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### **The consequences of EU eastern enlargement on human capital accumulation and wages in Germany**

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# The consequences of EU eastern enlargement on human capital accumulation and wages in Germany

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June 2021

## *Abstract*

The eastward enlargement rounds of the European Union (EU) between 2004 and 2007 represent a broad regulatory expansion of the European labor market that facilitated the recruitment of individuals from new member states. We focus on the effects of EU enlargement on human capital accumulation and wages in Germany. The analysis employs linked employer-employee data from 2004 to 2017 to investigate the association between the immigration of apprentices from new eastern and central European member states and wages in the German labor market. Descriptive statistics reveal a clear and continuous increase in the number of foreign apprentices from new member states in the years following the removal of transitional restrictions. We find strong positive selection effects, as these immigrants were better educated and subsequently employed in higher-paying establishments compared to individuals who entered the German apprenticeship market prior to EU enlargement. Moreover, the study provides the first extensive evidence of apprentice wage developments in the context of immigration. As apprenticeship graduates eventually become skilled workers, we also analyze indirect effects of migration on the labor market, highlighting the temporal dimension of considerations around the substitutability between foreign and domestic workers.

**Keywords:** Wages, immigration, vocational education and training, apprenticeship, firm-sponsored training

**JEL No.** J24, J31, J61, M53

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## **1. Introduction**

In March 2020, as the reality of the Covid-19 pandemic began to dawn upon many Europeans, a sweeping regulatory reform took effect in Germany, opening its labor market more extensively to international immigrants than at any point since the Second World War (see *Fachkräfteeinwanderungsgesetz*). The newly introduced law was motivated to no small degree by the growing importance of the international talent pool of skilled workers for the German economy and by looming insecurities about the country's social security system, particularly its pension component. Besides skilled workers, visa requirements were also loosened for vocational education and training (VET) positions in Germany. These changes came on the back of an already considerable increase in the share of foreign apprentices over the past decades, from 5% in 2000 to almost 12% in 2019 (as of 31 December respectively; Federal Employment Agency, 2020c). This study seeks to provide an initial view on what consequences resulted from these developments for wages in the German labor market. Research has, thus far, not investigated VET remuneration in the context of immigration, and prior studies on the wage effect of more general immigration have come to differing, at times contradicting results (Dustmann, Schönberg, & Stuhler, 2016). Empirical evidence for Germany points to relatively rigid wage levels and a greater likelihood of employment effects in the face of immigration (Brücker, Hauptmann, Jahn, & Upward, 2014; D'Amuri, Ottaviano, & Peri, 2010; Felbermayr, Geis, & Kohler, 2010; Glitz, 2012). We seek to build on such previous findings and expand them with a perspective focused on apprenticeships. Specifically, we investigate how increasing labor market openness to international VET immigration affects prevailing wage levels for apprentices in those occupations into which migration occurs. Beyond remuneration for employees in VET programs, an increase in the supply of apprentices may also impact market equilibria for skilled workers, both immediately, to the extent that apprentices are used as (cheaper) substitutes, as well as down the road, as their training is completed. We attempt to quantify and discuss such possible secondary effects.

Empirical evidence of the past two decades provides us with a rich context for analyses of immigration in the German apprenticeship market. Historically, labor market access was relatively restricted for foreign school graduates seeking vocational education and training. In 2005, legislative reforms loosened some immigration regulations and made visas for foreign apprentices more of a possibility (Fellmer & Kolb, 2009). Subsequently, the eastward enlargement rounds of the European Union (EU) and the corresponding opening of the European labor market to the population of new member states produced a sharp increase in

immigrant apprentices. Between 2000 and 2019, VET immigration among new member states was especially pronounced from Poland, with Polish apprentices in Germany increasing by 230%, and Romania, with Romanian apprentices increasing by 507% (measured as of 31 December respectively; Federal Employment Agency, 2020c). We treat EU eastward enlargement as a quasi-natural experiment and utilize these developments to analyze the wage effects of inward international migration in an apprenticeship context between 2004 and 2017 through a difference-in-differences approach.

The empirical analysis portrays a differentiated picture of relationships between apprentice immigration and wage levels. Initially, a negative association between occupation-level apprentice immigration and first-year apprentice wages is evident in the data, but only for the years preceding the eastward expansion of the German labor market. Thereafter, immigrant apprentices appear to have been increasingly better educated and sorted into relatively better-paying occupations and establishments, causing this initial negative association with wages to fade. For skilled worker wages, individual-level estimations do confirm a negative association between the share of foreign apprentices and individual first-year wages for some market segments. This study is careful, however, not to interpret these results as a causal link that leads immigration to decrease wages. It rather seems like immigrant apprentices are sorted into occupations with relatively lower skilled worker wages. The labor supply shock, however, which this immigration should represent, does not seem to significantly influence wage levels in the German labor market.

This study offers several contributions to the academic debate. First, it provides a novel, extensive perspective on wage implications of immigration in the context of apprenticeship training. In fact, to our knowledge, it also represents the first analysis of individual-level apprentice wage drivers that employs a large-scale dataset. Second, the study joins the broader debate on the labor market impact of immigration with a previously unexplored point of view. The unique characteristics of apprenticeship markets offer a setting where the temporal dimension of immigration is inherently essential and assumptions around the substitutability of immigrants in the labor market, often front and center in debates about the consequences for domestic workers, are less complex. Moreover, we draw practical conclusions from inherent characteristics of the German regulatory changes that may inform future policy debates.

The following sections first provide an overview of related literature on determinants of apprentice remuneration and the wage effects of immigration. We then offer some context on the empirical setting and the employed dataset. The following section outlines the analytical

approach and discusses key assumptions in the study's identification strategy. We subsequently present the results of our analyses and discuss their implications for research and practice. The final section concludes.

## 2. Relevant literature

The academic debate about the wage impact of immigration is extensive and diverse (for a recent overview, see Peri, 2016). At first sight, the consequences of immigration for wages seem quite straightforward. An increased supply of workers in a segment of the labor market should reduce wages for competing individuals.<sup>1</sup> Empirical studies, however, have been far less clear in their conclusions. Early analyses often focus their attention on spatially defined labor markets and conclude that immigration only exerts a small wage effect, if any at all (e.g., Altonji & Card, 1991; Card, 1990; Grossman, 1982; LaLonde & Topel, 1991). As has been pointed out since (e.g., Orrenius & Zavodny, 2007), the results of such an approach can be misleading if the response of natives, which may go beyond the spatial focus area, is not accounted for or if there is reason to believe that the location choice of migrants is endogenous. Researchers have, therefore, sought alternative approaches. One popular school of thought places labor market participants into national skill cells (Borjas, 2003). The subsequently derived nested structure of wage effects within an aggregate production function (see Ottaviano & Peri, 2012 for an illustrative example) has led studies to conclude more pronounced negative wage relationships (see Borjas, 2014). Nonetheless, studies continue to produce vastly differing results. There are likely empirical reasons for these disparities, such as inherent heterogeneity within labor market segments that is not accounted for in prevailing models (for instance, the level of wage rigidity may differ between younger and older workers). In part, diverse answers also arise because different models come with slight variations in the questions they seek to answer, particularly differentiating between partial and total wage effects of immigration (Dustmann et al., 2016). Studies that seek to quantify an overall wage impact across the economy ought to take indirect influences between skill groups into account and have mostly come to do so through some form of nested structure (e.g., Borjas, 2003; Ottaviano & Peri, 2012). Analyses of partial wage effects, on the other hand, limit their focus on the impact within directly affected labor market groups. The approach pursued in the present study is much closer

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<sup>1</sup> For a theoretical model that describes these likely consequences, readers are referred to Borjas (1999).

to this latter variant and other occupational-level analyses, such as an earlier contribution by Orrenius and Zavodny (2007).

In these discussions, the German labor market has received broader attention since the early 1990s. Studies have investigated employment (e.g., Pischke & Velling, 1997) as well as wage effects (e.g., De New & Zimmermann, 1994a), and results were, again, not immediately conclusive. More recently, research efforts have pointed out significant wage rigidities in the German labor market (Franz & Pfeiffer, 2006) and indicated that immigrants may largely compete in separate market segments (Bonin, 2005), limiting effects, particularly on worker remuneration. D'Amuri et al. (2010), for example, in their analysis of immigration to Germany in the 1990s, find only a small wage impact, which affects mainly other migrants, rather than native workers. They argue that because of wage rigidities in the German labor market, adverse outcomes of immigration materialize not mainly in the form of wage decreases but rather in employment effects. These results are confirmed by Felbermayr et al. (2010), who similarly emphasize employment implications and even conclude positive wage effects for complementary natives. How immigration influences workers in Germany appears to vary significantly between different segments of the labor market, separated mainly by educational characteristics and between recent immigrants and natives or incumbent foreigners (Brücker & Jahn, 2011). Steinhardt (2011) argues that these different effects can be attributed to foreigners and natives often working in separate occupations, partly driven by restrictions in the transferability of educational qualifications. Overall, prior research does not provide strong evidence for a significant wage effect following immigration into the German labor market. Instead, employment effects, which also impact the native population, have more frequently been found (e.g., Glitz, 2012). Labor market institutions likely play a significant role in these outcomes. They are emphasized, for example, by Brücker et al. (2014), who confirm a very limited wage effect and a more considerable impact on employment rates in Germany, in their comparative study between Germany, Denmark, and the United Kingdom.

Consistently at the heart of discussions of the effects new labor market entrants have on previous participants are questions about who exactly they compete with. Researchers have framed this issue through the term substitutability (Hamerossen, 1986). In this view, immigrants, or any labor market participants, should not be seen as perfect alternatives to all other workers across the labor market. They act as substitutes to some and complement others, mostly depending on perceived or actual skill differences. This suggests not only that the effect of immigration on a particular segment of the labor market can be both positive and negative

but also that there can be multiple simultaneous effects, possibly counterbalancing one another. Prior research has pointed out that even small differences in observable skills between foreign and domestic workers may significantly influence the labor market outcome (Ottaviano & Peri, 2005). This theoretical expectation has early on also been pointed out for the German context in particular (De New & Zimmermann, 1994b) and has since been empirically supported (Brücker & Jahn, 2011).

