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ARTICLE

Why to employ both migrants and natives? A study on task-specific substitutability

Anette Haas · Michael Lucht · Norbert Schanne

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Abstract This paper analyses the performance of migrants on the German labour market and its dependence on the tasks performed on their jobs. Recent work suggests quantifying the imperfect substitutability relationship between migrants and natives as a measure for the hurdles migrants have to face. Our theoretical framework adopts that migrant shares vary with qualification, task categories, and experience.

Hence, substitution elasticities of an aggregate production function can be quite different regarding different job cells. Finally, we estimate elasticities of substitution for different aggregate CES-nested production functions for Germany between 1993 and 2008 using administrative data and taking into account the task approach. We find significant variation in the substitutability between migrants and natives across qualification levels and tasks. We show that especially interactive tasks seem to impose hurdles for migrants on the German labour market.

Keywords Heterogeneity · Migrants · Substitution elasticity · Tasks

JEL Classification J15 · J24 · J31

Warum gleichzeitig Migranten und Einheimische beschäftigen? Eine Untersuchung der Aufgaben-spezifischen Substituierbarkeit

Zusammenfassung Dieser Beitrag untersucht den Erfolg von Einwanderern auf dem deutschen Arbeitsmarkt in Abhängigkeit von deren beruflichen Tätigkeitsfeldern. Aktuelle Forschungsergebnisse zeigen, dass Migranten im Vergleich zu Einheimischen eventuell dadurch benachteiligt sind, dass sie andere Aufgaben am Arbeitsplatz ausführen. Unser theoretisches Modell berücksichtigt, dass das Arbeitsangebot und damit die Anteile der Migranten mit der beruflichen Qualifikation, dem Tätigkeitsbereich und der Berufserfahrung variieren. Demzufolge unterscheiden sich die Substitutionselastizitäten einer aggregierten Produktionsfunktion für einzelne Jobzellen. Ausgehend vom „TASKS-Ansatz“ schätzen wir für den Zeitraum 1993 bis 2008 die Substitutionselastizitäten für unterschiedlich stark aggregierte CES-Produktionsfunktionen. Die Resultate verweisen auf deutliche Unterschiede in der Substituierbarkeit von Migranten und Einheimischen je nach beruflicher Qualifikation und Tätigkeitsfeld. Insbesondere interaktive und kommunikative Aufgaben erweisen sich für Migranten als Hürde für den Arbeitsmarkterfolg.

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A. Haas (✉) · M. Lucht · N. Schanne
Institut für Arbeitsmarkt- und Berufsforschung (IAB),
Weddigenstr. 20-22, 90478 Nürnberg, Germany
e-mail: anette.haas@iab.de

M. Lucht
e-mail: michael.lucht@iab.de

N. Schanne
e-mail: norbert.schanne@iab.de

1 Introduction

The current labour market performance of migrants in Germany has stirred a lively public debate on how policy could foster and improve the integration of immigrants into the labour force. Until 1973, during the economic boom, German firms focused on the recruitment of foreign labour without demanding special (formal) skill or job prerequisites. Many of these "guest workers" did not remigrate as initially planned. They settled down, some family members followed from the country of origin for the purposes of family reunion. In general, equal job opportunities do not prevail anywhere, workers with an immigration background face a risk of becoming unemployed nearly twice as high as Germans, work in different jobs than natives and mostly earn lower wages.

Many potential explanations for these wage differences exist, including discrimination and differing productivities in the same jobs caused by imperfect transferability of labour market skills required in a foreign country or lack of language skills. Various studies analyze the effects of immigration for natives, how immigrants adapt to the labour market, and how they perform in terms of wages. The common framework uses the variation to the marginal productivity of native labour caused by immigration by changes in aggregate wages (Borjas 1992, 2003; Borjas and Katz 2007; Bonin 2005; Card 2001, 2007; Bruecker and Jahn 2011; Suedekum et al. 2012; D'Amuri et al. 2010). Despite differences in productivity and discrimination, imperfect substitutability between migrants and natives is a realistic scenario for persistently lower wages. Comparing the existing studies, estimating wage effects of immigration relies strongly on the nested form of production function, which factors are used as inputs, the assumptions about separability between groups of inputs and a short- or long-run perspective. It is more realistic to assume that capital adjusts in the long run. Borjas (2003) assumes that capital is fixed, whereas in Ottaviano and Peri (2012) capital is supplied perfectly elastic. Furthermore, the main conceptual innovation is the question of the level of substitutability concerning the effect of labour market outcomes for natives and different subgroups.

The idea by Borjas (2003) is that workers with equal qualification levels might be imperfect substitutes if they exhibit different work experience. With regard to the size of the elasticity of migrant-native substitution, evidence for the German labour market is however ambiguous. Bonin (2005) focuses on a long-run perspective by using the period 1975–1997 and replicates the analysis of Borjas (2003) at the aggregate level dividing immigrants and natives in experience and education cells. In contrast to Borjas' findings for the US, he finds for Germany that immigration does **not** have negative consequences on employment outcomes; at most, a 10 percent increase in immigration will decrease wages by 1 percent. However, discrepancies in estimates yielded with almost equal data and equal periods (e.g. Bruecker and Jahn 2011 vs. D'Amuri et al. 2010) call for further explanation.

What we want to contribute to this discussion is to distinguish labour horizontally by different job requirements, in addition to the vertical distinctions by formal qualification level or by experience duration.

Peri and Sparber (2009) observe that a major difference between immigrants and natives is English language skill, and show that as more immigrants enter a local labour market, natives shift to occupations where communication skills are relatively more valuable and leave those where only pure manual skills are required. They observe that in the US migrants with graduate degrees specialise in occupations demanding cognitive and analytical skills, whereas their native-born counterparts specialise in occupations requiring interactive and communication skills. Such adaptive behaviour generates imperfect substitution endogenously and mitigates an important fraction of negative wage competition between natives and immigrants. The contribution by Peri and Sparber (2009) addresses comparative advantages as an explanation for occupational sorting by migrants even with the same formal qualification level.

Similarly, Borjas concludes for the US: "(...) *the growing divergence between immigrants and natives does not lie in which sector of the economy they are employed. Rather, the divergence is occurring in the* ***kinds of tasks*** *that immigrants and natives perform on the job*" (Borjas 2003, pp. 1335–1374). Following the literature, our interest is to investigate the elasticity of substitution between migrants and natives considering various qualifications; however, we contribute to the literature with a special focus on the task dimension.

We extend the model by Borjas (2003) by considering a nested CES production technology containing qualification group, task dimension, and experience group. This modified specification has particular importance in the German case because the labour market is organised by occupation-specific skills, so that a certain level of formal education is required for most occupations.

