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Immigration and Wage Dynamics in Germany

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Abstract

German wages have not increased very rapidly in the last decade despite strong employment growth and a 5 percentage point decline in the unemployment rate. Our analysis shows that a large part of the decline in unemployment was structural. Micro-founded Phillips curves fit the German data rather well and suggest that relatively low wage growth can be largely attributed to low inflation expectations and low productivity growth. There is no evidence—from either aggregate or micro-level administrative data—that large immigration flows since 2012 have had dampening effects on aggregate wage growth, as complementarity effects offset composition and competition effects.

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I. Introduction and Executive summary

The performance of the German economy and its labor market have been impressive in recent years and there is widespread perception that wages should have grown faster. Despite rapid GDP growth, booming employment and dropping unemployment that has reached record lows, nominal wage growth seems to have stabilized around 2.5 percent. This has led many commentators to conclude that the time-honored relationship between labor market slack and wage inflation—the Phillips curve—does not hold for Germany anymore.

Many reasons have been invoked to try and rationalize such a phenomenon. One widely cited argument is that competition from foreign labor may have put downward pressure on wages. Increased competition from foreign labor—so the argument goes—has curtailed workers’ bargaining power and flattened the slope of the Phillips curve: wages have become less sensitive to variations in the unemployment rate. Also, because immigrants tend to work in relatively low paid jobs, overall wage growth may have been dampened by a change in the composition of the labor force.

Theoretically, immigration may affect wage dynamics in two different ways, through so-called competition and composition effects.

• Immigration may in principle push down wages due to increased competition in the labor market. Native workers may lose bargaining power when confronted to a larger pool of competitors, which would result in lower wage growth for given labor demand.

• However, other forces tend to work in the opposite direction. First, labor demand is not fixed. An inflow of foreign labor will lead to a corresponding increase in labor demand, as the demand for goods and services will grow in tandem with the larger population. In the long run, induced capital accumulation should even further boost labor demand.

• Second, the more foreign labor inflows are concentrated in a limited number of sectors/occupations, the less immigration weighs on overall wage dynamics. In a nutshell, immigration exerts downward pressure on the wages of workers to which immigrants are close substitutes (typically earlier generations of migrants and low-skilled native workers), but upward pressure on the wage of workers to which immigrants are complements (typically high-skilled native workers).

As a way of illustration, assume that immigration is

1 See e.g., Blau J. (Oct. 2017).
2 See e.g., Wolff G. (Nov. 2017), Bundesbank (2018).
3 Competition from foreign labor could also materialize itself through the threat of offshoring production to lower labor cost countries. This threat has possibly contributed to the wage moderation period early 2000s.
exclusively concentrated in the construction sector. Immigration will exert pressure on wages in the construction sector, pushing down construction costs and housing prices. At the same time, the larger pool of workers will boost demand for other goods and services, increasing demand for labor and wages in these activities. Wages in construction will be pushed down, but wages for e.g., doctors, nurses, engineers, etc. will tend to increase faster.

Immigration also affects overall wage dynamics through composition effects. Immigrants usually tend to be concentrated in lower-skilled, lower-paid sectors. And even when controlling for skills, age, experience and sector of activity, immigrants tend to be paid less than natives. Therefore, mechanically, large immigration would weigh on overall wage growth through changes in the composition of the labor force.

All in all, whether immigration exerts a dampening influence on overall wage growth will depend on i) the size of the immigration flow, ii) its sectorial distribution and iii) the degree of substitution with native labor. The international literature is discordant on this point, which, at the end of the day, remains an empirical question.

Given large immigration and the seeming disconnect between employment and wages in Germany in recent years, a "German answer" to this empirical question is of special interest. To analyze the impact of immigration on aggregate wages in Germany we follow a two-pronged approach.

• First, we follow Gali (2010) and Bentolila et al (2007) and derive a micro-founded Phillips curve based on aggregate data where immigration is allowed to play a role in affecting both the slope and the intercept of the Phillips curve. We also complement the micro-founded approach with a more reduced form specification, allowing for richer dynamics and potentially better fit.

• The second approach focuses on micro-level data. We rely on social security data to construct a panel data set where both cross-sectional and longitudinal dimensions can be used to disentangle competition from composition effects of migration on aggregate wages.