For the purpose of this undertaking, we assume that immigrant apprentices, which have already been hired by domestic firms, are near-perfect substitutes for domestic alternatives within occupational groups. Orrenius and Zavodny (2007) similarly use such sorting across occupations as a proxy for skills and we argue it is appropriate in the present case as well. The assumption of a higher degree of similarity between young workers is also supported by previous research results, which show that wage effects of migration tend to be more pronounced for younger natives (Brücker & Jahn, 2011; Dustmann, Schönberg, & Stuhler, 2017). In previous studies, schooling and labor market experience have long been considered crucial criteria to determine the likeness of workers (Borjas, 2003). In these terms, as apprentices are by default at the very beginning of their careers, we do not expect systematic differences in work experience across groups (although it is conceivable that they may exist in individual cases). Educational backgrounds may differ, of course. However, all observations included in this study have already successfully entered the labor market and undergone initial screening by domestic companies, which, among other things, would have assessed their schooling records. Thus, we assume comparable qualifications, at least to the extent as they are relevant for the respective occupational segments of the labor market. More recently, Ottaviano and Peri (2012) have argued for the inclusion of foreignness itself as a differentiating criterion for educational attainment. Such differences should similarly fall within the discussed market assessment of skill levels performed by companies.<sup>2</sup> The presented approach, furthermore, addresses the frequently raised issue of potential downgrading of foreign workers upon arrival (Dustmann et al., 2016), as it observes foreign apprentices in the occupational segment in which they were hired.<sup>3</sup> Of course, substitutability between workers may also change over time. This is especially relevant in the case of immigrants, as they adjust to the new labor market environment, for example, through improved language skills. Studies have previously

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<sup>2</sup> Nonetheless, we perform robustness checks on a subpopulation of foreigners.

<sup>3</sup> Other researchers have used probability models to assign likelihoods of competing in a certain occupation (see, e.g., Card, 2001).

differentiated between “old” and “new” immigrants when analyzing labor market effects (see, e.g., D’Amuri et al., 2010), but without looking at possible skill development over time. This is where the present study provides a unique perspective. Foreign apprentices are often admitted into the labor market with the explicit goal to increase the supply of skilled labor down the road. They are trained by domestic companies and acquire skills directly relevant to the respective occupational segment of the labor market. Therefore, the assumption of direct competition between immigrant and native workers is even stronger when looking at the impact of apprentice migration on skilled worker wages.

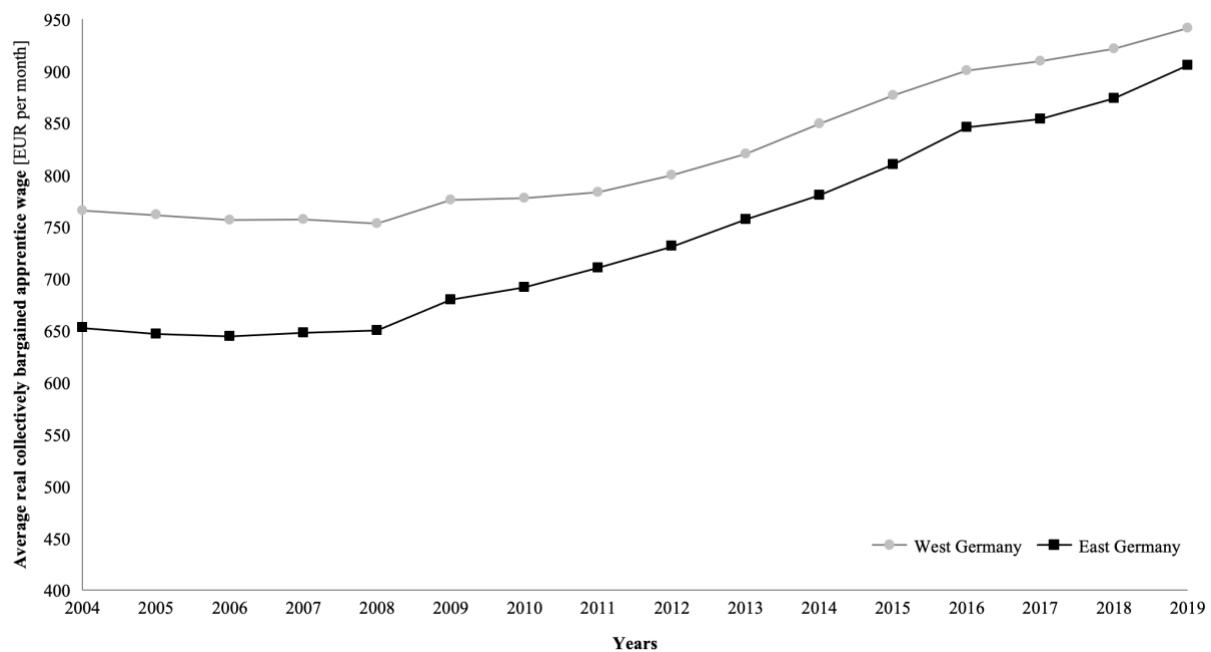
Looking beyond immigration, research on wage determinants has long established a principal relationship between individual pay, education, and professional experience (Mincer, 1974). The determinants of apprentice wages, by contrast, for which the influence of professional experiences is necessarily limited and wage-setting may be more heavily influenced by regulatory provisions, are relatively underresearched. Prior publications have mostly looked at apprentice pay through the lens of cost-benefit analyses that influence the willingness of firms to offer such VET positions or the degree of labor market competition (e.g., Kriechel, Mühlemann, Pfeifer, & Schütte, 2014; Mühlemann, Ryan, & Wolter, 2013; Wolter & Ryan, 2011). An exception in the German context is provided by Beicht and Walden (2012), who put forward an organizational perspective on aggregate wage levels. In particular, their study establishes geographical factors, sector affiliation, company size, and institutional aspects as crucial wage drivers. Ryan, Backes-Gellner, Teuber, and Wagner (2013) expand on the latter aspect and derive wage implications from a comparison of several national institutional settings, especially the political interplay between labor unions and employer associations. Even though the importance of apprentice wages has long been acknowledged, especially if organizations are to be encouraged to provide training, there have not been significant research efforts in analyzing their determinants. This seems especially relevant in Germany, where companies, on average, incur significant net costs in the provision of apprenticeships (Schönenfeld, Wenzelmann, Pfeifer, Risius, & Wehner, 2020).

### **3. The German dual apprenticeship system**

VET in Germany is provided through a publicly regulated “dual” system. School graduates enter into contracts with public or private enterprises and typically start their apprenticeships in August or September, following the completion of their compulsory education. During these training programs, apprentices study for one or two days per week in part-time vocational

schools. The remainder of their time is spent on on-the-job training, provided by their employers. The details of such programs are governed by regulatory provisions in the Vocational Training Act (*Berufsbildungsgesetz*) and negotiated between labor unions and employer associations. This includes apprentice wages, which are often determined through collective bargaining agreements and mandated to rise at least annually. Legal practice has further established that apprentice remuneration is prohibited from dropping below 80% of the prevailing collectively bargained wage in the respective industry and region (see, e.g., Federal Labour Court, 2015), creating a de facto industry-specific wage floor. Average real wages have generally trended upwards over the past decade. Figure 1 serves as an overview of inflation-adjusted collectively bargained averages.

*Figure 1: Average collectively bargained apprentice wage, adjusted for inflation, in West and East Germany 2004-2019*

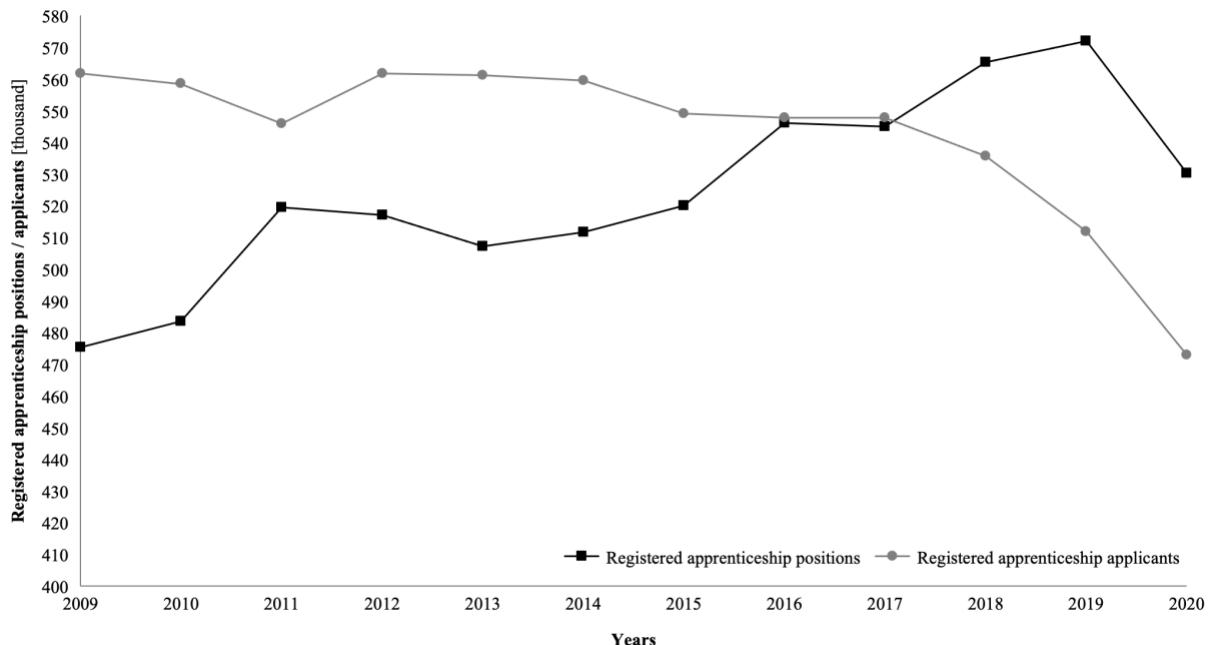


*Notes: Average wages are adjusted for inflation to 2019 levels, using nationwide consumer price index information published by the Federal Statistical Office. Source: Federal Institute for Vocational Education and Training (2020a), Federal Statistical Office (2021a)*

Approximately half of school graduates enter the VET system in Germany each year (54.5% in 2018). Figure 2 provides a perspective on registered apprenticeship positions as well as registered applicants since 2009. It shows a steady increase in apprentice demand, as well as a stagnating or slightly decreasing number of applicants throughout the timeframe in focus for this study. For 2020, the impact of the Covid-19 pandemic is clearly visible through a sharp drop in offered VET positions. Additionally, the apprenticeship market has experienced

persisting problems matching supply and demand. In 2019, approximately 9.4% of VET positions were not filled, while roughly 74 thousand registered applicants remained without an apprenticeship (Federal Institute for Vocational Education and Training, 2020b).

