Problem or opportunity? Immigration, job search, entrepreneurship and labor market outcomes of natives in Germany *

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Abstract

In this study we evaluate the effects of low-skilled immigration on small businesses, wages and employment in Germany. We develop a search and matching model with heterogeneous workers, cross-skill matching, and endogenous entry into entrepreneurship. The model is calibrated using German Socio-Economic Panel (SOEP) data. Quantitative analysis shows that low-skilled immigration benefits high-skilled workers while negatively affecting the welfare of low-skilled workers. It leads to the endogenous expansion of immigrant entrepreneurial activities, generating positive spillovers for all demographic groups except native entrepreneurs. Overall, there is a marginal loss to the economy in terms of per worker welfare. This loss is mitigated with increased skilled migration from India. Policies restricting immigrant entrepreneurship relax competition for native small businesses but reduce welfare for all other worker groups. Ethnic segregation of small businesses benefits low-skill native entrepreneurs.

Keywords: entrepreneurship, small business, self-employment, search frictions, immigration

JEL codes: J23, J31, J61, J64, L26

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1 Introduction

In this paper we revisit the impact of immigration on receiving countries. We develop a macroeconomic model with search frictions and endogenous entry into entrepreneurship. The model is calibrated to German data and makes four contributions to the literature. First, we develop a unified framework that allows for the dual role of immigrants as job seekers and as entrepreneurs or job creators. By doing so, we capture the higher competition native workers face due to immigration and the better outside options due to jobs created by immigrant entrepreneurs. Second, we provide a quantitative assessment of the model mechanism generating new insights into the heterogeneous effects of immigration on wages, employment opportunities of natives and incumbent immigrants as well as job creation in small businesses in Germany. Third, we evaluate the welfare effects of policies facilitating immigrants' entry into entrepreneurship and analyze the role of ethnic segregation. Fourth, we quantify the impact of recently established cooperation on worker mobility between Germany and India.[1]

On the one hand, the literature provides evidence that immigrant entrepreneurs contribute to job creation.[2] For example, Sachs et al. (2016) finds that entrepreneurs with migration background employed at least 1.3 million people in Germany in 2014, while Leicht and Langhauser (2014) report this number between 1.5 to 2 million. Nevertheless, this literature does not explore the general equilibrium consequences of immigration in host countries. On the other hand, the large body of literature dealing with diverse aspects of migration in receiving countries ignores the immigrants' entrepreneurial role despite its direct implications for the employment opportunities and wages of natives. This literature treats immigrants as workers who compete with natives for jobs and influence their welfare via the effects on wages, employment and fiscal transfers.[3]

In this paper we synthesize the aforementioned strands of literature and address the following questions 1) does ignoring the role of immigrants as entrepreneurs lead to biased predictions concerning the consequences of immigration for labor market outcomes and the welfare of natives? 2) whether policies reducing barriers to self-employment may be beneficial in reducing unemployment and increasing income/welfare 3) which worker groups gain/lose from the ethnic segregation of small businesses?

We develop a search and matching (SaM) model with four demographic groups: natives/immigrants and high/low-skilled. Within each demographic group there are individuals with a high entrepreneurial spirit, called *potential entrepreneurs*, and individuals with a low entrepreneurial spirit, called *regular workers*. This distinction is motivated by

[1] Germany and India signed the "Migration and Mobility Partnership Agreement" (MMPA) in December, 2022 to facilitate skilled migration from India to Germany. In October 2024 Germany agreed to increase the number of visas granted to Indian skilled workers and promote fair migration.

[2] (Kerr and Kerr, 2020; Riillo and Peroni, 2022; Li, 2001; Lofstrom, 2002; Constant and Zimmermann, 2006)

[3] (D'Amuri et al., 2010; Ben-Gad, 2008; Borjas, 2003, 1999; Dustmann et al., 2017; Pischke and Velling, 1997; Busch et al., 2020; Iftikhar and Zaharieva, 2019; Battisti et al., 2018)

the SOEP data, which shows that regular workers, making up the majority, remain in paid jobs with an annual probability of at least 97% (see Appendix A.1 for details). However, those defined as potential entrepreneurs are frequently moving between paid jobs and self-employment with annual probabilities in the range of $15-23\%$. This evidence shows that most workers do not consider self-employment as an alternative to their job. But also for those who do, self-employment is not a "once and for all" decision and should be modeled dynamically. Hence, potential entrepreneurs in our model have several options: they can enter solo self-employment, register a small business with coworkers, or search and accept a regular paid job. Entry into these states is endogenous and depends on the labour market conditions. Regular workers can be employed in regular jobs (large and medium-size firms) or small businesses operated by self-employed entrepreneurs. Large and medium-size firms are modeled in a classical SaM tradition with free entry.

Our model has several novel features. First, we explicitly allow for the possibility of self-employment "out of necessity", when self-employed entrepreneurs continue searching for regular paid jobs, and self-employment "out of opportunity", when the income from self-employment activities is high enough, and there are no gains from job search. Self-employment out of necessity is motivated by the empirical finding that the unemployment rates of potential entrepreneurs are lower than those of regular workers. Also other studies, for example, Poschke (2023) find evidence for self-employment out of necessity. At the same time, our wage regressions reveal that the earnings of business owners are higher than the wages of comparable individuals employed in regular paid jobs, suggesting an important "opportunity" component of entrepreneurship. Second, the size distribution of small businesses is endogenous. Third, we incorporate the possibility of cross-skill matching on a micro-level, whereby small businesses founded by high-skill entrepreneurs hire workers from both skill groups.

The model is calibrated using the German Socio-Economic Panel (SOEP), a comprehensive survey of German households. We combined this data with information on vacancies from the Federal Employment Office. The data shows that high-skill immigrant entrepreneurs are more frequently observed operating small businesses rather than being solo self-employed, compared to all other groups of entrepreneurs. Moreover, immigrant businesses are more profitable than the businesses of native workers. Another relevant empirical fact is that low-skill workers are overrepresented in small businesses compared to high-skill workers, making them more susceptible to the entry of small businesses. Our modeling framework is well suited to capture these empirical facts.

We use our framework to study the implications of a 20% increase in the number of low-skilled immigrants corresponding to the immigration wave observed in Germany in 2012-2017.[4] In line with previous research, we find that rising low-skill immigration

[4] During the Syrian war the number of immigrants to Germany increased from 15 to 18 million. Also the most recent immigrant wave in 2020-2024 (dominated by the Russian-Ukrainian conflict) is associated with a similar increase from 20 to 23 million as reported by www.destatis.de

benefits high-skill regular workers with a corresponding gain in welfare equal to 1%, but there is a reduction in the welfare of low-skill regular workers equal to -1.3%. The results for potential entrepreneurs are novel and reveal asymmetric effects. Immigrant entrepreneurs (high and low-skilled) experience higher profits and their business entry is reinforced by immigration, generating a welfare gain of 3.1%. There is a reduction in welfare (-2%) of low-skilled native entrepreneurs due to the reduced profits and a rise in the probability of staying in solo self-employment without coworkers. Thus, and contrary to the previous studies (e.g., D'Amuri et al. (2010), Ottaviano and Peri (2012)), we find that some groups of incumbent low-skill immigrants are gaining from new immigration. The underlying reason for this finding is that immigrant businesses are more profitable on average, making them more sensitive to the improved chances of hiring coworkers in response to the immigration increase. In contrast, we find that the expected profits of native entrepreneurs are less sensitive on the recruitment margin and fall due to the lower marginal productivity of their low-skill coworkers.

In a nutshell, our results show that low-skill immigration reduces the welfare of an average incumbent individual by 0.4%, but there is pronounced heterogeneity in this effect across demographic groups. A skill-neutral immigration scenario emerging in a preview of the recent German-Indian cooperation to promote skilled migration from India to Germany will reduce the losses of the incumbent to 0.27%.

Addressing the second question, we conduct a counterfactual experiment by introducing legal barriers to self-employment and entrepreneurship for immigrant individuals. This experiment sheds light on the spillover effects of immigrant entrepreneurship for regular workers and native entrepreneurs. We find that immigrant entrepreneurship has moderate positive spillovers in the range $0.2 - 0.4\%$ for regular workers. On the one hand, immigrant potential entrepreneurs entering self-employment out of opportunity reduce competition for regular jobs; on the other hand, immigrant entrepreneurs operating small businesses create additional workplaces. On the contrary, our model indicates substantial negative spillovers for native potential entrepreneurs ($1.1 - 1.6\%$ of welfare). This is intuitive since the business entry of immigrant entrepreneurs creates additional competition in recruiting and reduces the hiring chances of native small businesses. Our findings suggest that policies restricting immigrant entrepreneurship shield native small businesses from competition but reduce welfare for all other worker groups.

Considering the last question, we allow for ethnic segregation in small businesses such that job matches between workers and business owners of the same ethnicity become more likely compared to random matching. Ethnic segregation benefits low-skill native entrepreneurs by increasing the profits associated with hiring high-productivity native workers but it is detrimental for the profits of immigrant low-skill businesses and welfare of regular workers. Reduced business entry of low-skill immigrant entrepreneurs suggest that their entrepreneurial potential could be underutilized in the presence of ethnic segregation.

The outline of the paper is as follows. Section 2 positions our study in the related literature. Section 3 describes the theory. Section 4 presents the data and the calibration strategy, while section 5 discusses the results, and section 6 concludes the paper.

2 Related Literature

Our paper contributes to the literature concerning the impact of (low-skilled) migration on the labor market outcomes and welfare of natives in developed countries. The seminal paper by Borjas (1999) and later Ben-Gad (2004) show that an influx of immigrants in the US creates an immigration surplus, assuming homogeneous labour and imperfect substitution between labor and capital. Subsequent papers with heterogeneous labour support varied conclusions regarding wages of competing workers and immigration surplus (Borjas, 2003; Ben-Gad, 2008). Literature on wage effects of immigration is inconclusive, vastly empirical, and assumes perfectly competitive labor markets (Altonji and Card, 1991; Borjas et al., 1997; Card, 2001; Borjas, 2006; D'Amuri et al., 2010). Goldin (1994), Borjas (2003), Aydemir and Borjas (2007), and Aydemir and Borjas (2011) find a negative effect of immigration on native wages. Several papers report a negligible effect.[5]

More recent studies provide evidence for heterogeneous wage effects. For example, the wage effects are considerably larger for younger natives (Dustmann et al., 2017) in Germany, while in the UK, migration negatively affects the wages of low earners but increases the wages of high earners (Dustmann et al., 2013). Our framework accommodates the heterogeneity in immigration's effects by assuming different skill groups and occupation choices between paid employment and entrepreneurship. D'Amuri et al. (2010), Felbermayr et al. (2010), and Ottaviano and Peri (2012) further find that migration adversely affects the wages of the incumbent immigrants when immigrants are imperfect substitutes to natives in the same skill group. We follow a parsimonious approach in assuming perfect substitution between immigrants and natives in the same skill group. However, assuming productivity differences between ethnic groups with the same skills allows us to compute the effects of migration for incumbent immigrants and natives.

There are mixed findings in the literature discussing the employment consequences of immigration. Some papers find a substantial adverse effect of immigration on native employment (Borjas, 2003, 2006; Dustmann et al., 2017). Others find either a positive, negligible, or no effect of migration on native employment in receiving countries.[6] Only Dustmann et al. (2017) discuss the interaction between wage and employment effects. Our theoretical framework incorporates interactions between wage and job creation, and the quantitative analysis provides insights into the distributional consequences of migration shock to the German labor market.

[5] Card (2001), Card (2005), Friedberg (2001), D'Amuri et al. (2010), Felbermayr et al. (2010), Ottaviano and Peri (2012), Busch et al. (2020)

[6] (Altonji and Card, 1991; Hunt, 1992; Pischke and Velling, 1997; D'Amuri et al., 2010; Scharfbillig and Weissler, 2019; Friedberg, 2001; Malchow-Møller et al., 2009; Felbermayr et al., 2010)

Several papers employ SaM models to analyze the general equilibrium effects of immigration. Ortega (2000) is one of the first papers studying the effects of migration in a frictional labor market. However, this paper is theoretical and lacks a detailed data-based quantitative analysis. Liu (2010) develops a dynamic search and matching model with heterogeneous labor but focuses solely on the consequences of illegal migration for the US economy. Chassamboulli and Palivos (2014) extend Liu's framework with a nested CES production function, low and high-skilled labor, and capital to study the impact of immigration on the US economy. Battisti et al. (2018) calibrate a SaM model featuring two skill types, wage bargaining and a redistributive welfare state for 20 OECD countries. Iftikhar and Zaharieva (2019) extend the framework of Battisti et al. (2018) by considering a two-goods economy and endogenous price setting. Their framework identifies additional effects of immigration on Germany through its impact on domestic demand. Nanos and Schluter (2014) and Moreno-Galbis and Tritah (2016) also use the SaM model to analyse consequences of migration in selected European economies. Our framework borrows several elements from these frameworks but substantially deviates and innovates by adding entrepreneurship and cross-skill matching into the model.

Our paper also addresses how small businesses respond to migration shocks. Papers on this topic suggest positive contributions of migrants to entrepreneurship in receiving countries (Kerr and Kerr, 2020; Riillo and Peroni, 2022). Duleep et al. (2021) find that immigrant entrepreneurs facilitate innovation and entrepreneurship among natives.[7] None of these papers consider entrepreneurship's spillovers on the job market for workers in paid jobs. Entrepreneurs contribute to job creation (Kerr and Kerr, 2020; Azoulay et al., 2022) as well as job destruction (Georgarakos and Tatsiramos, 2009), resulting in direct consequences of immigrant entrepreneurship for employment opportunities of workers in regular employment. Provided this evidence, we propose a unified framework for the entrepreneurial pursuits of natives and immigrants and regular employment activities.

Finally, our paper builds on a traditional SaM framework (Mortensen and Pissarides (1994), Pissarides (2000)) and augments it with entrepreneurship. An early search model with occupational choice between paid employment and entrepreneurship is by Fonseca et al. (2001). Rissman (2007) and Kredler et al. (2014) extend this setup to a "business idea ladder", where entrepreneurs generate business ideas and implement those of them that are more profitable. We contribute to this literature by combining the approach of a "business idea ladder" with endogenous business creation in the spirit of Masters (2016).

[7] An interesting strand of literature focuses on comparing characteristics of native and immigrant entrepreneurs in terms of earnings, human capital, likelihood, and reasons to start a business (Li, 2001; Lofstrom, 2002; Constant and Zimmermann, 2006).

3 The Model

3.1 The environment

The labour market is populated by four demographic groups: low-skill immigrants d^{IL}, low-skill natives d^{NL}, high-skill immigrants d^{IH} and high-skill natives d^{NH}. All individuals are risk-neutral and discount future income flows at the rate r. Labour supply is inelastic, and the total labour force is normalized to 1:

$$d^{IL} + d^{NL} + d^{IH} + d^{NH} = 1$$

i denotes the origin of the individual $\{I, N\}$ and j indicates the skill level $\{L, H\}$. Within each demographic group ij, there are two subgroups: potential entrepreneurs with high entrepreneurial spirit l^{ij} and regular workers with low entrepreneurial spirit $d^{ij} - l^{ij}$. This group distinction is exogenous and based on innate ability, attitudes, and personality traits, which we do not model explicitly.[8] Being a *potential* entrepreneur does not imply being an *active* entrepreneur at a given point in time. Potential entrepreneurs can also be observed in paid employment or unemployment. However, their entrepreneurial spirit may lead them to switch from these states to starting a solo self-employment or business with coworkers. This group distinction is motivated by the SOEP data, which shows that 85% of individuals in our sample were never observed in self-employment over 18 years and remain in paid employment with an annual probability of at least 97%. On the contrary, there are 15% of individuals actively moving between paid jobs and self-employment with an average annual probability equal to $15 - 23\%$ and a similarly high transition probability back to a paid job (see Appendix A.1 for details).

Regular workers. There are two employment states for regular workers. First, regular workers can be employed in a regular job $\bar{e}^{ij}$, producing output $\bar{y}^{ij}$ and receiving a wage $\bar{w}^{ij}$. Regular jobs are positions in medium and large-size firms. Second, potential entrepreneurs can employ them in a small business $\bar{e}_0^{ij}$. Hence, we have:

$$\bar{e}^{ij} + \bar{e}_0^{ij} + \bar{u}^{ij} = d^{ij} - l^{ij}$$

Where $\bar{u}^{ij}$ is a state of involuntary unemployment for regular workers associated with a flow income $\bar{z}^{ij} - h$. Variable $\bar{z}^{ij}$ is the unemployment benefit, whereas h – is the disutility from unemployment (e.g., the stigma of failure). The exogenous shock of job destruction arrives to all employees in regular jobs at rate $\bar{\gamma}^{ij}$, rendering them unemployed.

Potential entrepreneurs. Potential entrepreneurs have a high entrepreneurial spirit, so they can be solo self-employed s^{ij} or operating small businesses with coworkers b^{ij}. The decision to become self-employed and start a business is endogenous and driven by mar-

[8] Intuitively, individuals with high managerial and organizational skills, low risk-aversion, extroverted, and communicative are more likely to be potential entrepreneurs.

ket forces. The stock of potential entrepreneurs in paid employment in a regular job is denoted by e^{ij} and is associated with a flow output y^{ij} and a wage w^{ij}, this yields:

$$s^{ij} + b^{ij} + e^{ij} + u^{ij} = l^{ij}$$

where u^{ij} is a state of unemployment with a flow income $z^{ij} - h$.

Potential entrepreneurs generate business ideas associated with a product/service quality α, which follows a distribution $F(\alpha)$, $\alpha \in [0..\bar{\alpha}]$. New realizations of α arrive to potential entrepreneurs at the Poisson rate δ^{ij}. The intuitive idea behind this process is that potential entrepreneurs may invent new products and decide to work in self-employment or improve the quality of the existing product and register a small business with coworkers. The idiosyncratic productivity shocks δ^{ij} are positive since potential entrepreneurs can ignore the new realization of α if it is not beneficial for them. We follow the "business idea ladder" approach (Rissman (2007), Kredler et al. (2014)) and assume that new business ideas can not be stored for future use. In addition, we assume that there are no productivity shocks δ^{ij} in the state of business ownership with coworkers.

Self-employed entrepreneurs produce the flow output $\sigma^{ij}\alpha$. However, if they decide to register a business they incur a flow cost of capital c_k^{ij} and the cost of posting a vacancy c_h^j. Let the two costs together be denoted by $c^{ij} = c_k^{ij} + c_h^j$, so the individual net output of the business owner becomes $\sigma^{ij}\alpha - c^{ij}$. Profits generated by coworkers and the firm size distribution are introduced later in the paper. Small businesses become bankrupt at the Poisson arrival rate γ^{ij}, where ij is the demographic group of the business owner. In the case of bankruptcy, all coworkers and the business owner become unemployed. The same shock arrives to solo self-employed and leads to involuntary unemployment.