○ Composition effect. Because immigrants to Germany are paid less than natives, aggregate wages would have risen by 0.49 percent more over the period 2012–2016 (about 0.12 percent per year) if the immigration boom had not taken place. The overall negative composition effect for 2012–2016 of -0.49 percent is partly accounted for by the specific attributes of the migrant population. For example, immigrants are relatively young (-0.05 percent), this mechanism can in principle also be found within sectors. When immigration is mainly low-skilled, it ends up pushing up wages of higher-skilled labor in the same sector.

Negative effects, if any, will also tend to be larger in the short term.
work in marginal jobs or part-time (0.08 percent) and are usually employed in sectors that pay less (0.24 percent). Even controlling for all these factors, immigrants are paid less than natives bringing aggregate wages down by 0.18 percent over the period (see Text Table).

**Competition effect.** After controlling for the fact that the wages of immigrants are typically lower than those of native workers, wages of men are typically higher than wages of women, and wages in manufacturing are typically higher than average wages, among other factors, we find a small but positive effect of immigration on wages over 2012–2016. The so-called competition effect of immigration leads to an increase of aggregate wages of 0.26 percent per year as the dampening effect of immigration on wages of substitute labor is more than compensated by stimulating effects on wages of workers for which immigrants are complement. We also find that the substitution effect dominates and puts downward pressures on the wages of incumbent foreign workers.

Putting it all together, we conclude that immigration seems to have had only negligible impact on aggregate wage growth in Germany. The Phillips curve is alive and well and accounts for the bulk of wage dynamics, suggesting no role for immigration on aggregate.

Analysis based on social security data confirms this result and shows that competition and composition effects broadly cancel out. Post-crisis, large immigration waves did tend to dampen wage growth of foreign labor in direct competition with the newcomers, but this negative effect was more than offset by higher wage growth for relatively skilled and native workers.

The rest of the paper is structured as follows. Section II presents key stylized facts and argues that the natural rate of unemployment has dropped in Germany following the Hartz reforms, with important implications for the specification and estimation of the wage Phillips curve. Section III derives a theoretical specification of the wage Phillips curve that allows immigration to play a distinct role in wage formation. Section IV estimates it along competitive specifications and establishes that immigration did not play a significant role in explaining overall wage developments in Germany. Section V relies on administrative micro data and corroborates the conclusion of Section IV.

This is consistent with recent results from Weber and Weigand (2018), who do not find any negative effects of immigration shocks on wages in a structural macro-econometric analysis conducted over the period 1970–2014.
II. Labor Market Stylized Facts

A. Unemployment, structural reforms, and labor market tightness

From the beginning of the 1990s to mid-2000s, unemployment had been trending upward in Germany amid lackluster GDP and employment growth. The unemployment rate had reached a peak of 11 percent in 2005, the highest rate among the G7 countries (The Economist, 2004). Arguably, the relentless increase of German unemployment rate up to the mid-2000s was largely due to the combination of technological factors and institutional shortcomings (Ljungqvist and Sargent, 1998, Hutter and Weber, 2019). While technological change, such as automation and computerization, increased the pressure on the low-skilled labor market segment, weak institutions, such as inefficient labor market-matching mechanisms and deteriorated employment incentives (Krause and Uhlig, 2012, Jung and Kuhn, 2014), led to strong hysteresis effects in unemployment (Klinger and Weber, 2016a).

The upward unemployment trend was broken mid-2000 by the introduction of major labor market reforms. The so-called Hartz reforms were enacted in a sequence of major steps between 2003 and 2005. The first steps (Hartz I to III) focused on reforming the Federal Employment Agency and developing better tools for improving matching efficiency (temporary agency, self-employment, retraining, stronger incentives to accept jobs, etc.). The last step was the reform of the unemployment insurance benefits (Hartz IV), implemented in January 2005. The labor market reforms coincided with a new implicit social contract (subscribed by the largest labor unions) that focused on dampening labor costs and increasing 8

Before Hartz IV, German workers unemployed for more than 52 weeks were entitled to indefinite income support based on previous net earnings—the so-called unemployment assistance—at a rate that was only slightly below the typical unemployment insurance. The incentive for relatively high-paid employees with depreciated (or firm-specific) skills to look for new jobs (at a potentially lower pay) was low. Hartz IV eliminated this unique feature and merged unemployment assistance with social assistance, eliminating the former. Long-term unemployed workers are now only entitled to (much lower) means-tested payments based on basic needs and family status and conditional on the beneficiary’s willingness to work.

