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Abstract

We adopt a general equilibrium approach in order to measure the effects of recent immigration on the Western German labor market, looking at both wage and employment effects. Using administrative data for the period 1987-2001 and refining them to capture Ethnic German Immigrants and immigrants from eastern Germany, we find that the substantial immigration of the 1990's had no adverse effects on native wages and on their employment levels. It had instead significant adverse employment effects on previous waves of immigrants as well as a small adverse wage effect on them. The asymmetric effect is partly driven by a higher degree of substitution of old and new immigrants in the labor market. However the significant negative employment effect is the result of wage rigidities in the German Labor market. In a counterfactual experiment we show that removing wage rigidities, a large part of the aggregate wage losses to old immigrants (due to job losses) are eliminated.

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1 Introduction

Germany has the largest number of foreign individuals in Europe, and foreign workers represent around 10% of the total labor force.[1] The socioeconomic worries produced by rising immigration led the German government to introduce a selective immigration system based on quotas, which was passed by the parliament but declared void by the Federal Constitutional Court in 2002. In 2004 a comprehensive Immigration Act introduced the possibility for migrant workers to change their temporary residence permit for an unlimited one after having paid at least 60 monthly contributions to social security, provided that they pass a German language proficiency test.[2]

German labor market institutions are characterized by generous unemployment benefits and wage rigidities, which increase the potential for negative employment consequences due to immigration: newcomers and in general immigrants are more likely to stay jobless as wages do not adjust. Such institutional features, specific to Germany, prevent the possibility of a straightforward extension from recent analyses focusing on the United States (Borjas 2003, Ottaviano and Peri 2006), or the United Kingdom (Manacorda, et al 2006) and Israel (Friedberg, 2001) to the German case. Those countries all have more flexible labor markets, lower hiring and firing costs and smaller unemployment insurance vis-a-vis Germany. Two considerations, however, emerge from those studies that should inform the analysis of the effects of immigration in Germany. First, the effects of immigration depend on the composition of native and immigrant workers, in terms of education and experience, and not just on the overall inflow of immigrants. In the case of Germany, this is stressed by De New and Zimmermann (1994) who analyze the wage effects of immigration to Germany for the 1984-1989 period. Segmenting the national labor market across industries, these authors find that immigrant workers substitute for unskilled natives and complement skilled natives. Second, and less obvious, is that even after controlling for education and experience, native and immigrant workers may not be perfectly substitutable.

Certainly the labor market effects of immigration are sensitive to the institutional setup.[3] For instance, the importance of labor market institutions in mediating the effects of immigration on wages and employment is stressed by Angrist and Kugler (2003). For a panel of European Economic Area countries for 1983-1999, those authors show that labor market rigidities cause adverse employment effects. This finding echoes the results of Pischke and Velling (1997) who,

[1] Authors' calculation using the IAB data introduced in section 4.

[2] See Zimmermann et al. (2007) for an outline and an economic evaluation of the norms contained in the Immigration Act.

[3] For a theoretical model in which labor market institutions prevent wages from falling to their market clearing level when immigration occurs, see Schmidt et al. (1994).

using data on 167 German regions for the 1985-1989 period, show some evidence of the displacement of the native workforce by immigration. More recently, Glitz (2006) analyzes the specific issue of the impact of *ethnic German* immigration on relative skill-specific employment and wage rates of the resident population in different geographical areas between 1996 and 2001. He finds evidence of adverse employment effects but no detrimental effects on average wages.

The present paper investigates the interactions between immigration, employment and wages in Western Germany using the more structural labor market equilibrium approach recently employed in several national studies (Aydemir and Borjas, 2006; Borjas, 2003; Manacorda et al., 2006; Ottaviano and Peri, 2006). This approach is based on the aforementioned idea that the average and distributive effects of immigration depend on the exact composition of native and immigrant workers in terms of education and experience. This requires a careful estimation of the substitution elasticities between different groups of workers because the marginal productivity (wages) of each group depends on the supply of workers in each other group. In particular, we allow native and migrant workers to be imperfect substitutes in production, even if sharing the same education and experience levels as in Ottaviano and Peri (2008) and Manacorda et al. (2006). In addition, differently from these works, we also allow for a further degree of imperfect substitutability between old and recent immigrant workers. Moreover, to account for the institutional frictions existing in the German labor market, we investigate not only the wage effects of immigration but also its employment effects as in an imperfectly competitive labor market employment could be a margin of adjustment to shocks as wages could be rigid.

Our results provide a full picture of the adjustment of the Western German labour market to migration in the period from 1987 to 2001. In terms of employment, we find negative effects of new immigrants on previous immigrants, while we do not find evidence of such effects on native workers. For each ten new immigrants in the German labor market three to four old immigrants are driven out of employment but no native is. Reinforcing the evidence of stronger competition between new and old immigrants than between immigrants and native workers, we also find a high but imperfect degree of substitutability between natives and new immigrants while new and old immigrants are close to perfect substitutes. In particular we estimate an elasticity of substitution between natives and immigrants around 20 (close to what Ottaviano and Peri, 2008 find between native and immigrants in the US) and an elasticity between new and old immigrants around 60 and not significantly different from perfect substitution.

In terms of wage effects, those elasticities translate into a decrease by 0.5% of wages of old immigrants as effect of 1992-2001 immigration with highly educated long-term immigrants loosing

around 1.1% of their wages. More than half of the negative wage effect on highly educated was due to immigration from East Germany. As for the effects of new immigration on natives there is essentially a zero average effect, a negative effect on highly educated (-1%) and close to 0 or positive effects on the less educated and on those with vocational education. A counterfactual experiment reveals that in the aggregate, the largest loss for native and old immigrants is due to the employment loss of old immigrants caused by wage rigidity. Removing that rigidity the German labor market would not have any large effect on native or old immigrants from new immigration.

The rest of the paper is organized as follows: section 2 briefly outlines the relevant features of the history of immigration in Germany and reviews the relevant related literature. Section 3 describes the theoretical framework behind our evaluation of the wage and employment effects of immigration. Section 4 presents the data used for our econometric analysis, describes the refinements aimed at making the data best suited to analyze the labor market effects of immigrants and presents summary statistics. Results from the econometric analysis of the employment effects of immigration are presented in Section 5 which also discusses important empirical issues, estimates the substitutability between natives and migrant workers and across skills and uses those results to calculate the equilibrium effects of immigration on employment and wages. Section 5.4 compares the aggregate wage losses in the actual case with wage rigidities and decrease in employment of old immigrants with a counter-factual alternative with fully flexible wages, hence no negative employment effect on old immigrants but larger wage decrease. Section 7 concludes.

2 Immigration to West Germany and Related Literature

After World War II West Germany experienced two large flows of immigrants. First, during the 1950's and 1960's, the country experienced a large inflow of Turks and Southern European (mostly unskilled) workers with no German background. Then, during the early 1990's, so-called *ethnic Germans* (individuals with German ancestry returning from abroad), and East Germans moved "en masse" to West Germany.[4]

The first inflow of foreign workers began in the mid-1950s. In that period the recruitment of *guest workers* coming mainly from South and South-East European countries started. Guest workers were poorly qualified workers recruited for a limited period of one to two years and then required to return to their countries of origin. The inflow of foreigners steadily increased during the cold war period until the 1973 oil crisis, when the economic downturn induced the government to

[4]For a detailed description of immigration flows in Germany and for a survey of empirical results of its labor market impact see Zimmermann et al. (2007).

ban the recruitment of workers from abroad. According to the German Federal Statistical Office, in that year foreign population accounted for around 6.4% of West Germany's total population. Notwithstanding the ban on the recruitment of *guest workers*, the foreign population remained constant, thanks to family reunifications for those workers who managed to settle permanently in Germany.[5]

After the end of the Cold War, Germany resumed the temporary migration policy, mainly attracting workers from Central and Eastern Europe. Over the eleven years following the reunification in 1990, more than 2 millions Germans moved from the East to the West.(Statistisches-Bundesamt-Deutschland (2006a)) Another parallel immigration flow of *ethnic Germans* involved 2.8 million people between 1988 and 2001 (Statistisches-Bundesamt-Deutschland (2006b)). *Ethnic Germans* are a peculiar group of immigrants because they have German nationality but, since they lived abroad for a long period (often more than one generation), their knowledge of the German language and of German habits is not comparable to that of natives. For example, according to Federal Administration Office data reported in Bauer et al. (2005), 62.6% of 133817 *ethnic Germans* applying for admission to Germany between July 1996 and April 1999 failed the German language test. In the words of Zimmermann (1999), "ethnic Germans are basically facing the same difficulties with social and economic integration as foreigners". Overall, in 2001 7.3 million foreigners accounted for 8.8% of the total German population.

The present paper is related in its approach to the recent literature that analyzes the impact of immigration on labor market outcomes of natives of different skills (education and experience) popularized by Borjas (2003), Borjas and Katz (2007) and Ottaviano and Peri (2008) for the US and applied by Manacorda et al (2007) to the analysis of immigration to the UK. Bonin (2005) applies a skill-based analysis of immigration to German labor market. His approach. however, is simply reduced-form. He identifies the partial effect of immigration on wages of each skill group but, as he does not specify a structure of labor demand and supply he cannot identify the total effects of immigration on wages and employment. Moreover that analysis takes the definition of immigrants as simply foreign nationals in the IAB and therefore omits the very important inflow of eastern Germans and Ethnic German immigrants.

Following the working paper version of the present paper (D'Amuri et al. 2008) other studies have analyzed the impact of immigration on employment and wages of West Germans. Those studies have either used somewhat different data (such as the GSOEP used in Felbermayr et

[5]Even if *guest workers* were formally allowed to spend only a limited time period in Germany, this provision was not effectively enforced. Moreover, no recruitment halt was possible for foreign workers coming from European Community countries.

al. 2008) or focussed on somewhat different policy experiments (as Brucker and Jahn 2008). While generally confirming our results those extensions provide interesting robustness checks and alternative policy analysis and consideration.

3 Theoretical framework

To analyze the wage and employment effects of immigration in West Germany we use a framework similar to the one Ottaviano and Peri (2006); Borjas (2003) adopted to analyze immigration to the US. Output is produced using a combination of physical capital and a labor composite of groups of workers differing in their education, age and national origins. The wage paid to each group is equal to its skill-specific marginal productivity jointly determined by the supplies of the various types of labor and their productivity. However, in the context of the German labor market, we augment the original setup of Ottaviano and Peri (2006); Borjas (2003) with elements used by Saint-Paul (1996), Acemoglu and Angrist (2001) as well as Angrist and Kugler (2003) to study the effects of labor market regulation. In particular, to fit the high flexibility of the US labor market, Ottaviano and Peri (2006); Borjas (2003) assume that the labor supplies of native and previously settled migrant workers ('old immigrants', for brevity) are perfectly inelastic. Hence, in their setup the inflow of new immigrants is entirely absorbed by changing wages. However, in the case of Germany, an additional and potentially relevant adjustment channel is constituted by changes in employment. Thus, following Angrist and Kugler (2003), we allow for some degree of flexibility in the labor supplies of both natives and old immigrants.

Using this framework wage elasticities and employment responses are estimated, focusing on the effect of new immigration on old immigrants and natives. The estimated wage elasticities and labor supply responses are then combined in order to reconstruct the overall effect of immigration on the Western German labor market.