*Figure 2: Registered apprenticeship positions and applicants 2009-2020 as of 30 September*



*Source: Federal Employment Agency (2020a)*

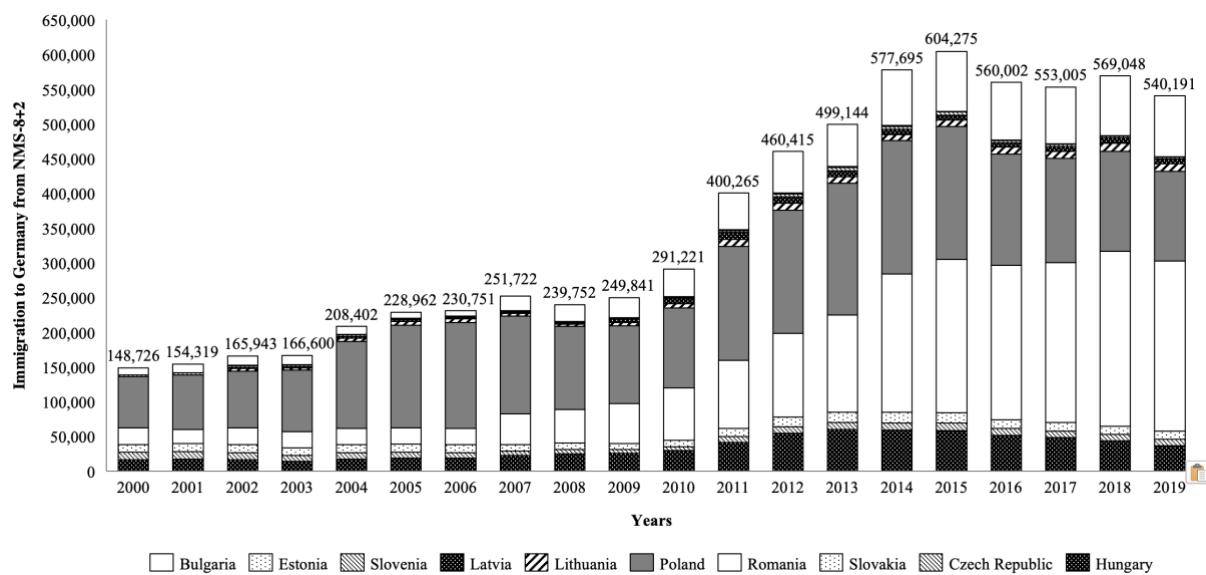
Since 2013, the federal government has intensified efforts to attract applicants from European countries to enter the VET system in Germany, offering, among other things, language courses and financial relocation support through its *MobiPro-EU* program (Hippach-Schneider & Huismann, 2016, who also provide a more comprehensive overview). An overview of the characteristics of foreign apprentices in the German VET system is provided, for example, by Kroll and Uhly (2018). Their descriptive summary highlights that compared to apprentices with German citizenship, foreign trainees on average tend to be slightly older, less educated, and relatively more represented in skilled crafts and trades rather than in industrial sectors. Furthermore, they point out that the rate of premature apprenticeship termination has been consistently higher for foreign apprentices over the past years.

#### **4. Eastward enlargement of the European Union**

This study's identification strategy makes use of a quasi-natural experiment, which occurred in the German labor market following the 2004 and 2007 eastward enlargement rounds of the

EU. As the European Single Market and its provisions guarantee free movement of labor for all citizens of EU member countries, the accession of new member states represented a significant increase of the available labor supply and resulted in a strong increase in overall inward migration flows from new member countries (see Figure 3). This expansion of the European labor market, however, did not take immediate effect. In 2004, existing member countries were permitted to put in place national transitional regulations, restricting migration from new member states for up to seven years, split into three phases of two, three, and an additional two years (*2+3+2 model*). The same measures were allowed for a second round of eastward enlargement by two additional south-eastern European countries in 2007 (Bulgaria and Romania; see Bug, 2011 for an overview). Germany made full use of these regulatory options, restricting the mobility of workers from eight central and eastern European member countries that acceded in 2004 (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia; NMS-8) until 1 May 2011.<sup>4</sup>

*Figure 3: Immigration to Germany from relevant new member states, 2000-2019*



Source: Federal Statistical Office (2021b)

Even though some exceptions applied in the form of bilateral agreements, for example, for seasonal agricultural workers, during these transitional measures immigration regulations for workers from NMS-8 remained mostly similar to what they had been prior to enlargement (Holland, Fic, Rincon-Aznar, Stokes, & Paluchowski, 2011). Equivalent restrictions applied to

<sup>4</sup> Citizens from the island nations of Malta and Cyprus were not affected by these labor market restrictions.

workers from Romania and Bulgaria (NMS-2), which acceded to the European Union in 2007, permitting only limited access to the German labor market until 1 January 2014.<sup>5</sup> More significant changes for highly skilled foreign workers initially resulted from a new immigration law adopted at the beginning of 2005, irrespective of EU enlargement (Fellmer & Kolb, 2009). This revision permitted foreigners to apply for visas for the purpose of taking up an apprenticeship while, however, still assigning priority to domestic applicants through a labor certification requirement (*Zuwanderungsgesetz*, §17). Additionally, with continued uncertainty about the transition into regular employment in Germany after a completed VET program, often the purpose of an apprenticeship, the attractiveness of such possibilities remains questionable. This is broadly in line with the spirit of many supplementary regulations at the time, which often explicitly stated that visas for primary vocational education programs were not intended as a stepping-stone into the German labor market. Visa-issuing authorities were required, for example, to verify that the skills acquired during the apprenticeship would be of “practical use” in the home country (e.g., *Anwerbestoppausnahmeverordnung*, §2 (1) 4).<sup>6</sup>

Since restrictions were lifted, the German labor market has seen an influx of workers from new member states (see Figure A1). This increase has also, at least in part, been attributed to the financial crisis of 2008 and its economic consequences, which left the German labor market comparatively unaffected and increased its attractiveness relative to its European neighbors (Elsner & Zimmermann, 2016). A useful, comprehensive overview of more general migratory patterns in the European Union following the eastward enlargement of 2004 is provided by Kahanec and Zimmermann (2016). The situation for apprentices changed fundamentally in mid-2011 for NMS-8 and subsequently in 2012 for NMS-2 when visa requirements were fully lifted on 1 January (eight months after full freedom of movement of labor was realized for NMS-8 and two years prematurely for NMS-2; *Verordnung zur Änderung und Aufhebung arbeitsgenehmigungsrechtlicher Vorschriften*, Art. 1 Nr. 2). With full freedom of movement of labor then realized or in sight, a clear labor market perspective existed for foreign apprentices following their VET programs. Therefore, we assume that 2012 represents the turning point for inward migration of foreign apprentices from NMS-8 and NMS-2

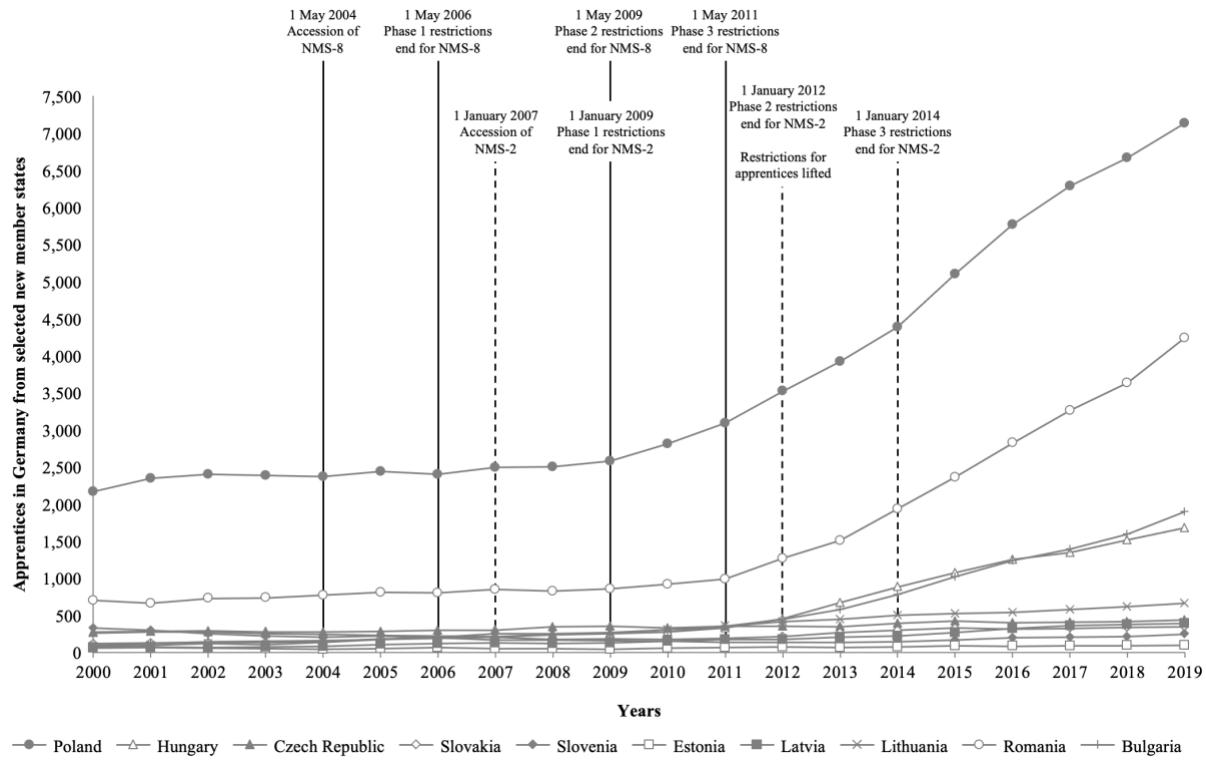
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<sup>5</sup> Felbermayr et al. (2010) provide an interesting counterfactual estimation of what might have happened in the absence of transitional restrictions in Germany. They conclude that the imposed limitations likely only benefitted incumbent foreign workers and may even have been harmful, in economic terms, to the German population as a whole.

<sup>6</sup> A descriptive overview of immigration into Germany around the time of EU eastward enlargement can be found in Steinhardt (2009).

(collectively NMS; we do not include Malta and Cypris when we refer to these new member states throughout this study) into Germany. This is reflected in empirical data, as shown in Figure 4 and Figure 5.