Figure 1. Wage Growth and Unemployment (Percent)

Sources: Bundesbank, Haver Analytics; and IMF staff calculations.
1/ per employee hour worked.
2/ three-month moving average.

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Employment growth. Employers and employees basically agreed that wage moderation was a prerequisite for job creation.

The reforms had spectacular impact on Germany’s unemployment rate. By reducing the long-term unemployment assistance and by improving matching efficiency, labor market reforms increased the incentive to look for work and brought down the reservation wage. This development can be seen on a Beveridge curve that shows the downward sloping cyclical relationship between unemployment and vacancy rates (Figure 2.1). Structural changes in the labor market leading to changes in the long-term structural unemployment—also known as the natural rate of unemployment—were typically characterized by shifts of the Beveridge curve. Following a persistent rightward drift during most of the 1990s (higher unemployment for similar vacancies), the Beveridge curve shifted back inwards after the Hartz reforms (after 2005). This reflects better incentives and a more efficient matching of vacancies and unemployed. In other words, a significant part of the decline in unemployment between 2005 and 2008 seems to reflect a more efficient (not a tighter) labor market (see Klinger and Weber, 2016b or Krause and Uhlig, 2012).

The reforms helped accelerate the ongoing wage moderation process as can be seen on the downward shift of real unit labor costs (real wages over labor productivity or labor share) between 2000 and 2007 (Figure 2.2). After the financial crisis, unemployment and vacancies resumed their typical negative relationship along a new Beveridge curve, a sign that the transition to a new and lower long-term structural unemployment rate seems to have been completed.

Figure 2. Lower Unemployment Reflects More Efficient Labor Market

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B. Wage Inflation and the NAIRU

While useful to visualize shifts in the level of structural unemployment, the Beveridge curve may be unreliable at times as an indicator of slack. It is true that the ratio of job vacancies to unemployed (V/U) can generally be thought as a measure of labor market tightness—a higher ratio theoretically implies higher search costs and ensuing wage pressure. However, when employers have access to a large pool of jobseekers outside of the national labor force—as was the case in Germany after 2011 (see next section for a discussion)—companies may be encouraged to post more vacancies as they are aware of the greater potential to fill them. In such cases, the ratio of vacancies to unemployed would overestimate tightness since vacancies are posted domestically while domestic unemployed typically underestimate the pool of available labor.

Looking at Figure 3, the correlation between (V/U) and an alternative measure of slack based on the unemployment gap (the deviation of unemployment to the non-accelerating inflation rate of unemployment, NAIRU) is very strong up to 2009. After 2009, the two series start diverging, suggesting that (V/U) started to grossly overestimate labor market tightness. When it comes to assessing inflationary pressures, the concept of NAIRU is usually preferred (because of its relationship with other measure of long-term equilibrium such as potential output via the Okun’s law). We will rely on the NAIRU to compute the unemployment gap—the deviation of unemployment from its structural equilibrium—a measure of labor market slack.

Since the NAIRU is unobservable, researchers typically use filtering methods based on the actual level of unemployment, inflation and output to simultaneously estimate the unemployment and output gaps relying on the Phillips curve and the Okun’s law relationships (see B\,et al. 2012 for an example). Results for Germany are displayed on Figure 4. Some differences between OECD and WEO estimates are clearly visible, reflecting methodological and estimation choices, but they are dwarfed by the growing gap with V/U.

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The WEO NAIRU hovers above the range of HP-filtered NAIRU estimates between 1991 and 2001, while the OECD NAIRU is below it. The two estimates converge after the crisis.

The two charts show the relationship between inflation and unemployment (Figure 5.1) and inflation and the unemployment gap (Figure 5.2). Controlling for the shift in the NAIRU as is done on Figure 5.2 reinstates the negative relationship between wage inflation and labor market slack characteristic of the Phillips curve.