3.1 Labor Demand

Labor demand is determined by the profit maximizing choices of firms that employ labor and physical capital (K) to produce a homogeneous final output under constant returns to scale and perfect competition. Technology is such that physical capital and the labor composite are combined in a Cobb-Douglas production function to produce output. The labor composite is itself a CES aggregator of employees with different work experience nested within educational groups. We allow for further degrees of possible imperfect substitutability between natives and immigrants and also

between old and new immigrants to Germany. The aggregate production function is:

$$Y_t = A_t L_t^{\alpha} K_t^{1-\alpha} \tag{1}$$

where the subscript t indicates the time period, Y_t is output, A_t is total factor productivity (TFP), K_t is physical capital, L_t is the CES aggregator of different types of employees and $\alpha \in (0,1)$ is the income share of labor. The labor composite L_t is in turn defined as:

$$L_t = \left[\sum_{k=1}^{3} \theta_{kt} L_{kt}^{\frac{\delta-1}{\delta}} \right]^{\frac{\delta}{\delta-1}} \tag{2}$$

where L_{kt} is itself a CES aggregator of employees with educational level k and θ_{kt} are education specific productivity levels standardized such that $\sum_k \theta_{kt} = 1$. Workers are grouped in three educational levels, $k = 1, 2, 3$, that, as will be detailed in Section 4.1, correspond to workers with no vocational degree, workers with a vocational degree and workers with tertiary education. The parameter $\delta > 1$ measures the elasticity of substitution between workers with different education. As in (Card and Lemieux, 2001), workers with the same education but different work experience are also considered as imperfect substitutes with L_{kt} defined as:

$$L_{kt} = \left[\sum_{j=1}^{8} \theta_{kj} L_{kjt}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{3}$$

where $j = 1, 2, ..., 8$ is an index capturing five-year intervals of potential experience, spanning from a minimum of 0 to a maximum of 40 years. The term $\eta > 1$ measures the elasticity of substitution between workers with the same education but different potential experience and θ_{kj} are their education-experience specific productivity levels, standardized such that $\sum_j \theta_{kjt} = 1$. Following Ottaviano and Peri (2006), native and immigrant workers are allowed to be imperfect substitutes in production since, at least for the US and the UK, there is evidence that the two groups have different abilities and skills which are likely to affect their comparative advantage and hence their choice of occupation (Peri and Sparber (2007)). Consequently, L_{kjt} is defined as:

$$L_{kjt} = \left[\theta_{Hkjt} H_{kjt}^{\frac{\sigma-1}{\sigma}} + \theta_{Mkjt} M_{kjt}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \tag{4}$$

where H_{kjt} and M_{kjt} denote, respectively, native ('Home') and immigrant ('Migrant') workers; $\sigma > 1$ is their elasticity of substitution; θ_{Hkjt} and θ_{Mkjt} are their specific productivity with $\theta_{Hkjt} + \theta_{Mkjt} = 1$. Finally, we also allow M_{kjt} to be a CES aggregator of old and new immigrants:

$$M_{kjt} = \left[\theta_{kjt}^{OLD} \left(M_{kjt}^{OLD} \right)^{\frac{\lambda-1}{\lambda}} + \theta_{kjt}^{NEW} \left(M_{kjt}^{NEW} \right)^{\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}} \tag{5}$$

where M_{kjt}^{OLD} and M_{kjt}^{NEW} respectively denote migrants with education k and experience j who migrated to Germany before and after 1992. In Section 4.1 we will argue that 1992 is an interesting watershed to identify 'old' (sometimes also called 'long-term' immigrants) and 'new' immigrants, particularly because German migrants from East to West are reported in the dataset starting with that year. In (5) the parameter $\lambda > 1$ denotes their elasticity of substitution while θ_{kjt}^{OLD} and θ_{kjt}^{NEW} represent their specific productivity levels standardized so that $\theta_{kjt}^{OLD} + \theta_{kjt}^{NEW} = 1$.

The production function (1) can be used to calculate the demand for each type of labor at a given period t. The relative efficiency parameters (θ) and the total factor productivity A_t depend on technological factors and are independent from the supply of migrant workers. In a competitive equilibrium and taking output as the numeraire good, the natural logarithm of the wage of native workers with education k and experience j equals the natural logarithm of their marginal productivity in units of output:

$$\begin{aligned} \ln w_{Hkjt} &= \ln\left(\alpha A_t \kappa_t^{1-\alpha}\right) + \frac{1}{\delta}\ln(L_t) + \ln(\theta_{kt}) - \left(\frac{1}{\delta} - \frac{1}{\eta}\right)\ln(L_{kt}) + \ln(\theta_{kjt}) - \left(\frac{1}{\eta} - \frac{1}{\sigma}\right)\ln(L_{kjt}) \\ &\quad + \ln(\theta_{Hkjt}) - \frac{1}{\sigma}\ln(H_{kjt}) \end{aligned} \tag{6}$$

where $\kappa_t = K_t/L_t$ is the capital-labor ratio. Similarly, the natural logarithm of the wage of old immigrants with education k and experience j is:

$$\begin{aligned} \ln w_{Mkjt}^{OLD} &= \ln(\alpha A_t \kappa_t^{1-\alpha}) + \frac{1}{\delta}\ln(L_t) + \ln(\theta_{kt}) - \left(\frac{1}{\delta} - \frac{1}{\eta}\right)\ln(L_{kt}) + \ln(\theta_{kjt}) - \left(\frac{1}{\eta} - \frac{1}{\sigma}\right)\ln(L_{kjt}) \\ &\quad + \ln(\theta_{Mkjt}) - \left(\frac{1}{\sigma} - \frac{1}{\lambda}\right)\ln(M_{kjt}) + \ln(\theta_{kjt}^{OLD}) - \frac{1}{\lambda}\ln(M_{kjt}^{OLD}) \end{aligned} \tag{7}$$

Aggregating the marginal pricing conditions for each education-experience group implies the following relationship between the compensation going to the composite labor input L_{kjt} and its supply:

$$\begin{aligned} \ln(\overline{W}_{kjt}) &= \ln\left(\alpha A_t^{\frac{1}{\alpha}} \kappa_t^{\frac{1-\alpha}{\alpha}}\right) + \frac{1}{\delta}\ln(L_t) + \ln\theta_{kt} \\ &\quad - \left(\frac{1}{\delta} - \frac{1}{\eta}\right)\ln(L_{kt}) + \ln\theta_{kj} - \frac{1}{\eta}\ln(L_{kjt}) \end{aligned} \tag{8}$$

where $\overline{W}_{kjt} = w_{Fbkjt}(M_{kjt}/L_{kjt}) + w_{Hbkjt}(H_{kjt}/L_{kjt})$ is the average wage paid to workers in the education-experience group k, j and can be considered as the compensation to one unit of the composite input N_{kjt}. Aggregating one level further the production function, together with marginal cost pricing, implies that the compensation going to the labor input L_{kt} and its supply satisfy the following expression:

$$\ln(\overline{W}_{kt}) = \ln\left(\alpha A_t^{\frac{1}{\alpha}} \kappa_t^{\frac{1-\alpha}{\alpha}}\right) + \frac{1}{\delta}\ln(L_t) + \ln\theta_{kt} - \frac{1}{\sigma_{bb}}\ln(N_{kt}) \tag{9}$$

where $\overline{W}_{kt} = \sum_j \left(\frac{L_{kjt}}{L_{kt}}\right) \overline{W}_{kjt}$ is the average wage in education group k[6] in broad group b. The wage equations 6, 7, 8 and 9 are the basis for the empirical estimation of the elasticities of the model and will be empirically implemented in section 5.3.

3.2 Labor Supply

Turning to the supply side of the labor market, we allow for the potential role of labor market regulation by assuming that the labor supply of natives and old immigrants is elastic and determined by unemployment insurance, since this is indeed a key characteristic of our dataset (see Section 4.1 for details). In particular, we assume that the labor supply function of natives with education k and experience j is:

$$H_{kjt} = \left[w_{Hkjt}\left(1-r\right)\right]^{\xi} \overline{H}_{kjt} \tag{10}$$

where $\overline{H}_{kjt}$ is the corresponding population, w_{Hkjt} is the wage rate as defined in the above section, $r \geq 0$ is the unemployment insurance replacement rate and $\xi > 0$ is the labor supply elasticity. Expression (10) captures the fact that employment supply by native workers responds to the uninsured portion of the wage they receive. Hence a change in wages (produced by a change in supply of some type of labor) may induce an employment response from natives. An analogous expression describes old immigrant labor supply:

$$M_{kjt}^{OLD} = \left[w_{Mkjt}^{OLD}\left(1-r\right)\right]^{\xi} \overline{M}_{kjt}^{OLD} \tag{11}$$

While the populations of native and old immigrant workers, $\overline{H}_{kjt}$ and $\overline{M}_{kjt}^{OLD}$, are given, the population of new immigrants is subject to exogenous shocks that map one-to-one into shifts in their labor supply. In particular, since new immigrants appear in our dataset only upon finding their first job in Germany, we assume that the labor supply of new immigrants M_{kjt}^{NEW} coincides with their population. Accordingly, M_{kjt}^{NEW} is exogenous whereas H_{kjt} and M_{kjt}^{OLD} are endogeneusly determined as wages adjust to the inflow of M_{kjt}^{NEW}.

3.3 Effects of Immigration on Wages

While in the short-run physical capital may be sluggish, on average it adjusts to changes in labor supply so as to keep its real rate of return constant. This implies that, in expressions (6) and (7), the capital-labor ratio κ_t follows a trend determined only by the growth of total factor productivity

[6]The weight for the wage of each group equals the size of the composite input for that education-experience cell, L_{kjt}, relative to the size of the composite input for the whole education group L_{kt}. This is measured by the share of group k, j in total working hours of educational group k.

A_t. Hence, the overall impact of new immigration on wages paid to native workers is obtained by taking the total derivative of equation (6) with respect to the changes in all the labor aggregates (L_t, L_{kt}, L_{kjt}) induced by new immigrants in the various education and experience groups. Specifically, we can write:

$$\begin{aligned}\left(\frac{\Delta w_{Hkjt}}{w_{Hkjt}}\right)^{Total} &= \frac{1}{\delta}\sum_m\sum_i\left[s_{Mmit}\frac{\Delta M_{mit}}{M_{mit}} + s_{Hmit}\left(\frac{\Delta H_{mit}}{H_{mit}}\right)_{response}\right] \\ &+ \left(\frac{1}{\eta}-\frac{1}{\delta}\right)\frac{1}{s_{kt}}\sum_i\left[s_{Mkit}\frac{\Delta M_{kit}}{M_{kit}} + s_{Hkit}\left(\frac{\Delta H_{kit}}{H_{kit}}\right)_{response}\right] \\ &+ \left(\frac{1}{\sigma}-\frac{1}{\eta}\right)\frac{1}{s_{kjt}}\left[s_{Mkjt}\frac{\Delta M_{kjt}}{M_{kjt}} + s_{Hkjt}\left(\frac{\Delta H_{kjt}}{H_{kjt}}\right)_{response}\right] - \frac{1}{\sigma}\left(\frac{\Delta H_{kjt}}{H_{kjt}}\right)_{response} \quad (12)\end{aligned}$$

where the variable $s_{Mkjt} = w_{Mkjt}M_{kjt}/\sum_m\sum_i(w_{Mmit}M_{mit} + w_{Hmit}H_{mit})$ is the share of total wage income paid to migrant workers of education k and experience j in year t and s_{Hkjt} is the share of wage income paid to native workers in the same education-experience group. Similarly, $s_{kjt} = (w_{Mkt}M_{kt} + w_{Hkjt}H_{kjt})\,/\sum_m\sum_i(w_{Mmit}M_mit + w_{Hmit}H_{mit})$ is the share in wage income paid to all workers of education k and experience j in year t; s_{kt} is the wage share paid to all workers with education k in year t, and so on. The first double summation captures the cross-effects of immigration in groups of any education-experience level, the second summation captures the effects of immigration in groups with the same education at all experience levels, and the third and fourth effects capture the effects of immigrants within the same education-experience group.

The term $\Delta M_{kjt}/M_{kjt} = (M_{kjt+1} - M_{kjt})\,/M_{kjt}$ represents the change in the supply of immigrant workers with education k and experience j over the period between t and $t+1$. Analogously, the term $(\Delta H_{kjt}/H_{kjt})_{response}$ represents the change in labor supply of native workers in the same group caused by immigration. These terms account for the employment effects of immigration that arise in the presence of the elastic supplies of native and old immigrant workers as of (10) and (11):

$$\begin{aligned}\left(\frac{\Delta H_{kjt}}{H_{kjt}}\right)_{response} &= \xi\frac{\Delta w_{Hkjt}}{w_{Hkjt}}, \\ \left(\frac{\Delta M^{OLD}_{kjt}}{M^{OLD}_{kjt}}\right)_{response} &= \xi\frac{\Delta w^{OLD}_{Hkjt}}{w^{OLD}_{Hkjt}}, \\ \frac{\Delta M_{kjt}}{M_{kjt}} &= \frac{\Delta M^{OLD}_{kjt} + \Delta M^{NEW}_{kjt}}{M^{OLD}_{kjt} + M^{NEW}_{kjt}} \end{aligned} \quad (13)$$

Taken together with (12), expressions (13) imply that employment effects will have consequences for the impact of immigration on wages. A complete analytical solution of the effects of immigration on wages would require substituting expressions (13) into (12) and then solving for

$\Delta w_{Hkjt}/w_{Hkjt}$ as a function of the change in new immigrants only, $\Delta M_{kjt}^{NEW}/M_{kjt}^{NEW}$. That would give a reduced form dependence of wages in each group on immigration, incorporating demand and supply parameters. In our empirical implementation, however, since we can observe $\Delta H_{kjt}/H_{kjt}$ and $\Delta M_{kjt}^{OLD}/M_{kjt}^{OLD}$, we will estimate empirically their supply response to $\Delta M_{kjt}^{NEW}/M_{kjt}^{NEW}$ (see equation (16)) and then include such estimation into (12).