Regular vacancies. Consider matching in the regular market $j = L, H$, these are skill-specific positions in medium and large firms. Posting a vacancy in submarket j is associated with a posting cost $\bar{c}_h^j$ and a flow capital cost $\bar{c}_k^j$. Let $M^j(\Sigma^j)^\zeta(v^j)^{1-\zeta}$, $j = L, H$ denote the corresponding Cobb-Douglas matching function, where v^j denotes the number of open vacancies and Σ^j denotes the number of searching workers in efficiency units. Σ^j consists of unemployed regular workers $\bar{u}^{ij}$, unemployed potential entrepreneurs u^{ij}, and searching solo self-employed entrepreneurs weighted by the exogenous search intensity X^{ij}. The solo self-employed entrepreneurs can search for regular jobs if it is optimal for them. We refer to searching self-employed (s_u^{ij}) as self-employed "*out of necessity*" since they would strictly prefer to have a regular job. In contrast, we refer to non-searching self-employed (s_e^{ij}) as self-employed "*out of opportunity*" as they would not accept a regular job even if they get an offer. Given this notation, we have:

$$\Sigma^j = X^{Ij}(\bar{u}^{Ij} + u^{Ij} + s_u^{Ij}) + X^{Nj}(\bar{u}^{Nj} + u^{Nj} + s_u^{Nj})$$

$s^{ij} = s_u^{ij} + s_e^{ij}$ implies that every self-employed person can be assigned into a searching or non-searching group based on the optimal job search decision. The job-finding rate $\lambda(\theta^j)$

and the vacancy filling rate $q(\theta^j)$ in a regular submarket j can then be written as:

$$\lambda(\theta^j) = M^j(\theta^j)^{1-\zeta} \qquad q(\theta^j) = M^j(\theta^j)^{-\zeta} \qquad \theta^j = \frac{v^j}{\Sigma^j}$$

where θ^j is the market tightness in the submarket j.

Small businesses. Consider matching between searching workers and small businesses operated by entrepreneurs. Small businesses post vacancies sequentially, meaning there is exactly one vacancy per business posted at any time. The next vacancy is posted only after the previous was filled with a worker. This means that small businesses grow over time and that the total number of posted vacancies is given by $b^{Nj}+b^{Ij}$ since both native and immigrant small businesses post vacancies. Let $\bar{M}^j(\Sigma_0^j)^{\zeta}(b^{Ij}+b^{Nj})^{1-\zeta}$, $j = L, H$ denote the corresponding matching function. Σ_0^j consists of unemployed regular workers $\bar{u}^{ij}$ weighted by their search intensities x^{ij}. We assume that high-skill regular workers can only be hired by the high-skill entrepreneurs, whereas low-skill regular workers are engaged in *cross-skill matching* and apply to all types of small businesses. Accounting for cross-skill matching allows us to accommodate the empirical fact that many low-skill workers and relatively few high-skill workers are employed in small businesses.

Given this setup, the job-finding rate $\bar{\lambda}(\theta_0^j)$ and the vacancy filling rate $\bar{q}(\theta_0^j)$ in submarket j become:

$$\bar{\lambda}(\theta_0^j) = \bar{M}^j(\theta_0^j)^{1-\zeta} \qquad \bar{q}(\theta_0^j) = \bar{M}^j(\theta_0^j)^{-\zeta} \qquad \theta_0^j = \frac{b^{Nj}+b^{Ij}}{\Sigma_0^j}$$

Where θ_0^j is the market tightness associated with small businesses.

Final output. The final good Y is produced using capital K and a composite labour good Z with a CRS technology. For the composite good Z, we follow the literature (Acemoglu (2001) and Battisti et al. (2018)) and use a CES production function with two intermediate skill-specific inputs, Y_L and Y_H, that is:

$$Y = AK^{\eta}Z^{1-\eta}, \quad \eta \in (0..1) \tag{1}$$

$$Z = [aY_L^{\rho} + (1-a)Y_H^{\rho}]^{\frac{1}{\rho}}, \quad \rho < 1 \tag{2}$$

where $1/(1-\rho)$ is the elasticity of substitution between high and low-skill intermediate inputs. Each intermediate input Y_j is a linear aggregate of output quantities produced in submarket j. Let variable $\bar{\varphi}^{ij}$ denote the quantity one regular worker produces in the group ij. Then the value of this worker's output becomes $\bar{y}^{ij} = \bar{\varphi}^{ij}P^j$, where P^j is the price of the intermediate good j. In a similar way we define variables φ^{ij} and ς^{ij}, so that $y^{ij} = \varphi^{ij}P^j$ and $\sigma^{ij} = \varsigma^{ij}P^j$. Output quantities are exogenous and specific to each worker group. However, the price of the intermediate good P^j is endogenous and common to all workers in the skill category $j = L, H$. Intermediate goods are sold to the final good producer in a competitive market, so the price P^j equals the marginal productivity of the intermediate good Y_j. The price of capital is exogenous and denoted by R.

Taxes. All employees in paid and self-employment pay an income tax t. In addition, regular firms and small businesses pay the corporate tax τ on their profits.

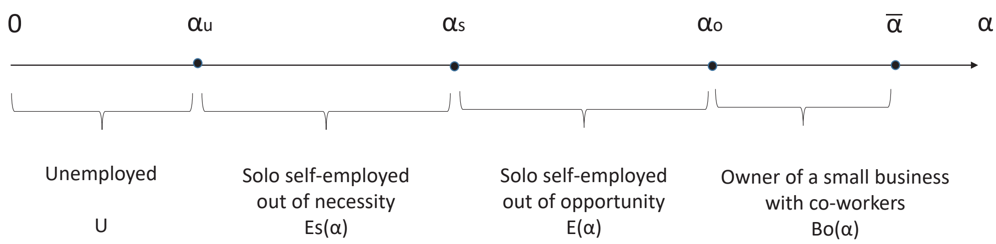
3.2 Entrepreneurial decisions

In this section we explain the decisions of potential entrepreneurs. There are three decisions to be considered: entering solo self-employment, searching for a regular paid job, starting a business with coworkers. All the following equations are specific to the entrepreneurs of the type ij, however, we drop the upper index where possible for the ease of exposition and recover full-scale notation later in the paper. Consider unemployed potential entrepreneurs and let U denote the present value of income in unemployment. Potential entrepreneurs generate business ideas associated with product/service quality α. If the new realization of α crosses the endogenous boundary α_u then potential entrepreneurs enter the state of self-employment and start producing the flow output $\sigma\alpha$. The threshold value α_u follows from the following optimization problem:

$$\max[U, E_s(\alpha)] = \begin{cases} E_s(\alpha) & \text{for} \quad \alpha > \alpha_u \\ U & \text{for} \quad \alpha < \alpha_u \end{cases} \qquad \text{and} \qquad E_s(\alpha_u) = U$$

where $E_s(\alpha)$ denotes the present value of income in solo self-employment *out of necessity*, if the entrepreneur continues searching for a regular job. We show later that $E_s(\alpha)$ is an increasing function of α. The sequence of labour market decisions for potential entrepreneurs is illustrated on figure 1.

Figure 1: Self-employment states for different values of α



Further, let $W > U$ denote the present value of income in a regular job. If the new realization of α exceeds the next threshold α_s, then self-employed entrepreneurs stop searching for regular jobs, and become solo self-employment *out of opportunity*. This is because staying in self-employment in this state is associated with a higher present value of income $E(\alpha)$ than regular employment, so we get:

$$\max[E_s(\alpha), E(\alpha)] = \begin{cases} E(\alpha) > W & \text{for} \quad \alpha > \alpha_s \\ E_s(\alpha) < W & \text{for} \quad \alpha < \alpha_s \end{cases} \qquad \text{and} \qquad E_s(\alpha_s) = W = E(\alpha_s)$$

where again $E(\alpha)$ should be increasing in α.

Finally, for very high realizations of α, such that $\alpha \in [\alpha_0..\bar{\alpha}]$ entrepreneurs register a small business and post vacancies. The present value of profits in this state is denoted by $B_0(\alpha)$, where the subindex refers to the number of coworkers. Any new business starts with 0 coworkers. Later we show that $B_0(\alpha)$ is increasing in α, so the endogenous cut-off α_0 driving the business entry can be obtained as:

$$\max[E(\alpha), B_0(\alpha)] = \begin{cases} B_0(\alpha) & \text{for} \quad \alpha > \alpha_0 \\ E(\alpha) & \text{for} \quad \alpha < \alpha_0 \end{cases} \qquad \text{and} \qquad E(\alpha_0) = B_0(\alpha_0)$$

3.3 Value functions

Applying the optimal decision strategies of potential entrepreneurs we can write down the present value of unemployment U in the following way:

$$\begin{aligned} rU &= z - h + X\lambda(\theta)(W - U) \\ &+ \underbrace{\delta \int_{\alpha_u}^{\alpha_s} (E_s(x) - U) dF(x)}_{\text{solo-entr. out of necessity}} + \underbrace{\delta \int_{\alpha_s}^{\alpha_0} (E(x) - U) dF(x)}_{\text{solo-entr. out of opportunity}} + \underbrace{\delta \int_{\alpha_0}^{\bar{\alpha}} (B_0(x) - U) dF(x)}_{\text{business with coworkers}} \end{aligned} \tag{3}$$

where X is the search efficiency parameter, so that $X\lambda(\theta)$ is the job-finding rate associated with regular jobs. This equation shows that depending on the product quality associated with the new business idea α unemployed potential entrepreneurs may decide to stay unemployed, move into solo self-semployment, or even register a business hiring coworkers.

Next, we describe the present value of income in solo self-employment out of necessity, which applies for $\alpha \in [\alpha_u..\alpha_s]$:

$$\begin{aligned} rE_s(\alpha) &= \sigma\alpha(1-t) + \underbrace{\delta \int_{\alpha}^{\alpha_s} (E_s(x) - E_s(\alpha)) dF(x)}_{\text{improving profits}} + \underbrace{\delta \int_{\alpha_s}^{\alpha_0} (E(x) - E_s(\alpha)) dF(x)}_{\text{solo-entr. out of opportunity}} \\ &+ \underbrace{\delta \int_{\alpha_0}^{\bar{\alpha}} (B_0(x) - E_s(\alpha)) dF(x)}_{\text{business with coworkers}} + X\lambda(\theta)(W - E_s(\alpha)) - \gamma(E_s(\alpha) - U) \end{aligned} \tag{4}$$

where $\sigma\alpha(1-t)$ is the after tax income in self-employment. This equation shows that the quality of the service/product and income of the self-employed entrepreneur are improving over time. So when the income achieves the level $\sigma\alpha_s(1-t)$, meaning $E_s(\alpha_s) = W$, self-employed entrepreneurs stop searching for regular jobs and focus on their entrepreneurial activities. The present value of entrepreneurship out of opportunity $E(\alpha)$ is given by:

$$\begin{aligned} rE(\alpha) &= \sigma\alpha(1-t) + \underbrace{\delta \int_{\alpha}^{\alpha_0} (E(x) - E(\alpha)) dF(x)}_{\text{improving profits}} + \underbrace{\delta \int_{\alpha_0}^{\bar{\alpha}} (B_0(x) - E(\alpha)) dF(x)}_{\text{business with coworkers}} \\ &- \gamma(E(\alpha) - U) \quad \text{for} \quad \alpha_s < \alpha < \alpha_0 \end{aligned} \tag{5}$$

where again the first integral on the right hand side accounts for the improving quality of the entrepreneurial product α, whereas the second integral refers to the possibility of registering a business and posting vacancies associated with a present value $B_0(\alpha)$.

When modeling small businesses with coworkers we follow the approach in Masters (2016). Small businesses post vacancies sequentially, so there is one open position per small business at any time. At rate $\bar{q}(\theta_0)$ small businesses are matched with potential candidates. Consider first the low-skill submarket. With endogenous probability μ, the applicant has immigrant background, while it is a native worker with probability $1-\mu$. The present value of a start-up business $B_0(\alpha)$ is then given by:

$$(r+\gamma)B_0(\alpha) = \sigma\alpha(1-t) - c + \bar{q}(\theta_0)[\mu(B_{10}(\alpha) - B_0(\alpha)) + (1-\mu)(B_{01}(\alpha) - B_0(\alpha))] + \gamma U$$

where $B_{km}(\alpha)$ denotes the present value of a small business with k immigrant coworkers and m native coworkers. Let y_0^i and w_0^i, $i = I, N$ denote productivity and wages of workers employed in small businesses. We assume that the output of workers in small firms is additive (constant returns to scale), but it is not a restrictive assumption because the output in different labour market segments is further aggregated by means of the CES production function (2). Thus, the present value $B_{km}(\alpha)$ can be written as:

$$\begin{aligned} rB_{km}(\alpha) &= \sigma\alpha(1-t) - c + k(y_0^I - w_0^I)(1-\tau) + m(y_0^N - w_0^N)(1-\tau) + \\ &+ \bar{q}(\theta_0)[\mu(B_{k+1m}(\alpha) - B_{km}(\alpha)) + (1-\mu)(B_{km+1} - B_{km}(\alpha))] - \gamma(B_{km}(\alpha) - U) \end{aligned}$$

The value gain from hiring one more coworker, denoted $\Delta^I = B_{k+1m}(\alpha) - B_{km}(\alpha)$ and $\Delta^N = B_{km+1}(\alpha) - B_{km}(\alpha)$, is constant $\forall k, m = 0..\infty$ and given by (see appendix A.2):

$$\Delta^I = \frac{y_0^I - w_0^I}{r+\gamma}(1-\tau) \qquad \Delta^N = \frac{y_0^N - w_0^N}{r+\gamma}(1-\tau)$$

This yields the following expression for a low-skill start-up business:

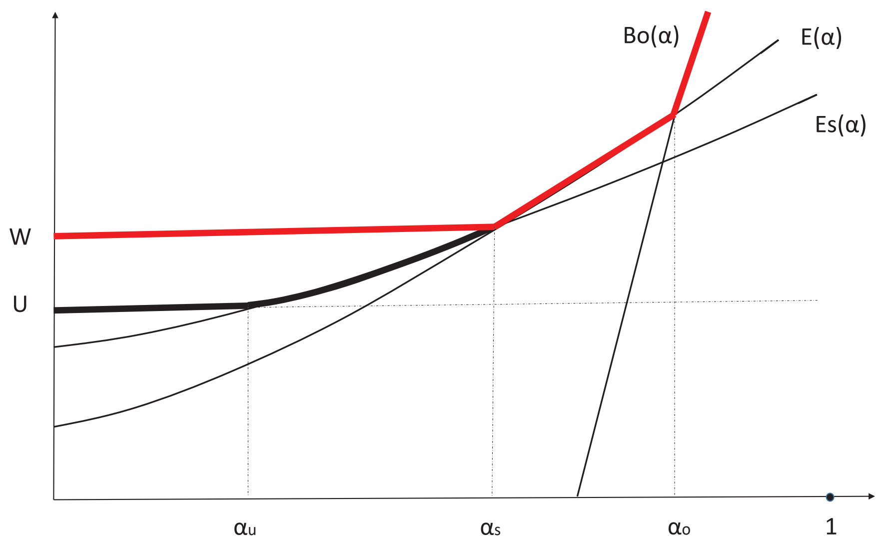
$$(r+\gamma)B_0(\alpha) = \sigma\alpha(1-t) - c + \bar{q}(\theta_0)\pi + \gamma U, \quad \text{where} \quad \pi = \mu\Delta^I + (1-\mu)\Delta^N \quad (6)$$

The variable π denotes the expected after-tax profit from hiring coworkers in small businesses. Posting a vacancy is only profitable if $c_h < \bar{q}(\theta_0)\pi$. $B_0(\alpha)$ is a linear increasing function of α with a slope $\sigma(1-t)/(r+\gamma)$. Next we consider high-skill start-up businesses. Recall that high-skill entrepreneurs hire both types of employees, high and low-skill ones. Let μ^{ij} denote the probability of matching and hiring a coworker of type ij, $i = I, N$, $j = L, H$. Applying the same approach as above to high-skill businesses we can show that $\pi = \mu^{IH}\Delta^{IH} + \mu^{NH}\Delta^{NH} + \mu^{IL}\Delta^{IL} + \mu^{NL}\Delta^{NL}$ (details in appendix A.2).

$E(\alpha)$ is an increasing convex function of α with a slope $E'(\alpha) = \sigma(1-t)/(r+\gamma+\delta(1-F(\alpha)))$ (details in appendix A.3). Both functions $E(\alpha)$ and $B_0(\alpha)$ are illustrated on figure 2. Building on this result we can show that there exists a unique cut-off value α_0

making entrepreneurs indifferent between remaining in solo self-employment $E(\alpha_0)$ and starting a small business ($B_0(\alpha_0)$), which yields Proposition 1:

Figure 2: Endogenous self-employment cut-offs



Proposition 1: *The endogenous quality cut-off α_0, which is driving the creation of small businesses, can be found from the following* ***indifference condition*** *$E(\alpha_0) = B_0(\alpha_0)$, and is implicitly given by:*

$$\delta(1-t)\int_{\alpha_0}^{\bar{\alpha}} \frac{(1-F(x))\sigma}{r+\gamma}dx + c = \bar{q}(\theta_0)\pi \tag{7}$$

$$\text{where} \quad \pi = \begin{cases} \mu\Delta^I + (1-\mu)\Delta^N & \text{for low-skill businesses} \\ \sum_{j=L,H} \mu^{Ij}\Delta^{Ij} + \mu^{Nj}\Delta^{Nj} & \text{for high-skill businesses} \end{cases}$$

The cut-off value α_0 exists and is unique if $0 < (-c+\bar{q}\pi)(r+\gamma) < \delta(1-t)\sigma\int_0^{\bar{\alpha}}(1-F(x))dx$. For given values of endogenous variables $\bar{q}(\theta_0)$ and π, α_0 is increasing in δ, σ, and c.
Proof: appendix A.3.

The left-hand side of equation (7) is the total cost of starting a business. It includes the direct cost of capital and recruitment c and the indirect cost reflected by the integral term. This is the option value of staying in solo self-employment and waiting for another product idea of better quality (above α_0). The right hand side of equation (7) is the expected (after tax) profit from hiring coworkers. Intuitively, it means that every new beneficial realization of α reduces the option value of staying in solo self-employment, so the business entry becomes optimal when the option value of waiting equalizes with the expected gain from registering a start-up.

The present value of employment in a regular job W paying wage w is given by:

$$rW = w(1-t) + \underbrace{\delta\int_{\alpha_s}^{\alpha_0}(E(x)-W)dF(x)}_{\text{solo-entr. out of opportunity}} + \underbrace{\delta\int_{\alpha_0}^{\bar{\alpha}}(B_0(x)-W)dF(x)}_{\text{business with coworkers}} - \bar{\gamma}(W-U) \tag{8}$$

where $w(1-t)$ is the after tax labour income and $\bar{\gamma}$ is the job destruction rate. This relationship shows that employed potential entrepreneurs continue generating new business ideas and may voluntarily quit the job and enter self-employment (out of opportunity) or start a new business.

At $\alpha > \alpha_s$, self-employed entrepreneurs stop searching and applying for regular paid jobs. This is because the quality of their product/service becomes sufficiently high, which is associated with a relatively high income $\sigma\alpha(1-t)$. So the cut-off value of α_s is given by the following indifference condition: $E(\alpha_s) = W$. It then holds that $E_s(\alpha_s) = E(\alpha_s)$ since the option of searching for a regular job has zero value for $\alpha = \alpha_s$.