It is common knowledge that a certain degree of imprecision typically plagues filtered measures of the NAIRU (See Aiyar and Voigts (2019) and Kangur, Kirabaeva, Natal and Voigts (2019) for a recent account). We take this into account by considering a swath of NAIRU estimates (painted in grey) computed by running HP filters with lambda parameters comprised between 1,000 and 1,000,000.

Both estimates are based on multivariate Kalman filters. The OECD NAIRU exploits the relationship between the unemployment gap and consumer price inflation (see e.g., Richardson et al., 2000), while the WEO NAIRU is structured around two economic relationships (Okun’s law and Phillips curve) that comprise the output gap, the unemployment gap, and inflation (see e.g., Benes et al. 2012 and WEO 2015 Chapter 3).

For example, the Hartz reforms are credited for improving matching efficiency, increasing flexibility and lowering workers’ bargaining power and their reservation wage and with it lowering the structural level of unemployment.

This result is independent of the particular NAIRU estimate used.
C. Immigration and wages

Following the crisis, employment quickly bounced back in Germany, supported by large immigration flows (Figure 6.1). In 2010, there were less than 15 million people with a migrant background in Germany, but by 2017 the figure rose to 19 million—almost 24 percent of the population. Note that Germany was in good company post-crisis as many other advanced economies experienced similar or even larger immigration flows (Figure 6.2).

Strong immigration since 2012 is often mentioned to explain German sluggish wage growth (see Deutsche Bundesbank, 2018). The argument seems straightforward: migration leads to higher labor supply and therefore higher competition on the labor market, dampening wage growth. While plausible a priori, it is important to recognize that the wages of workers that are complement to immigrants, typically high-skilled native workers, will tend to be lifted by immigration. For example, downward pressure on low-skilled wages would increase profits, supporting firms’ expansion plans and their demand for complementary higher-skilled labor.

Means: 
- Unemployment and Wage Inflation, 1992Q1 - 2017Q3
- Unemployment Gap and Wage Inflation, 1992Q1 - 2017Q3

Sources: Destatis, Haver Analytics, IMF WEO; and IMF staff calculations.
Over the long run, the capital stock is expected to adjust, boosting labor demand until the capital-labor ratio is back to a level consistent with balanced growth.

Figure 6. Strong Immigration to Most Dynamic Countries Post-Crisis

Sources: Eurostat, United Nations; and IMF staff calculations.
1/ From 2007, foreign employees are divided in EU and non-EU citizens.
Figure 7. Demand-Pull vs Supply-Push

Sources: Eurostat; and IMF staff calculations.

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A deep dive in data from the social security panel (covering 38 million employees over the period 2012-2016) provided by IAB (Institut für Arbeitsmarkt- und Berufsforschung, the research institute of the federal employment agency) reveals that the population of migrants has increased the most in i) sectors where wage increases were the highest, and ii) where previous immigrant workers were already the most active in 2012.

Figure 8 shows that immigration flows were the largest in sectors where labor demand and therefore wage growth was the highest (Food and accommodation, I, Support, N, Transport, H and Construction, F) and in sectors where earlier generations of migrants were already the most represented and where wages were the lowest.

This suggests that downward wage pressure due to immigration may have been more muted in Germany than in Spain (demand-pull) and if anything concentrated in low-skilled, low pay activities.

Without counterfactual analysis, these stylized facts are of course only suggestive. Whether wage growth, on aggregate, would have been higher absent immigration is an empirical question that sections III to V will tackle from two different angles, exploiting both time series and cross-sectional information, aggregate and micro-level data.

We first read aggregate time series data through the lens of economic theory and design Phillips curves that allow immigration to play a separate role in wage dynamics. The focus will be on the validation of traditional Phillips curve and the impact of immigration on aggregate wage growth. We then turn to micro-level administrative data to better understand the role of immigration on wage dynamics by decomposing its effect across different representations of the population. The analysis also allows to disentangle competition effects—the impact of migration on wages assuming a constant share of migrants—and composition effects—the mechanical impact on aggregate wages of changing the shares of lower paid migrants.