Similarly, we can express the long run effect of new immigrants on long-term immigrants' wages as:

$$\begin{aligned}\left(\frac{\Delta w_{Mkjt}^{OLD}}{w_{Mkjt}^{OLD}}\right)^{Total} &= \frac{1}{\delta}\sum_m\sum_i\left[s_{mit}^{NEW}\frac{\Delta M_{mit}^{NEW}}{M_{mit}^{NEW}}+s_{mit}^{OLD}\left(\frac{\Delta M_{mit}^{OLD}}{M_{mit}^{OLD}}\right)_{response}+s_{Hmit}\left(\frac{\Delta H_{mit}}{H_{mit}}\right)_{response}\right]\\ &+\left(\frac{1}{\eta}-\frac{1}{\delta}\right)\frac{1}{s_{kt}}\sum_i\left[s_{kit}^{NEW}\frac{\Delta M_{kit}^{NEW}}{M_{kit}^{NEW}}+s_{kit}^{OLD}\left(\frac{\Delta M_{kit}^{OLD}}{M_{kit}^{OLD}}\right)_{response}+s_{Hkit}\left(\frac{\Delta H_{kit}}{H_{kit}}\right)_{response}\right]\\ &+\left(\frac{1}{\sigma}-\frac{1}{\eta}\right)\frac{1}{s_{kjt}}\left[s_{kjt}^{NEW}\frac{\Delta M_{kjt}^{NEW}}{M_{kjt}^{NEW}}+s_{kit}^{OLD}\left(\frac{\Delta M_{kjt}^{OLD}}{M_{kjt}^{OLD}}\right)_{response}+s_{Hkjt}\left(\frac{\Delta H_{kjt}}{H_{kjt}}\right)_{response}\right]\\ &+\left(\frac{1}{\lambda}-\frac{1}{\sigma}\right)\frac{1}{s_{Mkjt}}\left[s_{kjt}^{NEW}\frac{\Delta M_{kjt}^{NEW}}{M_{kjt}^{NEW}}+s_{kit}^{OLD}\left(\frac{\Delta M_{kjt}^{OLD}}{M_{kjt}^{OLD}}\right)_{response}\right]-\frac{1}{\lambda}\left(\frac{\Delta M_{kjt}^{OLD}}{M_{kjt}^{OLD}}\right)_{response}\end{aligned} \tag{14}$$

To sum up, once the parameters δ, η, σ and λ are estimated and once we know the employment responses of old immigrants and native workers to new immigrants, we will be able to calculate the wage effects of immigration for each group.

4 Data and Empirical Implementation

In this section we present our dataset, we discuss its pros and cons and we detail some procedures used to clean and refine the data in order to make them as representative as possible.

We also show some summary statistics and preliminary evidence on immigration and on natives and immigrants' employment and wages.

4.1 The IAB Employment Subsample

The data we employ are from the German Institute for Employment Research (IAB).[7] The administrative dataset spans the period 1975-2001 and covers all employment spells subject to social security taxation and the unemployment spells during which the individual received unemployment benefits. The population includes workers and trainees liable to make social security contributions. Self-employed, civil servants and students enrolled in higher education are not included

[7]The interested reader can also refer to Bender et al. (2000) for a detailed description of the data.

in the dataset. Hence the dataset is representative of people with a stable job, not self-employed and it excludes groups with high turnover and marginal to the labor markets (such as students and day laborers). According to Bender et al. (2000), in 1995 the population covers nearly 79.4% of all employed individuals in Western Germany, but the coverage varies across occupations and industries (coverage levels are not declared). The data we use are an annual 2% random sample of the overall relevant population for a total of around 500,000 employment spells per year.

The IAB dataset is well suited for the analysis of labor market outcomes in the German labor market, especially for people with high attachment to the labor market such as male head of household. It has been largely used to inquire into issues related to German wages and employment. One major advantage of this data is the very large, consistent and continuous coverage over time: it records more than 20 million employment spells between 1975 and 2001. For each employment spell, all the relevant information regarding the employees is collected by the employer and reported directly to the social security agencies. Measurement error is therefore kept to a minimum. The transmission of all the relevant information to the employment agency is mandatory, so that there are no issues arising from non-response. At the same time the sample is representative of the whole (social-security-paying) labor force each year in the sample. The large size of the sample makes it representative of the national and immigrant labor force each year. An alternative dataset reporting information on wages, employment and immigration status is the German Socioeconomic Panel Study (GSOEP). While that panel study has some desirable features such as the identification of country of birth (that is better than nationality in identifying immigrants) and a complete history of employment that allows to compute effective experience, it also has two serious problems, in our view. The first is that it is based on a much smaller sample so that in many education-experience cells (according to our definition), especially for immigrants, it contains extremely few observations or none at all. This makes it very hard to construct representative measures of wage and employment by cell. Second, it is a Panel data set started in 1984 with infrequent refreshments (1994, 1998 and 2000). Hence the measure of data (wages and employment) relative to new immigrants is only included infrequently. During the intermediate years only the sample weights are adjusted to reflect the changing population but no new information on flows and wages is used. As our analysis focuses on new immigrants and on their effects on relative wages and employment, this seems a major limitation. Hence we decided to use the IAB dataset and to address a series of issues by refining and cleaning the data (as described below). In the end we have an aggregately representative dataset that we can compare to the GSOEP (see section 4.2 below) with a much larger number of observations in each cell. This allows more precise measures

of cell employment and wages used in the regressions.

4.2 Data refinements

The IAB dataset has some limitations. We try to address carefully each one of them to produce a dataset as good and representative as possible for our purposes. In table 1 we compare systematically some summary statistics obtained from our refined dataset with summary statistics from the GSOEP for year 1987, 1991 and 2001 that represent the initial, an intermediate and the final year for our empirical analysis. While, as stated above, the GSOEP dataset is also imperfect it is helpful to see what are some systematic differences between the two and whether they are likely to bias our results.

A first limitation of IAB data is that there are no recall questions on the working history of each worker prior to the date of entry in the dataset. As a consequence it is not possible to reconstruct the exact working experience of an individual and so we impute it. In so doing, we follow the standard assumption that the potential experience is equal to the worker's age minus the typical age at which she is expected to have completed her education (Borjas (2003))[8]. While this method can introduce some error, Table 1 shows the comparison of population mean and standard deviation of imputed experience (IAB) with actual experience from the GSOEP (as workers' history is available in those data). There is usually less than one year difference in the averages and standard deviations for both native and immigrants.

A second and, for our purposes, more severe limitation of the IAB data is that for immigrants neither the place of birth, nor the year of arrival in West Germany are recorded. What is available for each individual is the exact nationality at the country level. Since the focus of this paper is on immigration rather than nationality, this requires further assumptions about the link between the former and the latter. In particular, we assume that workers that declare *at least once* to be foreign nationals are immigrants. Hence people who naturalize during the period of consideration (notice that since 2000 the naturalization laws have become less strict) are still considered as immigrants while those naturalized before 1975 are very few. On the other hand, the presence of a large second generation of immigrants with foreign nationality, may produce an overcount of the number of immigrants. However, since we identify most of our effects from the changes in a cohort of immigrants, the presence of a constant group of second generation immigrants will not affect

[8]The age of entry in the labor force is assumed to be 16 for high school dropouts with no vocational education, 19 for high school dropouts with vocational education or high school graduates without vocational education, 21 for high school graduates with vocational education, 24 for those who completed non-university higher education and 25 for workers who hold a university degree.

the estimates much. Besides workers with *foreign nationality* we also identify two other groups as immigrants: German workers who migrated *from the East* to the West after reunification (and recorded as East German by the IAB); and *Ethnic German* workers, who primarily immigrated from Eastern Europe and who constitute a very large share of recent immigrant inflows. As they are an important group that would be missed by looking at the nationality variable only, we account for them using an external source of data. Essentially our procedure (described in detail in Appendix A) accounts for the inflows of *ethnic Germans* across years and country of origin assuming that within year-of-arrival and country-of-origin their education and age characteristics are similar to those of the other foreign-born from that country. The procedure may systematically alter the education structure of ethnic immigrants if for each country of origin regular immigrants are systematically more educated than ethnic Germans. This is possible as it was easier for less educated ethnic Germans to enter West Germany. We check in three different ways that this potential mis-classification does not alter our findings. First, we run some regressions using the "imputed" education of immigrants obtained from their occupation-industry rather than from their schooling. If ethnic Germans are systematically less educated they would choose appropriate occupations and the imputing of education should address this problem. Second, we specify some regressions omitting the imputed ethnic Germans among the immigrants to see wether their presence drives the results. Third, we compare the educational distribution of immigrants between our data and GSOEP. Table 1 shows that our data 2001 produce a lower share of highly educated than the GSOEP. This would argue against any upward bias introduced by imputing. While certainly imperfect, we think that our procedure uses the available data in its most efficient way and does not seem to introduce a systematic bias in the results.

After these imputations we compare the share and characteristics of immigrants (including ethnic and East Germans) in the IAB and in the GSOEP (see table 1). Notice again that their share in total employment is quite close (in the IAB we have if anything a slight overcount) and their gender, experience and educational distribution is very close, except for a much larger share of highly educated immigrants in 2001 according to the GSOEP. As this over-representation of highly educated in the GSOEP is also present for natives, it may be worth inquiring the cause but it should not depend on the procedures of imputation of immigrants.

A third refinement on the data is that we impute the daily wage data that are censored in the IAB. Gross daily wages are reported in the IAB and they are right censored by the upper limit of the social insurance contribution. Right censoring occurs in around 2% of the spells. Censored wages are imputed using the estimated wage values obtained from the estimation of a Tobit regression

model. This is run separately for each year and includes the following independent variables: experience, experience squared, educational attainment, nationality, 17 sectorial dummies and 131 occupational dummies. Table 1 shows that the average wages in IAB are 10 to 15% higher for all groups relative to those in GSOEP, and their standard deviation is similar in the two groups.

A fourth refinement that we use in some regressions is to allow for educational downgrading. Immigrants, in fact, may accept jobs requiring a lower level of qualifications than the ones actually achieved (Dustmann et al., 2007). In this case the reported level of education can be a poor indicator of the labor market position of immigrants, decreasing the precision of our stratification of workers across education-experience cells. In order to address this problem, we group native and immigrant workers according to reported education as well as according to 'adjusted' educational levels. In particular, similar to Card (2001) and Card (2007), for each available year we run an ordered Probit regression for the native population with the reported level of education as the dependent variable and 17 sectorial plus 131 occupational dummies as independent variables. While this correction should improve the homogeneity of workers' skills within the group, it is more subject to endogeneity bias as immigrants may adjust their occupation in Germany according to sectorial demand. For this reason, we only use it as a robustness check.

Finally to obtain a sample representative of days worked in a year in the economy (not just of total employment count), in each relevant year we include men aged 17 to 64 who were working and receiving salary income on the 1st of July.[9] The probability of being working that day (hence in the sample) is proportional to the number of days worked in a year. Hence the probability works as a weight of each worker by days worked. Nominal gross wages are all converted to 2000 Euros using the CPI-based deflator across years.

Our analysis focuses on the period 1987-2001. During this period an extremely large influx of immigrants (including eastern Germans and ethnic Germans) substantially increased the share of non-Western German workers in the Western German labor force. Figure 1 reports the share of immigrants in the labor force as obtained from the refined IAB dataset, showing that it climbed from about 9% in 1987 to 14% in 2001. The time period analyzed is particularly interesting for the analysis of the labor market impact of immigration: the inflow of immigrant workers was very large and in large part supply-driven (namely the fall of the Iron Curtain and the uncertainty following the aftermath of socialism in the countries of origin). Indeed, the large and sudden rise in the share of immigrant workers, mostly due to push factors, makes this somewhat of a 'natural experiment'– one which is well suited to assessing the impact of immigration on incumbent workers.[10]

[9] As a robustness check, we also run all the regressions on the sample including both men and women.

[10] Bauer et al. (2005), p. 217, provide descriptive evidence on the independence between the growth of foreign

4.3 Stylized Facts and Descriptive Statistics

Let us first describe simple aggregate evidence that points to the existence of significant differences in labor market performances between immigrants and natives. Figure 2 shows the evolution of the share of individuals receiving unemployment benefits relative to the total workforce ('unemployment rates'), calculated separately for native Germans and immigrant workers for the period 1987-2001 from the IAB dataset. Two tendencies emerge. First, the rates for native German and foreign workers are quite stable and fairly similar in the period 1987-1991, a period of relatively small inflow of immigrants. Second, beginning in 1991 the unemployment rate of foreigners increases significantly. For native Germans it increases much less, opening a gap that is quite persistent, though reduced towards the end of the 1990's.