*Figure 4: Apprentices from NMS-8 and NMS-2 in the German labor market, 2000-2019 (as of 31 December)*

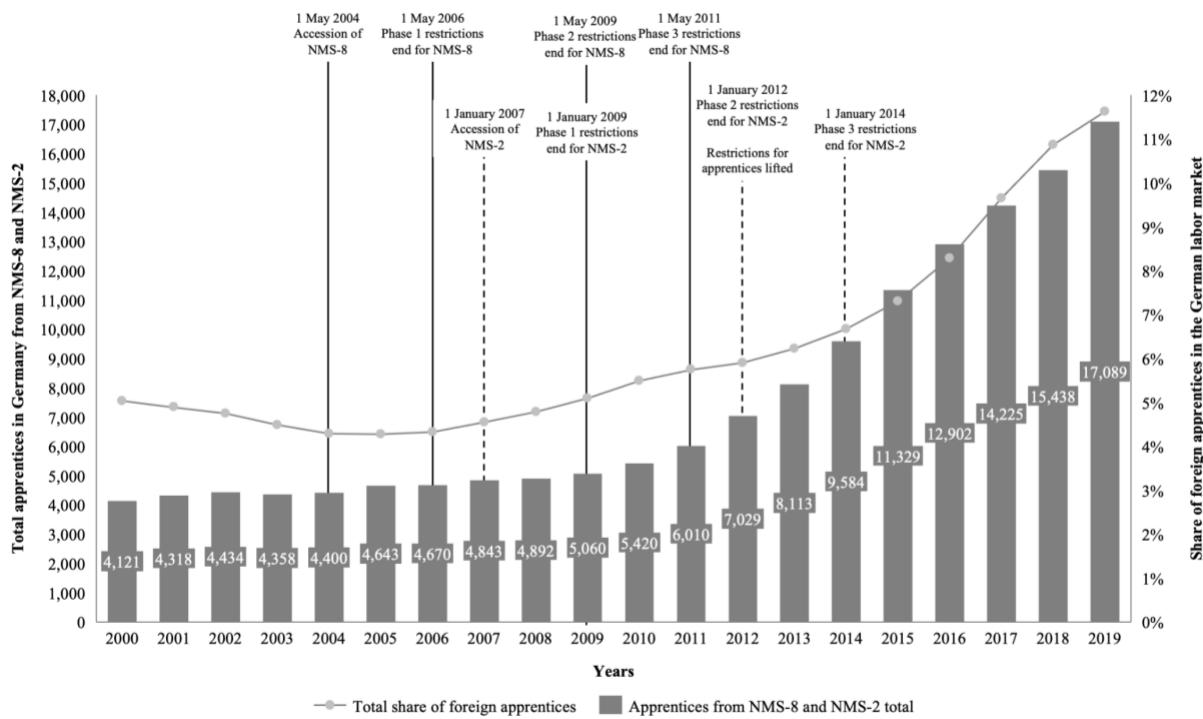


Source: Federal Employment Agency (2020c)

Previous research efforts have established that the German labor market as a whole is relatively rigid and not prone to a quick wage response in the event of changes in labor supply (D'Amuri et al., 2010; Felbermayr et al., 2010). We propose that this is likely to extend into the apprenticeship market as well, where regulatory provisions govern wages even more heavily and studies have previously confirmed the vital role of labor market institutions in wage-setting (Beicht & Walden, 2012; Ryan et al., 2013). Moreover, the additional immigration into the German VET system occurred during a period of rising apprentice wages, increasing firm demand, and decreasing availability of supply in the labor market. Each year since the opening of the labor market to applicants from NMS, a significant number of registered apprenticeship positions has remained unfilled (30,487 vacant registered positions in 2011 and 48,984 in 2017;

Federal Ministry of Education and Research [BMBF], 2020), providing incentives for companies to recruit abroad and further rendering an overall negative wage response unlikely.

*Figure 5: Total number of apprentices from NMS-8 and NMS-2 as well as total share of foreign apprentices in the German labor market, 2000-2019 (as of 31 December)*



Source: Federal Employment Agency (2020c)

Nonetheless, despite some unfilled vacancies, matching problems in the German VET system have simultaneously lead to a significant number of unsuccessful registered applicants over the past years (11,366 in 2011 and 23,712 in 2017; BMBF, 2020). Thus, a labor supply increase caused by immigration from new EU member states may still have affected wages in individual areas of the labor market if it occurred sufficiently concentratedly. Such areas may be found in individual sectors, low-skilled segments, among other foreign labor market participants, or in areas where wages are set independent of labor market institutions and collective bargaining agreements. Furthermore, despite particular rigidities in the apprenticeship market, effects still seem plausible for skilled workers. An increase in the supply of apprentices may, down the road, also lead to a more ready supply of skilled workers, which could come with its own wage implications. In the following sections, we seek to validate these preliminary considerations.

## 5. Data and descriptive statistics

We use pooled linked employer-employee data (LIAB) provided by the Institute for Employment Research for the period of 2004 to 2017 (IAB; Schmidlein, Seth, & Umkehrer, 2019).<sup>7</sup> The dataset combines firm-level observations from the IAB establishment panel (Ellguth, Kohaut, & Möller, 2014) with individual-level data generated in relevant labor administration and social security data processing for all employees of sampled establishments.<sup>8</sup> As we focus on wage information for employed individuals, we exclude spells from administrative processing related to unemployment. The dataset was subsequently limited to individuals in employment subject to social security contributions without special characteristics as well as apprentices without special characteristics. All other occupation statuses (e.g., marginal part-time workers) were dropped, so were apprentices that are reported as employed by the same company for more than six years (considered implausible). Furthermore, spells that do not contain information on essential variables, spells that report on a lump sum payment, or spells concerning other extraordinary circumstances are excluded. We drop observations for individuals younger than 15 or older than 65 and spells related to part-time employment or where the daily wage is reported to be less than or equal to zero (considered implausible). Duplicate spells for individual employees (same person, year, establishment, occupation, and employment status) were removed with a preference for routine annual spells first, a higher daily wage second (preference for higher daily wage finds precedence in Fuest, Peichl, & Siegloch, 2018), and a higher degree of available information third. Lastly, we limit the dataset to skill levels within occupations (corresponding to the five-digit level for occupation classifications) that are relevant to apprentices. This filter applies a minimum of two reported apprentices for the respective occupation-skill level across all included years. This last step does limit the inclusion of possible skilled worker wage effects across skill levels within occupations in the analysis. A total of 18,372,924 observations remain in the sample.

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<sup>7</sup> Data access was provided during on-site guest visits at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) and via remote access (DOI: 10.5164/IAB.LIABQM29317.de.en.v1). Annual waves of the establishment panel were combined following instructions by Umkehrer (2017). The LIAB sampling design can be viewed as clustered sampling, where clusters are represented by companies included in the IAB establishment panel. Thus, we employ establishment panel sampling weights and account for stratification details of the establishment panel sampling design (across federal states, establishment size categories, and industrial sectors; see Fischer, Janik, Müller, & Schmucker, 2008) in our control variables.

<sup>8</sup> Previous studies (see, e.g., Glitz & Wissmann, 2017) have, at times, described the years following the 2008 financial crisis as problematic in analyses of wage levels, due to the extended use of short-time working programs (*Kurzarbeit*), especially during 2009 and 2010. In the presented analysis, any such effects should be mitigated through the use of year indicator control variables.

Since employee nationality is a core variable of interest in this study, additional steps were taken to ensure adequate data quality. The applied procedure largely follows Drews, Groll, and Jacobebbinghaus (2007, pp. 21-28). Measures were associated with identifying missing information as well as inconsistencies within an individual's various spells and substituting these occurrences with plausible existing values in the data. Furthermore, special attention was paid to the daily wage information contained in the dataset. Implausible data points (i.e., less than or equal to zero) were removed, so were the top and bottom 1-percentiles for apprentices as well as the bottom 1-percentile for skilled workers (top 1-percentile of skilled worker wages is reviewed through imputation, described in the next step), separately by year. The imputation of wages above the regulatory censoring limit (EUR 76,200 per year in 2017) follows Gartner (2005), Dustmann, Ludsteck, and Schönberg (2009), as well as Glitz and Wissmann (2017). We consider wages as censored if they were up to EUR 2 below the censoring limit for the respective year (identified in the data as the mode of reported daily wages). Censored wages are imputed separately for men and women by year, regressing log wages on indicator variables for three education groups, five age groups, as well as their interactions. Missing education information in the dataset is coded as low-skilled, following Dustmann et al. (2009; the appropriateness of this choice was confirmed through a comparison of the wage distribution for each education category). The estimation employs a Tobit regression for right-censored data and assumes no heteroskedasticity. Table 1 provides a summary of descriptive statistics for the imputed daily nominal wage across both apprentices and skilled workers.

*Table 1: Descriptive statistics – imputed daily individual wage (apprentices and skilled workers)*

<b>Year</b>	<b>Mean</b>	<b>Std. deviation</b>	<b>Min</b>	<b>Max</b>	<b>Observations</b>
2004	89.9185	47.4977	5.76	962.89	1,755,677
2005	91.2330	48.0092	5.96	931.53	1,756,756
2006	92.1537	49.3723	5.96	1,063.23	1,619,928
2007	93.7457	51.7302	5.75	1,022.43	1,451,442
2008	94.3641	52.3757	5.97	1,106.64	1,398,165
2009	95.2788	52.4987	6.20	1,447.80	1,358,093
2010	96.8643	54.3461	6.33	1,144.33	1,154,123
2011	102.8469	54.7184	7.03	1,010.79	1,016,435
2012	101.0011	53.8395	11.01	980.50	1,305,953
2013	103.0570	54.7690	11.66	982.80	1,261,680
2014	105.4253	56.7296	12.69	1,122.12	1,133,170
2015	108.6902	56.5877	14.10	1,173.05	1,101,450
2016	110.6436	57.4909	14.87	1,085.77	1,055,208
2017	112.2197	58.0485	15.36	1,211.78	1,004,844
Total	99.9316	54.0716	5.75	1,447.80	18,372,924

*Note: Descriptive statistics account for sampling weights.*

Table 2 summarizes selected individual and establishment-level characteristics of foreign apprentices from NMS before and after the opening of the German labor market in 2011/2012. The data show that VET immigrants after EU enlargement were relatively better educated than before and joined firms, which more frequently benchmarked their compensation to collective bargaining agreements. Both developments suggest that immigrant apprentices may have entered relatively better-paying segments of the labor market. This is further underscored when looking at average wage levels of relevant companies. While this particular type of immigration seems to have been more prevalent in lower-paying establishments in the first decade of the 21<sup>st</sup> century, between 2012 and 2016 almost 15.6% of apprentices from NMS worked for companies with mean establishment wages in the fourth quartile of the distribution, up from only 3.6% before 2012.