According to the nested theoretical framework, we augment the empirical standard model for migrant-native substitutability which distinguishes labour by qualification and experience (as used by D'Amuri et al. 2010 and Borjas et al. 2011) by the task dimension to account for the job selection. Our estimations indeed highlight the importance of differentiation by task and qualification and of properly accounting for their heterogeneity.

However, we are aware of the fact that even if qualification, task, job experience and language skills are comparable, there might be relevant discrimination aspects that also manifest in the wage structure. Also, task issues play not only a role with regard to the wage differential; for example,

the occupational choice and the occupation-specific human capital are crucial for the labour market performance and the risk to become unemployed over the whole working life (Kambourov and Manovskii 2009; Longhi and Brynin 2010; Schmillen and Moeller 2012).

The paper is structured as follows. Firstly, we present related literature and some empirical evidence to motivate our research question. Secondly, we sketch the theoretical framework using a nested CES production technology similar to the well-established approach by Borjas (2003) and thirdly, we estimate elasticities of substitution between migrants and natives for different task and qualification groups. To our knowledge, no prior study has addressed this question differentiated by skill groups using the task approach to distinguish different types of occupation.

2 Why consider tasks: Related literature and empirical evidence

Recent work (Ottaviano and Peri 2005, 2007, 2012; Card 2007) points at a positive and significant effect of immigration on the average wage of US natives across US states and metropolitan areas. Research on the links between migrants and economic outcomes has to date focused primarily on the aggregate level. Most studies do not consider that migrants concentrate in different occupations and firms with heterogeneous requirements of skills. However, the occupational classification is a central dimension of the German labour market: on the one side the choice of occupation determines earnings and career opportunities to a large extent, on the other hand firms try to select the "best matching" worker by including vocation and job in the advertisement of the vacancy. Abraham et al. (2011) state that especially in Germany the vocational dimension is a key element for theoretical explanations of the labour market. The authors interpret occupations as a kind of ideal typical indicator and description of tasks of vacant jobs. Every occupation paraphrases a spectrum of tasks that requires specific knowledge and skills. There are plausible arguments that recruiting behaviour or matching processes might differ across occupational groups (Stops and Mazzoni 2010).

Descriptive evidence for Germany shows that foreigners and natives with comparable qualifications work in different occupational segments (Steinhardt 2011). Even after residing in the host country for a long time, immigrants are more likely than natives to work in jobs that require lower qualification, even if they possess higher skill levels. According to empirical evidence, it seems more reasonable to consider different occupational groups as defined by characteristic tasks in addition to the skill dimension. Moreover, studies of recruitment behaviour find that one of the reasons why unemployed persons generally face more problems to get a particular job is that they do not meet the job requirements in terms of qualification and experience levels in the immigration country (e.g. Gorter et al. 1993). There is additional evidence that firm size plays a role for the amount of employed migrants (Holzer 1998).

Although the human capital framework illuminates both the determination of skill prices and the incentives for skill investment, there is no further information on what kind of requirements workers have to satisfy and which task dimension is crucial to hold a certain occupation. Going beyond the common approach by using qualification as a proxy for human capital, Lazear (1999) supports the view of a broader definition of human capital as a vector of different attributes, including physical skills, education or cognitive abilities, language and communication skills.

Recent literature follows the idea of linking tasks and activities workers perform on the job to the skills needed to carry out these activities (Autor et al. 2003; Spitz-Oener 2006; Acemoglu and Autor 2010; Autor 2013). This so-called "task-based approach" offers a framework to classify jobs according to their core task requirements and then consider the set of formal and informal skills required to carry out these tasks. One asset of this new approach is that it provides a micro-foundation for linking the aggregate demand in the labour market to the specific skill demands of given job activities. One stylised fact observed by Autor et al. (2006) is that higher skilled workers perform different and more interactive (or communicative) tasks compared to less skilled workers. Further occupations are classified to the involved share of routine vs. non-routine tasks. We thus measure workers' non-routine skills by the extent of non-routine job tasks involved with the occupation of that worker.

Autor et al. (2003) define non-routine job tasks as tasks that cannot be performed by computers. More general, non-routine tasks are characterised by non-repetitive work methods. Such non-routine job tasks typically involve problem-solving and a lack of deductive rules and codifiable information that might require certain knowledge in the German labour market. Contrary to non-routine jobs, routine jobs are defined to be easily replaceable by machines. As a consequence, routine labour shows a higher elasticity of substitution towards capital than non-routine labour. If migrants are assigned to different tasks than natives, omitting the task dimension could lead to biased estimates of this elasticity. Insofar, considering the task-based approach could add to the aforementioned discussion about capital adjustment and its relation with the short-run and long-run perspective on the substitution elasticity between migrants and natives.

In following the task based approach, we use a task classification scheme according to Black and Spitz-Oener (2007), Gathmann and Schoenberg (2010) and Dustmann et al. (2010) to order the occupations by the intensity with which they use each type of attributes. We look deeper

into the data to confirm first evidence for comparative (dis)advantages for migrants relative to Germans in certain occupations or tasks. For the US as well as for most European countries, there has been an increase in demand for jobs requiring more complex and abstract skills coupled with a decrease in the demand for unskilled jobs in the last decade. In particular, non-routine manual jobs can also be assigned to foreign workers who may have poor native language skills or who may not know the cultural specifics, social norms and institutions of the host country. A central finding by Peri and Sparber (2009) demonstrates that immigrants who do not speak the language of the host country are concentrated in more manual and less interactive tasks (especially unskilled workers) and tend to receive lower wages than natives. Evidence for the UK shows the phenomenon that immigrants downgrade substantially upon arrival and work in jobs and professions that are far beneath where they would be assigned based on their observable skills. For instance, 26 % of the highly educated recent immigrants in the UK were employed in routine and semi-routine occupations, the two lowest paid occupation categories (Goos and Manning 2007; Goos et al. 2009; Dustmann et al. 2008, 2009). A special feature of the German labour market is that occupational mobility is not very high compared to other countries. All in all theoretical and empirical results underline the importance to deal carefully with job selection to get a more detailed picture of substitutability between migrants and natives.

3 Theoretical framework

Relaxing the assumption of perfect substitutability between natives and migrants is a crucial factor in up-to-date migration research assessing the impact of immigration to labour market outcomes (Borjas 2003; D'Amuri et al. 2010; Bruecker and Jahn 2011). These studies measure the relationship by estimation of the parameters of the aggregate production function of the economy, and the empirical results indicate that indeed migrants and natives can be seen as imperfect substitutes. We follow this well-established approach and extend it to account also for the different job selection of migrants and natives by including task categories.