Table 2 reports, for selected years, the shares of immigrants in each of the education-potential experience cells, used in the regressions. As always we reclassify the *ethnic Germans* as immigrants following the procedure described in the previous section and we show in the Table 2 the percentage of non-western Germans divided into those from foreign countries and those from Eastern Germany. The share of the non-native workforce in total employment more than doubles in many cells between 1987 and 2001. Large inflow of immigrants took place in all education groups. Interestingly, while the East German immigrants were over-represented among those of intermediate and high levels of educations, the immigrants from foreign countries were proportionally more numerous among the less educated group. Merging the two groups we obtain a fairly balanced immigration among the three education groups. This is part of the reason why we do not find large relative wage shifts as a consequence of immigration.

To summarize, a preliminary look at the data suggests that there has been a substantial increase in the number of immigrant workers over the period of observation. While this increase has been quite evenly distributed across educational levels, the labor market performance of migrants has been worse compared to natives in terms of unemployment rates. This may suggest stronger competition of new immigrants with existing foreign-born workers in terms of employment. The following econometric analysis will investigate this hypothesis.

5 Employment and Wage Effects

The aim of the present section is to estimate the employment and wage responses of old immigrants and natives to the arrival of new immigrants building on the theoretical framework detailed in

employment and the business cycle after the fall of the Iron Curtain.

Section 3. We proceed in three steps. First, we estimate the effects of new immigration on the employment levels of native and old immigrant workers in the same skill group. Second, from the production function (1) we derive empirical specifications that allow us to estimate the various elasticities of substitution. In particular, we estimate the elasticity of substitution between natives and immigrants for given education and experience (σ) as well as the elasticity between new and long-term immigrants for given education and experience (λ). We then estimate the elasticity of substitution between educational levels (δ) as well as between experience levels for a given educational level (η). Finally, once we have the estimated employment effects and elasticities of substitution, we use expressions (12) and (14) to compute the impacts of the inflow of new immigrants on the wages of natives and old immigrants with different levels of education.

5.1 Empirical Issues: Demand Shocks and Estimation Bias

Before implementing the empirical specifications let us notice that a common feature of the estimation procedure is to consider changes in employment of new immigrants as a labor market supply shock. In particular, when we estimate either the employment response of previous immigrants and natives, or the response of wages we rely on the assumption that the inflow of new immigrants is an exogenous supply shock. Therefore (i) we can consider the employment response of natives as actually caused by the immigrant inflow and (ii) we can consider the wage responses as identifying the relative wage elasticity (elasticity of substitution) of labor demand. This may look like a strong assumption. After all we are essentially regressing employment (total) on immigration and wages on immigration and we may be identifying a parameter that mixes demand and supply changes. We think, however, that considering the estimated parameters in section 5.2 as genuine measures of employment response, and those in section 5.3 as demand elasticities is reasonable in the light of the following three facts. First, and less importantly, the whole literature analyzing the national effect of immigration within this framework makes the same simple assumption that immigrants are an exogenous supply shock to the national labor supply (e.g. Borjas 2003, Borjas and Katz 2007, Ottaviano and Peri 2008). Second, while the overall flow of immigrants can be driven by demand pull and change with changes in demand, as we use changes and control for year, education and experience fixed effects we rely on the differential change of immigrant flows within an education-experience cell. That is likely to be driven mostly by demographic factors in the sending country (size of a cohort relative to the other). Moreover in all the elasticity regressions we use relative native-immigrant wages and relative native-immigrant employment [11] so that any

[11] Or new/old immigrant wage and employment ratios.

demand shock specific to education and experience groups will affect both native and immigrants and would be simplified when taking the ratio. Third, and most importantly, in our estimates we also rely on an IV strategy based on a quasi-natural experiment: the German reunification. In the aftermath of the reunification (1991) a large increase in East German immigrants was observed, certainly unrelated to any demand-side shock, but simply because migrating became a possibility. Hence, treating the inflow of East Germans as a pure supply shock, post 1991, we perform several 2SLS estimations using that flow as instrument for all new immigrants. Let us notice, finally, that if some demand shock, not controlled for, were still driving part of the correlation (between relative wages and relative supply of new immigrants) that would bias our estimates of the inverse elasticity of substitution towards 0. Hence, particularly for the elasticity of substitution between native and immigrants, our estimates (around 0.04-0.05) could be a lower bound of the actual inverse elasticity, which would imply even lower substitutability between native and immigrants and certainly less than perfect substitutability.

5.2 Employment Effects

We first estimate the response of long-term immigrants' and natives' employment levels to the inflow of new immigrants in the same education-experience cells. Such adjustment in employment (if it takes place) must be accounted for when analyzing the effect of immigration on wages.

5.2.1 New and Long-term Immigrants

Following a standard specification (see, e.g., Card 2007), we assess the possible employment effects of new immigrants on long-term immigrants by regressing the increase in the total employment of immigrants (new plus long-term) in skill cell k, j, denoted as ΔM_{kjt-1}on the increase in employment due to new immigrants in the same cell denoted as ΔM^{NEW}_{kjt-1}. To obtain scale-independent changes we standardized both changes by the initial level of employment of immigrants in the skill group M_{kjt-1}. We consider as "new immigrants" those in the country by five years or less and as long-term immigrants those in the country by more than five years. In particular we estimate the following specification:

$$\frac{\Delta M_{kjt-1}}{M_{kjt-1}} = D_k + D_j + D_t + \gamma \frac{\Delta M^{NEW}_{kjt-1}}{M_{kjt-1}} + u_{kjt} \tag{15}$$

In expression (15) D_k, D_j and D_t are, respectively, education, experience and year fixed effects included in order to control for systematic differences in employment growth across education groups, experience groups and years. The term u_{kjt} is a zero mean cell-specific random shock.

Since the data used are yearly data, the coefficient γ captures the short-run employment effect of recent immigration on the employment of previous immigrants. A value of $\gamma = 1$ implies that an inflow of new immigrants with education k and experience j equal to 1% of the initial employment in that cell is associated with an increase in total immigrant employment within the same education-experience cell of 1%. In this case, new immigrants add to previous employment without crowding out any old immigrants so there is no response of employment of old immigrants to inflow of new immigrants. In contrast, an estimated value of $\gamma < 1$ implies that new immigrants crowd out the employment of old immigrants inducing a decrease in their employment.

Table 3 reports the estimates of the coefficient γ from estimating equation (15). Different columns show estimates from different specifications. Column (1) reports the basic specification: Least squares estimates, weighting each cell by total employment in it, spanning the period 1987-2001, including male only in the sample and considering the sum of East Germans, foreign nationals and ethnic Germans born abroad as immigrants. Specification (2) omits the ethnic German from the computation of immigrants, specification (3) includes both men and women in the sample; In specification (4) we assign workers to education cells according to their imputed education (computed as described in section 4.2). Specifications (5) and (6) restrict data to subsamples that omit the very early years (pre-unification) and recent years (post monetary union). Finally the last two columns (7) and (8) estimate the coefficient γ using 2SLS with the flow of Eastern Germans only as instrument for total immigrants. Most of the point-estimates of γ are between 0.6 and 0.7, and in all cases the hypothesis that the coefficient is one can be rejected at standard confidence levels against the alternative $\gamma < 1$. This is evidence that new immigrants are crowding out long-term immigrants. The estimates of γ are lowest when using the 2SLS method, implying the largest crowding out. Notice that the first stage of the instrument reveals that the inflow of East Germans is a powerful instrument (F-test above 200). In the post 1991 period the inflow of East Germans represented a very sizeable group among new immigrants. A formal test cannot reject the hypothesis that WLS and 2SLS estimates are identical. This suggests, if we believe that the inflow of east Germans was mainly a supply shock, that, once we control for year and cell fixed effects the largest part of the immigration fluctuations are supply-driven. Our estimates for γ imply that on average when 10 new immigrants join the German labor force, 3 to 4 old immigrants lose their jobs.

5.2.2 Immigrants and Natives

To estimate the impact of immigrants on the employment of native workers, we use an empirical specification similar to 15 and based on the theoretical model in 3. In particular we estimate the coefficient ρ from the following regression:

$$\frac{\Delta EMPL_{kjt-1}}{EMPL_{kjt-1}} = D_k + D_j + D_t + \rho \frac{\Delta M_{kjt}}{EMPL_{kjt-1}} + u_{kjt} \tag{16}$$

Using the notation of the Model the variable $EMPL_{kjt-1} = M_{kjt-1} + H_{kjt-1}$ is total employment (immigrants plus natives) with education k and experience j at time $t-1$ and $\Delta EMPL_{kjt} = [(M_{kjt} + H_{kjt}) - (M_{kjt-1} + H_{kjt-1})]$ is its variation from $t-1$ to t. The variables D_k, D_j and D_t are the usual education, experience and time dummies and u_{kjt} is a zero mean cell-specific random shock. The parameter ρ captures the impact of immigration on total employment. If it is smaller than 1, it implies that new immigrants crowd natives out. If it equals 1, new immigrants have no impact on native employment.

Table 4 shows the estimates of the coefficient ρ. The different specifications across columns of Table 4 mirror those of Table 3. In this case, however, while the estimates are quite imprecise, they are all around, in fact above, the value of one. We can never reject the hypothesis of $\rho = 1$ at any significance level and even the point estimates seem to rule out the possibility of a crowding out. The 2SLS estimates, while they are very imprecise, also because the inflow of East Germans is not as good an instrument for total immigrants as it was for new immigrants. All in all the estimates of Table 4 do not provide any support to the idea that changes in immigrant employment crowds out employment of native Germans. These results seem to preclude the presence of adverse employment effects of new immigrants on natives even in the short run (as we use yearly observations). To further check this result, we run another regression (not in the Table) in which we stratify native and migrant workers according to their education only, instead of using the finer stratification in education-experience cells. If Western German employers valued differently the work experience acquired inside and outside West Germany, our labor market segmentation along education and experience levels could fail to appropriately identify groups of workers competing for the same jobs. Also if there are employment effect spilling across experience groups one would not capture them with the above regression. Hence, we group workers only according to their education level and we run the following regression:

$$\frac{\Delta EMPL_{kt-1}}{EMPL_{kt-1}} = D_k + Trend_k + \rho_{EDU} \frac{\Delta M_{kt-1}}{M_{kt-1}} + u_{kt}$$

where $EMPL_{kt-1} = \sum_j EMPL_{kjt-1}$, $M_{kt} = \sum_j M_{kjt-1}$ and u_{kt} is a zero mean education-specific shock. This regression controls for education fixed effects (D_k) as well as education-specific trends

($Trend_k$) and is estimated on the usual samples. The point estimate of ρ_{EDU} in the basic specification is 1.48 (standard error 0.51) so that we cannot reject $\rho_{EDU} = 1$. The limit of this regression is that it is run on 45 observations only.

All in all, the results from employment regressions imply that *we can rule out the presence of adverse effects of new immigration on the employment levels of native workers, while long-term immigrants seems negatively affected by new comers*[12]. Moreover, as the time horizon is one year (short-run) and labor markets were somewhat rigid in Germany during the period the lack of an effect on natives seems to imply a strong segmentation of the labor market, possibly due to differences between immigrants (outsiders) and natives (insiders).

5.3 Elasticities of Substitution

We turn now to the estimation of the elasticities of substitution. The empirical evidence discussed so far highlights the presence of different employment effects of recent immigration on the German labor market: significant negative effects on old immigrants and no effects on native employment. These differences seem to confirm that immigrant workers compete more between themselves than with natives, even within groups of similar observable skills. Indeed, if the only relevant variables for identifying similar workers were their education and experience, we would not observe different employment effects. In line with this consideration, the theoretical framework outlined in Section 3 allows for imperfect substitutability in production between natives and immigrants as well as between old and recent immigrants. It also suggests how to estimate the elasticities of substitution between these groups of workers.