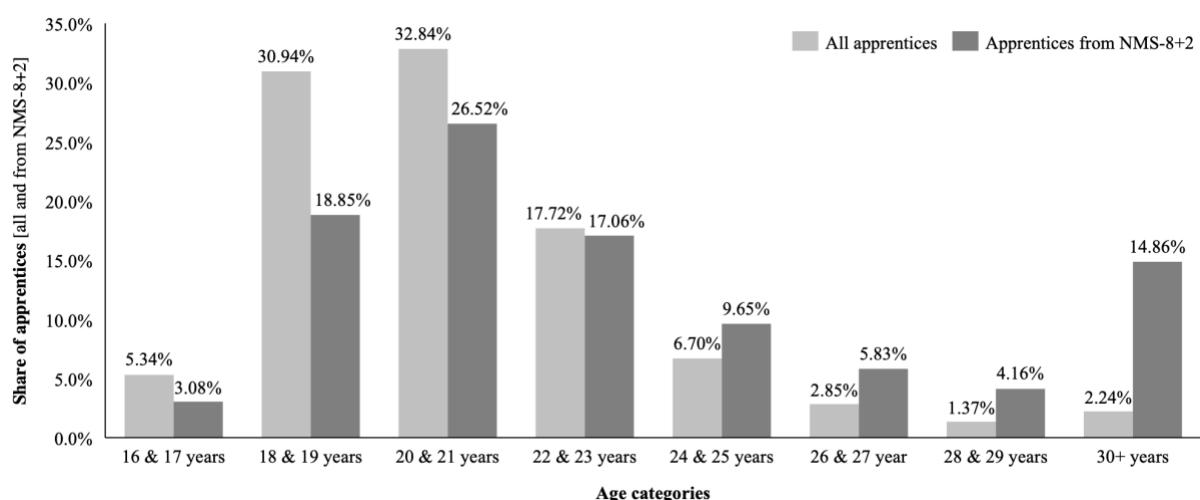
*Table 2: Selected individual and establishment-level summary statistics for foreign apprentices from NMS in the dataset*

Characteristic	2004-2011	2012-2016
<i>Upper secondary education or higher</i>	20.78%	30.71%
<i>Establishment location in East Germany</i>	4.58%	9.09%
<i>Establishment size</i>		
<i>1-4 employees</i>	21.82%	20.84%
<i>5-9 employees</i>	11.88%	9.81%
<i>10-19 employees</i>	10.02%	8.66%
<i>20-49 employees</i>	12.63%	16.09%
<i>50-99 employees</i>	11.78%	11.88%
<i>100-199 employees</i>	11.75%	12.81%
<i>200-499 employees</i>	9.05%	8.80%
<i>500-999 employees</i>	5.48%	3.79%
<i>1,000-4,999 employees</i>	4.67%	5.98%
<i>5,000+ employees</i>	0.93%	1.33%
<i>Works council</i>		
<i>Establishment with works council</i>	35.83%	33.55%
<i>Establishment without works council</i>	64.17%	66.45%
<i>Collective bargaining</i>		
<i>Wages not collectively bargained</i>	25.35%	20.49%
<i>Wages benchmarked to collective bargaining</i>	12.13%	27.14%
<i>Wages collectively bargained</i>	62.33%	52.26%
<i>Mean establishment wage quartiles (calculated by year)</i>		
<i>1<sup>st</sup> quartile</i>	70.64%	56.97%
<i>2<sup>nd</sup> quartile</i>	14.91%	17.07%
<i>3<sup>rd</sup> quartile</i>	10.88%	10.39%
<i>4<sup>th</sup> quartile</i>	3.57%	15.57%

*Notes: Descriptive statistics employ sampling weights; years listed account for one-year lead, resulting from the annual administrative reporting cutoff date of 30 June.*

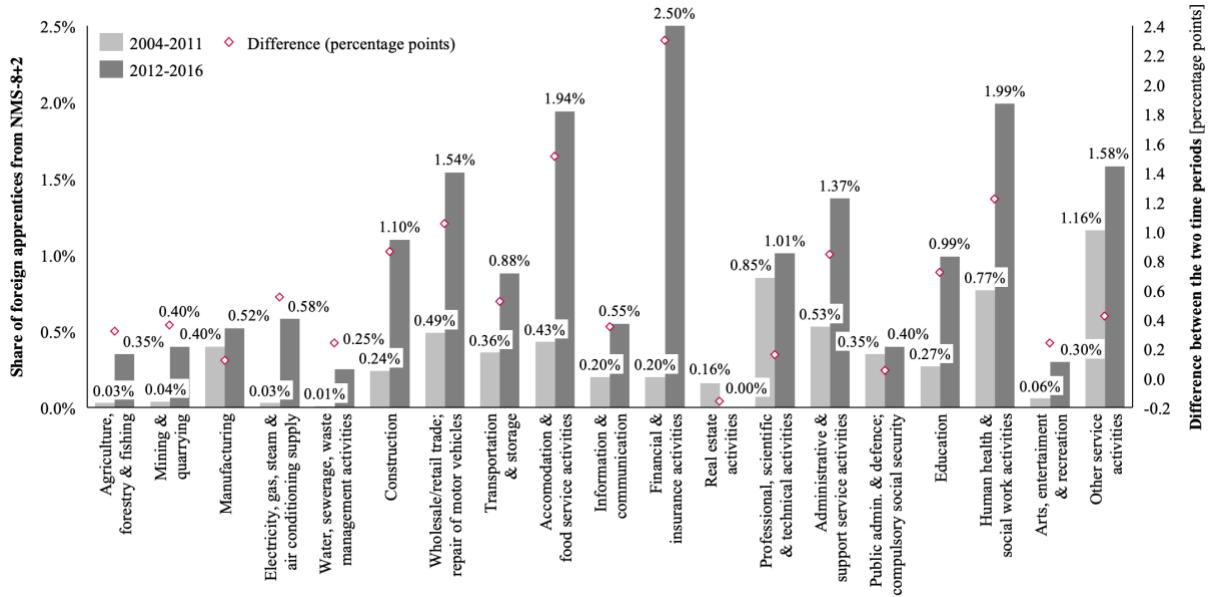
Figure 6 provides an additional overview of apprentices by age categories. It is evident that VET employees from relevant new EU member states tend to be older than the sample as a whole. Especially the high share of apprentices that are 30 years and older stands out and may partly be driven by qualification requirements that regulate entry into the national labor market for individual professions. Older immigrant apprentices, of course, generally come with a more extensive professional background, which may, in turn, have positive wage implications relative to more recent school graduates. In terms of industry sectors, the largest increases can be observed in financial and insurance services, accommodation and food services, as well as human health and social services (see Figure 7).

*Figure 6: Share of total apprentices by age categories*



*Notes: Descriptive age statistics consider apprentices across all available time periods and do not employ sampling weights; distribution does not vary substantially for the periods before or after EU eastward enlargement for both groups shown above.*

Figure 7: Share of apprentices from NMS by time period and industry sectors



Notes: Descriptive statistics employ sampling weights; years listed account for one-year lead, resulting from the annual administrative reporting cutoff date of 30 June.

## 6. Identification strategy

Our main objective is to identify the effect of EU eastward enlargement on apprentice wages in Germany. As these vary strongly by occupation and occupations can be viewed as a good approximation of comparable skill-based segments in the labor market (Orrenius & Zavodny, 2007), in which alike labor market participants compete, we measure inward apprentice migration as the within-occupation share of immigrant apprentices from a particular country group, relative to total apprentices in an occupational field.<sup>9</sup> Based on these considerations, we refer to our main variable of interest as labor market openness  $LMO_{NMS}$ , which measures the share of apprentices with a nationality from NMS. We identify the effects of changes in the associated immigration policies and the labor market restrictions (including restrictions for apprentices) that were lifted in 2012 by means of a difference-in-differences estimation:

$$w_{it}^a = \mathbf{x}'_{it}\beta + \gamma NMS_{it} + \delta LMO_{NMS,ot} + \theta LMO_{NMS,ot} \times Year_{\geq 2012} + \lambda_t + u + \varepsilon_{it}$$

where  $w_{it}^a$  is the first-year apprentice wage for an individual  $i$  at time  $t$ . The difference-in-differences estimator is given by  $\theta$ , which identifies the change in the association between the

<sup>9</sup> Finding precedence, e.g., in Altonji and Card (1991); occupations are observed at the three-digit level, see Federal Employment Agency (2015).

share of apprentices from NMS in training occupation  $o$ , for the period since 2012, when training and labor market restrictions were lifted (compared to the years 2004-2011). We do not have reason to believe that the trend for these years would have been fundamentally different to the previous period, had it not been for the opening of the labor market, especially as other, economically relevant changes related to the accession of NMS to the European Union would have already influenced developments since 2004. Moreover, we include a binary indicator variable for an individual's nationality from NMS and control for year-specific effects  $\lambda_t$ . Finally, we account for the number of graduates from compulsory schooling at the state-level, state dummies, job skill level indicators, control variables for personal characteristics, such as age or gender, as well as characteristics of the training firm, including firm size, the existence of a collective bargaining agreement (CBA), or the average wage for full-time employees in the establishment.

Following Borjas (2003), we identify the relevant labor market segments at the national level and categorize them based on occupational classifications. Employing occupations as a proxy for skills takes previous evidence into account that points to the importance of the occupational dimension in analyses of migration to Germany (Steinhardt, 2011). In addition to apprentices from NMS, we also include a variable indicating Turkish citizenship (reflecting Turkey's status, historically and currently, as the largest individual country of origin for immigrants in Germany; Federal Statistical Office, 2020), as well as all other non-German nationalities. Table 3 provides a summary of descriptive statistics for the occupation-level labor market openness variable for immigrant apprentices from NMS.

In later models, we also add establishment fixed effects, denoted by  $u$ , (AKM effects; see Abowd, Kramarz, & Margolis, 1999; Bellmann, Lochner, Seth, & Wolter, 2020; skilled worker wage analyses also include person fixed effects) to control for possible remaining heterogeneity at the firm-level<sup>10</sup>.

Besides focusing on apprentice wages, we also account for secondary wage effects of apprentice immigration and run additional models with log daily skilled worker wages for individuals in their first year with their respective establishment as the dependent variable. We expect any potential wage effect from a labor supply shock associated with apprentice immigration to affect all establishments in the relevant labor market segments, irrespective of whether they themselves offer VET positions or not (assuming no significant market frictions

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<sup>10</sup> We thank Jens Mohrenweiser for helpful comments on the inclusion of AKM effects in the LIAB data.

that would somehow isolate labor markets for training and non-training firms; see, e.g., Acemoglu & Pischke, 1999). Nonetheless, we verify this assumption by including an indicator for training establishments and its interaction with the LMO variable in the analyses. As the dataset contains only those individuals, who were employed at an establishment panel company on 30 June of the respective year, new apprentices should generally only show up in the sample in the year after the initial start of their training program. Therefore, we employ a one-year lead in the measurements for apprentice labor market openness when looking at skilled worker wages (for apprentice wage regressions, this is accounted for through the interpretation of year references).