Note that the large increase in wages in the first decile of the wage distribution (the outlier on Figure 8.4) can be attributed to the introduction of the minimum wage, which did not by itself trigger an inflow of migrant.
III. Deriving the Phillips Curve from First Principles

\[ E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, \{N_t(i)\}) \]

\[ U(C_t, \{N_t(i)\}) = \log C_t - \int_0^1 \frac{N_t(i)^{1+\varphi}}{1+\varphi} \, di, \]

Sources: Eurostat, The Institute for Employment Research; and IMF staff calculations.
subject to a sequence of budget constraints:

\[ P_t C_t + Q_t B_t \leq B_{t-1} + \int_0^1 W(i)N_t(i)di + \Pi_t \]

and forecast future unemployment rates based on an AR(2) process for unemployment (a good statistical representation for Germany), it is possible to derive a traditional Phillips curve:

\[ \pi_t^w = \alpha(1 - \beta)^{-1} + \gamma\pi_t^{p} - \delta\hat{u}_t - \psi_1\Delta\hat{u}_t \]

for \( \delta > 0, \gamma > 0, \alpha > 0, 0 < \beta < 1 \) and \( \psi_1 > 0 \).

Gali’s traditional New Keynesian (NK) theoretical model can be extended to account for the role of immigration. Following Bentolila et al. (2007), we allow for heterogeneous labor force composed of imperfectly substitutable native and immigrant workers. Aggregate employment can then be expressed via the CES specification:

\[ N_t = (\delta_1 N_{1,t}^{P} + \delta_2 N_{2,t}^{P})^{1/\rho} \]

\[ \sigma = (1 - \rho)^{-1} \]

where we expect \( \alpha_1 \) and \( \alpha_3 \) to be positive, and \( \alpha_2 \) to be negative given \( \delta_1 > 0, \gamma > 0, \alpha > 0, 0 < \beta < 1 \) and \( \psi_1 > 0 \).
\[ \pi_t^{w,4} = b_0 + b_1 \pi_{t-1}^8 + b_2 \bar{u}_t + b_3 \Delta \bar{u}_t + b_4 (u_{2,t} - u_t) + b_5 u_{2,t} r_t + b_6 u_{2,t} r_t^2 + \varepsilon_t \]

In this setup, immigration can in principle affect wage setting in two different ways: via either the intercept or the slope of the Phillips curve (PC).

- First, immigrants are more mobile and keener to accept jobs at potentially lower wages than natives (lower reservation wage, lower bargaining power), and this effect will be the more pronounced the higher the unemployment rate of immigrants with respect to natives. Intuitively, the larger the unemployment gap between immigrants and natives \((u_{2,t} - u_t)\), the stronger the immigration rate \(i_{rt}\), the larger the downward pressure on wages. Therefore, the unemployment gap, and interactions terms between immigrants' unemployment rate and the rate of immigration could in principle explain downward shifts in the otherwise standard Phillips curve's intercept (through coefficients \(b_4\) to \(b_6\), expected to be negative).

- Second, because immigrants have different preferences (lower elasticity of substitution between consumption and leisure and lower wage elasticity of labor supply than natives), their labor supply curve will be more vertical, which in principle could affect the slope of the Phillips curve for a given NAIRU through coefficients \(b_2\) and \(b_3\).

In the next section, we estimate equation (1) and (2) and also turn to more reduced form specifications that relax the NK model's theoretical restrictions and potentially provide a better fit.

IV. The Phillips Curve: from Theory to Empirics

We start from the restricted, micro-founded specifications (1) and (2) derived in section II and relax the most constraining assumptions.

- We first relax the model-consistent (rational) expectation hypothesis and rely instead on survey measures (consensus) of expectations. We allow for both backward and forward-looking expectations through the parameter \(c_1\).