Proposition 2: *The endogenous threshold α_s separating solo self-employed out of necessity and opportunity can be obtained from the following indifference condition: $E_s(\alpha_s) = E(\alpha_s) = W$, which yields:*

$$\sigma\alpha_s = w - \frac{(\bar{\gamma}-\gamma)}{r+\bar{\gamma}+X\lambda(\theta)}\left(w - \frac{z-h}{1-t} - \delta\int_{\alpha_u}^{\alpha_s}\frac{(1-F(x))\sigma}{r+\gamma+X\lambda(\theta)+\delta(1-F(x))}dx\right) \tag{9}$$

The cutoff α_s is increasing in the wage w. It is convex in w if $\gamma > \bar{\gamma}$ and concave otherwise. The slope is given by:

$$\frac{\partial\alpha_s}{\partial w} = \frac{(r+\gamma+X\lambda(\theta)+\delta(1-F(\alpha_s)))}{\sigma(r+\bar{\gamma}+X\lambda(\theta)+\delta(1-F(\alpha_s)))} \tag{10}$$

Proof: appendix A.3

Equation (9) is an explicit form of a shorter expression $\sigma\alpha_s(1-t) = w(1-t) - (\bar{\gamma}-\gamma)(W-U)$. First, self-employed entrepreneurs compare their flow incomes $\sigma\alpha(1-t)$ and $w(1-t)$. Second, they also consider the risk of dropping back to the state of unemployment, which is $\bar{\gamma}$ in a regular job and γ in self-employment. In the special case $\bar{\gamma} = \gamma$ we would get $\alpha_s = w/\sigma$. Equation (10) implies that a higher wage w makes regular jobs even more valuable and gives rise to a higher threshold α_s.

The threshold value α_u is given by the indifference condition $E_s(\alpha_u) = U$. $E_s(\alpha)$ is an increasing convex function of α with a slope $E_s'(\alpha) = \sigma(1-t)/(r+\gamma+X\lambda(\theta)+\delta(1-F(\alpha)))$ as shown on figure 2. Comparing the present value from solo self-employment $E_s(\alpha_u)$ and the present value of unemployment U gives the following result:

Proposition 3: *The endogenous threshold α_u driving the entry into solo self-employment can be obtained from condition $E_s(\alpha_u) = U$, which yields: $\sigma\alpha_u(1-t) = z-h$.*

Proof: appendix A.3

Potential entrepreneurs entering self-employment keep the option of searching for regular jobs, and they also keep the option of starting a small business, so there are no costs of starting self-employment apart from losing the flow income in unemployment $z-h$. The additional gain from self-employment is the flow income $\sigma\alpha(1-t)$, which leads to the finding $\alpha_u = (z-h)/(\sigma(1-t))$. Even though parameters z, h, t are exogenous, the productivity in self-employment is a product of the quantity and the endogenous price

($\sigma = \varsigma P$), making the entry cut-off α_u endogenous as well. Hence, if the output price P is increasing, more potential entrepreneurs decide to enter self-employment.

3.4 Steady-state distribution

The firm size distribution. In this section we discuss the steady-state distribution of the number of employees in small businesses. We start by analyzing low-skill small businesses. Let p_k^I – be the number of small businesses with k immigrant coworkers and and p_m^N = be the number of businesses with m native coworkers. In proposition 4 we characterize these distributions and show that they do not depend on α:

Proposition 4: *The numbers of immigrant and native coworkers in low skill businesses are given by geometric densities with parameters $\gamma/(\gamma + \bar{q}(\theta_0)(1-\mu))$ and $\gamma/(\gamma + \bar{q}(\theta_0)\mu)$ respectively. The number of all employees in low-skill businesses has a geometric density with parameter $\gamma/(\gamma + \bar{q}(\theta_0))$.* **Proof:** Appendix A.4.

This proposition allows us to infer the average number of immigrant/native coworkers per low skill business which is given by $\bar{q}(\theta_0)\mu/\gamma$ and $\bar{q}(\theta_0)(1-\mu)/\gamma$ respectively. So the average size of a small business is $\bar{q}(\theta_0)/\gamma$. The size distribution of small businesses (p_n) is also given by the geometric density with parameter $\gamma/(\gamma + \bar{q}(\theta_0))$:

$$p_n = \Big(\frac{\bar{q}(\theta_0)}{\gamma + \bar{q}(\theta_0)}\Big)^n \frac{\gamma}{\gamma + \bar{q}(\theta_0)}$$

This density is decreasing in the whole support, implying that a vast majority of businesses are small and only very few of them survive for a long period of time and become large. We find that this decreasing pattern is consistent with the empirical evidence observed in Germany. For example, according to Leicht and Langhauser (2014) the share of native-owned businesses with less than 5 employees is 59%, the share of businesses with 6-10 employees is 21%, with $11-19$ employees – 10%, with $20-49$ employees – 6% and more than 50 employees – 3%. A similar decreasing pattern is also reported for immigrant businesses and it is well captured by the geometric distribution function.

Considering high-skill businesses, the average number of type ij employees, $i = I, N$, $j = L, H$, is given by $\bar{q}(\theta_0)\mu^{ij}/\gamma$. Moreover, the unconditional distribution of employees ij in these businesses also has a geometric density with parameter $\gamma/(\gamma + \bar{q}(\theta_0)\mu^{ij})$.

The distribution of entrepreneurs. Variables s_u and s_e are the numbers of necessity and opportunity entrepreneurs, respectively, so that $s = s_u + s_e$ is a total number of solo-entrepreneurs. Given that the total number of potential entrepreneurs (in the group ij, which we omit for the ease of exposition) is denoted by l, we get: $s_u + s_e + e + u + b = l$. Potential entrepreneurs, who are not business owners $l - b$, register start-up firms at rate $\delta f(\alpha)$ if $\alpha > \alpha_0$. At the same time, businesses are destroyed at rate γ, which gives rise to the following dynamics: $\dot{b}(\alpha) = \delta f(\alpha)(l-b) - \gamma b(\alpha)$. Imposing the steady state condition

$\dot{b}(\alpha) = 0$ and integrating $b(\alpha)$ we can find the total number of small businesses b:

$$b = \int_{\alpha_0}^{\bar{\alpha}} b(\alpha) d\alpha = \frac{\delta(1 - F(\alpha_0))(l - b)}{\gamma} \quad \Rightarrow \quad b = \frac{\delta(1 - F(\alpha_0))l}{\gamma + \delta(1 - F(\alpha_0))}$$

This condition postulates a negative monotonous relationship between the entry threshold α_0 and the stock of small businesses b. Intuitively, a higher cut-off α_0 leads to a lower probability of starting a business $1 - F(\alpha_0)$, so the stock of small businesses b declines.

Let $G(\alpha)$ be the equilibrium distribution of solo self-employed out of opportunity with respect to the quality of their product α. More precisely it is the accumulated stock of self-employed entrepreneurs with a product quality in the range $[\alpha_s..\alpha]$. The dynamic equation for $G(\alpha)$ is given by:

$$\dot{G}(\alpha) = \underbrace{(s_u + e + u)}_{=l-b-s_e} \delta(F(\alpha) - F(\alpha_s)) - (\gamma + \delta(1 - F(\alpha)))G(\alpha) \tag{11}$$

Unemployed entrepreneurs u, and those self-employed out of necessity s_u, stop searching for regular jobs, if they develop a product/service with quality above α_s. Also employees in regular employment e quit their jobs and become self-employed out of opportunity if they get a realization of α above α_s. So the first term in equation (11) is the inflow of entrepreneurs into solo self-employment out of opportunity. The second term is the outflow consisting of unsuccessful entrepreneurs dropping back into unemployment (at rate γ) and those who develop a better product (at rate $\delta(1 - F(\alpha))$). Imposing the steady state condition $\dot{G}(\alpha) = 0$ and taking into account that $s_e = G(\alpha_0)$ we get:

$$s_e = G(\alpha_0) = \frac{\delta(F(\alpha_0) - F(\alpha_s))}{[\gamma + \delta(1 - F(\alpha_0))]} \frac{\gamma l}{[\gamma + \delta(1 - F(\alpha_s))]} \tag{12}$$

Next, consider the steady-state equation for employed potential entrepreneurs:

$$\dot{e} = (u + s_u)X\lambda(\theta) - (\bar{\gamma} + \delta(1 - F(\alpha_s)))e = 0$$

where the first term is the inflow which corresponds to all searching potential entrepreneurs $(u + s_u)$ starting a regular job at rate $X\lambda(\theta)$. Again, the second term is the outflow consisting of those losing regular jobs at rate $\bar{\gamma}$ or quitting their jobs voluntarily and becoming solo self-employed out of opportunity. Taking into account that $u + s_u = l - b - s_e - e$ we get the equilibrium expression for e:

$$e = \frac{X\lambda(\theta)}{[\bar{\gamma} + X\lambda(\theta) + \delta(1 - F(\alpha_s))]} \frac{\gamma l}{[(\gamma + \delta(1 - F(\alpha_s))]} \tag{13}$$

Further, let $H(\alpha)$ be the equilibrium distribution of solo self-employed out of necessity with respect to the quality of their product or service α. It is the accumulated stock of self-employed with product qualities in the range $[\alpha_u..\alpha]$. So we get:

$$\dot{H}(\alpha) = u\delta(F(\alpha) - F(\alpha_u)) - (\gamma + \delta(1 - F(\alpha)) + X\lambda(\theta))H(\alpha)$$

The first term is the inflow and includes unemployed individuals developing product qualities above α_u and starting self-employment. The second term is the outflow consisting of self-employed entrepreneurs taking a regular job (at rate $X\lambda(\theta)$), dropping back into unemployment (at rate γ) and developing a better product quality (at rate $\delta(1 - F(\alpha))$). Imposing again the steady state condition $\dot{H}(\alpha) = 0$ and taking into account that $s_u = H(\alpha_s)$ we can find the equilibrium stock of potential entrepreneurs out of necessity s_u and in unemployment u. We summarize these results in proposition 5:

Proposition 5: *The equilibrium number of solo self-employed out of necessity s_u and the number of unemployed potential entrepreneurs u are given by:*

$$\begin{aligned} s_u &= \frac{\delta(F(\alpha_s) - F(\alpha_u))}{[\gamma + X\lambda(\theta) + \delta(1 - F(\alpha_u))]} \frac{(\bar{\gamma} + \delta(1 - F(\alpha_s)))}{[\bar{\gamma} + X\lambda(\theta) + \delta(1 - F(\alpha_s))]} \frac{\gamma l}{[\gamma + \delta(1 - F(\alpha_s))]} \\ u &= \frac{\gamma + X\lambda(\theta) + \delta(1 - F(\alpha_s))}{[\gamma + X\lambda(\theta) + \delta(1 - F(\alpha_u))]} \frac{(\bar{\gamma} + \delta(1 - F(\alpha_s)))}{[\bar{\gamma} + X\lambda(\theta) + \delta(1 - F(\alpha_s))]} \frac{\gamma l}{[\gamma + \delta(1 - F(\alpha_s))]} \end{aligned}$$

Proposition 5 shows that, other things being equal, the stock s_u is decreasing in the cut-off α_u. On the contrary, a higher α_u is associated with a higher stock of unemployed entrepreneurs u.

The distributions of solo self-employed with respect to the quality of their products α can be found due to the fact that $s_u(\alpha) = H'(\alpha)$ and $s_e(\alpha) = G'(\alpha)$. The exact expressions are delegated to appendix A.4.

3.5 Wage setting

In this section we address the determination of wages. Regular firms can be matched with regular workers or potential entrepreneurs seeking to take a paid job, however, small businesses only hire regular workers. This gives rise to several types of wage negotiations which we model by means of Nash bargaining. First, we describe the wage bargaining between regular firms and potential entrepreneurs.

Bargaining with potential entrepreneurs: Consider a match between a regular firm and a potential entrepreneur and let the corresponding present value of a job be denoted by J, it becomes:

$$rJ = y - \bar{c}_k - w - \bar{\gamma}(J - V) - \delta(1 - F(\alpha_s(w)))(J - V)$$

where $\bar{c}_k$ corresponds to the flow cost of capital for regular firms. This equation shows that the total job destruction rate associated with potential entrepreneurs is relatively high since there is a positive probability $\delta(1 - F(\alpha_s(w)))$ that they will quit the job and enter self-employment. This reduces the value of the job surplus to the firm.

In order to model wage bargaining between job applicants and regular firms we follow the approach in Gautier (2002). This approach assumes that applicants matched with an employer and negotiating over the wage stop searching for alternative jobs. In addition, we assume that they also disregard their activities in self-employment out of necessity, since paid employment is a superior state of income (i.e $E_s(\alpha) < W \quad \forall \quad \alpha < \alpha_s$). However, they continue considering self-employment out of opportunity and the possibility of starting a business (which happens for $\alpha > \alpha_s$) while negotiating with a regular employer. The advantage of this approach is that labour contracts are renegotiation proof, meaning that potential entrepreneurs receive the same wage w in paid employment irrespective of their previous income in self-employment. Assuming additionally that potential entrepreneurs still enjoy the unemployment benefit z while bargaining, but no longer the stigma of failure h, gives rise to the following Nash bargaining problem:[9]

$$\max_w \Big(\frac{w(1-t)-z}{r+\bar{\gamma}}\Big)^{\beta}\Big(\frac{(y-\bar{c}_k-w)}{r+\bar{\gamma}+\delta(1-F(\alpha_s(w)))}\Big)^{1-\beta}$$

This equation shows that higher wages have an ambiguous effect on the present value of firms' profits. On the one hand, there is the direct effect of higher labour costs reducing profits. But on the other hand, paying a higher wage reduces the probability that the potential entrepreneur employed in a regular job will quit into self-employment (i.e. higher $\alpha_s(w)$). This reduces the overall job destruction rate from the perspective of the firm and has a positive effect on the present value of profits.

Proposition 6: *The wage of potential entrepreneurs in paid employment is given by:*

$$w(1-t) = \beta(y-\bar{c}_k)(1-t) + (1-\beta)z + (1-\beta)\frac{(y-\bar{c}_k-w)(w(1-t)-z)\delta f(\alpha_s)}{r+\bar{\gamma}+\delta(1-F(\alpha_s))}\frac{\partial\alpha_s}{\partial w}$$

where $\partial\alpha_s/\partial w$ is given by equation (10). *If the distribution of product qualities is uniform ($f(\alpha) = 1$) and $\gamma \leq \bar{\gamma}$ then the wage is increasing in the productivity y and in the bargaining power β such that $z \leq w(1-t) \leq (y-\bar{c}_k)(1-t)$.*

Proof: appendix A.5

This proposition presents conditions which are sufficient for the wage w to be increasing in the productivity y and the bargaining power β, however, these conditions are strong and the described properties of the wage hold for a broader range of parameter values.

We follow the same approach and use the renegotiation-proof Nash bargaining for determining wages of regular workers in large and medium-size firms ($\bar{w}$) and in small businesses (w_{0N}, w_{0I}, w_{CN}, w_{CI}). The subindex referes to the type of small business, for example, $0N$ indicates wages paid by native small businesses to their employees, while the subindex $0I$ indicates wages paid by immigrant small businesses. Further, the

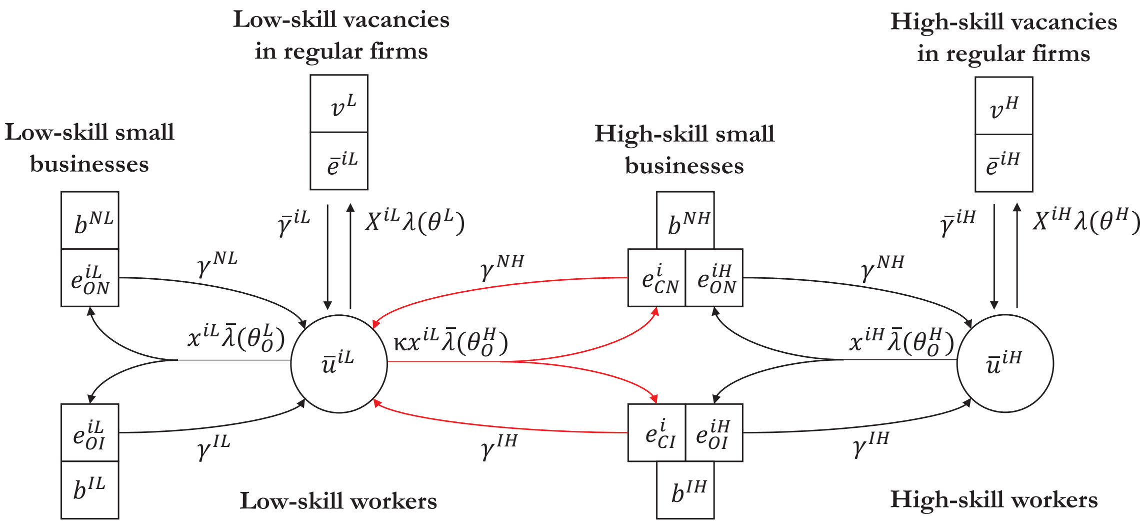
[9]The present value of potential entrepreneurs in paid jobs W and their disagreement value W_D are presented in appendix A.5

subindex CN indicates wages paid by native high-skill businesses to low-skill employees, while the subindex CI indicates wages paid by immigrant high-skill businesses to their low-skill workers (engaged in cross-skill matching). In appendix A.5 we show that each wage is a weighted average of the respective productivity ($\bar{y}$, y_{0N}, y_{0I}, y_{CN}, y_{CI}) and the unemployment benefit $\bar{z}$. We use parameter β_0 for the bargaining power of workers in small businesses. All wages and productivities are specific to a particular demographic group of the individual ij, where the superscript ij was omitted for the ease of exposition.

3.6 Matching and free-entry

In this section we describe matching between searching workers and vacancies in the market for regular jobs, as well as matching between searching workers and openings in small businesses. Figure 3 illustrates all the states and transitions of regular workers.

Figure 3: Labour market states and transitions of regular workers



The middle part of the diagram (red) corresponds to the cross-skill matching whereby low-skill regular workers apply for positions in high-skill small businesses. We use parameter κ to describe the intensity of cross-skill matching.[10] This parameter allows us to determine the number of regular workers searching and applying for positions in small businesses given by Σ_0^j. Σ_0^L consists of unemployed regular low-skill workers $\bar{u}^{iL}$ weighted by their search intensities x^{iL}, whereas Σ_0^H consists of unemployed regular high-skill workers $\bar{u}^{iH}$ weighted by their search intensities x^{iH} as well as regular low-skill workers weighted by their search intensities κx^{iL}. With this notation we get:

$$\Sigma_0^j = x^{Ij}\bar{u}^{Ij} + x^{Nj}\bar{u}^{Nj} + \mathbb{1}_H \kappa (x^{IL}\bar{u}^{IL} + x^{NL}\bar{u}^{NL})$$

where $\mathbb{1}_H$ takes value 1 for $j = H$ and value 0 for $j = L$.

[10] A doctor hiring a receptionist or a tax-consultant hiring a secretary are the real life examples of the type of cross-skill matching our model captures.

Next, consider low-skill small businesses. From proposition 4 we know that the average number of immigrant employees per small business is given by $\bar{q}(\theta_0^L)\mu/\gamma^{iL}$, where i reflects the ethnic group of the business owner. At the same time, the average number of native employees is $\bar{q}(\theta_0^L)(1-\mu)/\gamma^{iL}$. Given that the number of small businesses in this group is equal to b^{iL}, we can find the number of immigrant and native workers employed in these businesses e_{0i}^{IL} and e_{0i}^{NL}:

$$\frac{\bar{q}(\theta_0^L)}{\gamma^{iL}} b^{iL} = \frac{e_{0i}^{IL}}{\mu} = \frac{e_{0i}^{NL}}{1-\mu} \quad \text{where} \quad \mu = \frac{x^{IL}\bar{u}^{IL}}{x^{NL}\bar{u}^{NL} + x^{IL}\bar{u}^{IL}} \tag{14}$$

Here the superscript $i = N, I$ refers to the ethnic background of the worker, while the subscript refers to the ethnic background of the entrepreneur and 0 stands for small businesses. Next consider high-skill businesses. Here the average number of immigrant high-skill employees is given by $\bar{q}(\theta_0^H)\mu^{IH}/(\gamma^{iH})$, while the average number of native high-skill workers is $\bar{q}(\theta_0^H)\mu^{NH}/(\gamma^{iH})$. In a similar way, we can use information about the average number of immigrant and native low-skill employees. Multiplying the average number of employees per business with the number of businesses b^{iH} yields the following:

$$\frac{\bar{q}(\theta_0^H)}{\gamma^{iH}} b^{iH} = \frac{e_{0i}^{IH}}{\mu^{IH}} = \frac{e_{0i}^{NH}}{\mu^{NH}} = \frac{e_{Ci}^{I}}{\mu^{IL}} = \frac{e_{Ci}^{N}}{\mu^{NL}} \tag{15}$$

where the probabilities of hiring an employee of type iH and iL from the perspective of the business owner are given by:

$$\mu^{iH} = \frac{x^{iH}\bar{u}^{iH}}{\sum_{i=I,N} x^{iH}\bar{u}^{iH} + \kappa x^{iL}\bar{u}^{iL}} \quad \text{and} \quad \mu^{iL} = \frac{\kappa x^{iL}\bar{u}^{iL}}{\sum_{i=I,N} x^{iH}\bar{u}^{iH} + \kappa x^{iL}\bar{u}^{iL}}$$

These probabilities do not depend on the ethnic background of the business owner.