The economy uses a nested CES production technology similar to Borjas (2003), Borjas et al. (2011), D'Amuri et al. (2010) and Bruecker and Jahn (2011) all following Card and Lemieux (2001). At the top level the qualifications are distinguished:

$$Q = A \cdot \left(\sum_{h=1}^{3} \theta_h \cdot L_h^{\frac{\delta-1}{\delta}} \right)^{\frac{\delta}{\delta-1}}, \quad \sum_{h=1}^{3} \theta_h = 1 \tag{1}$$

where Q is output, A total factor productivity L_h the inelastic labour supply of low, medium and high skilled and δ is the elasticity of substitution between these groups, θ_h is a share parameter. On the second stage, we introduce task cells to account for the job selection. We use 5 task categories following Black and Spitz-Oener (2007) and Gathmann and Schoenberg (2010) distinguishing non-routine analytical tasks, non-routine interactive tasks, routine cognitive/analytical tasks, routine manual tasks, and non-routine manual tasks:

$$L_h = \left(\sum_{i=1}^{5} \theta_{hi} \cdot L_{hi}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}, \quad \sum_{i=1}^{5} \theta_{hi} = 1 \tag{2}$$

Here L_{hi} is the labour supply of workers with an experience level i and qualification h. On the third level the labour supply in the different qualification and task groups is further distinguished by experience. We use 5 experience groups for each $h = 1, 2, 3$:

$$L_{hi} = \left(\sum_{j=1}^{5} \theta_{hij} \cdot L_{hij}^{\frac{\zeta-1}{\zeta}} \right)^{\frac{\zeta}{\zeta-1}}, \quad \sum_{j=1}^{5} \theta_{hij} = 1 \tag{3}$$

for every $h = 1, 2, 3$ and $i = 1, \ldots, 5$. On the fourth level, which is the most important for our analysis, we distinguish between migrants and natives:

$$L_{hij} = \left(\theta_{hijM} \cdot L_{hijM}^{\frac{\gamma_{hi}-1}{\gamma_{hi}}} + (1 - \theta_{hijM}) \cdot L_{hijN}^{\frac{\gamma_{hi}-1}{\gamma_{hi}}} \right)^{\frac{\gamma_{hi}}{\gamma_{hi}-1}} \tag{4}$$

The γ_{hi} is the elasticity of substitution between migrants and natives, which is our main variable of interest in this study. Though we first estimate under the assumption that $\gamma_{hi} = \gamma$ for all $h = 1, 2, 3$; $i = 1, \ldots, 5$ to check whether the introduction of the task level has an impact in comparison to other studies, we later leave the possibility open that this elasticity may vary across the task cells and/or the qualification groups.

Following Autor et al. (2003) we might also include a sub-step between the second (task) and the third (experience) level and assume that routine jobs are also substitutable to computer capital C_{hi} which is subject to technological change. Then, L_{hi} becomes $\tilde{L}_{hi}$ in (2) for all routine tasks i and

$$\tilde{L}_{hi} = \left(\theta_{hic} \cdot C_{hi}^{\frac{\chi-1}{\chi}} + (1 - \theta_{hic}) \cdot L_{hi}^{\frac{\chi-1}{\chi}} \right)^{\frac{\chi}{\chi-1}}$$

with an elasticity $\chi \geq 0$ and a parameter $\theta_{hic} \in [0, 1)$. Such a technological change has no impact on our estimation of the elasticity of substitution between migrants and natives, but causes a bias on estimations that do not differentiate between tasks as long as the distribution of migrants and natives is unequal between routine and non-routine tasks.

We assume that the firm faces a price-demand function of the following type:

$$Q = \Lambda \cdot P^{-\sigma} \tag{5}$$

where Q is the quantity and P is the price of the product of the firm, $\Lambda > 0$ and $\sigma > 1$ are fixed parameters. This assumption may e.g. stem from a Dixit-Stiglitz type general

equilibrium model, where each firm faces the price-demand function

$$q = \Lambda \cdot p^{-\sigma} \tag{6}$$

with firm individual price p and quantity q, and

$$\Lambda = \tilde{Q} \cdot \tilde{P}^{\sigma} \tag{7}$$

where $\tilde{Q}$ is the aggregated output of all firms and $\tilde{P}$ is the related price index. The aggregation of the individual firms then corresponds to the aggregate firm behaviour.

The first order condition on the lowest CES level for the optimising aggregated firm then is:

$$w_{hijk} = \Lambda^{\frac{1}{\sigma}} \cdot Q^{\frac{1}{\delta}-\frac{1}{\sigma}} \cdot \theta_h \cdot L_h^{\frac{1}{\eta}-\frac{1}{\delta}} \cdot \theta_{hi} \cdot L_{hi}^{\frac{1}{\zeta}-\frac{1}{\eta}} \cdot \theta_{hij} \cdot L_{hij}^{\frac{1}{\gamma_{hi}}-\frac{1}{\zeta}} \cdot \theta_{hijk} \cdot L_{hijk}^{-\frac{1}{\gamma_{hi}}} \tag{8}$$

for all h, i, j and $k = N.M$. The elasticity of substitution on the lowest level is a measure of the similarity between the jobs of migrants and natives. Therefore, we would expect that the difference between migrants and natives is smaller in jobs where language competence and culturally adequate behaviour play only a minor role. Language skills are obviously linked to interactive tasks; thus we expect the elasticity to be lowest in jobs relying heavily on interactive tasks. Cultural knowledge, the knowledge about the norms, values and beliefs of the native population, is more diffusely related to the variables we use. It is also negatively related to interactive tasks, but additionally it depends on the decisions a worker has to make for his job. Therefore it is linked to jobs with a low complexity, which means jobs where only a low qualification is necessary and in manual and routine jobs.

4 Empirical design

Our approach is to slice the labour market into cells along certain dimensions, such as skill groups, occupation/task groups and experience to use the variation induced by the differences in immigration intensity across these cells to estimate the effect of immigration on wages.

Thus, when estimating γ_{hi} the substitution elasticities between different groups of labour at a certain CES sub-aggregate level—e.g., between migrants and natives in low-skilled employment with manual routine tasks—we employ a strategy similar to Card and Lemieux (2001) and D'Amuri et al. (2010). In the present paper, we modify the overall log-wage equation from D'Amuri et al. (2010) with regard to two aspects. Firstly, we add the task level as an additional intermediate level of disaggregation; here, we test various specifications where to put it in (whether as a substitute for formal qualification, at a level beyond formal qualification but above experience, or at a level below experience). Secondly, we allow for heterogeneity of the migrant-native substitution elasticity across the CES sub-aggregates.