*Table 3: Descriptive statistics – occupation-level labor market openness variable for immigrant apprentices from NMS*

Year	Mean	Std. deviation	Min	Max	Observations
2004	0.0031	0.0073	0.0000	0.1084	1,755,677
2005	0.0035	0.0098	0.0000	0.1553	1,756,756
2006	0.0032	0.0078	0.0000	0.1312	1,619,928
2007	0.0024	0.0050	0.0000	0.0757	1,451,442
2008	0.0068	0.0431	0.0000	1.0000 <sup>11</sup>	1,398,165
2009	0.0087	0.0208	0.0000	0.1062	1,358,093
2010	0.0043	0.0076	0.0000	0.0601	1,154,123
2011	0.0036	0.0110	0.0000	0.1303	1,016,435
2012	0.0038	0.0054	0.0000	0.0437	1,305,953
2013	0.0070	0.0085	0.0000	0.0394	1,261,680
2014	0.0074	0.0122	0.0000	0.2985	1,133,170
2015	0.0103	0.0158	0.0000	0.2147	1,101,450
2016	0.0096	0.0326	0.0000	0.5183	1,055,208
2017	0.0089	0.0117	0.0000	0.0463	1,004,844
Total	0.0060	0.0181	0.0000	1.0000	18,372,924

*Notes:* Descriptive statistics employ sampling weights; years listed show data as reported in the dataset and do not account for one-year lead, resulting from the annual administrative reporting cutoff date of 30 June.

Findings are validated through several robustness checks<sup>12</sup>. In particular, to account for sector-level heterogeneity, the analysis looks at a subpopulation limited to the manufacturing

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<sup>11</sup> Driven by an individual occupation with a very low number of observed apprentices.

<sup>12</sup> We also aggregated the data at the occupational level and analyzed the resulting panel observations through fixed effect estimations, controlling for time-invariant heterogeneity between occupations. Subsequently, to account for potential endogeneity issues inherent to the described analytical approach, we performed fixed effects two-stage least squares estimations, developing an instrumental variable by exploiting the temporal correlation of regulatory changes (resulting in a binary indicator variable  $z_{ot}$  for the period since 2012 as an instrument for labor market openness for immigrants from NMS). Results from these additional analyses did not provide any further evidence for a wage effect of inward apprentice immigration in our context.

industry<sup>13</sup>, as it is the sector with, by far, the largest number of apprentice observations in the employed dataset. Additionally, estimations are performed for a sample limited to foreigners, reflecting indications in the literature that this group may be particularly affected by additional immigration (D'Amuri et al., 2010; Felbermayr et al., 2010). We further perform separate estimations for observations from Mecklenburg-Vorpommern, Brandenburg, Berlin, and Saxony, eastern German states that border Poland (with the city-state of Berlin being in close proximity), to rule out regional differences in areas close to the country of origin with the single largest number of new immigrants following EU enlargement (see Figure 4 and Figure A1).

The described approach comes with several limitations and corresponding assumptions, which are briefly discussed below. First, the employed data only permits the observation of immigration based on citizenship information without specifying how long individuals have already been in Germany. Since this undertaking is interested in young adults at the very beginning of their careers and the study differentiates its measurements between NMS and other citizenship groups with historically higher immigration volumes (e.g., Turkish immigrants), possible issues in this regard should be largely mitigated and likely limited to later years, after some time has passed that allowed skilled workers from NMS and their families to migrate to Germany. Furthermore, as apprenticeships usually represent an individual's initial entry into the labor market, irrespective of any previous time spent inside the country, we argue this measurement does provide an adequate view of immigration for the stated purpose. Second, the described model does not account for changes in capital that may be related to immigration or easier access to future skilled workers. Increased availability of labor may influence the allocation of capital in the market, which may subsequently affect wages through substituting or complementing effects (e.g., if labor becomes relatively inexpensive in one industry or sector, capital may be incentivized to move elsewhere). Furthermore, immigrants may themselves contribute to the capital stock, immediately (by transferring savings from their home countries) and down the road, which may, in turn, influence wages. This should not be a substantial concern in the context of this study, as changes in the allocation of capital often require a more extended period of time to materialize (Orrenius & Zavodny, 2007), and immigrant apprentices cannot be expected to add significantly to the capital stock, at least initially. Third, since our main variable of interest

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<sup>13</sup> We ran additional models that focus on the financial and insurance sector as well as the accommodation and food services industry. Throughout the conducted estimations, these variants did not yield fundamentally different results.

$(LMO_{NMS})$  is calculated based on pooled cross-sectional data, the employed dataset does not allow us to directly observe the potential response of domestic labor market participants to the influx of immigrants (see, e.g., Card, 2001). It is conceivable that domestic apprentices adapt their occupation choices to increased foreign competition, which may counterbalance potential negative wage effects caused by immigration. However, such a response is, again, likely to occur over a longer period than is the subject of the present analysis. Lastly, the described approach does not directly observe possible substitution or complementarity effects between occupations. We focus on examining the direct effect on individuals within the occupations into which the immigration occurs. One may, thus, interpret the subsequent results as the partial wage impact (Ottaviano & Peri, 2012) of immigration.

## 7. Results

Our results show that the share of apprentices from relevant new member states ( $LMO_{NMS}$ ) is initially negatively associated with apprentice wages (Table 4, model 1). As the nationality per se (NMS) is not statistically associated with the wage, this implies that apprentices from NMS were more likely to be trained in occupations that pay lower apprentice wages on average. However, this negative association fades after the removal of transitional training and labor market restrictions in 2012, as shown by the large positive and statistically significant coefficient of the difference-in-differences estimator. A 1-percentage-point increase of the share of foreign apprentices from new member states in the period before 2012 was associated with a  $0.792\%$  lower daily wage for first-year apprentices and a  $(-0.792 + 1.626) * 10^{-2} = 0.834\%$  higher daily wage since labor market opening (Table 4, model 3).

Interestingly, we find an opposite effect for apprentices with Turkish nationality for the periods before and since 2012, when apprentices from NMS gained significantly simplified access to the German labor market. While a higher within-occupation share of apprentices with Turkish citizenship in the period prior to EU enlargement was associated with higher apprentice wages, we find a dampening effect following the year 2012 (Table 4, Model 2). Although the effect size is rather small, this finding may in part reflect the increased competition of apprentices from NMS, followed by a sorting of apprentices with Turkish nationality in alternate and lower-paying training occupations.

*Table 4: Apprentice wage regressions*

<b>Dependent variable:</b> <b>log first-year apprentice wage</b>	<b>Model (1)</b>	<b>Model (2)</b>	<b>Model (3)</b>
LMO <sub>NMS</sub>	-0.725*** (0.148)	-0.891** (0.350)	-0.792** (0.339)
Year <sub>≥2012</sub> × LMO <sub>NMS</sub>		1.587*** (0.319)	1.626*** (0.297)
NMS	-0.0279 (0.0248)	-0.00775 (0.0194)	-0.0103 (0.0139)
NMS × LMO <sub>NMS</sub>		-0.868** (0.357)	-0.437 (0.374)
LMO <sub>Turkish</sub>	-0.664*** (0.0910)	0.621*** (0.166)	0.571*** (0.162)
Year <sub>≥2012</sub> × LMO <sub>Turkish</sub>		-0.321*** (0.116)	-0.248** (0.115)
Turkish nationality	-0.0480*** (0.0120)	-0.0192 (0.0151)	-0.0191 (0.0163)
Turkish × LMO <sub>Turkish</sub>		0.259 (0.386)	0.175 (0.401)
LMO <sub>other</sub>	-0.410*** (0.0749)	0.0936 (0.270)	-0.173 (0.168)
Year <sub>≥2012</sub> × LMO <sub>other</sub>		0.198 (0.143)	0.233* (0.122)
Other non-German nationalities	-0.0445*** (0.0102)	-0.0332*** (0.00987)	-0.0340*** (0.00976)
Other × LMO <sub>other</sub>		0.0957 (0.204)	0.0801 (0.191)
CBA <sub>benchmark</sub> × LMO <sub>NMS</sub>		-0.0822 (0.458)	-0.242 (0.460)
CBA × LMO <sub>NMS</sub>		-0.156 (0.308)	-0.314 (0.313)
Works council		0.0722*** (0.00349)	0.0659*** (0.00342)
Age	0.00105 (0.000646)	0.00633*** (0.000564)	0.00631*** (0.000527)
Female	0.00231 (0.00335)	0.0334*** (0.00288)	0.0329*** (0.00273)
Log (avg. establishment wage)		0.281*** (0.0133)	0.186*** (0.0164)
AKM establishment fixed effects	No	No	Yes
Observations	353,204	347,380	346,806
R <sup>2</sup>	0.382	0.630	0.641

*Notes:* Heteroscedasticity-robust standard errors in parentheses; significance levels: \* p<0.10, \*\* p<0.05, \*\*\* p<0.01; Control variables: Model 1 includes year indicators, the number of graduates from compulsory schooling, federal state dummies, an indicator for East Germany, individual indicators for level of education, and job skill level indicators. Models 2 and 3 further include all variables included in model 1 as well as firm size controls, collective bargaining information (CBA), and sector dummies.

We do not observe a more pronounced significantly negative association in a separate analysis that focuses on foreign apprentices (Table 5), a subpopulation that is often considered to be most directly comparable, and thus substitutable, to newly immigrated labor market participants (see, e.g., D'Amuri et al., 2010; LaLonde & Topel, 1991). The sign of the coefficients, however, is in line with the results in Table 4. The association between labor

market openness for apprentices from NMS in the respective occupations and individual first-year apprentice wages is further differentiated by sectors, as can be seen in our robustness check for the manufacturing industry below, which shows a more decidedly negative relationship even for the period since 2012.

To add one additional level of robustness verification, the analysis also investigates possible spatial differences in the effects of apprentice immigration from NMS on regional labor markets. Specifically, we estimate a distinct model, limited to the German federal states that border Poland (Brandenburg, incl. Berlin, Mecklenburg-Vorpommern, and Saxony; Poland being the single largest country of origin for immigrating apprentices following EU eastward enlargement). While descriptive statistics do not suggest that all of these border states were disproportionately strongly affected by apprentice immigration flows (see Figure A2), the nature of such movements could still conceivably be less driven by firm demand than in other parts of the country and, thus, result in migration movements that exert more quantitative pressure on wages. Immigration that is initiated by the apprentice may simply be easier with closer spatial proximity to the respective foreign labor market. However, this analysis does not produce fundamentally different results. On the contrary, the observed positive correlation for the period since 2012 appears to be slightly stronger than for the sample as a whole (see last column in Table 5).