Further, we write down the steady state equation for employees in regular jobs: $X^{ij}\lambda(\theta^j)\bar{u}^{ij} = \bar{\gamma}^{ij}\bar{e}^{ij}$ and take into account that the total number of workers employed in small businesses is given by: $\bar{e}_0^{ij} = e_{0N}^{ij} + e_{0I}^{ij} + \mathbb{1}_L(e_{CN}^i + e_{CI}^i)$, where the indicator function $\mathbb{1}_L$ takes value one for $j = L$ and zero otherwise. This allows us to find the equilibrium unemployment rate of regular workers given by: $\bar{u}^{ij} = d^{ij} - l^{ij} - \bar{e}^{ij} - \bar{e}_0^{ij}$. The exact expression is presented in appendix A.6.

Finally, we consider the vacancy posting conditions for regular jobs. Recall that $\bar{c} = \bar{c}_h + \bar{c}_k$ is the total cost of capital and posting facing regular firms. Using this notation we write down the present value equation for V, which is the present value of expected profits associated with an open vacancy, and impose the free-entry condition $V = 0$ to get:

$$\frac{\bar{c}}{q(\theta)} = \sum_{i=I,N} \underbrace{\frac{X^i\bar{u}^i}{\sum_{i=I,N} X^i(\bar{u}^i + u^i + s_u^i)}}_{\text{matching with regular workers}} (\bar{J}^i - V) + \underbrace{\frac{X^i(u^i + s_u^i)}{\sum_{i=I,N} X^i(\bar{u}^i + u^i + s_u^i)}}_{\text{matching with pot. entrepreneurs}} (J^i - V) \tag{16}$$

Thus, regular firms create vacancies up to the point, where the expected cost of an open vacancy is equal to the expected present value of profits from a filled job. Writing down these equations for $j = L, H$ allows us to find the equilibrium vacancies v^L and v^H.

3.7 Production of the final good and welfare

The final good is produced using capital K and a composite good Z using the constant returns to scale technology (1). The composite good Z is produced using two intermediate inputs, Y_L and Y_H according to the CES production function (2), where Y_j is a linear aggregate of output quantities produced by regular workers and potential entrepreneurs of type j, so it can be calculated as:

$$\begin{aligned} Y_j &= \sum_{i=I,N} \Bigg(\varsigma^{ij} \int_{\alpha_u^{ij}}^{\alpha_s^{ij}} \alpha s_u^{ij}(\alpha) d\alpha + \varsigma^{ij} \int_{\alpha_s^{ij}}^{\alpha_0^{ij}} \alpha s_e^{ij}(\alpha) d\alpha + \varsigma^{ij} \int_{\alpha_0^{ij}}^{\bar{\alpha}} \alpha b^{ij}(\alpha) d\alpha \\ &+ \varphi^{ij} e^{ij} + \bar{\varphi}^{ij} \bar{e}^{ij} + \varphi_{0N}^{ij} e_{0N}^{ij} + \varphi_{0I}^{ij} e_{0I}^{ij} + \mathbb{1}_L (\varphi_{CN}^{i} e_{CN}^{i} + \varphi_{CI}^{i} e_{CI}^{i}) \Bigg) \end{aligned}$$

where the first three terms include output quantities of self-employed entrepreneurs and business owners, $\varphi^{ij} e^{ij}$ is the output produced by potential entrepreneurs employed in regular jobs, $\bar{\varphi}^{ij} \bar{e}^{ij}$ – output produced by workers in regular jobs, and the remaining terms constitute the output produced by workers employed in small businesses. Finally, the indicator variable takes value 1 for $j = L$ and value zero for $j = H$.

Since capital as well as the two intermediate goods are supplied in competitive markets, their prices R and P^j are equal to the marginal productivities:

$$R = A\eta K^{\eta-1} [aY_L^\rho + (1-a)Y_H^\rho]^{\frac{1-\eta}{\rho}} \quad (17)$$

$$P_L = a(1-\eta) A K^\eta Y_L^{\rho-1} [aY_L^\rho + (1-a)Y_H^\rho]^{\frac{1-\eta-\rho}{\rho}} \quad (18)$$

$$P_H = (1-a)(1-\eta) A K^\eta Y_H^{\rho-1} [aY_L^\rho + (1-a)Y_H^\rho]^{\frac{1-\eta-\rho}{\rho}} \quad (19)$$

where R is the exogenous price of capital including the risk-free interest rate and the cost of capital depreciation. Finally, let $\bar{\Omega}^{ij}$, denote social welfare of regular workers and Ω^{ij} denote the welfare of potential entrepreneurs in the demographic group ij, where $i = I, N$, $j = L, H$. Since potential entrepreneurs are characterized by various qualities of the product α, we calculate an average product quality in each group:

$$\bar{\alpha}_{us} = \int_{\alpha_u}^{\alpha_s} \alpha \frac{s_u(\alpha)}{s_u} d\alpha \qquad \bar{\alpha}_{s0} = \int_{\alpha_s}^{\alpha_0} \alpha \frac{s_e(\alpha)}{s_e} d\alpha \qquad \bar{\alpha}_{01} = \int_{\alpha_0}^{\bar{\alpha}} \alpha \frac{b(\alpha)}{b} d\alpha$$

Variable $\bar{\alpha}_{us}$ stands for the average product quality of solo self-employed out of necessity distributed in the range $[\alpha_u ... \alpha_s]$. Variable $\bar{\alpha}_{s0}$ denotes the average product quality of solo self-employed out of opportunity distributed in the range $[\alpha_s ... \alpha_0]$ and, finally, $\bar{\alpha}_{01}$ corresponds to the average product quality of business owners distributed in the range

$[\alpha_0...\bar{\alpha}]$. Based on these definitions, the welfare values for all worker groups can be obtained as (we suppress the upper index ij for the ease of exposition):

$$\bar{\Omega} = \frac{1}{d-l}(\bar{u}(\bar{z}-h) + (1-t)(\bar{e}\bar{w} + e_{0N}w_{0N} + e_{0I}w_{0I} + \mathbb{1}_L(e_{CN}w_{CN} + e_{CI}w_{CI}))) + T$$

$$\Omega = \frac{1}{l}\Big(u(z-h) + (1-t)(ew + s_u\sigma\bar{\alpha}_{us} + s_e\sigma\bar{\alpha}_{s0} + b\sigma\bar{\alpha}_{01}) + \underbrace{b\Big(-c + \frac{\bar{q}(\theta_0)}{\gamma}\pi(r+\gamma)\Big)}_{\text{net profit from coworkers}}\Big) + T$$

where the indicator function $\mathbb{1}_L$ takes value one for $j = L$ and zero otherwise and variable T is the lump-sum transfer from the public budget. The cash inflow into the public budget consists of revenues from labour income taxes of regular workers and potential entrepreneurs BR_t and corporate taxes paid on flow profits by small businesses and regular jobs BR_τ. The outflow from the public budget consists of expenses for unemployment benefits for all demographic groups BE. Given that total revenues exceed substantially the expenses for unemployment benefits, the surplus of the budget is equally split and distributed as a lump-sum transfer T across all worker groups. The revenues and expenses are calculated as follows:

$$BR_t = t\sum_{ij}\Big(\underbrace{\bar{e}\bar{w} + e_{0N}w_{0N} + e_{0I}w_{0I} + \mathbb{1}_L(e_{CN}w_{CN} + e_{CI}w_{CI})}_{\text{income taxes of regular workers}} + \underbrace{ew + s_u\sigma\bar{\alpha}_{us} + s_e\sigma\bar{\alpha}_{s0} + b\sigma\bar{\alpha}_{01}}_{\text{income taxes of potential entrepreneurs}}\Big)$$

$$BR_\tau = \tau\sum_{ij}\Big(\underbrace{b\frac{\bar{q}(\theta_0)}{\gamma}\frac{\pi(r+\gamma)}{1-\tau}}_{\text{small businesses}} + \underbrace{(\bar{y} - \bar{c}_k - \bar{w})\bar{e} + (y - \bar{c}_k - w)e}_{\text{regular jobs}}\Big)$$

$$BE = \sum_{ij} zu + \bar{z}\bar{u} \qquad T = \frac{1}{\sum_{ij} d}\Big(BR_t + BR_\tau - BE\Big) \tag{20}$$

where $\sum_{ij} d$ is the total size of the population. It is normalized to 1 in the benchmark calibration, but will be larger than 1 upon the immigration shock.

4 Data

We use data from the German Socio-Economic Panel (SOEP) waves 2000-2017. SOEP is a representative panel of households and individuals in Germany. It provides detailed information about the respondent's ethnicity, qualifications, wages, size of employer firm, employment status, and the possibility of self-employment and entrepreneurship. Moreover, it contains information about self-employed entrepreneurs' business size (i.e., the number of coworkers). We restrict the sample to labour force participants working full/part-time or actively searching for jobs (workers who report being registered as unemployed at the federal employment agency). Non-participants, retired, marginally employed or military personnel and those below 17 years of age are dropped from the sample. This yields an unbalanced panel with 302686 person-year observations over the spell of 18 years.

We define as ***native*** (N) an individual who is born in Germany or has German nationality since birth and is not an ethnic German from Eastern Europe. All second-generation immigrants born in Germany are considered natives. Workers with at least 13 years of schooling are defined as ***high-skilled (H)*** while others are considered ***low-skilled (L)***. 13 years of schooling correspond to the upper secondary schooling degree ("Abitur") and grant direct access to tertiary education in Germany. High-skilled immigrants form the smallest fraction of the sample. The average share of high and low-skilled natives in the sample is 32.6% and 51.0%, respectively. In comparison, the high and low-skilled immigrants form 13.7% and 2.7% of the sample. Table 1 provides the sample profile.

We define as ***potential entrepreneurs*** the individuals who are observed at least once in the data as self-employed, freelance professionals, or as small business owners (with or without coworkers). Their stock is denoted by l^{ij} in the model. Individuals who are never observed as business owners or in self-employment are considered ***regular workers*** (low entrepreneurial spirit). Their stock is denoted by $d^{ij} - l^{ij}$. We may underestimate the share of potential entrepreneurs as some individuals may have been in entrepreneurship before participating in the survey, while other potential entrepreneurs may have dropped out of the sample before being observed in an entrepreneurial state. The attrition rates could be particularly high for immigrants due to return migration. However, it is a reasonable measure given that there is no other way to deduce entrepreneurial abilities due to the lack of detailed information about the interest in entrepreneurship or efforts (both successful and unsuccessful) to open up a business.

Table 1 shows the distribution of all workers in the sample across the four demographic groups and labour market states. High-skill native workers are least likely to be employed in small businesses (15.3%). This share is slightly higher for high-skill immigrant workers (18.3%), whereas it is much higher for low-skill workers ($22.5 - 23.5\%$). It is interesting that potential entrepreneurs have much lower unemployment rates than workers without entrepreneurial abilities. Low-skilled immigrant workers have the highest unemployment rates. Both natives and immigrants in the high-skill group have the highest shares of active entrepreneurs $(b^{ij} + s^{ij})/l^{ij}$.

Further, SOEP provides information on solo self-employed entrepreneurs $s^{ij} + b_0^{ij}$ and business owners with coworkers $b^{ij} - b_0^{ij}$. The last group is split into business owners with less than nine coworkers $\sum_{n=1}^{9} b_n$ and those with more than nine coworkers. $59 - 60\%$ of native and immigrant potential business people with low skills are solo entrepreneurs, and $36 - 37\%$ of them manage small businesses with 1 to 9 coworkers. This differs in the high-skill group, where only 46% of immigrant entrepreneurs are self-employed, and 43% are managing small businesses.

Table 1: Sample Profile. SOEP, waves 2000 − 2017

Natives $d^{NL}+d^{NH}=0.836$			
Low-skill $d^{NL}=0.510$ No. obs.= 154566		**High-skill** $d^{NH}=0.326$ No. obs.= 98488	
Regular workers	**Pot. Entrepreneurs**	**Regular workers**	**Pot. Entrepreneurs**
$d^{NL}-l^{NL}=0.449$	$l^{NL}=0.061$	$d^{HN}-l^{NH}=0.261$	$l^{NH}=0.065$
$\frac{\bar{u}^{NL}}{d^{NL}-l^{NL}}=0.085$	$\frac{u^{NL}}{l^{NL}}=0.035$	$\frac{\bar{u}^{NH}}{d^{NH}-l^{NH}}=0.022$	$\frac{u^{NH}}{l^{NH}}=0.014$
$\frac{\bar{e}^{NL}}{d^{NL}-l^{NL}}=0.680$	$\frac{b^{NL}+s^{NL}}{l^{NL}}=0.547$	$\frac{\bar{e}^{NH}}{d^{NH}-l^{NH}}=0.825$	$\frac{b^{NH}+s^{NH}}{l^{NH}}=0.568$
$\frac{\bar{e}_0^{NL}}{d^{NL}-l^{NL}}=0.235$	$\frac{b_0^{NL}+s^{NL}}{b^{NL}+s^{NL}}=0.586$	$\frac{\bar{e}_0^{NH}}{d^{NH}-l^{NH}}=0.153$	$\frac{b_0^{NH}+s^{NH}}{b^{NH}+s^{NH}}=0.591$
	$\frac{\sum_{n=1}^{9} b_n^{NL}}{b^{NL}+s^{NL}}=0.366$		$\frac{\sum_{n=1}^{9} b_n^{NH}}{b^{NH}+s^{NH}}=0.326$
Immigrants $d^{IL}+d^{IH}=0.164$			
Low-skill $d^{IL}=0.137$ No. obs.= 41460		**High-skill** $d^{IH}=0.027$ No. obs.= 8172	
Regular workers	**Pot. Entrepreneurs**	**Regular workers**	**Pot. Entrepreneurs**
$d^{IL}-l^{IL}=0.124$	$l^{IL}=0.013$	$d^{IH}-l^{IH}=0.022$	$l^{IH}=0.005$
$\frac{\bar{u}^{IL}}{d^{IL}-l^{IL}}=0.141$	$\frac{u^{IL}}{l^{IL}}=0.049$	$\frac{\bar{u}^{IH}}{d^{IH}-l^{IH}}=0.091$	$\frac{u^{IH}}{l^{IH}}=0.039$
$\frac{\bar{e}^{IL}}{d^{IL}-l^{IL}}=0.634$	$\frac{b^{IL}+s^{IL}}{l^{IL}}=0.525$	$\frac{\bar{e}^{IH}}{d^{IH}-l^{IH}}=0.726$	$\frac{b^{IH}+s^{IH}}{l^{IH}}=0.577$
$\frac{\bar{e}_0^{IL}}{d^{IL}-l^{IL}}=0.225$	$\frac{b_0^{IL}+s^{IL}}{b^{IL}+s^{IL}}=0.607$	$\frac{\bar{e}_0^{IH}}{d^{IH}-l^{IH}}=0.183$	$\frac{b_0^{IH}+s^{IH}}{b^{IH}+s^{IH}}=0.459$
	$\frac{\sum_{n=1}^{9} b_n^{IL}}{b^{IL}+s^{IL}}=0.362$		$\frac{\sum_{n=1}^{9} b_n^{IH}}{b^{IH}+s^{IH}}=0.425$

4.1 Calibration

Our model includes a vector of 13 parameters $\{x, X, \gamma, \delta, c, \varsigma, \bar{\gamma}, \varphi_{0I}, \varphi_{0N}, \bar{\varphi}, \varphi, \bar{z}, z\}^{ij}$, specific to the four demographic groups $i = I, N$ and $j = L, H$. Recall that variables φ and ς denote output quantities produced by employed and self-employed individuals, for example, $y_{0I}^{ij} = \varphi_{0I}^{ij} P^j$ and $y_{0N}^{ij} = \varphi_{0N}^{ij} P^j$. This is combined with four parameters φ_{CI}^{i}, φ_{CN}^{i}, $i = I, N$ corresponding to output quantities of low-skill workers employed in high-skill small businesses (cross-skill matching). Five parameters are skill-specific but common to all workers in the same skill group; these parameters include $\{M, \bar{M}, \bar{c}, \beta_0, t\}^j$

for $j = L, H$. There are 11 parameters common to all demographic groups; these are $\{r, \rho, \eta, R, \kappa, \zeta, a, A, h, \tau, \beta\}$.

To summarize, the model has 73 parameters; 50 of these parameters are calibrated by targeting data moments from the SOEP, and the rest are either taken from the literature, normalized to one, or taken from macro data on legally set indicators such as the tax rates and the replacement rate. Table 13 in the appendix contains a complete list of the calibrated parameter values and targeted data moments. The rest of this section is dedicated to providing details of the calibration strategy.

Preset Parameters: One period of time is one quarter, so we set $r = 0.0125$ corresponding to the 5% annual interest rate. Following Ottaviano and Peri (2012) and Battisti et al. (2018), we take $\rho = 0.5$, the parameter governing the elasticity of substitution between high and low-skill labour. Following Chassamboulli and Palivos (2014) and Battisti et al. (2018), we set the quarterly cost of capital for the final goods producer and the capital share as follows: $R = 0.03$, $\eta = 0.35$.

Calibrated Parameters: The search intensity parameters x^{ij}, X^{ij} and the multipliers of the matching function $M^j, \bar{M}^j$ can not be identified separately from the data, so we normalize $x^{NL} = 1$, $x^{NH} = 1$, $X^{NL} = 1$, $X^{NH} = 1$. Targeting the empirically observed unemployment rates of regular workers and potential entrepreneurs $\bar{u}^{ij}$, u^{ij}, we compute x^{Ij}, X^{Ij}, M^j and $\bar{M}^j$. We use the remaining data moments from table 1 to calibrate parameters $\gamma, \delta, c, \varsigma$ for each group of entrepreneurs ij. In addition, we use information about the tenure of native and immigrant workers in regular jobs from table 12 to identify the job-destruction rates $\bar{\gamma}$. We target the average job tenure in small firms, 8.2 years, to obtain the cross-skill matching parameter $\kappa = 0.170$. The calibrated job destruction rates of small businesses γ vary between 0.029 and 0.036 depending on the type of business owner; this corresponds to the 2-year survival probabilities in the range $71 - 76\%$.

The model has three tax rates: income tax t^L for low-skilled workers, t^H for high-skilled workers, and a corporate tax τ for small businesses and large firms. According to German law, solo self-employed individuals and freelancers are subject to the tax on labour income. The regular income tax varies between 14-45% depending on the taxpayer's income. Therefore, we use an average tax rate of 25% for low-skilled workers and solo self-employed entrepreneurs and a tax rate of 35% for the high-skilled group. We use a 15% tax rate for corporate taxes, in line with the German law.

