openness variable (β_1) and the interaction term between openness and the share of foreign population (β_2) match the theoretical predictions. Higher openness may lead to a lower unemployment rate for migrants when the share of foreign-born individuals in the population of a developed country is small (implying that $\beta_1 + \beta_2$ is negative). When the share of migrants is large, more trade can shift the sign on the total effect of trade openness ($\beta_1 + \beta_2$), thus inducing a positive correlation with the unemployment rate of migrants relative to the one of the native popu-

[15] In fact, the data corresponds to an extension of the paper published by Jahn (2016). Relevant information is made available by the author and can be found at http://comparativepolitics.uni-greifswald.de/data.html.

[16] We only work with 76 observations, essentially an unbalanced panel with 20 countries over four time periods. We lose two data points for Canada because of missing values on the unemployment rate of migrants in the first two periods, and two observations for Luxembourg because of the lack of information on employment protection legislation again for the first two periods.

[17] We have also tried to implement GMM models to control for the potential endogeneity of the variable of interest and to run a dynamic panel model where the lagged dependent variable is included as a covariate. However, the low number of panels available in the data led to inconsistent estimates as the standard assumptions of the GMM estimator can not be satisfied.

Table 3: Trade openness, IPR and relative unemployment of foreign-born individuals

Dependent variable: relative unemployment rate of foreign-born individuals				
	(1)	(2)	(3)	(4)
Openness South	-0.132^{***}	-0.127^{***}		
	(0.043)	(0.043)		
Openness South (goods)			-0.172^{***}	-0.184^{***}
			(0.057)	(0.052)
Openness South × Foreign pop	0.004^{**}	0.005^{***}		
	(0.002)	(0.002)		
Openness South (goods) × Foreign pop			0.005^{**}	0.007^{***}
			(0.002)	(0.002)
IPR index (ln)		0.532^{*}		0.622^{**}
		(0.271)		(0.268)
Foreign population	0.028^{**}	0.031^{**}	0.024^{*}	0.025^{**}
	(0.013)	(0.012)	(0.012)	(0.010)
Wage distortion (index)	-0.010^{*}	-0.013^{**}	-0.011^{**}	-0.015^{***}
	(0.005)	(0.006)	(0.005)	(0.005)
Employment protection legislation	-0.639^{*}	-0.869^{***}	-0.598	-0.852^{***}
	(0.333)	(0.272)	(0.364)	(0.285)
Union density	0.035^{*}	0.040^{*}	0.037^{*}	0.043^{*}
	(0.018)	(0.020)	(0.019)	(0.021)
Product market regulation	0.023	0.039	0.003	0.022
	(0.070)	(0.076)	(0.070)	(0.080)
Output gap	0.018	0.017	0.017	0.017
	(0.015)	(0.012)	(0.016)	(0.013)
Corporatism	-0.057	-0.039	-0.079	-0.060
	(0.200)	(0.186)	(0.221)	(0.203)
GDP (ln)	1.056	1.036	0.970	0.797
	(0.879)	(0.905)	(0.940)	(0.954)
Hausman test	0.00	0.00	0.00	0.00
Observations	76	76	76	76
R^2 within	0.372	0.421	0.363	0.426

Notes: ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors are reported in parentheses. Source: Authors' elaboration based on data from OECD (2018a-2018h), Koske et al. (2015), United Nations Statistics Division (2018), World Bank, World Development Indicators (2017b), Visser (2016) and Park (2008).

lation. The findings hold for both measures of openness, as can be seen in columns (1) and (3).[18]

The theory also predicts that lower imitation in the South would cause a higher relative unemployment rate of foreign-born individuals. The correlations reported in columns (2) and (4) of Table 3 provide empirical support for the theoretical finding, as the coefficient of interest (β_3) is found to be positive. A higher IPR exposure index is equivalent to lower imitation of Northern products, and the measure is positively correlated with the unemployment rate

[18] The coefficient on openness and the interaction term are jointly significant at the one percent level in the four regressions. In our first regression in column one the threshold level of foreign population at which the joint openness coefficient becomes positive is at 32.7 percent. The minimum value of the foreign population variable in our dataset is at zero, the mean at 13.74 and the maximum at 43.16 for Luxembourg.

of migrants relative to the one of the native population in OECD countries.