The analysis of apprentice wages, although relevant on its own, does not allow us to conclude that immigrants sort into better- or worse-paying skilled worker occupations after graduation, as apprentices wages are not necessarily strongly correlated with future skilled workers wages. To the extent that apprenticeship training is in part financed by apprentices, human capital theory predicts that occupations where more human capital is accumulated during an apprenticeship may in fact be characterized by lower apprentice wages on average (Mühlemann et al., 2013; Wolter & Ryan, 2011). Moreover, apprenticeship graduates may work in a different occupation after having completed their training. We, therefore, also analyze whether apprentice immigration is associated with both current and future skilled worker wages. The results show a more persistent negative relationship, although the average estimated correlation across the sample is relatively small (a one percentage point increase in the share of foreign apprentices from NMS is associated with a roughly 0.1% lower first-year skilled worker wage; see Table 6, model 3).

*Table 5: Apprentice wage regressions - robustness checks*

<b>Dependent variable:</b> <b>log first-year apprentice wage</b>	<b>Manufacturing sector</b>	<b>Foreign apprentices</b>	<b>Border states</b>
LMO <sub>NMS</sub>	-3.379*** (0.624)	-0.0603 (1.524)	-0.881*** (0.321)
Year <sub>≥2012</sub> × LMO <sub>NMS</sub>	1.733*** (0.486)	0.616 (0.793)	2.331*** (0.489)
NMS	0.00732 (0.0256)	0.00596 (0.0134)	-0.0547* (0.0304)
NMS × LMO <sub>NMS</sub>	0.525 (0.859)	0.117 (0.507)	-0.321 (0.422)
LMO <sub>Turkish</sub>	1.617*** (0.336)	1.139 (0.761)	0.405** (0.164)
Year <sub>≥2012</sub> × LMO <sub>Turkish</sub>	-0.158 (0.171)	-0.779* (0.461)	-0.361** (0.179)
Turkish nationality	-0.00134 (0.0116)	-0.00134 (0.0116)	-0.0731** (0.0370)
Turkish × LMO <sub>Turkish</sub>	-0.0997 (0.217)	-0.0997 (0.217)	0.555 (0.749)
LMO <sub>other</sub>	0.0227 (0.293)	0.0310 (0.390)	-0.333 (0.291)
Year <sub>≥2012</sub> × LMO <sub>other</sub>	-0.0866 (0.163)	0.220 (0.337)	-0.0619 (0.269)
Other non-German nationalities	-0.0467*** (0.0113)	-0.0467*** (0.0113)	0.00245 (0.0339)
Other × LMO <sub>other</sub>	0.586*** (0.210)	0.586*** (0.210)	-0.884 (0.549)
CBA <sub>benchmark</sub> × LMO <sub>NMS</sub>	1.680* (0.935)	0.745 (1.437)	0.714 (0.512)
CBA × LMO <sub>NMS</sub>	2.571*** (0.654)	-0.835 (1.438)	-0.677 (0.537)
Works council	0.0642*** (0.00481)	0.0803*** (0.0138)	0.0348*** (0.00497)
Age	0.00208** (0.000852)	0.00455*** (0.00123)	0.00701*** (0.00109)
Female	-0.00784** (0.00392)	0.0431*** (0.0109)	0.0473*** (0.00506)
Log (avg. establishment wage)	0.324*** (0.0290)	0.136*** (0.0342)	0.325*** (0.0228)
Observations	115,477	12,825	66,640
R <sup>2</sup>	0.750	0.632	0.747

*Notes:* Heteroscedasticity-robust standard errors in parentheses; Significance levels: \* p<0.10, \*\* p<0.05, \*\*\* p<0.01; Control variables: All models include year indicators, the number of graduates from compulsory schooling, federal state dummies, an indicator for East Germany, individual indicators for level of education, job skill level indicators, firm size, collective bargaining information, and AKM establishment fixed effects. Models for foreign apprentices and border states additionally include sector dummies.

Table 6: Skilled worker wage regressions of new labor market entrants

Dependent variable: log first-year skilled worker wage	Model (1)	Model (2)	Model (3)	Model (4)
LMO <sub>NMS</sub>	-0.461*** (0.0447)	-0.113 (0.0923)	-0.0987** (0.0476)	
Year <sub>≥2012</sub> × LMO <sub>NMS</sub>		0.152** (0.0635)	0.0219 (0.0434)	
LMO <sub>NMS,t-3</sub>				-0.0790 (0.0602)
Year <sub>≥2015</sub> × LMO <sub>NMS,t-3</sub>				0.233*** (0.0628)
NMS	-0.131*** (0.00442)	-0.0280*** (0.00363)	0.0125*** (0.00252)	0.0114*** (0.00241)
NMS × LMO <sub>NMS</sub>		-0.0865 (0.162)	0.0241 (0.107)	
NMS × LMO <sub>NMS,t-3</sub>				0.286** (0.145)
LMO <sub>Turkish</sub>	-0.479*** (0.0257)	-0.287*** (0.0572)	-0.228*** (0.0420)	
Year <sub>≥2012</sub> × LMO <sub>Turkish</sub>		0.260*** (0.0371)	0.223*** (0.0259)	
Turkish nationality	-0.0565*** (0.00588)	-0.0177*** (0.00434)	0.0159*** (0.00345)	0.0134*** (0.00376)
Turkish × LMO <sub>Turkish</sub>		0.572*** (0.0926)	0.160*** (0.0578)	
LMO <sub>other</sub>	-0.180*** (0.0200)	-0.155*** (0.0538)	-0.0639 (0.0389)	
Year <sub>≥2012</sub> × LMO <sub>other</sub>		0.325*** (0.0380)	0.148*** (0.0260)	
Other non-German nationalities	-0.0609*** (0.00376)	-0.0256*** (0.00277)	0.00281 (0.00221)	0.00338 (0.00214)
Other × LMO <sub>other</sub>		0.0150 (0.0340)	0.00462 (0.0311)	
CBA <sub>benchmark</sub> × LMO <sub>NMS</sub>		0.0490 (0.0940)	0.135** (0.0602)	
CBA × LMO <sub>NMS</sub>		0.0593 (0.0878)	0.0822* (0.0455)	
CBA <sub>benchmark</sub> × LMO <sub>NMS,t-3</sub>				-0.0752 (0.0945)
CBA × LMO <sub>NMS,t-3</sub>				-0.0173 (0.0611)
Works council		0.0102*** (0.00149)	-0.000325 (0.00102)	-0.000598 (0.00111)
Training establishment × LMO <sub>NMS</sub>		-0.0727 (0.0567)	0.0265 (0.0385)	
Training establishment × LMO <sub>NMS,t-3</sub>				0.0431 (0.0576)
Log (avg. establishment wage)			0.701*** (0.00600)	0.683*** (0.00608)
AKM establishment fixed effects	No	No	Yes	Yes
AKM person fixed effects	No	No	Yes	Yes
Observations	1,159,207	1,147,215	1,139,722	1,032,009
R <sup>2</sup>	0.426	0.705	0.856	0.849

Notes: Heteroscedasticity-robust standard errors in parentheses; significance levels: \* p<0.10, \*\* p<0.05, \*\*\* p<0.01; Control variables: Model 1 includes year indicators, federal state dummies, an indicator for East Germany, individual indicators for level of education, the number of graduates from compulsory schooling, job skill level indicators, age, and gender. Models 2-4 further include all variables included in model 1 as well as firm size controls, collective bargaining information, an indicator for training establishments, labor market openness variables for skilled workers by nationality groups, and sector dummies. In addition, model 4 includes similarly lagged LMO variables for Turkish and other nationalities and their interactions.

For skilled worker wages, any downward wage pressure of apprentice immigration would, however, likely not happen immediately. Apprentices only enter the general labor market after graduation, typically after three to three and a half years. Thus, a quantitative labor supply increase for skilled workers may only be expected with some delay. We estimate this lagged relationship, employing a three-year lag for our labor market openness variable (Table 6, model 4). The coefficient for  $LMO_{NMS,t-3}$  is negative, as one would expect, but not statistically significant. The interaction term  $Year_{\geq 2015} \times LMO_{NMS,t-3}$ , however, indicates a highly significant, positive correlation – in our interpretation a further indication for the role of labor market sorting, rather than quantity-driven supply effects.<sup>14</sup>

## 8. Discussion

What conclusions can we draw from this for the impact of apprentice immigration on wages in the German labor market? First of all, our analysis does not establish a general wage effect of apprentice immigration following EU eastward enlargement. The absence of such an overall effect may serve as yet another indication for the critical role of labor market rigidities in the German empirical environment (see Brücker et al., 2014; Franz & Pfeiffer, 2006) that seem to limit the amount of downward pressure that immigration-driven labor supply increases can exert on wages in the context of apprentices. Especially the widespread application of collective bargaining agreements is said to limit wage implications of labor supply shocks (Felbermayr et al., 2010). This is underscored when considering that 80% of the wage level set by the respective collective bargaining agreement has long been established as a lower legal boundary for apprentice wages, even for companies, which are not directly governed by them.

Our results do confirm a relationship between labor market openness towards apprentices from NMS and individual apprentice and skilled worker wages, but such associations are not uniform or even unidirectional. Instead, the sorting of immigrant apprentices into the labor market, by individual choice or organizational recruiting, took on different forms before and after the opening of the German labor market. When looking at the characteristics of immigrating apprentices over time, it becomes clear that the nature of apprentice immigration

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<sup>14</sup> We further aggregated the data at the occupational level and estimated a panel fixed effects regression that accounts for time-invariant heterogeneity at the occupation level. The results remain qualitatively unchanged and are available upon request.

seems to have changed in the years after EU enlargement. In particular, the higher share of VET migrants with at least upper secondary education points to a higher average qualification of the immigrating talent pool, which should come with wage implications. That immigrant apprentices increasingly enter better-paying positions in the years since 2012 is confirmed by descriptive summaries in Table 2 as well as through our regression analyses. These findings may, of course, similarly be a consequence of the growing demand for apprentices and decreasing domestic applicant numbers, leading to rising wages. In such market conditions, increasing immigration into apprenticeships may be less relevant as a labor supply shock, but rather as an indication that relevant firms are more dependent on foreign labor supplies to fill vacant VET positions. Immigration, in this sense, is met with (or perhaps even driven by) demand, and, thus, immigrants are able to enter into better-paying positions. The nature of apprentice immigration, where labor mobility is largely enabled under the condition of a job offer from a domestic company (which comes with the prospect of additional qualification), may further facilitate such a demand-driven dynamic. The magnitude of such positive wage associations depends also on sector affiliations, not all too surprising in a market where labor unions and employer associations, often organized alongside industrial lines, exert substantial institutional influence.