The logarithm of average wages for workers with qualification h, task i, experience j and migration status k (with $k \in \{m, n\}$) at time t follows from Eq. (8) after taking logs and some little rearrangements

$$\begin{aligned} \ln w_{hijkt} = \Psi_t &+ \frac{1}{\delta}(\ln L_t - \ln L_{ht}) + \ln\theta_h \\ &+ \frac{1}{\eta}(\ln L_{ht} - \ln L_{hit}) + \ln\theta_i \\ &+ \frac{1}{\zeta}(\ln L_{hit} - \ln L_{hijt}) + \ln\theta_j \\ &+ \frac{1}{\gamma_{hi}}(\ln L_{hijt} - \ln L_{hijkt}) \\ &+ \ln\theta_{hik} + \varepsilon_{hijkt} \end{aligned} \tag{9}$$

where Ψ_t denotes a general productivity parameter which may result from the (time varying) demand on the goods market, the varying number of firms in the market (a certain fraction closes every period, others enter the market) and the firm-specific total factor productivity aggregated over all firms; this is constant across labour aggregates within a year and thus can be estimated by time dummies. Likewise, the productivity parameters in the CES sub-aggregates θ are estimated by group identifiers (qualification, task, experience dummies).[1] If at a certain level the respective sub-aggregate encloses more than two groups of labour, the respective parameters $(\theta, \delta, \eta, \zeta)$ need to be estimated from Eq. (9). Elasticities of substitution between migrants and natives can be estimated from the log of the wage ratio of w_{hijmt} over w_{hijnt} (that is, from the difference between $\ln w_{hijmt}$ and $\ln w_{hijnt}$). Most components of Eq. (9) are equal between both and thus are differenced away; the remainder is

$$\ln\left(\frac{w_{hijmt}}{w_{hijnt}}\right) = \ln\left(\frac{\theta_{\mathrm{him}}}{\theta_{\mathrm{hin}}}\right) - \frac{1}{\gamma_{\mathrm{hi}}}\ln\left(\frac{L_{hijmt}}{L_{hijnt}}\right) + (\varepsilon_{hijmt} - \varepsilon_{hijnt}) \tag{10}$$

The two equations are estimated by OLS with heteroscedasticity-consistent standard errors. The empirical analogue to Eq. (6) includes, besides the log wage-ratio as dependent variable and the log employment ratio as regressor only a constant and the disturbance. As in Card and Lemieux (2001), the labour demand equations are identified from the data only if we abstract from demand-supply interactions by assuming inelastic labour supply.[2]

[1] If we would want to account for qualification-specific technological change, we would have to use time-variant (trending) productivity parameters θ_{ht} rather than constant θ_h. With regard to the qualification-task-specific technology parameters of the migrant-native CES nest (not eliminated in Eq. (6)) which reflect the nest-specific mean integrative ability of firms, it is reasonable to assume a constant parameter rather than a trending.

[2] In principle, labour quantities are determined simultaneously with the wages/prices. However, the response of labour to wages is stronger at the level of qualification- and task-specific nests (included in Eq. (9)).

5 Data

Our individual employment data are based on the *Sample of Labor Market Biographies* (SIAB), a two percent representative sample of administrative social security records in Germany covering 1975–2008. The sample, which includes more than 200,000 employment spells per year, provides precise information on daily wages, working days and further individual characteristics for all individuals who contribute to the social security system. This represents about 80 percent of the German workforce; among the excluded groups are the self-employed and civil servants (Dorner et al. 2010). We construct our sample of aggregate employment and wages (by formal qualification, tasks, experience and nationality) considering only persons in regular employment subject to social security from 1993 to 2008; employment before 1993 is used to calculate a person's labour market experience. The presented results use volume data (working days per year and total annual salaries) for all employees to construct average monthly salaries and employment. As a robustness check we estimate the same equations with data only for full-time male workers, and for total employment with wages for full-time males. In addition, we split the data in two subsamples, the first covering the period from 1993 to 2000, the second the years from 2001 to 2008.

The information on task-specific labour is taken from the Qualification and Career Survey, an employee survey carried out by the German Federal Institute for Vocational Training ("Bundesinstitut fur Berufsbildung, BIBB") and the Research Institute of the Federal Employment Service ("Institut fur Arbeitsmarkt- und Berufsforschung, IAB"). Its four cross-sections were launched in 1979, 1986, 1992 and 1999, each covering about 30,000 individuals. An alternative, the "BIBB-BAuA survey" launched in 2006, cannot be combined easily with the previous surveys because of a distinct methodology. We use the 1998/1999 wave for our analysis as we start our analysis in 1993 and this wave is collected approximately in the midst of our sampling period. A major advantage is that these data use a consistent set of occupational classifications; the constant occupational titles thus provide the reference point for the analysis. Another major improvement over previous data is that survey respondents indicated themselves what kind of activities they perform on the job. It is very unlikely that this causes an underestimation of true changes in job content.

Occupational skill requirements are based on the activities that employees have to perform at the workplace. We pool these activities into five task categories, and each occupation has a value for each task category. The task categories are: non-routine analytical tasks, non-routine interactive tasks, routine cognitive/analytical tasks, routine manual tasks, and non-routine manual tasks (for detailed information, see Table 3 in the Appendix). We calculate for each occupation (2-digits) the working time spent within a certain task category and use this as an approximation for all workers in this occupation. Particularly, we use data information to calculate for each occupation (2-digits) a vector that describes how important each of the 5 task categories is for the job. We rate this procedure adequate to use full information about task allocation compared to a simple one to one classification of each occupation to one dominant task (see Table 4).

Experience (in the same occupation in the German labour market) is coded in 5-year groups, with all persons with more than 20 years working experience in one class. We use an approximation for persons firstly reported in the sample in Eastern Germany in 1993 since we do not know their working experience before German re-unification: Medium-qualified persons are considered to have age minus 20 years working experience, high-qualified persons' experience is set to age minus 28 if their experience would be lower otherwise.

We consider individuals as migrant (person with migration history) if they are reported at least once with foreign nationality, the standard (albeit problematic) proceeding to define migrants in the SIAB data. By this we count any person as a migrant who switched from a foreign to German nationality. We are aware that this might result in measurement error with regard to three points: Firstly, we count "Aussiedler" (non-native Germans with German ancestors) as natives; secondly, we count many second- or third-generation migrants as migrants though they were born in Germany; thirdly, there might be coding errors which we are not able to differentiate from real acquiring another nationality.

Descriptive evidence for the migrant-native wage differential is provided in the Appendix in Table 5. Information on the development of relative employment (as a ratio of migrant over native employment) by qualification and task group is shown in Figs. 1, 2 and 3.

6 Results

In the present research we focus on estimating and discussing the elasticity of substitution between migrants and natives heterogeneously across qualification levels and tasks. The inverse elasticities in Table 1 report Eq. (10) estimated across all experience groups and years. The first row reports estimates where we aggregate the qualification

In our regression (Eq. (10)), these strongly endogenous components are eliminated since we compare only the differential between migrants and natives of equal qualification and experience in the same task. Thus, endogeneity of the migrant-to-native labour ratio with regard to the migrant-to-native wage ratio seems negligible given equal qualification, task and experience.