5.3.1 New and Long-term Immigrants

In order to estimate the elasticity of substitution between immigrants, we use the logarithmic wages given by expression (7) for old immigrants and its analogue for new ones. Taking the ratio within education-experience cells and controlling for the relative demand term $\ln\left(\theta_{kjt}^{OLD}/\theta_{kjt}^{NEW}\right)$ using fixed education (D_k), experience (D_j) and year (D_t) effects we estimate the following specification:

$$\ln\left(\frac{w_{Mkjt}^{OLD}}{w_{Mkjt}^{NEW}}\right) = D_k + D_j + D_t - \frac{1}{\lambda}\ln\left(\frac{M_{kjt}^{OLD}}{M_{kjt}^{NEW}}\right) + u_{kjt} \tag{17}$$

Essentially we allow the relative new/old immigrant productivity to depend systematically on their education, age and on the year. We interpret the remaining within-cell variation of migrants over

[12] These results are consistent with those obtained using a similar framework by Peri (2007). His analysis of the impact of migration on the California labor market stressed the absence of any significant employment effects of migrants on natives.

time as supply driven. The response of relative wages identifies the inverse elasticity of substitution between new and old immigrants. The corresponding estimates are reported in Table 5. Different specifications check the robustness of results to different definitions of the sample, of immigrants, and of the education groups. Specifications (1) adopts the basic specification described above, specification (2) does not include the imputed ethnic Germans among immigrants. Specification (3) includes men and women in the sample, specification (4) includes only people who worked full time during the year (meaning for at least 40 weeks) and specification (5) uses groups workers according to their occupation-industry imputed schooling. Finally specification (6) and (7) consider two sub-samples and (8) and (9) adopt two stage least squares as estimation method, using Eastern European immigrants as instrument for total immigrants. The estimates are quite precise and consistent across specifications. The point estimates of the inverse elasticity are around 0.01 with a standard error also close to 0.01. In most cases we can reject a value larger than 0.03. Hence no evidence is found in any specification of imperfect substitutability between new and old immigrants. Thus, new and old immigrants are perfectly substitutable, $\lambda = \infty$ and all immigrants belonging to each education-experience group ($M_{kjt} = M_{kjt}^{OLD} + M_{kjt}^{NEW}$) can be considered as forming a homogeneous group of workers, which is what we assume in the remaining of the analysis.

5.3.2 Natives and Immigrants

Following the same strategy outlined in the previous section, we estimate the degree of substitutability between native and immigrant workers within education-experience cells. Specifically, we regress the logarithm of the relative wages of natives and immigrants on their relative employment levels with education, experience and year fixed effects to control relative demand and productivity levels. Table 6 reports the values of $\frac{1}{\sigma}$ from estimating the equation below:

$$\ln\left(\frac{w_{Mkjt}}{w_{Hkjt}}\right) = D_k + D_j + D_t - \frac{1}{\sigma}\ln\left(\frac{M_{kjt}}{H_{kjt}}\right) + u_{kjt} \tag{18}$$

Following the same type of specifications as in Table 5 we obtain a range of estimates of $\frac{1}{\sigma}$. All columns now show significant values between 0.03 and 0.06 with standard errors around 0.01 and never larger than 0.02. While the values are not too large they systematically indicate a degree of imperfect substitutability between native and immigrants. These estimates are perfectly in line with what Ottaviano and Peri (2008) estimate for the US (a value around 0.05), and are somewhat smaller than the values estimated for the UK by Manacorda et al. (ranging between 0.1 and 0.2). While apparently small such elasticity, coupled with the large increase in immigrant relative to natives in most groups, deliver significant effects on the relative native-immigrant wage ratio. In

particular, consider that the percentage of immigrants in Germany went from 9 to 14% between 1987 and 2001, implying an increase in the $\frac{M_t}{H_t}$ ratio for the aggregate economy of 64%. This would imply, using the median estimate of 0.045 as inverse elasticity, an increase in wage of natives relative to immigrants of 0.045*0.64=2.8%. Combining the two pieces of evidence revealed by the regressions of Table 4 and 6 we uncover a small but significant degree of imperfect substitutability between native workers and immigrants workers on the German labor market.

5.3.3 Across Experience and Education Groups

Following the implications of the model in section 3 we can use the expressions 8 and 9 to estimate $\frac{1}{\eta}$ and $\frac{1}{\delta}$ the inverse elasticity of substitution between experience and education groups. In particular, following Ottaviano and Peri (2008) we implement empirically regression 19 and 20 below:

$$\ln(\overline{W}_{kjt}) = D_t + D_{kt} + D_{kj} - \frac{1}{\eta}\ln(\widehat{L}_{kjt}) + u_{kjt} \tag{19}$$

$$\ln(\overline{W}_{kt}) = D_t + (Time\ Trend)_k - \frac{1}{\delta}\ln(\widehat{L}_{kt}) + u_{kt} \tag{20}$$

The dependent variable is the log average wage in the education-experience ($\overline{W}_{kjt}$) or in the education ($\overline{W}_{kt}$) group. In 19 we control with education-year (D_{kt}) and education-experience (D_{kj}) dummies the variation of the L_t and L_{kt} aggregates and we allow different productivity across groups. In 20 we control with time dummies and education-specific time trends the change in the cell-specific productivity. In both regression we allow for a zero-mean disturbance. Instrumenting the change in the cell labor-composite, $\widehat{L}_{kjt}$ and $\widehat{L}_{kt}$, with the inflow of immigrants, assumed as supply-driven once we control for the fixed effects, we can estimate consistently the coefficients $\frac{1}{\eta}$ and $\frac{1}{\delta}$.Table 7 reports the estimates of $\frac{1}{\eta}$ that turns out to be between 0.31 and 0.33. In column (1) the supply index $\widehat{L}_{kjt}$ is constructed using a CES aggregator of native and immigrant employment with $\frac{1}{\sigma} = 0.046$. In column (2) the supply index is the simple sum of native and immigrant employment. Similarly Table 8 shows the estimates of $\frac{1}{\delta}$ that range between 0.34 (when the supply index is constructed as CES aggregate) and 0.37 when supply is constructed as sum of employment across education cells. These estimates imply an elasticity of substitution between education groups around 2.7 and across experience groups of 3.2. The first is a bit larger than the corresponding estimates for the US (usually ranging between 1.5 and 2.5) and the second is also a bit smaller than the US counterpart, usually estimated around 5 (e.g. Card and Lemieux 2001). On the other hand recent estimates of those parameters by Brucker and Jahn (2008) find values for the parameter$\frac{1}{\delta}$ estimated on a comparable sample close to 0.3 (hence similar to ours) while

they estimate a lower value of $\frac{1}{\eta}$ around 0.06. The elasticity across age groups, however, does not play much of a role in our simulations in which we aim at characterizing the wage effect across education groups and between natives and immigrants. Hence we do use our estimated elasticity $\frac{1}{\eta}$ in simulating the wage effects of immigration and reassure the reader that using the Brucker and Jahn (2008) elasticity estimates of $\frac{1}{\eta}$ would give essentially identical results.

5.4 Wage Effects

Based on the theoretical framework of Section 3 and, in particular, on the implied expressions (12) and (14), we are now able to evaluate the total impact of immigration on the wages of native and old migrant workers. In so doing, we rely on the employment effects estimated in Section 5.2 and the elasticities of substitution σ, λ , η and δ estimated in Section 5.3. Section 5.4.1 analyzes the impact of the inflow of new immigrants between 1992 and 2001 on average wages and total wage income of long-term (pre-1992) immigrants . Then section 5.4.2 focuses on the impact of the same flow of immigrants on wages of native workers.

5.4.1 Wage Effects on Long-Term Immigrants, 1992-2001

The effects of new immigration on the wages of long-term immigrants are given by expression (14). This allows us to compute the overall impact of post-1992 immigration on the wages of pre-1992 immigrant workers taking into account both the degree of substitutability between different groups of workers (δ, η, σ and λ) and the response of employment to immigration flows (γ). Following Ottaviano and Peri (2008) we also assume that the adjustment of capital to the inflow of immigrants is fast enough that the simulation obtained for full capital adjustment (to keep return to capital constant) are a good approximation for the actual effect experienced year by year in the economy.

Table 9 reports the simulated wage effects of immigration obtained using the average point estimates for the elasticity parameters, namely $\delta = 2.9$, $\eta = 3.3$, $\sigma = 21.5$, $\lambda = 58.1$ and $\gamma = 0.69$. The terms on the right hand side of formula (14) can be sorted into three groups. In fact each square brackets on the right hand side of 14 contains three types of terms. The first terms (containing the expressions $\frac{\Delta M_{kjt}^{NEW}}{M_{kjt}^{NEW}}$) capture the direct effect on wages of the change in supply due to new immigrants. . The second terms, containing the expressions $\left(\frac{\Delta M_{kjt}^{OLD}}{M_{kjt}^{OLD}}\right)_{response}$, capture the wage effect of the employment change of old immigrants in response to the inflow of new immigrants ('indirect effect') and is different from 0. The third terms, containing the expressions $\left(\frac{\Delta H_{kjt}}{H_{kjt}}\right)_{response}$ capture the wage effect of a change in employment of natives in response to immigrants. These indirect effects, however, are essentially zero in the light of the results of Table 4,

that revel no employment response of natives to a change in immigrant employment. In Table 9 the direct and indirect effects of new immigrants are denoted by A and B respectively. The table shows the direct, indirect and total wage effects of new immigration from East Germany (columns 1-3), from the rest of the world including Ethnic Germans (columns 4-6) and the total effects, obtained adding A and B (columns 7-9). Notice, intuitively, that the indirect effects, driven by the reduced employment of old immigrants, attenuate the negative wage impact of new immigrants on previous immigrants. This is because the reduction in old immigrants' employment is a partial offset for the increased supply of new immigrants.

Column (9) of Table 9 shows that the overall effects of ten years worth of new immigration on the wages of old immigrants are negative, implying an average loss for the pre-1992 immigrant workers of 0.5% of their real wage. This is not a particularly large number for two reasons, first the inflow of new immigrants between 1992 and 2001 increased the share of foreign-born in employment only by 2 .2 percentage points which is a twenty percent increase on the initial level; second the elasticity of substitution between natives and immigrants, while not infinite is pretty large so that the effect of new immigrants in terms of wages spreads in part to natives too. Old immigrant workers with a high level of education suffer the largest wage losses (-1.11%), which is explained by the fact that post-1992 immigration to West Germany is relatively high-skilled, mainly due to East Germans (see in column 1 the direct effect of East Germans immigration on wage of highly educated). The comparison between columns 7, 8 and 9 reveals that the reduction in the employment levels of old immigrants, in response to immigration, attenuates the negative impact of immigration on the wages of those who keep their job by 0.78% on average and by 1.3% for the highly educated.

Decomposing the overall wage effect with respect to the origin of immigrants, columns 3 and 4 show that immigration from East Germany accounts for almost half of the negative wage effect for highly educated workers while it accounts for none of the negative effect on less educated workers. This is due to the fact that East German immigrants are on average more educated than immigrants from the rest of the world. This contributes to portray a more balanced picture of the effect of immigrants to West Germany when we consider Eastern Germans too, rather than focussing only on foreign immigrants (as done in Felbermayr et al. 2008).

All in all Table 9 shows that the wage response of old immigrants to new immigrants is not too large. This lead us to inquire more carefully into the employment effect and quantify it in terms of income lost. A way of doing it is to consider the effect of immigration on the wage bill of old immigrants. Table 10 reports the simulated effect of immigration 1992-2001on total wage

bill of old immigrants. Such effect combines the decrease in employment that essentially deprives of the average wage a part of the old immigrants and the decrease in wages that reduces, due to competition, the wages of each worker who keeps her jobs. Combining employment and wage losses Table 10 reveals that immigration from East Germany reduced total wage bill of old immigrants by 5.7% and immigration from the rest of the world by 11.9%. Again immigration from east Germany penalized mostly highly educated while immigration from the rest of the world had a more balanced effect on groups. All in all the wage bill of old immigrants was reduced by a substantial 17.6%, and such loss was mainly driven by lost employment. This simulations already suggest that the imperfect labor market adjustment of wages, and the implied loss in employment of long-term immigrants may be the most costly consequence of immigration. In particular such employment response, combined with generous unemployment benefits (as we will illustrate below) may put a large cost on the German welfare system. The question is whether the aggregate income cost of employment losses (lost production) and unemployment benefits is larger than the cost in terms of wage losses that old immigrants would have experienced in a flexible labor market in which wages would have adjusted to absorb the full inflow of immigrants without reduction in employment of old immigrants. This experiment and the related comparison will be developed in section 6

Summarizing the findings of this section we can say that *new immigrants penalized old immigrants mostly in terms of employment and only little by decreasing their wages.* Old immigrants with high education and old immigrants with no vocational education were the groups mostly hurt. The first group due to immigration from East Germany and the second group by immigration from the rest of the world.

5.4.2 Wage Effects on Natives, 1987-2001

Turning to the effects of immigration on native wages, we use expression (12). Following our findings in Sections 5.2.1 and 5.3.2, we impose the absence of employment effects for natives ($\rho = 1$) as well as imperfect substitutability between native and immigrant workers and almost perfect substitutability between new and old immigrants.