Furthermore, our findings suggest a relationship between the immigration of apprentices and skilled worker wages. Higher shares of foreign apprentices are associated with lower wages for skilled workers in those occupations into which immigration takes place. These results may suggest that as higher numbers of foreign apprentices enter labor market segments and are trained by domestic companies, these increased training expenditures are recovered by firms through lower skilled worker wages. Coefficients may, however, similarly indicate that foreign apprentices are simply sorted into occupations with lower pay because, for example, it may be easier for immigrants to migrate into occupations that are less financially attractive to domestic applicants. We test a direct downward wage effect of immigration, in the sense that foreign apprentices increase the labor supply of substitutable skilled workers down the road and put pressure on prevailing wage levels (or, in the context of previous supply shortages, prevent wages from rising further), most explicitly in our model specification that employs a three-year lag of labor market openness variables, as labor supply changes that are driven by apprenticeship immigration should occur with a delay of three years. We find that the correlation between skilled worker wages and (lagged) inward apprentice migration is positive for the years since EU enlargement, tentatively supporting the sorting hypothesis (possibly

suggesting that apprentices from NMS are recruited into occupations with persistent, strong labor demand that results in higher skilled worker wages down the road).

Nonetheless, the analysis has shown fundamentally that individual-level skilled worker wages are correlated with the share of foreign apprentices from NMS. This finding highlights apprenticeship markets as a potentially relevant context for more general analyses of immigration. In Germany, apprentices are often hired with the explicit goal of increasing the available supply of skilled workers down the road. Thus, assumptions around the substitutability of foreign and domestic labor market participants are much more straightforward than in other contexts. Future research efforts could incorporate such a temporal dimension and analyze how training, formal or informal, may influence assumptions around labor market competition. Such a perspective could also be fruitful in nested constant elasticity of substitution (CES) structures (e.g., Borjas, 2003), which have become the backbone of many analyses of the labor market impact of immigration. Incorporating apprentice immigration into such a CES-driven approach would permit a clearer view on competition within education-skill cells and how it changes as foreign apprentices become trained workers.

Overall, despite a substantial increase in immigration from new central and eastern European member states over the past decade, apprentice wages have continued to increase in Germany, and a growing number of VET positions has remained vacant each year. Apprentices from NMS seem to have entered the labor market predominantly in areas with lower skilled worker wages, where it may have become more difficult for companies to attract sufficient domestic applicants for vacant VET positions. Simultaneously, immigrating apprentices have been relatively better educated in the years after the opening of the German training and labor markets to workers from NMS and were, thus, sorted into positions with relatively higher apprentice remuneration. Rather than exerting a causal and negative influence on wages, apprentice immigration in the examined context, at best, seems to have alleviated existing dynamics in the German labor market.

## **9. Conclusion**

This study has investigated the consequences of increasing international immigration into apprenticeship positions in Germany for wages, following the eastward enlargement of the European Union in 2004 and 2007. Estimation results do not establish evidence of a negative

wage effect of higher shares of foreign apprentices. On the contrary, they provide several indications that immigrant apprentices from new EU member states were increasingly able to enter better-paying training market segments, at least partly because better-educated individuals migrated. The analysis of apprentice wages on the individual level draws a differentiated picture across time periods and sector affiliations. Especially in the years following EU enlargement, results show a decidedly positive correlation of first-year apprentice wages with higher shares of apprentices from NMS in the respective occupations. For first-year skilled worker wages, a negative association with immigration is observable. The absence of an unequivocal, detrimental wage effect for apprentices and skilled workers points to two aspects of the German empirical context, which likely contribute to the observed outcomes. First, the German labor market, as a whole, is relatively heavily regulated, creating significant rigidities that limit a potentially adverse response of wage levels to external shocks (and, similarly, the recruitment of foreign workers for the purpose of lowering wages). Second, estimation results together with the changing characteristics of immigrating apprentices after EU eastward enlargement lead us to suspect that existing strong labor demand may have been a key influence on migration movements.

Of course, the presented approach is not without limitations. While our identification strategy has the advantage of observing comparable workers in their skill cells (i.e., already hired in specified occupations), such a partial view of immigration does not measure total (or attempted) immigration, only the share that is successfully absorbed by the labor market. Thus, the employed data may not permit a full picture of potential negative effects. Moreover, the discussed estimations do not include any potential effects across industries or occupations. Overall, a closer view seems warranted, particularly as the analysis covers a period of wage growth and strong demand for apprentices in Germany. In such an environment, it may have been easier for the labor market to absorb any possible negative (wage) effects of immigration.

Nonetheless, the presented analysis offers a unique empirical perspective through its focus on immigration into VET positions. It suggests several key dimensions that determine how immigrant apprentices are sorted into labor markets and offers a first perspective on the potential wage implications of such immigration. Contributing to the broader debate, the study and its context particularly highlight the temporal aspect of how immigration influences labor markets. The analysis has shown that individual-level skilled worker wages are correlated with the openness of the labor market towards apprentice immigration. Resulting temporal considerations around training have significant potential to advance research on labor market

effects of migration, especially as they help strengthen arguments around the substitutability between foreign and domestic workers. Practically, our results provide an important indication that demand-driven apprentice migration into Germany did not have a general adverse impact on domestic wages. This finding is also relevant for recent regulatory changes in the apprenticeship market that motivate this study, as these implement a similarly demand-driven immigration scheme, requiring a job position to permit residency and, consequently, enabling markets to allocate immigrating apprentices. We hesitate, however, to generalize the presented results to all cases of increased immigration. The most recent refugee migration to Europe, beginning in 2015, for example, was arguably not driven by demand in the labor market and, thus, offers a distinct potential for future research efforts. This study provides only one piece of a larger puzzle, but an important one.

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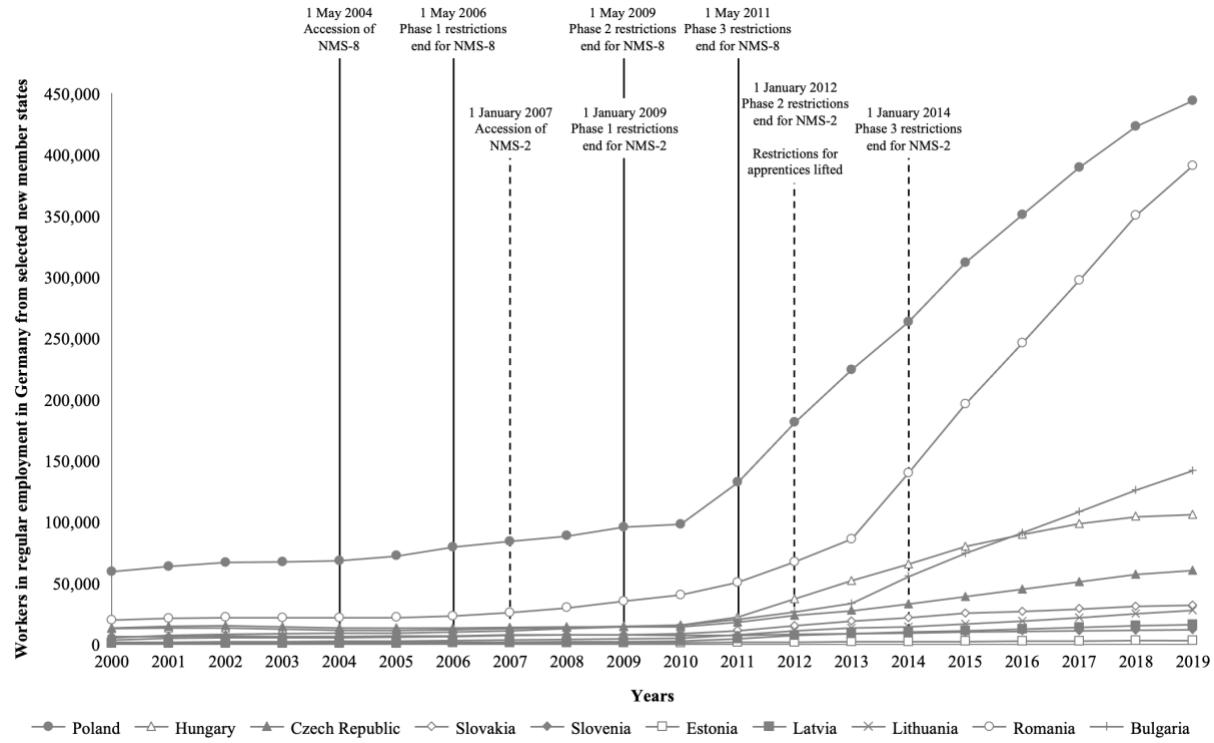
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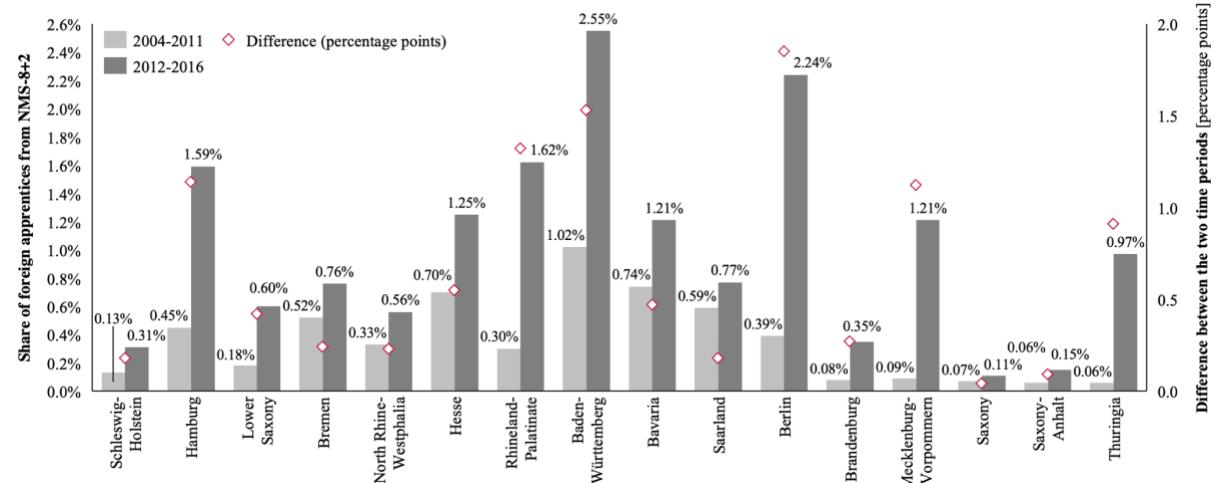
## Appendix

*Figure A1: Workers subject to social security contributions from NMS-8 and NMS-2 in the German labor market, 2000-2019 (as of 30 June)*



Source: Federal Employment Agency (2020b)

*Figure A2: Share of apprentices from NMS by time period and federal states*



Notes: Descriptive statistics employ sampling weights; years listed account for one-year lead, resulting from the annual administrative reporting cutoff date of 30 June.