Table 1 Inverse substitution elasticities between migrants and natives, by qualification and task

Qualification	Tasks					
	All tasks	Analytical routine	Analytical non-routine	Manual routine	Manual non-routine	Interactive (non-routine)
Aggregated (across skills)	0.0622	0.0884	0.0808	0.0696	0.0915	0.1036
	(0.0025)	(0.0048)	(0.0051)	(0.0071)	(0.0053)	(0.0055)
Low-skilled	0.0095	0.0073	0.0331	0.0130	0.0205	0.0506
	(0.0069)	(0.0106)	(0.0131)	(0.0168)	(0.0144)	(0.0115)
Medium skilled	0.0548	0.0771	0.0741	0.0533	0.0600	0.0827
	(0.0074)	(0.0082)	(0.0096)	(0.0080)	(0.0071)	(0.0092)
High-skilled	0.0592	0.0796	0.0356	0.0795	0.0523	0.0233
	(0.0077)	(0.0111)	(0.0087)	(0.0144)	(0.0159)	(0.0084)

Standard errors in parenthesis

The estimations in the first column build on 400 (16 years × 5 experience groups × 5 tasks) observations, the estimations in the second to sixth column on 80 observations

levels, the second row estimates where we pool the observations across the qualification levels. Likewise, the first column shows inverse elasticities estimated in a pooled regression across all task groups.

When we look at labour demand aggregated over all formal qualification groups (but disaggregated by year, task and experience), we estimate an overall inverse elasticity of substitution between migrants and natives of 0.0622, which corresponds to an elasticity of roughly 16. The task-specific elasticities of substitution are in the range between 9.6 and 14.4. These estimates are close to the threshold between perfect and imperfect substitutes which frequently in the literature is assumed to be at a value of 10 (though sometimes higher values are still considered as imperfect substitutes). We find that migrants and natives are better substitutable in manual routine tasks and somewhat worse substitutable when carrying out interactive tasks. However, when we consider only aggregates over all qualification levels, it is not clear whether the elasticities really reflect the substitutability between migrants and natives. These estimates may be affected to some extent by the different assignment of migrants and natives to qualification groups.

Hence, we disaggregate the labour-demand quantities by formal qualification in the next step. However, we still estimate a homogeneous elasticity of substitution across the qualification-task-experience cells. These estimations are, with regard to the specification, closest to those used in D'Amuri et al. (2010) though we consider another period (till 2008 rather than 2001); they report estimates in the same value range as the elasticities found by us. The results indicate (almost) perfect substitutability between migrants and natives throughout all tasks. Actually, our estimate for substitution in manual routine task is (insignificantly) negative, i.e. below the lower bound at zero (1 over infinity) as the value for which the inverse elasticity indicates absolutely perfect substitutability. Inverse elasticities of employees in both non-routine manual and interactive tasks are higher than those in other tasks, even if they are far from imperfect substitutability.

In the following, we relax the assumption of a homogeneous elasticity of substitution between migrants and natives over formal qualification levels. Indeed, we are able to reject homogeneity: migrants and natives with low formal qualification show—with an inverse elasticity of approximately 0.01 across all tasks, and a significantly higher value only in interactive tasks—higher substitutability than migrants and natives with medium or high formal qualification level. For migrants and natives with medium formal qualification, we find that they are relatively better substitutes in manual tasks and relatively worse substitutes in interactive tasks. This comes hardly at a surprise. Supposedly, formal degrees and certificates are pretty important when carrying out certain manual tasks, e.g. a German high-voltage certificate for an electrician as a prerequisite for insurance protection; a migrant with the German vocational degree has proven these formal requirements. For interactive tasks, (German) language competence and behaviour according to social and cultural norms seem more relevant. Here, natives have a natural advantage. Among the high-qualified, interactive tasks are often bi- or multilingual, dealing with international affairs and teams under various cultural backgrounds; thus, it is not clear if natives have an advantage at this qualification level. Surprisingly, we find relative to the non-routine and interactive tasks, less elastic migrant-native substitution among high-skilled in routine tasks (both, analytical routine and manual routine). A reason for this finding could be that these tasks are of particular importance in highly complex occupations characterised either by strongly limited access (e.g. pharmacists and physicians) or by particular knowledge of German law (jobs in public administra-

Table 2 Comparison between OLS and IV estimates

Qualification	Method	Tasks					
		All tasks	Analytical routine	Analytical non-routine	Manual routine	Manual non-routine	Interactive (non-routine)
Aggregated	OLS	0.0765	0.1148	0.1065	0.2269	0.1465	0.1284
	OLS	(0.0035)	(0.0037)	(0.0068)	(0.0115)	(0.0052)	(0.0063)
	IV	0.0832	0.1202	0.1006	0.3173	0.1738	0.1287
	IV	(0.0044)	(0.0077)	(0.0099)	(0.0367)	(0.0130)	(0.0108)
Low-skilled	OLS	0.0497	0.3913	0.5605	0.5897	0.5104	0.5041
	OLS	(0.0190)	(0.0246)	(0.0411)	(0.1770)	(0.0297)	(0.0247)
	IV	0.1842	0.4884	0.8631	−18.9794[a]	0.6707	0.5780
	IV	(0.0526)	(0.0507)	(0.0601)	(24.7456)	(0.0678)	(0.0353)
Medium skilled	OLS	0.0698	0.1041	0.1146	0.0694	0.0761	0.1136
	OLS	(0.0042)	(0.0038)	(0.0037)	(0.0058)	(0.0053)	(0.0040)
	IV	0.0701	0.1067	0.1111	0.0808	0.0863	0.1105
	IV	(0.0052)	(0.0044)	(0.0037)	(0.0070)	(0.0074)	(0.0037)
High-skilled	OLS	0.0612	0.0785	0.0304	0.1007	0.0422	0.0317
	OLS	(0.0067)	(0.0132)	(0.0091)	(0.0125)	(0.0138)	(0.0089)
	IV	0.0859	0.0864	0.0485[a]	0.1193	0.1049[a]	0.0607[a]
	IV	(0.0144)	(0.0191)	(0.0260)	(0.0215)	(0.0641)	(0.0383)

Standard errors in parentheses

The estimations in the first column build on 275 observations, those in column two to six on 55 observations

[a]Weak instrument—the F-statistic of the instrument in the first-stage regression is below 10

tions or related to the court). Overall, we provide evidence that migrants and natives are more or less perfect substitutes in most tasks if we account adequately for formal qualification. Further, they are not far from imperfect substitutability in interactive tasks requiring medium formal qualification, analytical tasks with medium qualification, as well as analytical-routine and manual-routine tasks carried out by employees with college/university degree.

7 Robustness checks and instrumental design

The identification of elasticities depends crucially on the assumption of inelastic labour supply. However, we cannot rule out completely that shocks on the ratio of migrants to natives differ across qualification-task-experience cells and that these labour ratios are unaffected by changes in the relative wage structures. We expect reverse causality to induce a positive correlation between wage ratios and employment ratios (as relative wages of migrants go up, so does relative migrant labour supply). Hence, this endogeneity concern might bias OLS coefficients towards zero, with the consequence that the inverses of our OLS estimates are somewhat larger than the true elasticities of substitution.