We also carry out some robustness checks on the baseline results although data limitations prevent us from doing a more comprehensive analysis as, e.g., the study developed by Felbermayr/Prat/Schmerer (2011b). First, in all four regressions, the results are robust to excluding the years 2008 and 2009 from the time period three, when the financial crisis occurred. Second, information (from the OECD) on the share of foreign-born individuals in the Italian population is available for only one year in period one (i.e., 3.9 percent in 2001). Moreover, for all years in period two, the values are zero, whereas the average value for period three is 9.58 percent. In the baseline specification, we take the data at face value and work with the above figures. However, the results are robust to either dropping the entire period two for Italy or imputing the value for the share of foreign-born in the population in period two as the average between the values in period one and three. Third, the results are also robust to the exclusion of Luxembourg from the sample, given that this country might be considered as an outlier with respect to the share of migrants in the population. Fourth, we evaluate the stability of our baseline findings by adding the R&D expenditures as a share of total country GDP, as in Stepanok (2018), and we find that our estimates are robust to the inclusion of this other control variable.

We investigate the heterogeneity of our results with respect to trade exposure. The literature has emphasized the fact that positive trade shocks that increase access to export markets have different effects than negative trade shocks that materialize through an increase in import competition (Pavcnik, 2017). The macroeconomic evidence provided by Felbermayr/Prat/Schmerer (2011b) has shown that export exposure plays a more important role in explaining the reductions in the total unemployment rate. We evaluate this question in our context, where the dependent variable is the relative unemployment rate of foreign-born individuals.

We do so by replicating the baseline specification while modifying the openness measure. More specifically, we create two variables based on the type of trade, i.e., one built only with exports thus reflecting export exposure and the counterpart with imports only. The results are reported in Table 4, where the first two columns correspond to the estimates with openness on exports and the last two depict the coefficients related to import exposure. We find that both openness variables are negatively correlated with the dependent variable, while the positive effects arising from the interaction term between openness and the size of the foreign-born population in a given developed country are only driven by exposure to exports, similar to Felbermayr/Prat/Schmerer (2011b). The same pattern applies to the correlations associates to the IPR index.

Table 4: Heterogeneity with respect to export and import exposure

Dependent variable: relative unemployment rate of foreign-born individuals				
	Exports		Imports	
	(1)	(2)	(3)	(4)
Openness South	-0.230^{**}	-0.194^{**}	-0.193^{**}	-0.216^{**}
	(0.095)	(0.080)	(0.080)	(0.083)
Openness South × Foreign pop	0.008^{**}	0.008^{***}	0.003	0.007
	(0.003)	(0.003)	(0.004)	(0.004)
IPR index (ln)		0.558^{**}		0.460
		(0.260)		(0.283)
Foreign population	0.035^{**}	0.039^{***}	0.030^{**}	0.030^{**}
	(0.013)	(0.011)	(0.013)	(0.012)
Wage distortion (index)	-0.009	-0.013^{**}	-0.011^{*}	-0.013^{**}
	(0.005)	(0.006)	(0.005)	(0.005)
Employment protection legislation	-0.725^{**}	-0.955^{***}	-0.585	-0.779^{**}
	(0.335)	(0.255)	(0.340)	(0.309)
Union density	0.035^{*}	0.041^{*}	0.037^{*}	0.040^{*}
	(0.019)	(0.020)	(0.019)	(0.020)
Product market regulation	-0.013	-0.028	-0.020	-0.036
	(0.076)	(0.079)	(0.069)	(0.075)
Output gap	0.019	0.017	0.014	0.015
	(0.015)	(0.012)	(0.015)	(0.012)
Corporatism	-0.093	-0.066	-0.023	-0.017
	(0.204)	(0.190)	(0.206)	(0.193)
GDP (ln)	1.178	1.271	1.431	1.221
	(0.756)	(0.797)	(1.034)	(1.095)
Hausman test	0.00	0.00	0.00	0.00
Observations	76	76	76	76
R^2 within	0.350	0.404	0.382	0.419

Notes: ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors are reported in parentheses. Source: Authors' elaboration based on data from OECD (2018a-2018h), Koske et al. (2015), United Nations Statistics Division (2018), World Bank, World Development Indicators (2017b), Visser (2016) and Park (2008).

4 Conclusion

In this paper, we build an asymmetric country model of endogenous growth driven by vertical innovation that features unemployment. We study how trade liberalization and IPR protection affect the unemployment rates of migrants and local-born people in the North. The effect of trade liberalization on the relative unemployment rate of migrants depends on the number of migrants in the North. A small migrant diaspora translates into trade liberalization leading to a lower relative unemployment rate of migrants. A large migrant diaspora leads to the opposite relation between trade and unemployment. Stronger IPR protection increases the relative unemployment rate of migrants irrespective of their total number in the North. The theoretical results find support in the data, based on the analysis of 20 OECD countries for the period 2000-2014.

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Corresponding author
Ignat Stepanok
E-Mail ignat.stepanok@iab.de