- We then relax the assumption of constant productivity growth implicit in equations (1) and (2). Real wages are expected to follow productivity growth in the long term, which is consistent with German data (see Appendix B), but persistent deviations are possible. This suggests a role for an error-correction mechanism in the Phillips curve. The resulting data generating process can be written as:

\[ \pi_t^{w,4} = c_0 + c_1 \pi_{t-1}^8 + (1 - c_1) \pi_{t+8}^4 + c_2 \bar{u}_t + c_3 \bar{e}_t - 4 + \varepsilon_t \]
\[\hat{e}_{t-4}\]

\[\log(W_t) = \mu_0 + \mu_1 \cdot \log(Y_{L_t}) + \mu_2 \cdot \text{dum} \cdot \log(Y_{L_t}) + \epsilon_t\]

\[\log(W_t) = \mu_0 + \mu_1 \cdot \log(Y_{L_t}) + \mu_2 \cdot \text{dum} \cdot \log(Y_{L_t}) + \epsilon_t\]

\[\pi_t^{w,4} = d_0 + d_1 \pi_{t-1} + (1 - d_1)\pi_t^{x_8} + d_2 \hat{u}_t + d_3 \hat{e}_{t-4} + d_4 ir_t + \epsilon_t\]

\[\pi_t^{w,4} = d_0 + d_1 \pi_{t-1} + (1 - d_1)\pi_t^{x_8} + d_2 \hat{u}_t + d_3 \hat{e}_{t-4} + d_4 ir_t + \epsilon_t\]

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\[\hat{e}_{t-4}\]

\[\log(W_t) = \mu_0 + \mu_1 \cdot \log(Y_{L_t}) + \mu_2 \cdot \text{dum} \cdot \log(Y_{L_t}) + \epsilon_t\]

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\[\pi_t^{w,4} = d_0 + d_1 \pi_{t-1} + (1 - d_1)\pi_t^{x_8} + d_2 \hat{u}_t + d_3 \hat{e}_{t-4} + d_4 ir_t + \epsilon_t\]

Finally, we build on the reduced form specification (3) by adding the immigration rate \(ir_t\) to the regression, as in Bundesbank (2018):

\[\pi_t = d_0 + d_1 \pi_{t-1} + \cdots + d_4 ir_t + \epsilon_t\]

\[\pi_t = d_0 + d_1 \pi_{t-1} + \cdots + d_4 ir_t + \epsilon_t\]

\[\pi_t = d_0 + d_1 \pi_{t-1} + \cdots + d_4 ir_t + \epsilon_t\]

\[\pi_t = d_0 + d_1 \pi_{t-1} + \cdots + d_4 ir_t + \epsilon_t\]

\[\pi_t = d_0 + d_1 \pi_{t-1} + \cdots + d_4 ir_t + \epsilon_t\]

The inclusion of \(ir_t\) is meant to capture any additional impact of the immigration rate on wage inflation; the idea being that if foreign labor plays a role in dampening wage inflation, for given slack and price inflation expectations, \(d_4\) should be significant and negative.

The estimation results are summarized in Table 1. The specifications directly derived from the NK model’s microfoundations (equations 1 and 2) are shown in columns I and II. As predicted by theory, the unemployment gap and the change in the unemployment gap both play a role in explaining aggregate wage dynamics. The coefficients are large, highly significant and have the expected sign.

Inflation expectations—as measured by lagged price inflation—is positively related to wage inflation. Other coefficients related to the impact of immigration on wage growth are statistically non-significant, suggesting that immigration played no additional role in explaining aggregate wage dynamics in Germany.

Immigration does not affect the slope of the Phillips Curve either, as coefficients associated with the unemployment gap are not significantly different in column I and II. Estimation results from equations (3) and (4) are shown in the last two columns. Again, with the exception of the coefficient related to immigration, most coefficients have the expected sign and are highly significant. Positive deviations of wages from the long-term equilibrium determined by labor...
productivity have dampening effects on wage growth as shown by the negative coefficient on the error-correction term.

Table 1 suggests that ignoring immigration does not affect the performance of the Phillips curve in Germany. The adjusted R-squared are high for equations (1) and (3) and there is no evidence of omitted variable bias. The coefficients are also stable, suggesting the equation is well-specified.

Figure 9.1 displays estimates of the slope of the Phillips curve from rolling window regressions of equation (1). Beyond the initial uncertainty due to short sample, the estimated coefficient rapidly converges to its long-term, stable, significant and negative value. Another way to make the same point is to decompose wage growth into its main drivers.

Figure 9.2 displays the contributions to wage growth derived from the RHS variables of equation (3). The exercise allows an easy visualization of the main drivers. First, the equation does a rather good job at explaining wage inflation in Germany. The contribution of the error term (grey bars) remains limited for the most part, with the exception of the pre-crisis period and the more recent period (2014-2015) when the model would have expected even lower wage growth due to low inflation expectations (green bars) and a realignment of wages with productivity from above (orange bars).