External instruments are hardly available. Thus, we rely on internal instrumentation (for a more general discussion on that issue see Card 2010), using the 5-year lag of the explanatory variable. This time lag exceeds both the duration of vocational training (including average schooling in college) and the typical frequency in (collective) wage bargaining. I.e., the instrument eliminates short-term or contemporaneous feedback effects from business cycle and anticipated effects due to the people currently upgrading their skills.

Every additional year used in the instrumentation comes at the cost of one year lost for the estimation. To provide a direct comparison, we report in Table 2 even OLS estimates at the reduced time span. We reject equality of the two estimates for low-skilled labour throughout several tasks (analytical non-routine, manual non-routine, interactive and across all tasks). On the contrary, the IV estimates do not differ significantly (at reasonable significance levels) from the OLS estimates over the same period for most qualification-task combinations; i.e. the OLS estimates cannot be considered as inconsistent. Thus, endogeneity seems to be indeed only a minor issue in our analysis.

As additional robustness checks, we test for stability regarding time period and working time. Most patterns are fairly stable across time. When we restrict the estimations to the earlier subsample from 1993 to 2000, the inverse elasticities are in general slightly smaller (between 0.005 and 0.01). In the period from 2001 to 2008, most estimates in-

crease by roughly the same amount relative to the inverse elasticities reported in Table 1. A notable exception are the estimates for substitution elasticities between low-skilled migrants and natives throughout all tasks; with data from 2001–2008, they are closer (albeit smaller) to those displayed in Table 2. I.e., the estimates for the second period increase sharply so that they indicate imperfect substitutability amongst the low-skilled. If we restrict both wages and employment only to full-time male workers, we find hardly any deviation from perfect substitutability. The estimated inverse elasticities are much smaller than those reported in the table; the corresponding elasticities are between twice and ten times higher than those which can be derived from Table 1. On the other hand, if we consider the wages for full-time male workers and contrast them with total employment, the estimated inverse elasticities of substitution are somewhat higher than those shown above.

8 Conclusion

In this paper we have investigated to what extent migrants are substitutes to natives in the German labour market with a particular focus on the task dimensions. Our study has been motivated by the fact that migrants earn on average less than natives. Despite discrimination, imperfect substitutability is a possible reason for persistently lower wages. Recent research on the German labour market is ambiguous regarding the question whether migrants and natives are perfect (D'Amuri et al. 2010, with elasticities between 16 and 35) or imperfect (Bruecker and Jahn 2011, with an overall elasticity of 7) substitutes in the labour market. Though the relations are conditional on comparable qualification and experience and almost equal data is employed in the analysis. However, migrants and natives—albeit possessing equal qualification level—frequently work in distinct occupational segments. They may have different language competence, and they will specialise in tasks in which they have comparative advantages. This suggests augmentation of the qualification-experience-nativity model employed in the previous literature by an additional dimension reflecting different tasks.

We sketch a theoretical framework by following the approach by Borjas (2003) using a nested CES-production technology with inelastic labour supply of different skill levels. On the following stages we augment the basis model by introducing task cells for each qualification group. The empirical part adds the task level as an additional intermediate level of disaggregation with various specifications allowing for heterogeneity of substitution elasticity across the CES sub-aggregates.

In general, we find substitution elasticities between migrants and natives above ten, that is, in a range typically considered to indicate perfect substitution but not too far away from imperfect substitution. Our estimations highlight the importance of differentiation by task and qualification and of properly accounting for their heterogeneity. Qualification is crucial, indeed, if we consider different task groups: migrants and natives with low formal qualification show higher substitutability than migrants and natives with medium or high formal qualification. With regard to migrants and natives with medium qualification, we find that they are better substitutes in manual tasks and relatively worse substitutes in interactive tasks. Surprisingly, in interactive tasks highly qualified migrants and natives are good substitutes.

What are the economic implications of our results? If the wage gap between migrants and natives declines e.g. because minimum wages are introduced (and thus the wage ratio becomes closer to one), we would expect an enormous effect amongst the low qualified (with a large number of migrant workers replaced by natives) and less strong effects amongst natives and migrants with medium and high formal qualifications. If, on the other hand, the wage ratio between migrants and natives is not affected by an immigration shock, we would expect hardly any effect on native labour demand in the respective qualification level if the migrants have low formal qualification and a slightly positive effect if they have medium or high formal qualification.

All in all we find mainly perfectly substitutability within the task levels. Evidence of imperfect substitutability of immigrant and native labour point at difficulties due to transferability of labour market relevant skills and qualification acquired abroad. Moreover, we conclude that integration into the labour market is hampered especially in interactive intensive tasks.

Executive summary

This paper is motivated by the fact that the task approach helps to explain why migrants earn on average less than natives. The disadvantage in the labour market performance of migrants in Germany has stirred a lively public debate on how policy could foster and improve the integration of immigrants into the labour force, and what are the causes for their lower performance. Despite discrimination, recent research points to imperfect substitutability in the production process as a possible reason for persistently lower wages. Results for the German labour market are ambiguous regarding the question whether migrants and natives are perfect (D'Amuri et al. 2010) or imperfect (Bruecker and Jahn 2011) substitutes. The divergence between the estimates is not intuitive since both studies estimate relations conditional on comparable qualification and experience, and almost equal data is employed in the analysis. Peri and Sparber (2009) address comparative advantages as an explana-

tion for occupational sorting by migrants even with the same formal qualification level. Descriptive figures confirm that migrants and natives—albeit possessing equal qualification level—frequently work in distinct occupational segments. They may have different language competence, and they will specialise in tasks in which they have comparative advantages.

This suggests augmentation of the qualification-experience-nativity model employed in the previous literature by an additional dimension reflecting different tasks. By distinguishing labour horizontally according to job requirements, we contribute to the existing literature which so far differentiates labour at most vertically by formal qualification or by experience.

In general, we find an elasticity of substitution between migrants and natives in a range typically considered to indicate perfect substitution but not too far away from imperfect substitution. Our estimations highlight the importance of differentiation by task and qualification and of properly accounting for their heterogeneity. Qualification is crucial, indeed, if we consider different task groups: migrants and natives with low formal qualification show higher substitutability than migrants and natives with medium or high formal qualification. With regard to migrants and natives with medium qualification, we find that they are better substitutes in manual tasks and relatively worse substitutes in interactive tasks. Surprisingly, in interactive tasks highly qualified migrants and natives are good substitutes. Evidence of imperfect substitutability of highly qualified immigrant and native labour in routine tasks point at difficulties due to transferability of labour market relevant skills and qualification acquired abroad. Moreover, we conclude that, in particular for the medium qualified, integration into the labour market is hampered especially in interactive intensive tasks.