The information on the share of net wages in the total output (GDP) over the years 2000-2017 with an average equal to 28% is used to obtain workers' bargaining power in regular jobs ($\beta = 0.9$).[11] The relatively high bargaining power suggests that a substantial share of the GDP consists of labour taxes, corporate taxes, and non-labour costs. In contrast, the share of firm profits is relatively low.

The quantity produced by native regular workers in a given skill group is normalized to 1 unit so that $\bar{y}^{NL} = P_L$ and $\bar{y}^{NH} = P_H$. Using these identities combined with

[11] www.destatis.de Volkswirtschaftliche Gesamtrechnungen, Fachserie 18, Reihe 1.4, Tabelle 2.1.8

equations (18) and (19), we find parameters $A = 2.563$ and $a = 0.555$. To calibrate output quantities for all worker groups, we estimate a Mincer earnings regression with a logarithm of gross monthly wages as the dependent variable for regular workers and a similar Mincer regression for the earnings of potential entrepreneurs. For regular workers, we control for ethnicity ($i = I, N$), skill ($j = L, H$), firm size, and the year-fixed effects. The exact regression specifications and output tables are presented in appendix B.1. The average wage of native low-skill workers employed in small businesses is normalized to 1, $\bar{w}_0^{NL} = 1$. This means that 1 monetary unit corresponds to 1086 EUR.

In the Mincer regression for potential entrepreneurs, we control for ethnicity ($i = I, N$), skill ($j = L, H$), and the economic state distinguishing between paid employment, solo self-employment, and business ownership. In particular, SOEP data includes information about the income of small businesses owners with less (more) than nine coworkers. Our regressions reveal that the predicted income of immigrant business owners with less than nine coworkers is substantially higher than the income of natives with a comparable business size. Another important observation is that the income from business ownership is higher than the average wage in paid employment for all potential entrepreneurs.

According to the German regulation, unemployed individuals eligible for unemployment insurance obtain 60% of the previous netto wage for a maximum period of 12 months (ALG I).[12] After the unemployment spell of 12 months, the person becomes eligible for social support (ALG II). This support was introduced during the labour market reform in 2005 and remained at 400 EUR until it started increasing in 2017. In order to account for the sharp reduction of the unemployment benefit after the first year of payments, we calculated a permanent flow value such that its present value is equivalent to 60% of the average net wage for 4 quarters and the normalized income 0.368 thereafter. Using wages predicted by the Mincer earnings regression, we find parameters z^{ij} and $\bar{z}^{ij}$. Further, we take $h = 0.3$ as the disutility from unemployment, ensuring that the model is internally consistent and potential entrepreneurs accept paid jobs ($W > U$) despite attractive opportunities in self-employment and entrepreneurship.

Combining predicted earnings with the Nash bargaining equations for wages allows us to indirectly infer the productivities of employees in paid employment $\{\bar{y}, y\}^{ij}$. Dividing these values by the endogenous prices of intermediate goods P^j, we find the quantities $\{\bar{\varphi}, \varphi\}^{ij}$. Further, combining information on wages of workers in small firms and the corresponding profits of small businesses, we obtain the bargaining power parameters in small firms: $\beta_0^L = 0.456$ and $\beta_0^H = 0.422$ (see appendix B.2). Both parameters are relatively close to 50% since bargaining between the self-employed entrepreneur and a worker in a small business is likely to be individual. In contrast, workers in medium and large firms are likely to be covered by collective agreements. Combining these values of

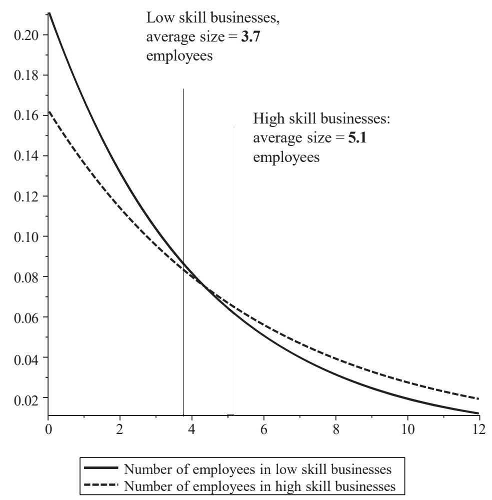
[12] www.arbeitsagentur.de. The unemployment benefit is slightly higher for families with children, and the duration of benefits can be longer for older individuals above the age of 50. However, we use the replacement rate of 60% as a benchmark value.

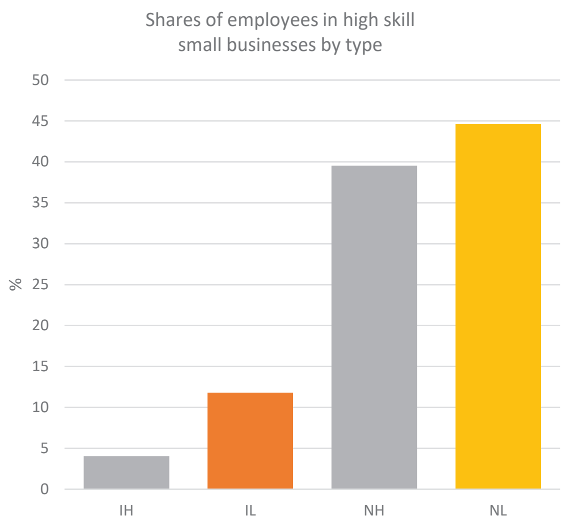
β_0 with the Nash bargaining equations and predicted wages of workers in small businesses we find the productivities $\{y^{ij}_{0I}, y^{ij}_{0N}, y^{i}_{CI}, y^{i}_{CN}\}$ and the corresponding output quantities $\{\varphi^{ij}_{0I}, \varphi^{ij}_{0N}, \varphi^{i}_{CI}, \varphi^{i}_{CN}\}$ $i = I, N$, $j = L, H$.

To estimate ζ, the elasticity parameter in the Cobb-Douglas matching function, we use statistics from the Federal Employment Office (Bundesagentur für Arbeit) between January 2000 and December 2018. It includes information on the absolute number of unemployed, vacancies and vacancy durations, which are not available in the SOEP survey. We use this information for calibrating ζ (see appendix B.3 for details). In addition, we use information about the average vacancy duration, which was 64 days or 64/92 quarters in the considered period. Targeting this data moment and using the free-entry condition (16) for $j = L, H$ allows us to find the flow cost of a vacancy $\bar{c}^j$. Further, we rely on the findings by Rebien et al. (2020) for the average recruitment cost. It is 521 EUR for positions with vocational training qualification (i.e., low-skill), whereas 2046 EUR for high-skill positions. Normalized values of these costs yield parameters $\bar{c}^j_h$ for $j = L, H$. The flow cost of capital is then obtained as a residual category$\bar{c}^j_k = \bar{c}^j - \bar{c}^j_h$.

Parameters Validation: In order to check the plausibility of our parameter values, we compare the non-target moments (the average size of micro-enterprises) generated by our model to those provided by the official statistics.[13] The calibration exercise shows that high-skill businesses are larger, with 5.1 employees on average, whereas the size of low-skill businesses is smaller, with 3.7 employees on average. This is illustrated on figure 4. The right panel of this figure shows the calibrated shares of coworkers from different demographic groups in high skill small businesses.

Figure 4: Left: firm size distribution in small businesses. Right: shares of employees from different demographic groups in high skill small businesses





In the official statistics, micro-enterprises are defined as businesses with less than 9

[13] www.destatis.de"Code: 48121-0001, Enterprises, persons employed, turnover and other business and economic figures: Germany, years, enterprise size".

coworkers, and their average size equals 2.7 over the period $2008-2017$. For comparison, we calculated conditional average numbers of employees (less or equal to 9) in our setting. They are equal to 2.6 for low-skill businesses and 3.1 for high-skill businesses. Similarly, our 2-year survival probabilities in the range $71-76\%$ are close to the average 2-year survival probability reported for Germany by the OECD and equal to 70.7%.[14] The values of non-target moments generated by our model are very close to those in the official statistics, which establishes the relevance of our parametrization strategy.

5 Results

In this section, we discuss the results of four experiments. First, we analyze the labor market's response to an exogenous low skill immigration shock similar to the one observed in Germany in $2012-2017$. Second, we briefly discuss the implications of skill-neutral migration motivated by the recently established cooperation between Germany and India on worker mobility. Third, we conduct a counterfactual experiment restricting immigrants from entering entrepreneurship and quantify how such a ban affects the welfare of all demographic groups. Fourth, we allow for ethnic segregation and quantify its impact on the welfare of workers.

5.1 Low-skill immigration

Aggregate statistics[15] reveal that the increase in the number of registered immigrants with own migration experience in $2012-2017$ was approx. 3 million, whereas the starting stock of individuals with immigration background in 2012 was 15 million. This corresponds to the additional immigration inflow of 20%. Since the immigration to Germany in this period consisted predominantly of the refugee influx, it is considered low-skill biased (Busch et al., 2020). Another reason is the skill degradation of immigrants upon arrival (Dustmann et al., 2013), as many high-skill workers take low-skill jobs, at least in the short and medium run. Hence, we study the implications of a 20% increase in the immigrant labour force attributed to low-skill immigration. This corresponds to a 24% increase in the number of low-skill immigrants and no change in the stock of high-skill immigrants, i.e., $\Delta d = 0.2(d^{IL} + d^{IH}) = 0.24d^{IL} = 0.033$. This implies an increase in the total population equal to 3.3% and an increase in the share of the low-skill population from 64.6% to 65.9%.

Table 2 displays changes in the key labour market indicators, namely: aggregate outputs Y_j, prices P^j, market tightness θ^j and θ_0^j, the capital cost rK, and the lump-sum transfer from the budget T. Table 3 summarizes our findings and presents %-changes in welfare for all worker groups compared to the benchmark (before migration shock)

[14]OECD.stat SDBS Business Demography Indicators (ISIC Rev. 3): Enterprise survival rates
[15]www.destatis.de Bevölkerung mit Migrationshintegrund, Fachserie 1, Reihe 2.2

equilibrium in row (0). We decompose the total effect into the following four steps:

- (A) In this step, we keep constant the capital stock K, the lump-sum transfer T, and the business entry thresholds α_0^{ij} for all potential entrepreneurs. Thus, the main effect of immigration at this stage is the change in the prices of intermediate goods P^j, $j = L, H$, which are directly linked to the productivities and wages of all workers. The market tightness variables θ^j and θ_0^j respond endogenously.
- (B) In this step, we allow for an endogenous adjustment of the capital stock K, but the lump-sum transfer T and the business entry thresholds α_0^{ij} for all potential entrepreneurs remain constant. The demand for capital is given by equation (17).
- (C) In this step, we update the lump-sum transfer T, but the business entry thresholds α_0^{ij} are still constant for all potential entrepreneurs. The new value of T follows from the budget constraint (20).
- (D) In the final step, we allow for the endogenous adjustment of the entry thresholds α_0^{ij} based on the business entry condition from proposition 1.

Table 2: Detailed changes of variables upon a 20% increase in low-skill immigration.

	Low-skilled				High-skilled				Aggregate	
	P^L	Y_L	θ_0^L	θ^L	P^H	Y_H	θ_0^H	θ^H	rK	T
(0)	5.221	0.459	0.443	0.103	5.303	0.287	1.356	0.626	0.879	0.493
(A)	5.171	0.471	0.417	0.091	5.307	0.288	1.280	0.632	0.879	0.493
(B)	5.199	0.476	0.426	0.096	5.340	0.291	1.312	0.673	0.903	0.493
(C)	–	–	–	–	–	–	–	–	–	0.486
(D)	5.198	0.476	0.427	0.096	5.341	0.291	1.316	0.675	0.904	0.487

Note: The table decomposes the impact of low-skill migration on endogenous variables in several steps. Row (C) only includes an adjustment of the lump-sum transfer T. Row (D) shows values in the post-migration equilibrium after a full adjustment.

Table 2 (row-A) shows that low-skill immigration is associated with a lower price of the low-skill intermediate good P^L and a higher price of the high-skill intermediate good P^H. This is a classical effect of immigration reducing productivity and wages in the same skill group and raising the productivity and wages of the other group of workers. At the same time, increasing numbers of low-skill immigrants imply that there are more applicants for low-skill positions posted by regular firms, making it easier for firms to hire workers. This effect boosts job creation in the low-skill submarket; thus, regular firms respond by creating more vacancies. This positive job creation effect increases aggregate output Y_L despite a drop in the marginal productivity of low-skill workers, reflected in the lower price P^L (table 2, row-A). Nevertheless, a larger number of applicants for regular jobs creates competition among workers, which is not compensated by the increase in vacancies. Due to this process, the market tightness θ_L and the job-finding rate in the low-skill submarket fall (table 2, row-A).

This development comes along with a lower welfare of low-skill individuals Ω^{iL} and $\bar{\Omega}^{iL}$ and an increase in welfare of high-skill individuals Ω^{iH} and $\bar{\Omega}^{iH}$, $i = I, N$ (Table 3, row-A). Moreover, it fosters the reallocation of native potential entrepreneurs with low skills from regular paid jobs to solo self-employment. Table 4 column (2) shows that the fraction of native potential entrepreneurs employed in regular jobs falls by 5.7%, and their wages also fall substantially in column (3). At the same time, their fraction in solo self-employment (column (4)) is increasing by 8.9%. The losses in the welfare of low-skill entrepreneurs (Table 3, row-A) are smaller compared to regular workers because the probability of hiring employees $\bar{q}(\theta^L)$ is increasing (note a lower θ_0^L), which moderates the negative effect of lower productivity on business profits. For the same reason, high-skill entrepreneurs' welfare gains are higher than high-skill regular workers.

In step (B), capital K adjusts endogenously. Firms in the final goods sector increase capital K, which has a positive effect on the productivity and welfare of all worker groups via changes in prices and market tightness. Due to capital adjustment, the welfare losses in step (A) are slightly compensated for low-skill workers.

In step (C), we update the lump-sum budget transfer T and welfare values. This transfer is measured per person and is lower in the post-immigration equilibrium. There are two reasons for this reduction. First, a composition effect is emerging because the net fiscal contribution of an average low-skill immigrant is lower than that of an average native. Second, there is an endogenous adjustment of equilibrium variables described in table 2 reducing wages of low-skill workers and their net fiscal contribution below the pre-immigration level. A combination of these effects leads to a lower lump-sum transfer per person $0.486 < 0.493$ in the post-immigration equilibrium, reducing the welfare of all worker groups (Table 3, row-C).

In the final step (D), we allow endogenous adjustment of the entrepreneurial business entry cutoffs α_0^{ij}. This is the novel part of our model, so we zoom in on the job creation process and potential entrepreneurs' business entry decisions in table 4 starting with the low-skill submarket. On the one hand, hiring workers for open positions becomes easier ($d\bar{q} > 0$). However, on the other hand, a drop in the price of the low-skill intermediate good makes workers in low-skill businesses less productive and leads to a lower profit per person ($d\pi^i < 0$, $i = I, N$). Table 4 shows that the first effect is dominating for businesses operated by immigrant entrepreneurs. Their profits in column (8) increase, making such businesses more attractive for their owners:

$$d\bar{q}\pi^I = \pi^I d\bar{q} + \bar{q} d\pi^I > 0$$

As a response, we observe a 13% increase in the fraction of immigrant potential entrepreneurs operating small businesses in column (6), inducing a reallocation of immigrant potential entrepreneurs away from regular jobs and solo self-employment towards operating small businesses. These effects are associated with a sizable increase in the

Table 3: Increase in immigration by 20%, low-skill scenario

	Low-skilled				High-skilled			
	Regular workers		Pot. entrepreneurs		Regular workers		Pot. entrepreneurs	
	N	I	N	I	N	I	N	I
	$\bar{\Omega}^{NL}$	$\bar{\Omega}^{IL}$	Ω^{NL}	Ω^{IL}	$\bar{\Omega}^{NH}$	$\bar{\Omega}^{IH}$	Ω^{NH}	Ω^{IH}
(0)	1.552	1.405	1.523	1.497	1.988	1.641	1.970	1.810
	Keeping K, T and α_0^{ij}							
(A)	-2.05%	-2.21%	-1.09%	-0.92%	+0.28%	+0.29%	+0.34%	+0.76%
	Keeping T and α_0^{ij} fixed							
(B)	-0.94%	-1.03%	-0.54%	-0.36%	+1.26%	+1.39%	+0.77%	+0.83%
	Keeping α_0^{ij} fixed							
(C)	-1.36%	-1.50%	-0.97%	-0.80%	+0.78%	+0.93%	+0.44%	+0.47%
	Full adjustment							
(D)	-1.27%	-1.37%	-2.04%	+3.15%	+1.00%	+1.08%	+0.34%	+3.10%
	Representative worker: -1.59% Incumbent worker: -1.27%				Representative worker: +0.9%			
	Representative worker: -0.88% Incumbent immigrant: -0.47% Incumbent worker: -0.37%							

Note: The table decomposes the impact of low-skill migration on welfare of different demographic groups in several steps. Row (D) shows the change in welfare after a full adjustment of endogenous variables in the post-migration equilibrium. The second last panel reports welfare changes for a representative/incumbent worker in a given skill group. The last panel reports welfare changes for a representative/incumbent worker in the economy.

welfare of immigrant potential entrepreneurs Ω^{IL} in table 3.

Considering the situation of native businesses, we find that the drop in productivity is dominating and leads to a slight decrease in profits in column (8):

$$d\bar{q}\pi^N = \pi^N d\bar{q} + \bar{q} d\pi^N < 0$$

Thus, operating small businesses becomes less attractive for native entrepreneurs. Their fraction in column (6) is falling by 3.2% inducing a reallocation away from regular employment and businesses towards solo self-employment. These effects are associated with a decrease in the welfare of native potential entrepreneurs Ω^{NL}. The asymmetric response of small businesses towards the immigration shock can be explained by the fact that immigrant businesses are more profitable on average, meaning that the expected profits per recruitment are also higher ($\pi^I > \pi^N$, inline with the empirical data in table 11 in the appendix). This makes immigrant businesses more sensitive to the job-filling rate since $\pi^I d\bar{q} > \pi^N d\bar{q}$. The profits of native entrepreneurs are lower, making them less responsive to changes in the probability of filling positions.