Table 11 reports the simulated wage effect for natives of three different educational attainment over the period 1992-2001. In the first column we report the results when we consider imperfect substitutability between natives and immigrants and in column 2 we report, for reference, those obtained assuming perfect substitutability between natives and immigrants. As in most specifications of Table 5 we find a significant inverse elasticity $1/\sigma$ we tend to prefer results of column 1 that uses the average estimated value for σ that equals 21.5. In the latter case, σ is set to infinity. With

imperfect substitutability, column (1) shows no average impact of immigration on native wages over the period 1992-2001. Across educational levels, relatively low educated workers experience a moderate improvement in their wage levels (+1.68%) , while highly educated ones suffer a small loss (-1%). This is again due to the fact that, during the period of observation, immigration to Germany (mostly from East Germany) was relatively skilled. These small wage effects are consistent with the absence of negative employment effects found in Section 5.2.2. Moreover, even when in column (2) we impose perfect substitutability ($\sigma = \infty$) between natives and immigrants, the overall effect on wages is negative but still very close to zero, with the same distributional pattern across educational groups as in the case of $\sigma = 21.5$.

Hence, *new immigrants do not penalize native workers much either in terms of employment or in terms of wages.* Indeed, native workers with low education see their wages rise.

6 Policy Experiment

There is a growing consensus that the reaction of a country's labor market to immigration depends on its institutional features and, in particular, that more 'flexible' labor markets are more efficient in absorbing the supply shocks arising from migrant inflows (see Angrist and Kugler 2003). In particular if reducing the benefits and duration of unemployment insurance, as implemented by the Hartz reforms in Germany since 2003, implies a lower rigidity of wages as the bargaining power of workers is reduced those reforms could go a long way in introducing wage flexibility in response to shocks such as immigration. In this section we use the framework developed so far to quantify the monetary costs of wage 'rigidity' vis-a-vis a situation of full wage flexibility in response to immigration. In particular we ask how much German workers as a whole would gain from eliminating wage rigidity, by introducing more competition in the labor market (reducing size and duration of unemployment benefits, reducing hiring and firing costs) which is exactly the direction taken by labor market reforms enacted since 2003.

In practice we compare two scenarios. The first is the current situation in which immigrants generate a reduction in employment of native workers because wages are not fully flexible downwards. We use our current estimates of employment and wage effects on old immigrants and natives to quantify the net effect on existing German workers (native and Old immigrants), assuming that if they loose their job they are paid the unemployment insurance in place in Germany as of 2001 (before the reforms). We compare this with a case in which wages are fully flexible (and no unemployment insurance is paid) and as a consequence immigration does not cause any employment loss on old immigrant but the wage fully adjust in response to immigration to grant full employment.

The existence of wage 'rigidity' leads to employment effects while we consider "fully flexible" the alternative case in which no employment loss is generated. The crucial question is whether or not the fall in immigrant wages, which would occur if the German labor market responded fully flexibly to the shock, would be compensated for by the corresponding savings in unemployment insurance payments.

In our policy experiment we focus on the year 2001 and allow the wages of pre-1992 immigrants to adjust downward until any adverse employment effect disappears[13]. The results of this policy experiment are reported in Table 12 where all the values are expressed in real terms at year 2000 prices. According to (12) and (14), for employment effects on pre-1992 immigrants to disappear the average wage of this group has to fall a further 0.14% (relative to the wage-rigid case) while natives' wages would increase by 0.02% . The first two rows of table 12 show the calculations to obtain the wage costs of flexibility. Clearly a labor market where the whole adjustment happens through adjustments of wage would imply a larger wage loss of old immigrants (although natives would actually gain a bit with more flexibility [14]). Column 3 of Table 12 shows the extra percentage wage change with full wage flexibility and then, by multiplying the above variations first by the average daily wage levels prevailing in 2000 (reported in 2000 Euros in Column 2), then by the corresponding employment levels (obtained from our sample multiplied by the sample weights and reported in column 1) , and by the days worked in a full year[15] we obtain an overall decrease in the wages paid to old immigrant workers equal to approximately 38.4 million euros per year. At the same time, due to a small degree of imperfect substitution between natives and immigrants the wages of natives would actually increase of a very small amount in the flexible scenario. This would imply an overall increase of the wage paid to natives of 30.7 million as consequence of immigration. The total wage loss as of year 2001 for existing German workers from immigration in a fully flexible market would be a small 7.7 million euros.

In the last row of Table 12 we calculate instead the cost of rigidity. We consider as main cost of rigidity the foregone production of displaced workers and the fact that those workers are paid unemployment insurance. These are not additive costs but two aspects of the same type of loss. As workers are not productive any longer a similar amount of per-person income has to be given to them in the form of unemployment insurance, and has to be transferred from some working people According to our calculations, based on an estimate of $\gamma = 0.69$ approximately 25,300 old

[13]We implicitly assume that wages do not fall below their reservation level for any group, so that their decline does not affect labor supply in a world with no labor market rigidities.

[14]This happens due to the increase in the employment level of the complementary migrant workforce.

[15]There are 240 working days, assuming 48 weeks of work, in one calendar year.

immigrants have been displaced by the 2001 inflow of new immigrants. This is the cost of rigidity. We can then multiply this value by the average yearly wage of old immigrants (equal to 18,720 assuming a 48 week year) to obtain the amount of foregone income (and product) reported in column 5 , an equal to 473 million euros. Alternatively we can multiply employment loss by the cost of unemployment benefits, which, following Adema et al. (2003), we set at 14,449 euros per displaced worker and obtain the value of 365 million euros reported in column (6). This is just a lower bound estimate of the overall cost borne by the government because the full cost should also include unemployment assistance (for the long-term unemployed), housing benefits, active labor market policies, etc. in both cases the cost of rigidity, in the aggregate, is much larger (in fact one order of magnitude larger) than the total wage losses old immigrant workers suffered with flexible wages in the absence of employment effects.

Hence the negative employment effects produced by immigration combined with wage rigidity in Germany were by far more costly (in terms of foregone income and unemployment insurance) than any wage loss that would accrue to old immigrants in the presence of flexible labor markets responding through wage adjustments.. In this sense, a more 'flexible' German labor market would be more efficient in dealing with the effects of immigration and the post 2003 reforms implemented in Germany should probably already have enhanced the wage flexibility in the needed direction. Interestingly the main beneficiary of such flexibility would be the old immigrants who get displaced by new immigrants as, under more flexibility, they would retain their jobs, although at a lower wage. The benefit to citizens would be in the form of lower taxes if one thinks that unemployment insurance is funded by a general tax.

7 Conclusion

This paper contributes to the recently revived literature analyzing the impact of immigration within a general equilibrium framework which is able to take fully into account the interactions between production factors and the overall effects of immigration on the economy (Aydemir and Borjas, 2006; Borjas, 2003; Manacorda et al., 2006; Ottaviano and Peri, 2006; Peri, 2007).

With respect to the existing literature, we have made some progress in the empirical methodology employed. First, the elasticity parameters necessary to disentangle the wage effects of immigration are estimated on a yearly panel, using German data and exploiting the large inflow of Eastern German as exogenous shock. Second, we have allowed for imperfect substitution between old and new immigrants as well as between immigrants and natives. Third, we employed a general equilibrium framework including the employment response, driven by imperfect wage flexibility to

estimate the impact of new immigrants on old ones in terms of wages and employment. When we look at the employment effects of immigration we find that new immigration has a negative impact on the employment level of old immigrants and no impact on employment of natives, suggesting a closer competition (substitutability) between new and old immigrants than between immigrants and natives. Fourth, in calculating the wage effects of immigration we take the aforementioned employment effects into account. In so doing, we distinguish between the 'direct effect' of immigration, which refers to the change in wages taking place for given supplies of natives and old immigrants, and the 'indirect effect', which refers to the change in wages due to changes in the labor supplies of different groups of workers. The estimated wage effects of new immigrants are on average very small for natives and small and negative for old immigrants. The most statistically and economic significant effect of migration, all in all, is the negative employment effect on old immigrants.

As such negative employment effect is driven by wage rigidity, caused probably by imperfect competition, high unemployment benefits and long duration, we performed an experiment comparing the effects of immigrants under the labor market rigidity prevailing in 2001 and under perfect wage flexibility. The experiment shows that a labor market reform that removes the negative employment effects of immigration (by increasing wage flexibility) would generate an increase in produced income large enough to more than compensate the wage losses of old immigrants. The high cost of immigration in terms of lost jobs by old immigrants would largely disappear in the presence of flexible wages.

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A Imputation of *Ethnic German* Immigrants

A worker is considered as Western German if her nationality is German and if she has always been working in West Germany. All the others are considered as immigrants. Eastern Germans, in particular are considered as Immigrants. They are identified as individuals with German nationality who started working in the East and then moved to the West within the considered period. Foreign migrants are individuals who have a non-German nationality or *ethnic Germans* coming from abroad. Particular attention is devoted to identifying the *ethnic German* group of immigrants. These are immigrants mostly from Eastern European countries and, as discussed in Section 2, tend to behave just like other immigrants from those countries. However, they are barely distinguishable from Western German nationals in the data set. With the end of the cold war a large number of *ethnic Germans* (slightly less than 3 million over the period 1989-2001 according to Bundesverwaltungsamt (2003)) previously living in Eastern Europe moved to West Germany, settling there permanently.[16] These immigrants, after having successfully applied for a visa in the German embassy of their country of origin, were allowed to enter Germany enjoying unrestricted rights of German citizenship upon arrival.

Since in the IAB dataset only nationality identifiers are reported, we are not able to distinguish *ethnic German* workers from Western German workers in the individual records. However, omitting their inflow would distort our analysis especially as they were correlated over time with that of immigrants from East Germany and from other foreign countries. Indeed, *ethnic Germans* were mostly born abroad and were not able to speak German fluently at their arrival, hence they were in all respects more comparable to immigrants than to Western German nationals. As reported in Section 2, the perception is that "Ethnic Germans are basically facing the same difficulties with social and economic integration as foreigners" (Zimmermann, 1999) and, therefore, they should be considered as foreign immigrants in our context.

We estimate the total inflow of *ethnic Germans* in each education-experience-year group and then identify the impact of such inflow (together with those of East Germans and foreigners) on the employment levels and wages of previous immigrants and native Germans. To construct such estimates, we merge different sources of information. First, we obtain the inflow of *ethnic Germans* by year of arrival and country of origin from Bundesverwaltungsamt (2003) and Statistisches-Bundesamt-Deutschland (2006b), respectively. Then, from the IAB data we retrieve the exact information on the characteristics and labor market performance of foreign immigrants coming

[16] See Bauer and Zimmermann (1997) for an analysis of labor market integration of *ethnic German* workers.

from the same set of countries in the same year of arrival as *ethnic Germans*.[17] Finally, we assume that, for country of origin x and year of arrival t, the educational and age composition of *ethnic Germans* is identical to that of foreign immigrants and that, within education-experience cells, *ethnic Germans* and foreign immigrants from the same country of origin have exactly the same labor market performance in terms of employment levels and wages. For example, we consider *ethnic Germans* who migrated to West Germany from the Czech Republic in 1994 as exactly mirroring in their observed and unobserved characteristics the group of Czech citizens migrating to West Germany in the same year.

Specifically, as a first step, for each of the major *ethnic Germans*' countries x and each year t, we construct $f_{xkjt} = M_{xkjt}/M_{xt}$ as the share of immigrant workers with education k and experience j in the total immigrant flow. Notice that the total inflow of immigrants from country x and year t, M_{xt} is obtained from Bundesverwaltungsamt (2003) and Statistisches-Bundesamt-Deutschland (2006b) while the number in each education-specific group M_{xkjt} from the IAB. Hence the share f_{xkjt} corrects for the employment/population ratio and allows to impute employment in each group from total population of immigrants. We then calculate the imputed number of immigrant *ethnic German* workers from country x with education k and experience j in year t as:

$$E_{xtkj} = E_{xt} f_{xtkj}$$

where E_{xt} is the total yearly inflow of *ethnic Germans* from country x in year t. Since the inflows of *ethnic German* and foreign immigrants from a specific country x can be highly volatile, our second step is to smooth the imputed values by taking averages over two consecutive years. We then attribute to each group E_{xtkj} the average wage of foreign immigrants coming from the same country x in the same year t and with the same education and age. After those two steps, we obtain a complete education-experience distribution of employment and wages for the *ethnic German* immigrants by country of origin x and year of arrival t. Summing across different years of arrival (starting with 1987) and countries of origin, we finally obtain the employment levels within education-experience cells for each year. Similarly the cell-specific wages are reconstructed using a weighted average of average wages by country of origin and year of arrival. As a final step, we subtract the imputed employment levels by cell from the analogous cells of the native Western German population and we add them to the immigrant population.