Building upon the estimates, further economic implications can be derived with regard to the employment effects of wage and migration policy. If the wage gap between migrants and natives declines e.g. because minimum wages are introduced (and thus the wage ratio becomes closer to one), we would expect an enormous effect amongst the low qualified (with a large number of migrant workers replaced by natives) and less strong effects amongst natives and migrants with medium and high formal qualifications. If, on the other hand, the wage ratio between migrants and natives is not affected by an immigration shock, we would expect hardly any effect on native labour demand in the respective qualification level, for migrants with low formal qualification and a slightly positive effect for medium or high formal qualification.

Kurzfassung

Ausgehend vom TASK-Ansatz versucht dieser Beitrag zu erklären, warum Migranten im Schnitt weniger verdienen als Deutsche. Die schlechtere Performanz von Migranten auf dem Arbeitsmarkt hat eine lebhafte Debatte darüber angestoßen, wie die Position von Migranten auf dem Arbeitsmarkt verbessert und der Aufholprozess beschleunigt werden kann. Warum sind Migranten am Arbeitsmarkt benachteiligt? Sieht man einmal von der Möglichkeit der Diskriminierung ab, so deuten aktuelle Forschungsergebnisse darauf hin, dass Einheimische und Migranten im Produktionsprozess nur bis zu einem gewissen Grade substituierbar sind. Dies könnte die niedrigeren Löhne von Migranten erklären. Die einschlägigen empirischen Befunde für den deutschen Arbeitsmarkt sind nicht eindeutig: Folgt man D'Amuri et al. (2010), so sind Migranten und Einheimischen vollkommene Substitute – ein Befund, dem Bruecker and Jahn (2011) widersprechen. Das ist insofern überraschend, als die in beiden Studien verwendeten Modellierungen auf sehr ähnlichen Datensätzen basieren und bezüglich beruflicher Qualifikation und Berufserfahrung für vergleichbare Variablen kontrollieren.

Die Konzentration von Migranten in bestimmten Berufen – selbst bei gleicher Qualifikation – erklären Peri and Sparber (2009) damit, dass diese über relative Vorteile in bestimmten Tätigkeitsfeldern verfügen. Deskriptive Evidenz bestätigt, dass Migranten und Einheimische – selbst bei vergleichbarer Ausbildung – häufig in unterschiedlichen Berufen arbeiten. Denn Migranten verfügen über unterschiedliche sprachliche Kompetenzen und spezialisieren sich meist auf diejenigen Tätigkeiten, in denen sie relative Vorteile haben. Im Gegensatz zu bisherigen Studien zur Situation von Migranten am Arbeitsmarkt, die auf unterschiedliche Grade an formaler Qualifikation und Berufserfahrung abheben, wird in diesem Beitrag auch nach den horizontalen Arbeitsplatzanforderungen (job tasks) unterschieden.

Generell bewegen sich die Substitutionselastizitäten zwischen Migranten und Einheimischen, nach unseren Schätzungen in einem Bereich, der von perfekter bis zu relativ weitgehender Substituierbarkeit reicht.

Unsere Ergebnisse unterstreichen, dass die Unterschiede in den Taskdimensionen **und in der** beruflichen Qualifikation gleichermaßen beachtet werden müssen. Die Ebene der beruflichen Qualifikation bleibt weiterhin zentral – auch wenn man nach Taskebenen differenziert: Migranten und Einheimische ohne abgeschlossene Berufsausbildung sind stärker substituierbar als Personen mit mittlerer und höherer Qualifikation. Auf der mittleren Qualifikationsebene ist die Substituierbarkeit zwischen Migranten und Einheimischen bei manuellen Tätigkeiten deutlich höher als bei Tätigkeiten mit interaktiven Anforderungen.

Überraschend ist indes, dass Hochqualifizierte bei interaktiven Tätigkeiten gut substituierbar sind, nicht jedoch bei

Routinetätigkeiten. Dies dürfte daran liegen, dass in diesem Bereich die relevanten Arbeitsmarktkenntnisse häufig fehlen und ausländische Berufsabschlüsse nur zum Teil übertragbar sind. Zudem zeigt sich, dass Migranten mit abgeschlossener Berufsausbildung Schwierigkeiten bei der Integration in den Arbeitsmarkt haben, wenn sie mit überwiegend interaktiven Tätigkeitsanforderungen konfrontiert sind.

Aus den Ergebnissen lassen sich zudem wichtige Erkenntnisse für die Lohn- und Migrationspolitik ableiten. Falls der Lohnabstand zwischen Migranten und Einheimischen schrumpft, etwa weil ein Mindestlohn eingeführt wird, hätte dies deutliche Auswirkungen für die geringer Qualifizierten. So dürfte insbesondere die Nachfrage nach geringqualifizierten Arbeitskräften mit Migrationshintergrund abnehmen. Bei unverändertem Lohnabstand zwischen Migranten und Einheimischen hingegen hätte Zuwanderung leicht positive Beschäftigungseffekte für mittel- und hochqualifizierte Einwanderer, und keine nennenswerten Auswirkungen für geringqualifizierte Migranten oder Deutsche.

Appendix

Table 3 Assignment of activities to task classification scheme

Task classification	Activities
Non-routine analytic	Researching/analysing/evaluating and planning, making plans/constructions/designing and sketching, working out rules/prescriptions, using and interpreting rules
Non-routine interactive	Negotiating/lobbying/coordinating/organising, teaching/training, selling/buying/advising customers/advertising, entertaining/presenting, employ/manage personnel
Routine cognitive	Calculating/bookkeeping, correcting of texts/data, measuring of length/weight/temperature
Routine manual	Operating/controlling machines, equipping machines
Non-routine manual	Repairing/renovation of houses/apartments/machines/vehicles, restoring art/monuments, serving or accommodating

Note: Overview of how activities asked for in the Qualification and Career Survey are grouped into the task categories

Source: Black and Spitz-Oener (2007), p. 30

Table 4 Occupations by dominant task (Kl.d.B.88)

	Analytic routine		**Manual routine**
52	Goods examiners, goods receivers, dispatchers	6	Forestry occupations, hunters
68	Sales personnel	7	Miners
73	Mail carrier and handler, postal clerk	8	Mineral, oil, natural gas quarriers
74	Storekeeper, warehouse keeper	9	Mineral preparers
		10	Stone preparers
	Analytic non-routine	11	Stoneware makers
60	Engineers	12	Ceramics workers
61	Chemists, physicists, mathematicians	13	Glassmakers
62	Technician	14	Chemical processing
63	Special technical professionals	15	Plastics and polymer processing
77	Accountant, bookkeeper	16	Paper and pulp processing
78	Office specialists, office auxiliary workers	17	Printer, typesetter, typographer
		18	Wood, lumber, and timber processing
	Interactive	19	Metal and iron manufacturer
4	Agricultural workers, Animal keepers	20	Moulding, shaping
5	Gardeners	21	Metal presser and moulder
69	Banking, Insurance clerks	22	Metal polisher, sander, buffer, Lathe
70	Traders, trading personnel	23	Operator
75	Entrepreneurs, organisers, chartered accountants	24	Welder, brazing, soldering
76	Members of Parliament, government officials	25	Blacksmiths