Next, we consider the high-skill submarket. High-skill workers become more productive, reflected in the higher price of the high-skill intermediate good P_H. This boosts job creation in the high-skill submarket, leading to a higher market tightness θ_H and a higher

Table 4: Detailed changes in the steady-state distribution of potential entrepreneurs upon a 20% increase in low-skill immigration

Group	(1) u/l	(2) e/l	(3) w	(4) $(s_u + s_e)/l$	(5) $\sigma\bar{\alpha}_{u0}$	(6) b/l	(7) $\sigma\bar{\alpha}_{01}$	(8) $\bar{q}(\theta_0)\pi/\gamma$
Low-skill								
Natives	0.035	**0.418**	1.222	**0.259**	1.145	**0.288**	1.291	1.971
Change	+0.001	**-0.057**	-0.019	**+0.089**	+0.019	**-0.032**	-0.004	-0.001
Low-skill								
Immigr.	0.049	**0.426**	1.245	**0.251**	1.100	**0.274**	1.314	2.077
Change	+0.001	**-0.054**	-0.019	**-0.077**	-0.102	**+0.130**	-0.019	+0.01
High-Skill								
Natives	0.014	**0.418**	1.884	**0.290**	1.883	**0.277**	1.953	3.763
Change	-0.001	**+0.072**	+0.030	**-0.070**	+0.010	**-0.001**	+0.014	-0.000
High-Skill								
Immigr.	0.039	**0.384**	1.309	**0.206**	1.199	**0.370**	1.374	5.270
Change	-0.001	**+0.056**	+0.026	**-0.093**	-0.092	**+0.037**	+0.006	+0.004

Note: $\bar{\alpha}_{u0}$ is the average entrepreneurial ability in the range $[\alpha_u..\alpha_0]$, calculated as $(s_u\bar{\alpha}_{us} + s_e\bar{\alpha}_{s0})/(s_u + s_e)$. $\bar{\alpha}_{01}$ is the average entrepreneurial ability in the range $[\alpha_0..\bar{\alpha}]$.

job-finding rate. Thus, there is a sizable increase in the fraction of high-skill potential entrepreneurs employed in regular paid jobs in column (2): 7.2% for natives and 5.6% for immigrant potential entrepreneurs. This process is accompanied by increasing wages in column (3) of table 4 and leads to the increased welfare of regular high-skill workers $\bar{\Omega}^{IH}$ and $\bar{\Omega}^{NH}$ in table 3.

Higher productivity of coworkers is also beneficial for high-skill small businesses, but the productivity of low-skill coworkers employed in high-skill businesses is decreasing. We find that the second effect dominates, so the average productivity of coworkers in small businesses operated by high-skill entrepreneurs decreases moderately. However, at the same time, filling positions becomes easier, especially low-skill positions; thus, the market tightness θ_0^H is decreasing, while the job-filling rate is increasing. Again, we find that immigrant and native entrepreneurs operating businesses are asymmetrically affected. Column (8) of table 4 shows that the positive effect of a higher job-filling rate is dominating for immigrant entrepreneurs, and there is a slight increase in their profits. This makes immigrant businesses more attractive for their owners and induces the reallocation of immigrant entrepreneurs from solo self-employment to operating small businesses equal to 3.7%. Overall, we observe a sizable increase in the welfare of high-skill immigrant entrepreneurs Ω^{IH} in table 3. This is partially due to higher profits from operating small businesses and the reallocation from low-income activities in solo self-employment to regular jobs. More specifically, table 4 shows that the income of immigrant self-employed (1.199) is well below their wages in regular paid jobs (1.309).

For native high-skill entrepreneurs, the situation is different. The lower productivity of an average coworker neutralizes the positive effect of a higher job-filling rate. Thus, the profits and the fraction of native high-skill business owners are hardly changing, and the only meaningful change is a shift towards regular jobs. However, the difference in income between these two states is negligibly tiny, compare columns (5) and (3) in table 4, so there is only a slight increase in the welfare of native entrepreneurs Ω^{NH} in table 3.

Detailed wage and employment changes for regular workers are presented in table 14 in appendix C. Wages of low skill regular workers fall (column (3)); moreover, finding jobs becomes more difficult since both market tightness variables θ_0^L and θ^L are falling due to the stronger competition among workers. This leads to slightly higher unemployment rates in column (1) of table 14 and a moderate reduction in welfare $\bar{\Omega}^{NL}$ and $\bar{\Omega}^{IL}$.

Our results suggest a marginal decrease of about 0.5% in the welfare of an incumbent immigrant. A moderate decline of 0.88% is observed in the welfare of a representative worker. It reflects a combination of lower welfare of incumbent workers reduced by 0.37% and a composition effect since a representative worker becomes "more immigrant" and "more low skilled" on average. At the same time, we find that the average estimate hides substantial heterogeneity of the effect across worker groups. Contrary to the previous studies reporting wage and welfare losses for the incumbent immigrant population (D'Amuri et al. (2010), Ottaviano and Peri (2012)), we find that immigrant entrepreneurs experience sizable welfare gains from a new immigration wave equal to 3.1%.

5.2 Cooperation with India

Germany signed the "Migration and Mobility Partnership Agreement" (MMPA) with India in December 2022. It is the first migration agreement between Germany and a non-EU country. The agreement aims to promote the mobility of high-skill immigrants from India to Germany. Recent developments in October, 2024 led Germany to agree to increase the annual number of visas granted to skilled Indian workers from 20,000 to 90,000. Given the increasing refugee migration to the developed world, we expect the low-skill scenario to dominate. However, policies facilitating high-skill immigration in Germany may, at best, result in skill-neutral immigration. These developments motivate the experiment of a skill-neutral immigration scenario to analyze the possible effects of increased Indian immigration to Germany. Therefore, table 15 in appendix C.1 reports the implications of a 20% skill-neutral migrant influx.

Our analysis suggests that in the case of skill-neutral immigration an incumbent worker will experience a smaller welfare loss (−0.27%) compared to the low skill scenario (−0.37%). Moreover, the welfare of incumbent immigrant workers will increase (+0.38%). The reason is that hiring coworkers becomes easier for all types of small businesses, boosting immigrant entrepreneurs' welfare. Combined with higher wages and the welfare of high-skill immigrant workers, this effect is dominating despite a slight reduction in the welfare of low-skill immigrants. The welfare loss of a representative worker will also be smaller (−0.66%) than the one experienced in a low-skill scenario (−0.88%).

5.3 Value of immigrant entrepreneurship

In this section, we conduct a counterfactual experiment on the legal barriers to self-employment and entrepreneurship for immigrants. We set $\delta^{IL} = 0$ and $\delta^{IH} = 0$, implying that the legal entry barrier into self-employment and business ownership is infinitely high for immigrant potential entrepreneurs so that none of them are observed in the states s^{Ij} and b^{Ij}, $j = L, H$. We consider the benchmark model without an immigration shock and analyze how the lack of immigrant entrepreneurial activity affects the welfare of workers compared to the benchmark model with the option of entrepreneurship.

The goal of this experiment is twofold. First, it allows us to estimate the option value of entrepreneurship for immigrants. Second, we can estimate the spillover effects of immigrant entrepreneurship for all other groups producing insights about the entry barriers policies for immigrant small businesses. The results are summarized in table 5, where line (0) corresponds to the benchmark equilibrium and line (E) contains welfare changes for all worker groups in the counterfactual setting with entry barriers.

Table 5: Welfare changes in the counterfactual scenario without immigrant entrepreneurship

	Low-skilled				High-skilled			
	Regular workers		Pot. entrepreneurs		Regular workers		Pot. entrepreneurs	
	N	I	N	I	N	I	N	I
	$\bar{\Omega}^{NL}$	$\bar{\Omega}^{IL}$	Ω^{NL}	Ω^{IL}	$\bar{\Omega}^{NH}$	$\bar{\Omega}^{IH}$	Ω^{NH}	Ω^{IH}
(0)	1.552	1.405	1.523	1.497	1.988	1.641	1.970	1.810
(E)	-0.35%	-0.43%	+1.62%	-15.2%	-0.17%	-0.18%	+1.08%	-30.5%

Note: Row (0) shows the welfare of workers in the benchmark model. Row (E) shows the change in welfare in the counterfactual case of a complete ban on immigrant entrepreneurship.

Table 5 shows that the welfare losses of high-skill potential entrepreneurs are dramatic and amount to 30.5% of their welfare. This is primarily driven by unemployment increasing from 3.9% to 11% (see table 16 in the appendix). The losses of low-skill potential entrepreneurs are also large, reaching 15.2% and caused by the corresponding increase in unemployment from 4.9% to 18%. These findings indicate a very high value of the entrepreneurship option for immigrant individuals with a high entrepreneurial spirit. They also suggest that entrepreneurship is an efficient way of reducing unemployment for immigrants.

Further, we observe moderate negative spillovers for regular workers with reduced welfare. These welfare losses suggest that policies reducing entry barriers for immigrant entrepreneurs are likely to be beneficial for regular workers (native and immigrant). Their welfare is higher in the benchmark scenario with immigrant entrepreneurship. The reasons for higher welfare are threefold: first, immigrant potential entrepreneurs entering self-employment reduce competition for regular jobs; second, immigrant small businesses create new working places for all worker groups; and third, the lump-sum transfer T

is higher due to higher net fiscal contributions of immigrants. At the same time, table 5 reveals that the welfare of native potential entrepreneurs is lower in the benchmark scenario with immigrant entrepreneurship. The reason is stronger competition with immigrant businesses, suggesting that entry barriers for immigrant entrepreneurs shield native businesses from competitive forces. Germany introduced several amendments in its Residence Act for non-German entrepreneurs between 2004 and 2012. These amendments relaxed the conditions required for entrepreneurial ventures and offered incentives to foreigners to invest in Germany.[16] Our experiment helps evaluate the effectiveness of these policies.

5.4 Ethnic segregation in small businesses

The literature on social networks documents ethnic homophily, meaning a higher probability of creating social ties with individuals of the same ethnic origin (McPherson et al. (2001)). Dustmann et al. (2016) reports for Germany that a new hire is more likely to be an immigrant if there is already a large share of immigrant workers in the firm. Alaverdyan and Zaharieva (2022) show that 44% of immigrants in Germany find their jobs via social contacts. Additionally, ethnic segregation could be an outcome of hiring discrimination. A field experiment conducted by Kaas and Manger (2012) finds that a foreign name reduces the average probability of a callback and that differential treatment of native and immigrant workers is particularly strong and significant in smaller firms. Yet another reason for ethnic segregation could be that small firms are often family businesses. This section investigates the implications of ethnic segregation in small businesses. Given the empirical evidence in Kaas and Manger (2012) that hiring discrimination is stronger in small firms and the findings in Goldberg et al. (1995) that it is more (less) pronounced in low (high) skill jobs, we focus on the ethnic segregation in low-skill small businesses for the following analysis.

Remaining agnostic about the reason for ethnic segregation, we introduce parameter $\psi > 0$, capturing the co-ethnic bias in matching. Table 6 shows that higher values of ψ increase the share of matches between native workers and native-owned small businesses and the share of matches between immigrant workers and immigrant-owned businesses (on the matrix's main diagonal). At the same time, it reduces the share of matches between workers and business owners with different ethnic origins (off the diagonal). The benchmark equilibrium with unbiased matching can be recovered when $\psi = 0$, where μ is the probability of hiring an immigrant coworker identical for both types of businesses, and $1 - \mu$ is the probability of hiring a native coworker. Note that parameter ψ only influences the shares of matches of a particular type but does not enter the expression for the total number of matches created per unit time.

[16] Residence Act 2004, Act to Implement Residence- and Asylum-Related Directives of the European Union 2007, Labour Migration Control Act 2009, Residence Act 1st August 2012

Table 6: Matching bias ψ giving rise to ethnic segregation in small businesses

Biased pairwise matching	Immigrant coworker	Native coworker	Sum
Immigrant business owner	$(\mu+\psi)\frac{b^{IL}}{b^{NL}+b^{IL}}$	$(1-\mu-\psi)\frac{b^{IL}}{b^{NL}+b^{IL}}$	$\frac{b^{IL}}{b^{NL}+b^{IL}}$
Native business owner	$(\mu-\psi)\frac{b^{NL}}{b^{NL}+b^{IL}}$	$(1-\mu+\psi)\frac{b^{NL}}{b^{NL}+b^{IL}}$	$\frac{b^{NL}}{b^{NL}+b^{IL}}$

We augment the corresponding equations for the profits of small businesses in the following way:

$$\pi^I = (\mu+\psi)\Delta_I^I + (1-\mu-\psi)\Delta_I^N \qquad \pi^N = (\mu-\psi)\Delta_N^I + (1-\mu+\psi)\Delta_N^N$$

where the upper (lower) index indicates the type of the worker (business owner). In addition, we adjust equations for the numbers of workers employed in small businesses:

$$\frac{\bar{q}(\theta_0^L)}{\gamma^{IL}} b^{IL} = \frac{e_{0I}^{IL}}{\mu+\psi} = \frac{e_{0I}^{NL}}{1-\mu-\psi} \quad \text{and} \quad \frac{\bar{q}(\theta_0^L)}{\gamma^{NL}} b^{NL} = \frac{e_{0N}^{IL}}{\mu-\psi} = \frac{e_{0N}^{NL}}{1-\mu+\psi}$$

We consider a marginal change in ethnic segregation equal to 1% and set $\psi = 0.01$. The implications of ethnic segregation for low-skill businesses are as follows. First, native workers are more productive on average. So, it leads to a higher specialization on the more productive group of native workers in native businesses. This is associated with higher profits, higher business entry and higher welfare of native entrepreneurs (see table 7 for welfare effects and table 17 in Appendix C.2 for further details). Second, there is a higher specialization of immigrant businesses on the less productive group of immigrant workers leading to lower profits. As a result immigrant entrepreneurs move intensively to solo self-employment, which is associated with lower welfare. Third, changes in the composition of small businesses are associated with lower earnings of native regular workers and lower welfare despite a higher probability of getting jobs in native businesses.

Furthermore, we find moderate spillovers of ethnic segregation for high-skill businesses. On the one hand, cross-skill matching implies that high-skill businesses compete with low-skill businesses for low-skill workers. Tighter competition for low-skill native workers reduces profits and welfare of native high-skill entrepreneurs. On the other hand, difficulties in hiring los skill native workers imply that vacancies in high-skill businesses are increasingly filled with high-skill applicants raising the productivity of an average employee. The latter effect is dominating for immigrant high-skill businesses leading to higher profits and a sizable increase in their welfare Ω^{IH}.

Overall, our findings in this section indicate that ethnic segregation could be beneficial to native low-skill businesses but it seems to be detrimental to the profits and entry of immigrant businesses in the same submarket leading to the underutilization of entrepreneurial potential in this group.

Table 7: Welfare changes upon a marginal increase in ethnic segregation, $\psi = 0.01$

	Low-skilled				High-skilled			
	Regular workers		Pot. entrepreneurs		Regular workers		Pot. entrepreneurs	
	N	I	N	I	N	I	N	I
	$\bar{\Omega}^{NL}$	$\bar{\Omega}^{IL}$	Ω^{NL}	Ω^{IL}	$\bar{\Omega}^{NH}$	$\bar{\Omega}^{IH}$	Ω^{NH}	Ω^{IH}
(0)	1.552	1.405	1.523	1.497	1.988	1.641	1.970	1.810
(F)	-0.18%	-0.07%	+1.74%	-7.63%	-0.12%	-0.14%	-0.15%	+0.95%

Note: Row (0) shows the welfare of workers in the benchmark model. Row (F) shows the change in welfare upon ethnic segregation in low-skill businesses, $\psi = 0.01$.

6 Conclusion

In this paper, we develop a unified framework that incorporates the dual role of immigrants as workers and entrepreneurs. As workers, migrants compete with native workers for jobs in the regular job market. In contrast, as entrepreneurs, they compete with native entrepreneurs but create employment opportunities for other natives and migrants looking for jobs. The theoretical setup combined with survey data from the SOEP is used to quantify the impact of low-skill immigration on small businesses, unemployment rates, wage structure, and welfare of native and incumbent immigrants in Germany.

We consider a low-skilled migration shock similar in intensity to the refugee wave of $2012 - 2017$. Consistent with the literature, we find that it is associated with increased unemployment and reduced wages for all low-skilled workers, negatively affecting their welfare. Similarly, the high-skilled workers gain from such an inflow. Nonetheless, we extend the literature by providing a more detailed picture of the effects of migration on small businesses and entrepreneurs. Contrary to the existing literature, suggesting a negative impact of migration on incumbent migrants, we find that incumbent immigrant entrepreneurs in both skill groups gain from immigration and expand their entrepreneurial activities. This amplifies the welfare gains of high-skill regular workers and reduces the welfare losses of the low-skilled. Yet, we document an adverse effect on native entrepreneurs, especially the low-skilled, losing welfare from the lower productivity of their coworkers and facing stronger recruitment competition from immigrant small businesses. We also find that recent German-Indian cooperation on skilled-worker mobility can reduce the losses from low-skilled migration.

The counterfactual experiment suggests that restricting the entry of immigrants into entrepreneurship leads to an overall welfare loss for the economy. All demographic groups incur welfare losses except for the native entrepreneurs who gain from reduced competition with immigrant businesses. Finally, quantifying the impact of ethnic segregation in small businesses, we find that low-skill native entrepreneurs and high-skill immigrant entrepreneurs gain while all other groups of workers lose welfare from such segregation.

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Appendices

A Motivating facts and theory

A.1 Employment transition matrices

Table 8: Transitions by ethnicity and skills: Potential entrepreneurs

	Native, high-skilled			Native, low-skilled		
	S	P	U	S	P	U
S	0.887	0.111	0.002	0.857	0.141	0.002
P	0.160	0.828	0.012	0.148	0.822	0.030
U	0.236	0.258	0.506	0.161	0.290	0.545
	Immigrant, high-skilled			Immigrant, low-skilled		
	S	P	U	S	P	U
S	0.875	0.125	0	0.808	0.190	0.002
P	0.217	0.734	0.0492	0.231	0.721	0.048
U	0.135	0.499	0.367	0.120	0.261	0.619

Note: Authors' calculations using SOEP 2000-2017. The transition matrix shows the probability of an individual in a given employment state. ***S*** is for self-employment/entrepreneurship, ***P*** for paid employment and ***U*** for unemployment.

Table 9: Transitions by ethnicity and skills: Regular workers

	Native, high-skilled		Native, low-skilled	
	P	U	P	U
P	0.995	0.005	0.981	0.019
U	0.421	0.579	0.259	0.741
	Immigrant, high-skilled		Immigrant, low-skilled	
	P	U	P	U
P	0.979	0.021	0.975	0.025
U	0.326	0.674	0.258	0.742

Note: Authors' calculations using SOEP 2000-2017. The transition matrix shows the probability of an individual in a given employment state. ***S*** is for self-employment/entrepreneurship, ***P*** for paid employment and ***U*** for unemployment.

A.2 Hiring in small businesses

In this part of the appendix we derive the value gains from hiring one more native (Δ_m^N) or immigrant (Δ_k^I) coworker:

$$(r+\gamma)\Delta_k^I = (y_0^I - w_0^I)(1-\tau) + \bar{q}(\theta_0)\mu\Delta_{k+1}^I - \bar{q}(\theta_0)\mu\Delta_k^I + \bar{q}(\theta_0)(1-\mu)\Delta_k^I - \bar{q}(\theta_0)(1-\mu)\Delta_k^I$$

In a similar way, let $\Delta_m^N = B_{tm}(\alpha) - B_{tm-1}(\alpha)$, $\forall t = 0..\infty\ \alpha > \alpha_0$ then we get:

$$(r+\gamma)\Delta_m^N = (y_0^N - w_0^N)(1-\tau) + \bar{q}(\theta_0)\mu\Delta_m^N - \bar{q}(\theta_0)\mu\Delta_m^N + \bar{q}(\theta_0)(1-\mu)\Delta_{m+1}^N - \bar{q}(\theta_0)(1-\mu)\Delta_m^N$$

In a stationary environment we get: $\Delta^I = \Delta_k^I = \Delta_{k+1}^I$ and $\Delta^N = \Delta_m^N = \Delta_{m+1}^N$.