[17] The countries are: Czech Republic, Slovakia, former Soviet Union, former Yugoslavia, Hungaria, Poland, Romania.

Table 1
Comparison between IAB and GSOEP, Year 1987, 1991 and 2001

		1987				1991				2001			
		GSOEP*		IAB		GSOEP*		IAB		GSOEP*		IAB	
		Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.
Natives	Share Females	0.40		0.42		0.40		0.43		0.46		0.44	
	No Vocational Education	0.21		0.26		0.25		0.22		0.16		0.18	
	Vocational Education	0.66		0.68		0.65		0.71		0.64		0.71	
	Higher Education	0.12		0.06		0.10		0.07		0.20		0.11	
	Years of potential exp	17.73	11.77	16.90	11.28	17.69	11.40	17.67	11.10	19.58	10.60	19.52	10.72
	Less than 20 years of pot. Exp	0.59		0.62		0.60		0.60		0.53		0.53	
	Daily wage**	64.74	39.39	68.87	33.25	65.31	42.16	75.09	33.56	73.78	46.97	79.15	39.37
Immigrants	Share on total	0.07		0.09		0.12		0.10		0.13		0.14	
	Share Females	0.30		0.31		0.33		0.33		0.40		0.37	
	No Vocational Education	0.61		0.62		0.66		0.59		0.29		0.38	
	Vocational Education	0.36		0.34		0.31		0.37		0.46		0.54	
	Higher Education	0.03		0.04		0.02		0.04		0.25		0.08	
	Years of potential exp	20.59	10.75	18.64	10.15	20.37	11.98	18.22	10.69	17.88	11.09	18.68	10.56
	Less than 20 years of pot. Exp	0.46		0.54		0.47		0.56		0.61		0.58	
	Daily wage**	56.78	21.25	68.54	26.75	54.32	22.25	70.83	29.10	65.77	44.97	71.85	32.87

Note: The German Socio-Economic Panel GSOEP is a panel of individuals started in 1984 with refreshments (i.e. inclusion of new waves of people) in 1994/1995, 1998 and 2000 over the considered period. The IAB is an administrative dataset including all workers contributing to social security. Immigrants are defined as foreign-born plus those born in East Germany in the GSOEP and as foreign-nationals plus those born in East Germany in the IAB.

Table 2
Share of Foreign Immigrants/Eastern German Immigrants on total workers by education and potential experience

		1987		1991		2001		
Education	Potential Experience	Overall Share of Immigrants	Overall Share of Immigrants	Share East-German	Share Foreign Immigrants	Overall Share of Immigrants	Share East-German	Share Foreign Immigrants
No Vocational Education	Up to 4	7.2%	15.5%	1.1%	14.4%	8.80%	1.00%	7.80%
	5 to 9	20.6%	28.4%	1.9%	26.6%	22.90%	2.90%	20.00%
	10 to 14	20.1%	35.7%	1.8%	33.9%	42.50%	3.70%	38.80%
	15 to 19	24.7%	28.0%	1.4%	26.5%	39.30%	3.40%	35.90%
	20 to 24	32.4%	29.1%	1.6%	27.4%	35.70%	2.50%	33.20%
	25 to 29	38.1%	33.2%	0.9%	32.4%	27.90%	3.00%	24.90%
	30 to 34	23.3%	37.7%	0.5%	37.2%	26.10%	2.40%	23.80%
	35 to 40	16.4%	21.8%	0.5%	21.3%	33.70%	1.50%	32.20%
Vocational Education	Up to 4	4.9%	13.1%	3.9%	9.2%	15.40%	5.00%	10.40%
	5 to 9	4.0%	9.1%	2.2%	6.9%	18.20%	5.50%	12.70%
	10 to 14	4.2%	8.0%	2.0%	6.0%	14.10%	4.90%	9.20%
	15 to 19	5.5%	6.8%	1.6%	5.2%	11.10%	3.80%	7.30%
	20 to 24	7.7%	7.8%	1.5%	6.3%	9.60%	3.80%	5.80%
	25 to 29	4.9%	9.0%	1.0%	8.0%	8.40%	3.30%	5.10%
	30 to 34	3.4%	5.8%	0.8%	5.0%	9.10%	2.70%	6.50%
	35 to 40	2.8%	3.5%	0.3%	3.2%	8.70%	1.90%	6.80%
Higher education	Up to 4	4.8%	7.0%	1.4%	5.6%	13.70%	3.80%	10.00%
	5 to 9	4.3%	6.3%	1.5%	4.8%	8.90%	3.00%	5.80%
	10 to 14	5.7%	5.8%	1.2%	4.6%	7.90%	2.90%	5.00%
	15 to 19	7.5%	8.7%	1.6%	7.0%	7.70%	2.80%	4.90%
	20 to 24	6.4%	8.8%	1.6%	7.3%	8.20%	2.90%	5.40%
	25 to 29	4.3%	7.6%	1.2%	6.4%	9.40%	2.80%	6.50%
	30 to 34	4.2%	4.9%	0.6%	4.3%	10.10%	3.30%	6.80%
	35 to 40	0.0%	2.9%	0.0%	2.9%	10.00%	2.90%	7.10%

Note: The percentages are calculated from IAB data refined as described in the main text. Immigrants are defined as foreign-nationals, foreign-born ethnic Germans plus those born in East Germany.

Table 3
Estimates of γ: the employment effects of new immigrants on previous immigrants

Column	(1) Basic	(2) No Ethnic Imputation	(3) Males and Female	(4) Using Imputed Equivalent Education	(5) 1992-2001 subsample	(6) 1987-1999 sub-sample	(7) 2SLS, Basic	(8) 2SLS, No Ethnic Imputation
Estimate of γ	0.686***	0.668***	0.623***	0.727***	0.658***	0.652***	0.58***	0.59***
	(0.097)	(0.105)	(0.094)	(0.077)	(0.093)	(0.103)	(0.11)	(0.11)
P-value: H_0: γ =1	0.004	0.005	0.001	0.002	0.002	0.004	0.00	0.00
Period	1987-2001	1987-2001	1987-2001	1987-2001	1992-2001	1987-1999	1992-2001	1992-2001
Group	Males	Males	Males and Females	Males	Males	Males	Males	Males
Ethnics' imputation	Yes	No	Yes	Yes	Yes	No	Yes	No
Equivalent education	No	No	No	Yes	No	No	No	No
Observations	313	313	313	313	210	271	210	210
First stage								
East-west migrants							1.01	1.00
Standard error							0.04	0.07
T statistic							25.42	14.47
F-test of exclusion							163.40	209.42

Note: Dependent variable is the yearly change in total immigrant employment in an education-experience cell as percentage of initial immigrant employment in the cell; the explanatory variable is the change in new immigrant employment as percentage of the initial immigrant employment. Each regression includes education, experience and year fixed effects. Each observation point is an education-experience cell in a year. In parenthesis we report the heteroskedasticity-robust standard errors, clustered by education-experience group. *** significantly different from 0 at the 1% level.

Table 4
Estimates of ρ: the employment effects of immigrants on natives

Column	(1) Basic	(2) No Ethnic Imputation	(3) Males and Female	(4) Imputed Equivalent Education	(5) 1992-2001 subsample	(6) 1987-1999 sub-sample	(7) 2SLS, Basic	(8) 2SLS, No Ethnic Imputation
Estimates of ρ	1.272*** (0.384)	1.327*** (0.391)	1.023*** (0.520)	1.358*** (0.431)	1.280*** (0.530)	1.207*** (0.324)	2.683*** (1.015)	2.819*** (1.069)
T statistic	3.310	3.393	1.967	3.151	2.416	3.728	2.640	2.640
P-value: H_0: ρ=1	0.487	0.412	0.965	0.415	0.603	0.529	0.097	0.089
Period	1987-2001	1987-2001	1987-2001	1987-2001	1992-2001	1987-1999	1992-2001	1992-2001
Group	Males	Males	Males and Females	Males	Males	Males	Males	Males
Ethnics' imputation	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Equivalent education	No	No	No	Yes	No	No	No	No
Observations	359	359	359	359	240	311	238	238
First stage								
East-west migrants							1.29	1.23
Standard error							0.17	0.17
T statistic							7.58	7.34
F-test of exclusion							57.38	53.91

Note: Dependent variable is the yearly change in total employment in an education-experience cell as percentage of the initial employment in the cell; the explanatory variable is the change in immigrant employment as percentage of the initial employment. Each regression includes education, experience and year fixed effects. In parenthesis we report the heteroskedasticity-robust standard errors, clustered by education-experience group.
*** significantly different from 0 at the 1% level.

Table 5
Estimates of the Inverse elasticity of substitution between new and long-term immigrants

Column	(1) Basic	(2) No Ethnic imputation	(3) Males and Females	(4) Full time workers only	(5) Imputed Equivalent Education	(6) 1992-2001 subsample	(7) 1987-1999 subsample	(8) 2SLS basic	(9) 2SLS, no ethnic Imputation
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	2SLS	2SLS
Estimate of $1/\sigma$	0.017 (0.011)	0.014 (0.010)	0.000 (0.009)	0.022 (0.012)	0.004 (0.010)	0.017 (0.010)	0.010 (0.010)	0.02 (0.01)	0.02 (0.01)
Period	1987-2001	1987-2001	1987-2001	1987-2001	1987-2001	1992-2001	1987-1999	1992-2001	1992-2001
Group	Males	Males	Males and Females	Males	Males	Males	Males	Males	Males
Ethnics' imputation	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Equivalent education	No	No	No	No	Yes	No	No	No	No
Wages of FY work. only*	No	No	No	Yes	Yes	No	No	No	No
Observations	313	313	313	313	313	210	313	210	210
First stage									
East-west migrants								0.66	0.67
Standard error								0.05	0.05
T statistic								12.10	13.85
F-test of exclusion								146.74	191.91

Note: dependent variable is the relative new/old immigrant wages in an experience-education cell, explanatory variable is the relative new/old immigrant employment in the cell. Each regression includes education, experience and year fixed effects. In parenthesis we report the heteroskedasticity-robust standard errors, clustered by education-experience group.

*** significantly different from 0 at the 1% level.

Table 6
Estimates of 1/σ the Inverse elasticity of substitution between immigrants and natives

Column	(1) Basic	(2) No Ethnic imputation	(3) Males and Females	(4) Full time workers only	(5) Imputed Equivalent Education	(6) 1992-2001 subsample	(7) 1987-1999 subsample	(8) 2SLS basic	(9) 2SLS, no ethnic Imputation
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	IV	IV
Estimates of 1/σ	0.046*** (0.011)	0.046*** (0.011)	0.038*** (0.011)	0.035*** (0.011)	0.037* (0.020)	0.029** (0.013)	0.060*** (0.013)	0.030** (0.016)	0.030** (0.015)
Period	1987-2001	1987-2001	1987-2001	1987-2001	1987-2001	1992-2001	1987-1999	1992-2001	1992-2001
Group	Males	Males	Males and Females	Males	Males	Males	Males	Males	Males
Ethnics' imputation	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Equivalent education	No	No	No	No	Yes	No	No	No	No
Wages of FY work. only*	No	No	No	Yes	Yes	No	No	No	No
Observations	359	359	359	359	359	240	359	238	238
First stage									
East-west migrants								0.80	0.80
Standard error								0.05	0.05
T statistic								16.24	17.29
F-test of exclusion								263.67	298.86

Note: dependent variable is the relative native/immigrant wages in an experience-education cell; the explanatory variable is the relative native/immigrant employment in the cell. Each regression includes education, experience and year fixed effects. In parenthesis we report the heteroskedasticity-robust standard errors, clustered by education-experience group.

***, **, * different from 0 at the 1%, 5%, 10% significance level.

Table 7
Estimates of $1/\eta$, the inverse of the elasticity of substitution between workers with different potential experience

Column	(1) Using the model to calculate (L_{kj}) as a CES composite	(2) L_{kj} calculated as simple employment counts
Estimates of $1/\eta$	0.31***	0.33***
	(0.11)	(0.13)
T statistic	2.69	2.50
Education –Year dummies	Yes	Yes
Education-Experience Dummies	Yes	Yes
Observations	359	359

Note: Dependent variable is the average daily wage in real term for the education-experience group. In column (1) the explanatory variable is log of L_{kj} obtained as a CES composite of natives and immigrants for a value of $1/\sigma = 0.046$. In column (2) the explanatory variable is the log of the L_{kj} obtained as the simple sum of native and immigrant employment. The method of estimation used is 2 SLS using as Instrumental variable for $\ln(L_{kj})$ the variable $\ln(F_{kj})$, that is the log of immigrant employment in the cell. Standard errors are heteroskedasticity-robust clustered at the education-experience level.
***, different from 0 at the 1% significance level.