Table 4 (*Continued*)

	Interactive		**Manual routine**
81	Jurists, legal advisors	26	Sheet metal workers, plumbers
82	Journalists, translators, librarians	27	Locksmith
83	Artists and associated occupations	29	Toolmakers
86	Social worker	30	Metal craftsman
87	Teacher (except university)	31	Electrician, electrical installation
88	Humanities specialist, scientific occupations, nec	32	Assembler
89	Ministers of religion	33	Weaver, spinner, lnitter, wool trade
		34	Textile manufacturer
	Manual non-routine	35	Textile processing operatives
28	Mechanic	36	Textile dyers and finishers
45	Carpenters, roofers, scaffolders	37	Leather makers, leather and fur processing operatives
48	Plasterer	39	Baker
51	Painters, lacquerers and related occupations	40	Meat, fish processing operatives
71	Truck driver, conductor	41	Cooks, preparers
72	Sailor, seaman, navigator, mariner	42	Beverage, luxury food makers
79	Guard, watchman, police, security	43	Other nutrition occupations
80	Protective services workers	44	Bricklayer, mason
84	Physicians, pharmacists	46	Road makers, civil engineering workers
85	Nurse, dietitian, physical therapist	47	Unskilled construction worker
90	Body care occupations	49	Room equippers, upholsterers
91	Hospitality related occupations	50	Joiner, cabinet maker
92	Domestic occupations	53	Unskilled worker
		54	Crane driver, crane operator, skinner, machine
		93	Cleaning occupations

Own calculation and presentation based on data source: Dustmann et al. (2010) and classification of occupations (2-digit)

Table 5 Descriptive statistics of the mean log wage difference between Germans and natives by qualification level (conditional on equal experience, task qualification, and years)

	Low skilled	Medium skilled	High skilled
Descriptive statistics across all tasks			
mean	−0.0131	−0.0051	−0.0013
s.d.	0.0178	0.0080	0.0075
min	−0.0526	−0.0269	−0.0244
max	0.0206	0.0117	0.0194
Average log wage difference by task			
Analytical routine	−0.0157	−0.0097	0.0002
Analytical non-routine	−0.0156	−0.0069	0.0006
Manual routine	−0.0235	−0.0097	0.0001
Manual non-routine	−0.0041	0.0015	−0.0046
Interactive	−0.0066	−0.0008	−0.0030

The log wage difference between migrants and natives with qualification h in task I with experience j at time t is defined as $\ln(\frac{w_{hijmt}}{w_{hijnt}})$, which we employ as dependent variable in the estimation

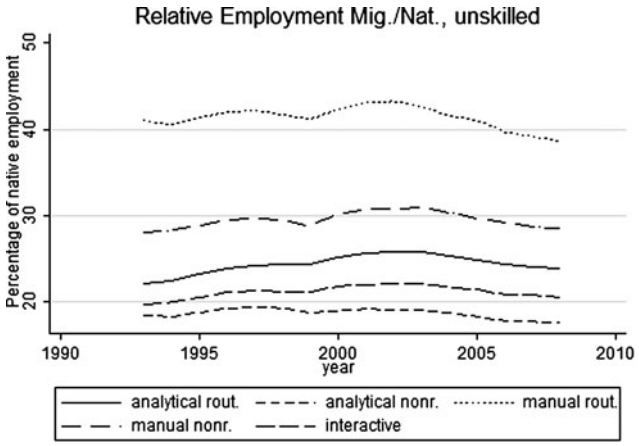

Fig. 1 Relative Employment Mig./Nat., unskilled

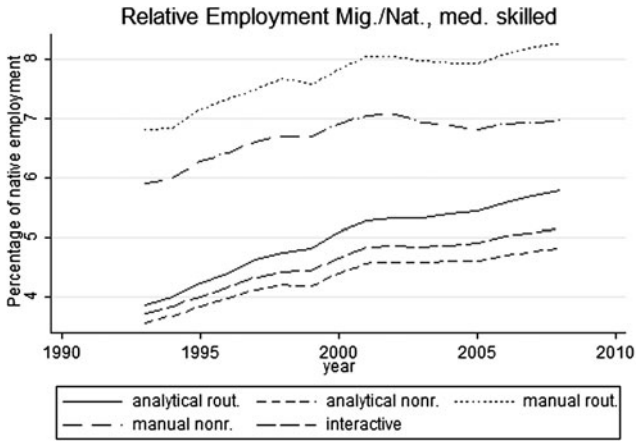

Fig. 2 Relative Employment Mig./Nat., med. skilled

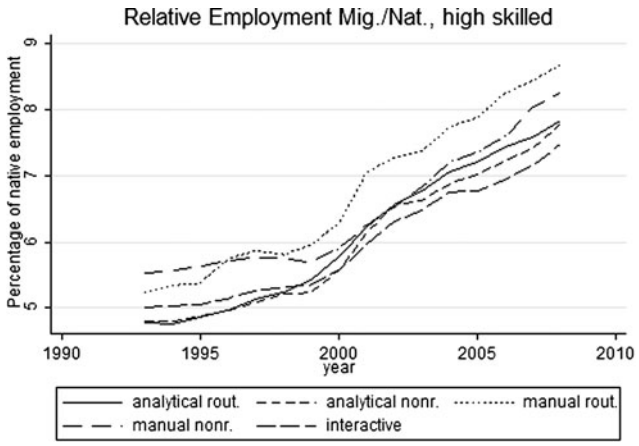

Fig. 3 Relative Employment Mig./Nat., high skilled

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Anette Haas graduated in Economics at the University of Regensburg, specializing in regional and urban economics, econometrics and empirical macroeconomics. She has been working at the IAB since 1997. Currently, she is head of IAB's "Working Group on Migration and Integration". She is interested in regional and international migration and labor market integration.

Michael Lucht studied maths and economics at the Christian Albrecht University in Kiel completing his studies in 2010 (Diplom Volkswirt) and 2011 (Diplom Mathematiker). He has been a scholarship holder in IAB's Graduate Programme (GradAB) since November 2010 and is working at IAB's department "Regional Labour Markets" as a researcher.

Norbert Schanne studied Economics at Mannheim University where he graduated in 2004. He joined IAB's Regional Research Network in 2005 and moved to the IAB Research Data Centre in late 2012. He is interested in Labor Economics, Regional Evolution, Forecasting, and Spatial Econometrics.