Next, consider native high-skill businesses facing a business destruction rate γ^{NH}, hiring 4 types of workers and paying wages w_{0N}^{iH} to native/immigrant high-skill workers and w_{CN}^{iL} – to native/immigrant low-skill workers (engaged in cross-skill matching). At the same time immigrant high-skill businesses are facing a business destruction rate γ^{IH}, hiring 4 types of workers and paying wages w_{0I}^{iH} to native/immigrant high-skill workers and w_{CI}^{iL} – to native/immigrant low-skill workers (engaged in cross-skill matching). The associated outputs and profits are given by:

$$\Delta_N^{iH} = \frac{y_{0N}^{iH} - w_{0N}^{iH}}{r+\gamma^{NH}} \qquad \Delta_N^{iL} = \frac{y_{CN}^{iL} - w_{CN}^{iL}}{r+\gamma^{NH}} \qquad \Delta_I^{iH} = \frac{y_{0I}^{iH} - w_{0I}^{iH}}{r+\gamma^{IH}} \qquad \Delta_I^{iL} = \frac{y_{CI}^{iL} - w_{CI}^{iL}}{r+\gamma^{IH}}$$

A.3 Proof of propositions 1, 2, 3:

Proof of proposition 1: Consider the first and second integrals in (5), using integration by parts they can be rewritten as:

$$\int_{\alpha}^{\alpha_0}(1-F(x))E'(x)dx - (1-F(\alpha_0))(E(\alpha_0)-E(\alpha))$$
$$\int_{\alpha_0}^{\bar{\alpha}}(1-F(x))B_0'(x)dx + (1-F(\alpha_0))(B_0(\alpha_0)-E(\alpha))$$

Inserting both expressions back into (5) and taking into account that $E(\alpha_0) = B_0(\alpha_0)$ we get the final expression for $E(\alpha)$:

$$(r+\gamma)E(\alpha) = \sigma\alpha(1-t) + \delta\int_{\alpha}^{\alpha_0}\frac{(1-F(x))\sigma(1-t)}{r+\gamma+\delta(1-F(x))}dx + \delta(1-t)\int_{\alpha_0}^{\bar{\alpha}}\frac{(1-F(x))\sigma}{r+\gamma}dx + \gamma U$$

Evaluating $E(\alpha)$ at α_0 and using the definition $E(\alpha_0) = B_0(\alpha_0)$ we get equation (7). $\square$

Proof of proposition 2: Using integration by parts to rewrite the first, second and third integrals in equation (4) we get:

$$\int_{\alpha}^{\alpha_s}(E_s(x)-E_s(\alpha))dF(x) = \int_{\alpha}^{\alpha_s}(1-F(x))E_s'(x)dx - (1-F(\alpha_s))(E_s(\alpha_s)-E_s(\alpha))$$
$$\int_{\alpha_s}^{\alpha_0}(1-F(x))E'(x)dx - E(\alpha_0)(1-F(\alpha_0)) + E(\alpha_s)(1-F(\alpha_s)) + E_s(\alpha)(F(\alpha_s)-F(\alpha_0))$$
$$\int_{\alpha_0}^{\bar{\alpha}}(B_0(x)-E_s(\alpha))dF(x) = \int_{\alpha_0}^{\bar{\alpha}}(1-F(x))B_0'(x)dx + (1-F(\alpha_0))(B_0(\alpha_0)-E_s(\alpha))$$

Inserting all three expressions back into (4) and taking into account that $E_s(\alpha_s) = E(\alpha_s)$

and $B_0(\alpha_0) = E(\alpha_0)$ we get the final expression for $E_s(\alpha)$:

$$\begin{aligned}(r+\gamma)E_s(\alpha) &= \sigma\alpha(1-t) + X\lambda(\theta)(W - E_s(\alpha)) + \delta\int_{\alpha}^{\alpha_s}\frac{(1-F(x))\sigma(1-t)}{r+\gamma+X\lambda(\theta)+\delta(1-F(\alpha))}dx \\ &+ \delta\int_{\alpha_s}^{\alpha_0}\frac{(1-F(x))\sigma(1-t)}{r+\gamma+\delta(1-F(x))}dx + \delta(1-t)\int_{\alpha_0}^{\bar{\alpha}}\frac{(1-F(x))\sigma}{r+\gamma}dx + \gamma U\end{aligned}$$

Next, we consider the first and second integrals in eq. (8), rewriting them we get:

$$\int_{\alpha_s}^{\alpha_0}(1-F(x))E'(x)dx - E(\alpha_0)(1-F(\alpha_0)) + E(\alpha_s)(1-F(\alpha_s)) + W(F(\alpha_s) - F(\alpha_0))$$

$$\int_{\alpha_0}^{\bar{\alpha}}(B_0(x) - W)dF(x) = \int_{\alpha_0}^{\bar{\alpha}}(1-F(x))B_0'(x)dx + (1-F(\alpha_0))(B_0(\alpha_0) - W)$$

Inserting both expressions back into (8) and taking into account that $E_s(\alpha_s) = E(\alpha_s) = W$ and $B_0(\alpha_0) = E(\alpha_0)$ we get the final expression for W:

$$(r+\bar{\gamma})W = w(1-t) + \delta\int_{\alpha_s}^{\alpha_0}\frac{(1-F(x))\sigma(1-t)}{r+\gamma+\delta(1-F(x))}dx + \delta(1-t)\int_{\alpha_0}^{\bar{\alpha}}\frac{(1-F(x))\sigma}{r+\gamma}dx + \bar{\gamma}U$$

Evaluating $E_s(\alpha)$ at α_s and using the definition $E_s(\alpha_s) = W$ we can find the cut-off α_s in equation (9). Next, we show that α_s is increasing in the wage w by differentiating equation (9) and dividing both parts by $(1-t)$:

$$\frac{\partial\alpha_s}{\partial w} = \frac{(r+\gamma+X\lambda(\theta)+\delta(1-F(\alpha_s)))}{\sigma(r+\bar{\gamma}+X\lambda(\theta)+\delta(1-F(\alpha_s)))} \quad \frac{\partial^2\alpha_s}{\partial w^2} = \frac{\delta f(\alpha_s)(\gamma-\bar{\gamma})}{\sigma(r+\bar{\gamma}+X\lambda(\theta)+\delta(1-F(\alpha_s)))^2}\frac{\partial\alpha_s}{\partial w}$$

Hence, $\partial^2\alpha_s/\partial w^2$ is positive for $\gamma > \bar{\gamma}$ and negative otherwise. □

Proof of proposition 3: Using integration by parts we can rewrite the first, second and third integrals in equation (3) as:

$$\int_{\alpha_u}^{\alpha_s}(1-F(x))E_s'(x)dx - E_s(\alpha_s)(1-F(\alpha_s)) + E_s(\alpha_u)(1-F(\alpha_u)) + U(F(\alpha_u) - F(\alpha_s))$$

$$\int_{\alpha_s}^{\alpha_0}(1-F(x))E'(x)dx - E(\alpha_0)(1-F(\alpha_0)) + E(\alpha_s)(1-F(\alpha_s)) + U(F(\alpha_s) - F(\alpha_0))$$

$$\int_{\alpha_0}^{\bar{\alpha}}(B_0(x) - U)dF(x) = \int_{\alpha_0}^{\bar{\alpha}}(1-F(x))B_0'(x)dx + B_0(\alpha_0)(1-F(\alpha_0)) + U(F(\alpha_0) - 1)$$

Inserting these expressions back into (3) we get the final expression for U:

$$\begin{aligned}rU &= z - h + X\lambda(\theta)(W-U) + \delta\int_{\alpha_u}^{\alpha_s}\frac{(1-F(x))\sigma(1-t)}{r+\gamma+X\lambda(\theta)+\delta(1-F(x))}dx \\ &+ \delta\int_{\alpha_s}^{\alpha_0}\frac{(1-F(x))\sigma(1-t)}{r+\gamma+\delta(1-F(x))}dx + \delta(1-t)\int_{\alpha_0}^{\bar{\alpha}}\frac{(1-F(x))\sigma}{r+\gamma}dx \qquad (21)\end{aligned}$$

A.4 Proof of proposition 4:

Let b_k^I denote the number of small businesses with k immigrant coworkers, and b_m^N be the number of small businesses with m native coworkers. These unconditional densities can be derived as follows:

$$\dot{b}_1^I = \bar{q}\mu b_0^I - (\gamma + \bar{q}\mu)b_1^I = 0 \qquad \dot{b}_2^I = \bar{q}\mu b_1^I - (\gamma + \bar{q}\mu)b_2^I = 0 \qquad \dot{b}_3^I = \bar{q}\mu b_2^I - (\gamma + \bar{q}\mu)b_3^I = 0$$

Repeating equations for native employees b_m^N and continuing by induction we get:

$$b_k^I = \left(\frac{\bar{q}\mu}{\gamma + \bar{q}\mu}\right)^k b_0^I \qquad b_m^N = \left(\frac{\bar{q}(1-\mu)}{\gamma + \bar{q}(1-\mu)}\right)^m b_0^N$$

Adding up all values for $k = 0..\infty$ and for $m = 0..\infty$ we get:

$$b^I = \sum_{k=0}^{\infty} b_k^I = \sum_{k=0}^{\infty}\left(\frac{\bar{q}\mu}{\gamma + \bar{q}\mu}\right)^k b_0^I \quad \Rightarrow \quad b_0^I = \frac{\gamma b^I}{\gamma + \bar{q}\mu} \quad \text{and} \quad b_0^N = \frac{\gamma b^N}{\gamma + \bar{q}(1-\mu)}$$

Therefore, the two distributions are given by geometric densities with parameters $\gamma/(\gamma + \bar{q}(\theta_0)(1-\mu))$ and $\gamma/(\gamma + \bar{q}(\theta_0)\mu)$ respectively:

$$p_k^I = \frac{b_k^I}{b^I} = \Big(\frac{\bar{q}(\theta_0)\mu}{\gamma + \bar{q}(\theta_0)\mu}\Big)^k \frac{\gamma}{\gamma + \bar{q}(\theta_0)\mu} \qquad p_m^N = \frac{b_m^N}{b^N} = \Big(\frac{\bar{q}(\theta_0)(1-\mu)}{\gamma + \bar{q}(\theta_0)(1-\mu)}\Big)^m \frac{\gamma}{\gamma + \bar{q}(\theta_0)(1-\mu)}$$

Finally, we consider the distributions of solo self-employed with respect to the quality of their products α. These can be found due to the fact that $s_u(\alpha) = H'(\alpha)$ and $s_e(\alpha) = G'(\alpha)$. The distributions are then given by $s_e(\alpha)/s_e$ for $\alpha \in [\alpha_s..\alpha_0]$ and $s_u(\alpha)/s_u$ for $\alpha \in [\alpha_u..\alpha_s]$, where:

$$\begin{aligned} \frac{s_e(\alpha)}{s_e} &= \frac{\delta f(\alpha)(\gamma + \delta(1 - F(\alpha_s)))}{[\gamma + \delta(1 - F(\alpha))]^2} \frac{(\gamma + \delta(1 - F(\alpha_0)))}{[\delta(F(\alpha_0) - F(\alpha_s))]} \\ \frac{s_u(\alpha)}{s_u} &= \frac{\delta f(\alpha)(\gamma + \delta(1 - F(\alpha_u)) + X\lambda(\theta))}{[\gamma + \delta(1 - F(\alpha)) + X\lambda(\theta)]^2} \frac{(\gamma + X\lambda(\theta) + \delta(1 - F(\alpha_s)))}{[\delta(F(\alpha_s) - F(\alpha_u))]} \end{aligned}$$

Note that $G(\alpha_s)/s_e = 0$, $G(\alpha_0)/s_e = 1$, $H(\alpha_u)/s_u = 0$ and $H(\alpha_s)/s_u = 1$.

A.5 Wage setting:

The disagreement value W_D is given by:

$$rW_D = z + \delta \int_{\alpha_s}^{\alpha_0} \frac{(1 - F(x))\sigma(1-t)}{r + \gamma + \delta(1 - F(x))} dx + \delta(1-t) \int_{\alpha_0}^{\bar{\alpha}} \frac{(1 - F(x))\sigma}{r + \gamma} dx - \bar{\gamma}(W_D - U)$$

Proof of proposition 6. The Nash maximization problem gives rise to the following first order condition:

$$\beta(y - \bar{c}_k - w) = -(1-\beta)(w - \frac{z}{1-t})[\Lambda(y,w) - 1] \quad \text{where} \quad \Lambda(y,w) = J\delta f(\alpha_s)\frac{\partial \alpha_s}{\partial w}$$

Note that the Nash bargaining condition requires $J'_w < 0$ implying that $[\Lambda(y,w) - 1] < 0$, since otherwise the worker and the firm would both gain from a higher wage. Implicitly differentiating the wage with respect to output y we get:

$$\frac{\partial w}{\partial y}(1-\beta)\left[\Lambda(y,w) - 1 + (w - \frac{z}{1-t})\Lambda'_w\right] = -\beta - (1-\beta)(w - \frac{z}{1-t})\Lambda'_y$$

where the right hand side is negative since $\Lambda'_y = J'_y \delta f(\alpha_s) \frac{\partial \alpha_s}{\partial w} > 0$ due to the fact that firm profits are increasing in output ($J'_y > 0$).

Implicitly differentiating the wage with respect to the bargaining power β we get:

$$\frac{\partial w}{\partial \beta}(1-\beta)\left[\frac{-\beta}{1-\beta} + \Lambda(y,w) - 1 + (w - \frac{z}{1-t})\Lambda'_w\right] = -(y - \bar{c}_k - w) + \beta(w - \frac{z}{1-t})[\Lambda(y,w) - 1]$$

where the right hand side is also negative since $[\Lambda(y,w) - 1] < 0$. Next, we differentiate the auxiliary function $\Lambda(y,w)$ w.r.t. w:

$$\Lambda'_w = J'_w \delta f(\alpha_s)\frac{\partial \alpha_s}{\partial w} + J\delta \frac{\partial f(\alpha_s)}{\partial \alpha_s}\left(\frac{\partial \alpha_s}{\partial w}\right)^2 + J\delta f(\alpha_s)\frac{\partial^2 \alpha_s}{\partial w^2}$$

If the distribution of product qualities is uniform, then $f(\alpha) = 1$ and the second term becomes zero. Finally, from proposition 2 we know that $\partial^2 \alpha_s / \partial w^2 \leq 0$ if $\gamma \leq \bar{\gamma}$. Thus, we can show that $\gamma \leq \bar{\gamma}$ is a sufficient condition for $\partial w / \partial y > 0$ and $\partial w / \partial \beta > 0$ if the distribution of product qualities is uniform.

Bargaining with regular workers: Consider bargaining between firms and regular workers. Let $\bar{W}$ denote their present value of employment, $\bar{W}_D$ be the payoff in disagreement and $\bar{J}$ be the present value of a job given by:

$$\begin{aligned} r\bar{W} &= \bar{w}(1-t) - \bar{\gamma}(\bar{W} - \bar{U}) \qquad r\bar{W}_D = \bar{z} - \bar{\gamma}(\bar{W}_D - \bar{U}) \\ r\bar{J} &= (\bar{y} - \bar{c}_k - \bar{w})(1-\tau) - \bar{\gamma}(\bar{J} - V) \end{aligned}$$

Formulating the Nash bargaining problem we get: $\bar{w}(1-t) = \beta(\bar{y} - \bar{c}_k)(1-t) + (1-\beta)\bar{z}$. In addition, these workers can be employed in small businesses run by self-employed entrepreneurs. Jobs in small businesses pay wages w_{0N} if the business is operated by the native owner, and w_{0I} if the business is operated by the immigrant owner.[17] Let W_{0N} and W_{0I} be the corresponding present values of employment in small businesses:

$$rW_{0N} = w_{0N}(1-t) - \gamma^N(W_{0N} - \bar{U}) \qquad rW_{0I} = w_{0I}(1-t) - \gamma^I(W_{0I} - \bar{U})$$

The job destruction rates are specific to the type of the business owner. Thus, all workers in a small firm are subject to the same job destruction rate γ^N if the business owner is a native entrepreneur, and γ^I if the owner is an immigrant entrepreneur. The disagreement payoffs in the bargaining state are denoted by W_{DN} and W_{DI} and can be written as:

$$rW_{DN} = \bar{z} - \gamma^N(W_{0N} - \bar{U}) \qquad rW_{DI} = \bar{z} - \gamma^I(W_{0I} - \bar{U})$$

Workers then seek to maximize their job rent $W_{0N} - W_{DN}$ or $W_{0I} - W_{DI}$ depending on the type of the business. Let β_0 denote the bargaining power of workers negotiating with small businesses. The Nash bargaining problem then becomes:

$$\max_{w_{0N}}(w_{0N}(1-t) - \bar{z})^{\beta_0}(y_{0N} - w_{0N})^{1-\beta_0} \quad \Rightarrow \quad w_{0N}(1-t) = \beta_0 y_{0N}(1-t) + (1-\beta_0)\bar{z}$$

and the same for immigrant business owners, so we get $w_{0I}(1-t) = \beta_0 y_{0I}(1-t) + (1-\beta_0)\bar{z}$. In addition, wages of low-skill workers employed in high-skill small businesses can be

[17] With full scale notation the two wages are written as: w_{0N}^{ij} for workers of type ij, $i = I, N$, $j = L, H$ employed in small businesses operated by the native owner, and w_{0I}^{ij} for workers of type ij employed in small businesses operated by the immigrant owner.

obtained as $w_{CI}(1-t) = \beta_0 y_{CI}(1-t) + (1-\beta_0)\bar{z}$ and $w_{CN}(1-t) = \beta_0 y_{CN}(1-t) + (1-\beta_0)\bar{z}$ where the subindex C stands for cross-skill matching.

A.6 Unemployment of regular workers

The equilibrium unemployment of regular workers $\bar{u}^{ij}$, $i = I, N$, $j = L, H$ is given by:

$$\bar{u}^{ij} = \Big[d^{ij} - l^{ij} - \mu^{ij}\bar{q}(\theta_0^H)\big(\frac{b^{NH}}{\gamma^{NH}} + \frac{b^{IH}}{\gamma^{IH}}\big) - \mathbb{1}_L \mathbb{M}\bar{q}(\theta_0^L)\big(\frac{b^{NL}}{\gamma^{NL}} + \frac{b^{IL}}{\gamma^{IL}}\big)\Big]\frac{\bar{\gamma}^{ij}}{\bar{\gamma}^{ij} + X^{ij}\lambda(\theta^j)}$$

where variable $\mathbb{M}$ takes value μ for immigrant low-skill workers and $1-\mu$ for native low-skill workers.

B Empirical data

B.1 Mincer earnings regressions

The information on gross monthly wage/income for regular workers and potential entrepreneurs is available in SOEP. We use data for 2000-2017 and run the following Mincer earnings regressions for regular workers:

$$\begin{aligned}\ln w_{it} &= \phi_0 + \phi_1 N_{it} + \phi_2 FS_{it} + \phi_3 HS_{it} + \phi_4 N_{it} \times FS_{it} + \phi_5 N_{it} \times HS_{it} \\ &+ \phi_6 HS_{it} \times FS_{it} + \phi_7 N_{it} \times HS_{it} \times FS_{it} + \phi_8 t + \varsigma_{it}\end{aligned}$$

Where w_{it} is the wage of worker i observed in year t. N_{it} is the indicator function that takes the value 1 for natives, FS_{it} is the indicator function with value 1 for large firms, HS_{it} takes value 1 for high-skill workers. We introduce interaction terms $(N_{it} \times FS_{it})$ and $(HS_{it} \times FS_{it})$ in order to capture variation in the effect of firm size on wages by ethnicity and skill. Similarly, $(N_{it} \times HS_{it})$ captures the fact that the return to schooling could be different for native and immigrant workers.