Table 8
Estimates of 1/δ the inverse of the elasticity of substitution between workers with different education levels

Column	(1) Using the model to calculate L_k as a CES composite	(2) L_k calculated as simple employment counts
Estimates of 1/δ	0.34***	0.37***
	(0.14)	(0.16)
Education trend Dummies	Yes	Yes
Year Dummies	Yes	Yes
Observations	45	45

Note: Dependent variable is the average daily wage in real term for the education group. In column (1) the explanatory variable is log of L_k obtained as a CES composite of different experience groups for a value of $1/\eta = 0.31$. In column (2) the explanatory variable is the log of the L_k obtained as the simple sum of employment across experience groups. The method of estimation is 2 SLS using as Instrumental variable for $\ln(L_k)$ the variable $\ln(F_k)$, that is the log of immigrant employment in the education cell. Standard errors are heteroskedasticity-robust clustered at the education-experience level.
***, different from 0 at the 1% significance level.

Table 9
Simulated long-run Effects of immigration 1992-2001 on real wage of long-term immigrants (pre 1992)

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Education	Due to east-west movers			Due to foreigner immigrants			Total		
	Direct immigration effect (A)	Indirect effect (B)	Total effect (A+B)	Direct immigration effect (A)	Indirect effect (B)	Total effect (A+B)	Direct immigration effect (A)	Indirect effect (B)	Total effect (A+B)
No Vocational Education	0.17%	-0.04%	0.14%	-1.63%	0.79%	-0.84%	-1.46%	0.76%	-0.70%
Vocational Education	-0.54%	0.37%	-0.17%	-0.34%	0.32%	-0.02%	-0.88%	0.69%	-0.19%
Higher Education	-1.08%	0.59%	-0.49%	-1.57%	0.95%	-0.62%	-2.65%	1.54%	-1.11%
Average	-0.22%	0.18%	-0.04%	-1.07%	0.60%	-0.47%	-1.29%	0.78%	-0.51%

Note: Long-Run Simulations, assuming that capital adjusts over the period to keep the real return constant. The column labeled "Direct Immigration effects" show the real wage impact of a change in supply due to new immigrants, while those labeled "indirect effect" show the wage impact of the reduction in labor supply from old immigrant in response to new immigration.

Parameters used for the simulation: δ=2.9, η=3.3; σ=21.5; λ=58.1γ=0.69.

Table 10
Simulated Effects of immigration 1992-2001 on the real wage bills of long-term immigrants (pre 1992)

Education	(1) Due to east-west movers	(2) Due to foreigners	(3) Total
No Vocational Education	-0.9%	-10.1%	-11.0%
Vocational Education	-9.7%	-11.9%	-21.6%
Higher Education	-14.4%	-25.1%	-39.5%
Average	-5.7%	-11.9%	-17.6%

Note: Long-Run Simulations, assuming that capital adjusts over the period to keep the real return constant.
Parameters used for the simulation: δ=2.9, η=3.3; σ=21.5; λ=58.1γ=0.69.

Table 11
Simulated Effects of immigration 1992-2001 on real wage of native workers

Column	(1)	(2)
σ	21.5	Infinite
No Vocational Education	1.68%	1.85%
Vocational Education	-0.14%	-0.25%
Higher Education	-1.01%	-1.26%
Average	-0.02%	-0.11%

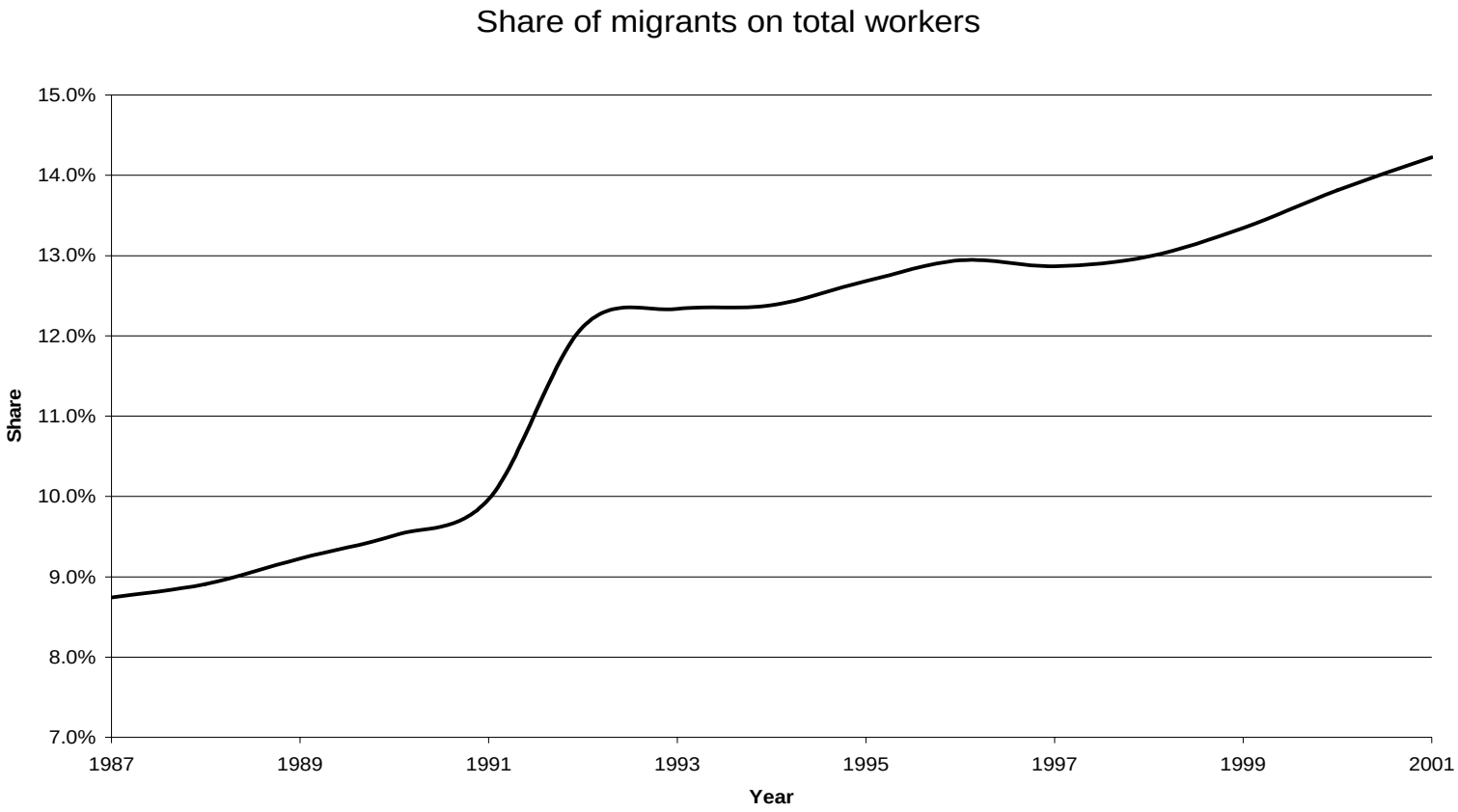
Note: Long-Run Simulations, assuming that capital adjusts over the period to keep the real return constant. Parameters used for the simulation: δ=2.9, η=3.3; λ=58.1γ=0.69

Table 12
Policy experiment:

Column	(1)	(2)	(3)	(4)	(5)=(1)*(2)*(3)	(6)=(5)*240 days
	Employment	*Average Daily wage*	*Additional % wage variation under flexibility*	*Additional absolute variation under flexibility*	*Total, daily wages*	*Cost of flexibility in total, yearly wages*
West Germany native workers	8,519,550	93	0.02%	0.0150	127,992	**30,718,080**
Old Immigrants	1,428,150	78	-0.14%	-0.1121	-160,130	**-38,431,200**
Total						**-7,713,120**
	Number	*Average yearly wage*	*Average UI cost per unemployed*		*Foregone production= wage*displaced workers*	*Total cost of unemployment Insurance*
Displaced migrants (among Old immigrants)	25,300	18720	14449		**473,616,000**	**365,559,700**

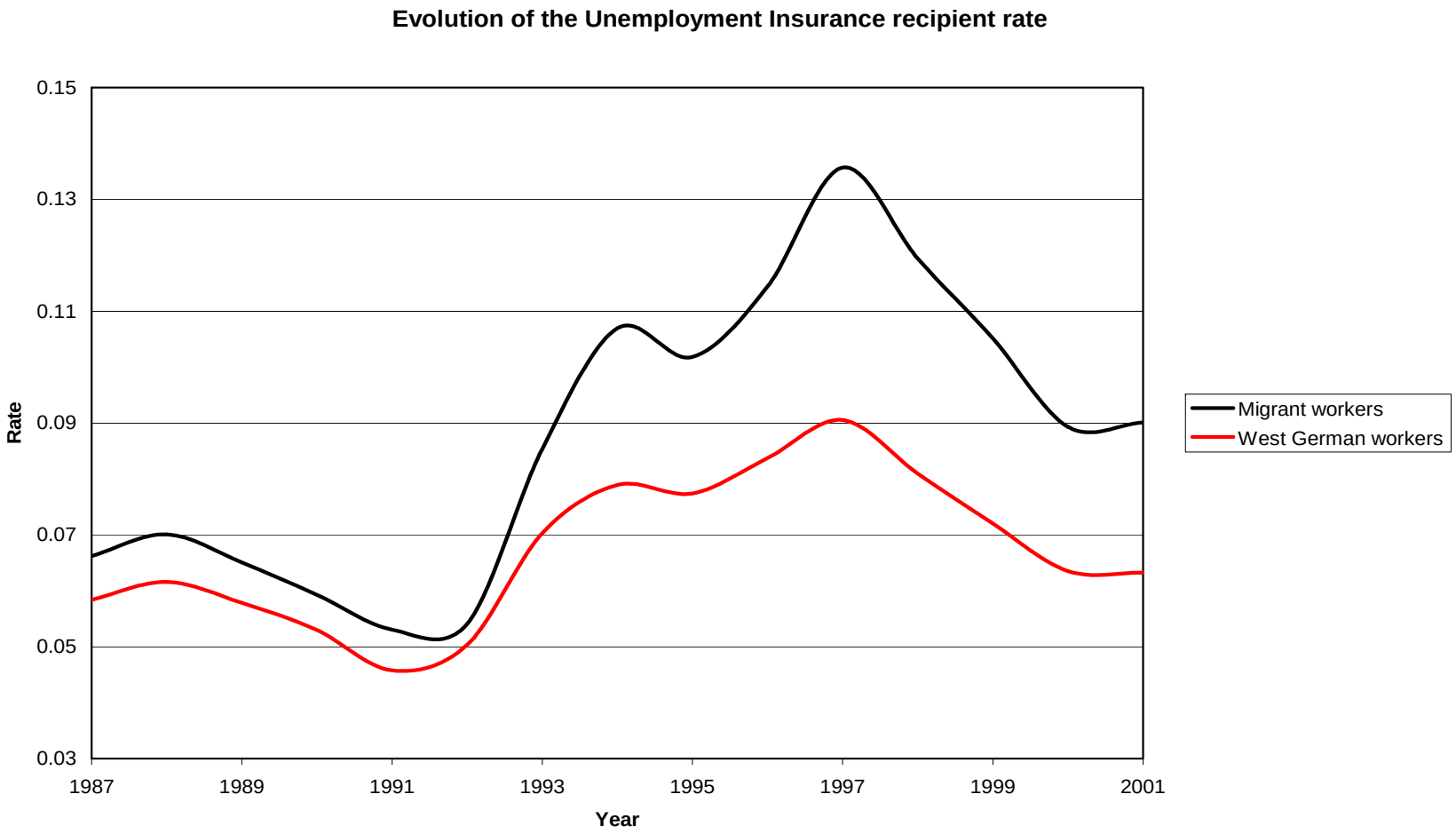
Note: Parameters used for the simulations: δ=2.9, η=3.3; σ=21.5; λ=58.1γ=0.69. Employment is calculated as the total count of workers employed as of July 1st of year 2000. Average daily wages are expressed in 2000 Euros. The percentage wage changes in Column (3) are obtained assuming no employment effect on old immigrants and natives.

Figure 1



Source: Calculations of the Authors on IAB data. Immigrants are the sum of foreign nationals plus workers immigrated from Eastern Germany plus Ethnic Germans immigrated from abroad.

Figure 2



Source: Calculations of the Authors on IAB data.