For the potential entrepreneurs we run the following regression

$$\begin{aligned}\ln w_{it} &= \phi_0 + \phi_1 N_{it} + \phi_2 HS_{it} + \phi_3 N_{it} \times HS_{it} + \sum_{l=1}^{3} \phi_{4l} PE_{it}^l + \sum_{l=1}^{3} \phi_{5l} N_{it} \times PE_{it}^l \\ &+ \sum_{l=1}^{3} \phi_{6l} HS_{it} \times PE_{it}^l + \sum_{l=1}^{3} \phi_{7l} HS_{it} \times PE_{it}^l \times N_{it} + \phi_8 t + \epsilon_{it}\end{aligned}$$

where PE_{it}^l is the indicator function, such that $l = 1$ for potential entrepreneurs in solo self-employment, $l = 2$ for business owners with less than 9 coworkers, $l = 3$ for business owners with more than 9 coworkers. Potential entrepreneurs in paid employment serve as a reference category. The interaction terms $N_{it} \times PE_{it}^l$ and $HS_{it} \times PE_{it}^l$ capture the ethnicity specific and skill specific fixed effects for entrepreneurs if different economic states. $N_{it} \times HS_{it}$ captures the skill fixed effects specific to the two ethnic groups. The coefficients from both regressions are summarized in tables 10 and 11 respectively. We use these results to predict gross earnings of different worker groups. These are used as target moments for the calibration of productivities of workers and the related parameters.

Table 10: Wage regression for regular workers, SOEP 2000-2017

Variable	Coefficient	Standard error	Predicted ln(w)	Normalized wage
Native	0.142***	(0.012)	$\bar{e}_0^{NH}$: 7.25	$w_0^{NH} = 1.295$
Fsize	0.609***	(0.012)	e^{NH}: 7.93	$\bar{w}^{NH} = 2.557$
Native × Fsize	-.064***	(0.014)	$\bar{e}_0^{NL}$: 6.99	$w_0^{NL} = 1$
HSkill	0.251***	(0.029)	$\bar{e}^{NL}$: 7.53	$\bar{w}^{NL} = 1.715$
Native × HSkill	0 .008	(0.030)	$\bar{e}_0^{IH}$: 7.10	$w_0^{IH} = 1.120$
Fsize × HSkill	0.048	(0.330)	$\bar{e}^{IH}$: 7.76	$\bar{w}^{IH} = 2.158$
Native × Fsize × HSkill	0.086**	(0.034)	$\bar{e}_0^{IL}$: 6.85	$w_0^{IL} = 0.870$
Constant	6.779***	(0.013)	$\bar{e}^{IL}$: 7.46	$\bar{w}^{IL} = 1.599$
Observations	180699			

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$Fsize = 1$ for large firm with more than 20 workers

Table 11: Wage regression for potential entrepreneurs, SOEP 2000-2017

Variable	Coefficient	Standard error	Predicted ln(w)	Normalized wage/profit
PE $type_1$	-0.009	(0.043)	s^{NH}: 7.43	1.551
PE $type_2$	0.770***	(0.048)	s^{NL}: 7.26	1.309
PE $type_3$	1.078***	(0.119)	$b^{NH}_{<9}$: 8.34	3.854
HSkill	0.049	(0.060)	$b^{NL}_{<9}$: 7.89	2.458
PE $type_1$ × HSkill	0 .131	(0.082)	$b^{NH}_{>9}$: 8.71	5.580
PE $type_2$ × HSkill	0 .460***	(0.091)	$b^{NL}_{>9}$: 8.37	3.972
PE $type_3$ × HSkill	0.182	(0.191)	e^{NH}: 7.62	1.876
Native	-0.018	(0.034)	e^{NL}: 7.19	1.220
PE $type_1$ × Native	0.081*	(0.046)	s^{IH}: 7.38	1.476
PE $type_2$ × Native	-0.077	(0.052)	s^{IL}: 7.20	1.232
PE $type_3$ × Native	0.101	(0.126)	$b^{IH}_{<9}$: 8.50	4.523
HSkill × Native	0.383***	(0.063)	$b^{IL}_{<9}$: 7.99	2.716
PE $type_1$ × HSkill × Native	-0.398***	(0.085)	$b^{IH}_{>9}$: 8.52	4.614
PE $type_2$ × HSkill × Native	-0.443***	(0.095)	$b^{IL}_{>9}$: 8.29	3.666
PE $type_3$ × HSkill × Native	-0.272	(0.199)	e^{IH}: 7.26	1.309
Constant	7.111***	(0.038)	e^{IL}: 7.21	1.245
Observations	37831			

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

PE $type_1$ = Solo self-employed or helpers in family business, PE $type_2$ = self-employed with less than 9 coworkers

PE $type_3$ = self-employed with more than 9 coworkers, PE $type_4$ = in paid employment

Table 12: Average tenure for different demographic groups of workers

Group	Tenure
Regular workers, immigrants average tenure	8.781
Regular workers, native average tenure	11.547
Regular workers, average tenure (native and immigrants combined)	8.237
Regular workers, small firms natives average tenure	8.504
Regular workers, small firms natives average tenure	6.750

B.2 Bargaining power in small firms

Combining information on wages of workers in small firms and the corresponding profits of small businesses we obtain the bargaining power parameter β_0. More specifically, for low-skill businesses we set the following expressions equal to the pre-tax profits predicted from a Mincer regression:

$$\underbrace{\sigma \int_{\alpha_0}^{1} \frac{f(\alpha)}{1-F(\alpha_0)} d\alpha - c}_{\text{individual earnings}} + \frac{\gamma + \bar{q}(\theta_0)}{\gamma} \underbrace{\frac{(1-\beta_0)}{\beta_0(1-t)} \Big(\mu(w_0^I(1-t) - \bar{z}^I)) + (1-\mu)(w_0^N(1-t) - \bar{z}^N) \Big)}_{\text{average profit per coworker}}$$

where $(\gamma + \bar{q}(\theta_0))/\gamma$ is the average number of coworkers conditional on hiring at least one. For high-skill businesses we extend the expression to account for cross-skill matching. Based on these target values for profits we find $\beta_0^L = 0.456$ and $\beta_0^H = 0.422$.

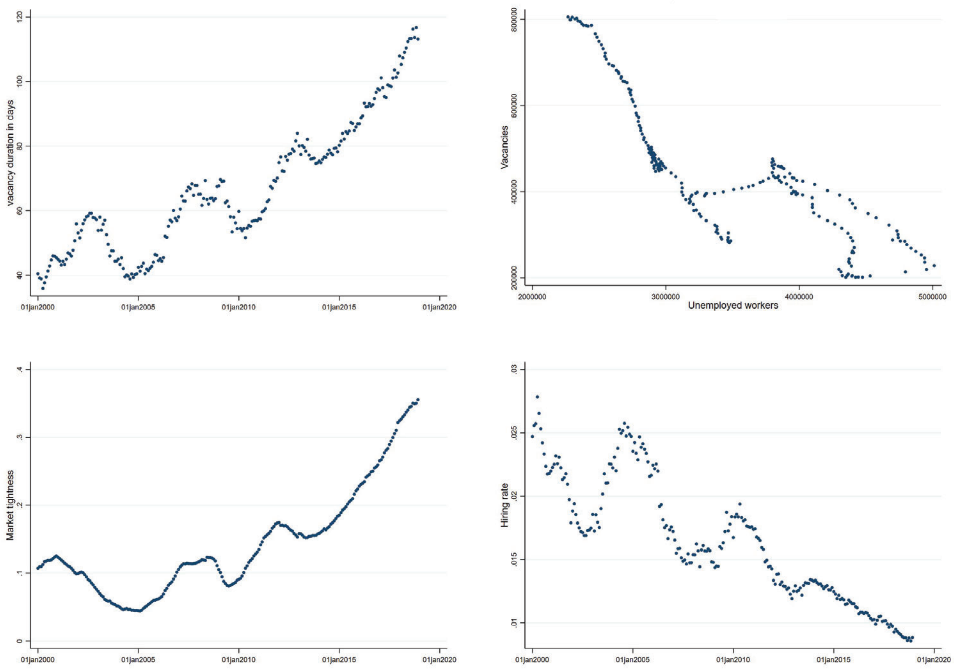
B.3 Matching function

The Federal Employment Office (Bundesagentur für Arbeit) data includes information on the absolute number of unemployed, vacancies and vacancy durations (in days) which are not available in the SOEP survey. In total there 228 monthly observations. We use this data to construct an economy wide average market tightness ($\theta_t = \frac{V_t}{U_t}$) and the hiring rate ($q(\theta_t)$. These variables are illustrated on Fig 5. The upper left panel of this figure shows a sharp increase of the average vacancy duration between the years 2000 and 2018. Whereas it was only 41.5 days on average in the year 2000, it almost tripled and reached a level 112 days by 2018. The top right panel of figure 5 shows the corresponding Beveridge curve for Germany showing a stable negative relationship between unemployment and vacancies. The bottom left panel shows the market tightness, while the aggregate job-filling rate $q(\theta)$ is illustrated in the bottom right panel of figure 5. Using this information we estimate the following regression:

$$\ln q(\theta_t) = cst - \zeta \ln \theta_t + Year + \iota_t \tag{22}$$

We control for time fixed effects by introducing a dummy for each year. This regression gives us a value of the slope parameter ζ equal to 0.47.

Figure 5: Vacancy duration and market tightness.



Note: Authors' calculations using statistical information of the Federal Employment Office (Bundesagentur für Arbeit) between January 2000 and December 2018.

Table 13: Parameters calibrated using SOEP data 2000-2017

Prm.	Empirical moment/target	NL IL NH IH	Definition and calibrated values	NL IL NH IH
$\bar{\gamma}$	Average tenure of regular workers	11.55 8.78 11.55 8.78	Regular job destruction rate	0.0198 0.0270 0.0206 0.0269
γ	Share of workers in small businesses $e_0/(e_0+\bar{e})$	0.265 0.270 0.165 0.212	Business destruction/exit rate	0.0296 0.0358 0.0305 0.0292
δ	Share of active entrepreneurs $(b+s)/l$	0.547 0.525 0.568 0.577	Transition rate to entrepreneurship	0.5893 0.5355 1.1149 0.5173
x	Unempl. rate of immigrant workers $\bar{u}/(d-l)$	- 0.141 - 0.091	Search intensity for small businesses	1 0.5713 1 0.2851
X	Unempl. rate of immigrant pot. entrepreneurs u/l	- 0.049 - 0.039	Search intensity for regular jobs	1 0.7593 1 0.2750
c	Share of solo-entrepreneurs $(b_0+s)/(b+s)$	0.586 0.607 0.591 0.459	Flow cost of a small business	1.1636 1.2919 2.2448 3.0985
ς	Businesses with 1-9 coworkers $\sum_{n=1}^{9} b_n/(b+s)$	0.366 0.362 0.326 0.425	Entrepreneurial productivity	0.2499 0.255 0.3703 0.2635
φ_{0N}	Profits of small businesses with coworkers	2.63 2.77 4.20 4.52	Quantities in small (native) businesses	0.2973 0.2398 0.4109 0.3363
φ_{0I}	Av. wages in small businesses $\bar{w}_0$	1 0.8674 1.2950 1.1144	Quantities in small (immigrant) businesses	0.3437 0.3097 0.5293 0.4227
$\bar{\varphi}$	Av. wages of workers in regular jobs $\bar{w}$	1.625 1.492 2.940 2.630	Quantities of workers in regular jobs	0.9727 1 0.9157 1
φ	Wages of pot. entrepreneurs in regular jobs w	1.222 1.246 1.884 1.309	Quantities of pot. entrepr. in regular jobs	0.8954 0.9004 0.8619 0.7440
z	60% replacement rate in the 1st year and ALG II assistance afterwords		Unemployment benefits of pot. entrepreneurs	0.3719 0.3723 0.3757 0.3709
$\bar{z}$	60% replacement rate in the 1st year and ALG II assistance afterwords		Unemployment benefits of regular workers	0.3838 0.3809 0.3948 0.3869
M	Unempl. rate of native entrepreneurs u/l	0.035 - 0.014 -	Matching multiplier, regular jobs	0.5319 0.9955
$\bar{M}$	Unempl. rate of native workers $\bar{u}/(d-l)$	0.085 - 0.022 -	Matching multiplier, small businesses	0.0748 0.1809
$\bar{c}_k$	Average job-filling rate $q(\theta)$	1.5500 1.2398	Capital cost in regular firms	3.3821 2.5642
c_h	Rebien, Stops, Zaharieva (2020)		Vacancy posting cost	0.7431 2.3344
β_0	Assumption $w_{0I}^N/w_{0I}^I = \bar{w}^N/\bar{w}^I$	1.0819 1.1905	Bargaining power of workers in small firms	0.4564 0.4222
r	Annual discount rate = 5%		(Quarterly) Discount rate	0.0125
η	Chassamboulli and Palivos (2014) Battisti et al. (2018)		Elasticity of subst. between K and Z	0.350
ρ	Ottaviano and Peri (2012) Battisti et al. (2018)		Elasticity of subst. between Y^H and Y^L	0.500
R	Chassamboulli and Palivos (2014) Battisti et al. (2018)		(Quarterly) cost of capital	0.030
A	Normalization $\bar{y}^{NH} = P_H$		Total factor productivity	2.5630
a	Normalization $\bar{y}^{NL} = P_L$		Income share of Y_L	0.5547
κ	Average tenure in small firms	8.2369	Cross-skill matching parameter	0.1700
ζ	Regression $\ln q(\theta)$ on $\ln\theta$		Elasticity of the matching function	0.47
β	Ratio of nominal wages to GDP	0.28	Bargaining power of workers in regular jobs	0.9084

C Results

C.1 Low-skilled immigration and skill-neutral immigration

We define $e_0 = e_{0N} + e_{0I}$ – total employment of workers in small businesses within their own skill group with the corresponding average wage $\bar{w}_0 = (w_{0N}e_{0N} + w_{0I}e_{0I})/(e_{0N} + e_{0I})$. Further, $e_C = e_{CN} + e_{CI}$ – total employment of low-skill workers in high-skill small businesses with the corresponding average wage $\bar{w}_C = (w_{CN}e_{CN} + w_{CI}e_{CI})/(e_{CN} + e_{CI})$.

Table 14: Detailed changes for regular workers upon a 20% increase in immigration, low-skill immigration scenario.

Group	(1) $\bar{u}/(d-l)$	(2) $\bar{e}/(d-l)$	(3) $\bar{w}$	(4) $e_0/(d-l)$	(5) $\bar{w}_0$	(6) $e_C/(d-l)$	(7) $\bar{w}_C$
Low-skill							
Natives	0.085	**0.680**	1.718	**0.135**	1.002	**0.100**	0.997
Change	+0.003	**-0.003**	-0.021	**-0.001**	+0.009	**+0.002**	-0.002
Low-skill							
Immigr.	0.141	**0.634**	1.588	**0.129**	0.871	**0.096**	0.862
Change	+0.004	**-0.004**	-0.021	**-0.002**	+0.016	**+0.001**	-0.001
High-Skill							
Natives	0.022	**0.825**	2.544	**0.153**	1.295		
Change	-0.001	**+0.007**	+0.034	**-0.007**	+0.009		
High-Skill							
Immigr.	0.091	**0.726**	2.163	**0.182**	1.120		
Change	-0.002	**+0.010**	+0.031	**-0.007**	+0.007		

We now consider skill-neutral immigration and increase proportionally the number of low and high-skill immigrants by 20%. Our results are summarized in table 15.

Table 15: Increase in immigration by 20%, skill-neutral scenario

Low-skilled				High-skilled			
Regular workers		Pot. entrepreneurs		Regular workers		Pot. entrepreneurs	
N	I	N	I	N	I	N	I
Ω^{NL}	Ω^{IL}	Ω^{NL}	Ω^{IL}	Ω^{NH}	Ω^{IH}	Ω^{NH}	Ω^{IH}
1.552	1.405	1.523	1.497	1.988	1.641	1.970	1.810
-0.77%	-0.83%	-1.56%	+2.95%	+0.52%	+0.53%	-0.08%	+4.24%
Representative worker: -1.05% Incumbent worker: -0.78%				Representative worker: +0.24%			
Representative worker: -0.68% Incumbent immigrant: +0.38% Incumbent worker: -0.27%							

The changes in wages, productivities and welfare of regular workers are less pronounced compared to the low-skilled scenario. This holds for the losses of regular low-skill workers (approx. -0.8% instead of -1.3%) and for the gains of the regular high-skill workers (approx. $+0.5\%$ instead of $+1\%$). The effect is also more moderate for the welfare of low skill entrepreneurs, but it is more pronounced for the profits and welfare (+4.2%)

of high-skill immigrant entrepreneurs. This is intuitive since hiring high-skill coworkers becomes easier in the case of skill-neutral immigration.

C.2 Entrepreneurship entry barriers and ethnic segregation

Table 16: The distribution of potential entrepreneurs upon business entry barriers

Group	(1) u/l	(2) e/l	(3) w	(4) $(s_u + s_e)/l$	(5) $\sigma\bar{\alpha}_{u0}$	(6) b/l	(7) $\sigma\bar{\alpha}_{01}$	(8) $\bar{q}(\theta_0)\pi/\gamma$
Low-skill								
Natives	0.035	**0.418**	1.222	**0.259**	1.145	**0.288**	1.291	1.971
Change	-0.000	**-0.002**	-0.001	**-0.052**	-0.032	**+0.054**	-0.004	+0.003
Low-skill								
Immigr.	0.049	**0.426**	1.245	**0.251**	1.100	**0.274**	1.314	2.077
Change	+0.132	**+0.393**	-0.001	**-0.251**	-	**-0.274**	-	-
High-Skill								
Natives	0.014	**0.418**	1.884	**0.290**	1.883	**0.277**	1.953	3.763
Change	-0.000	**+0.002**	+0.001	**-0.027**	-0.005	**+0.025**	-0.001	+0.001
High-Skill								
Immigr.	0.039	**0.384**	1.309	**0.206**	1.199	**0.370**	1.374	5.270
Change	+0.072	**+0.504**	+0.001	**-0.206**	-	**-0.370**	-	-

Note: $\bar{\alpha}_{u0}$ is the average entrepreneurial ability in the range $[\alpha_u..\alpha_0]$, calculated as $(s_u\bar{\alpha}_{us} + s_e\bar{\alpha}_{s0})/(s_u + s_e)$. $\bar{\alpha}_{01}$ is the average entrepreneurial ability in the range $[\alpha_0..\bar{\alpha}]$.

Table 17: The distribution of potential entrepreneurs upon ethnic segregation

Group	(1) u/l	(2) e/l	(3) w	(4) $(s_u + s_e)/l$	(5) $\sigma\bar{\alpha}_{u0}$	(6) b/l	(7) $\sigma\bar{\alpha}_{01}$	(8) $\bar{q}(\theta_0)\pi/\gamma$
Low-skill								
Natives	0.035	**0.418**	1.222	**0.259**	1.145	**0.288**	1.291	1.971
Change	-0.000	**+0.005**	+0.001	**-0.057**	-0.035	**+0.052**	-0.003	+0.003
Low-skill								
Immigr.	0.049	**0.426**	1.245	**0.251**	1.100	**0.274**	1.314	2.077
Change	-0.000	**+0.004**	+0.001	**+0.247**	+0.107	**-0.251**	+0.016	-0.006
High-Skill								
Natives	0.014	**0.418**	1.884	**0.290**	1.883	**0.277**	1.953	3.763
Change	-0.000	**-0.005**	-0.002	**+0.006**	-0.001	**-0.001**	-0.001	-0.000
High-Skill								
Immigr.	0.039	**0.384**	1.309	**0.206**	1.199	**0.370**	1.374	5.270
Change	+0.000	**-0.004**	-0.002	**-0.010**	-0.009	**+0.014**	-0.002	+0.001