The unemployment gap (blue bars) seems to have played the dominant role at the beginning of the 1990s and during the Hartz reforms; they have been consistently pointing towards higher wages since 2016.

Figure 9. Standard Phillips Curve is Alive and Well (continued)

Sources: Bundesbank, Destatis, Eurostat, Consensus Forecasts, Haver Analytics; and IMF staff calculations.

1/ specification I.
2/ step size = 1.
3/ specification III.
Table 1. The Wage Phillips Curve – Germany 1992–2017

| Specification                                      | (I)   | (II)   | (III)  | (IV)  |
|---------------------------------------------------|-------|--------|--------|-------|
| Inflation$_{t-1}$                                | 0.688*** | 0.392  | (0.239) | (0.290) |
| Inflation expectations                           |       | 0.642** | 0.178  | (0.293) | (0.311) |
| $U_g$                                             | -0.311*** | -0.308*** | (0.066) | (0.057) |
| Change in $U_g$                                   | 0.666*** |       | (0.231) |       |
| $U_g$ (constant NAIRU after 2009)                 |       | -0.290** | -0.114*** | (0.142) | (0.035) |
| Change in $U_g$ (constant NAIRU after 2009)       |       | 0.848*** |       | (0.191) |       |
| Error correction term$_{t-4}$                     |       | -0.105*** | -0.105*** | (0.024) | (0.022) |
| Immigration rate                                  |       | 0.029  |       | (0.056) |       |
| Foreign – total unemployment                      |       | 0.204** |       | (0.081) |       |
| Immigration rate * Foreign unemployment           |       | 0.002  |       | (0.014) |       |
| Immigration rate$^2$ * Foreign unemployment       |       | -0.001 |       | (0.001) |       |
| $c$                                               |       | 0.311*** | -0.117  | 0.157*** | -0.238 |
| Sample                                            | 1992-17 | 1995-17 | 1992-17 | 1995-17 |
| Observations                                      | 103   | 91     | 103    | 91    |
| Adj. R-squared                                    | 0.69  | 0.47   | 0.73   | 0.55  |

Serial correlation and heteroskedasticity-robust Newey-West standard errors in parenthesis. ***/**/* indicate significance at the 1%/5%/10%-level.
V. Immigration and Wages: Evidence from Social Security Data

A. Model estimation

In this section we look at labor market data from a different angle. The idea is to isolate the role of immigration in explaining wage developments by breaking down wage differences according to workers’ individual characteristics. To do so we exploit administrative data from the Federal Employment Agency and build a large panel that allows for the grouping of workers according to their individual characteristics such as age, gender, nationality, qualification, sector, region, type of working arrangement over five years 2012-2016 (the following Table describes the structure of the panel).

Table 2. Panel Structure

| Category | Dummy index | Characteristic |
|----------|-------------|----------------|
| Sex      | 0 Male, 1 Female |
| Age      | 0 15 to under 25, 1 25 to under 35, 2 35 to under 45, 3 45 to under 55, 4 55 to under 65, 5 65 and older |
| Nationality | 0 German, 1 EU, 2 8 asylum countries, 3 Other migrants |
| Qualification | 0 Low (without apprenticeship), 1 Medium (with apprenticeship), 2 High (with university degree) |
| Sector | 0 Agriculture, forestry and fishing, 1 Mining and quarrying, 2 Manufacturing, 3 Electricity, gas, steam and air conditioning supply, 4 Water supply; sewerage, waste management and remediation activities, 5 Construction, 6 Wholesale and retail trade; repair of motor vehicles and motorcycles, 7 Transportation and storage, 8 Accommodation and food service activities, 9 Information and communication, 10 Financial and insurance activities, 11 Real estate activities, 12 Professional, scientific and technical activities, 13 Administrative and support service activities, 14 Public administration and defence; compulsory social security, 15 Education, 16 Human health and social work activities, 17 Arts, entertainment and recreation, 18 Other service activities |
| Region | 0 West Germany, 1 East Germany |
| Working time | 0 Covered by social security + full-time, 1 Covered by social security + part-time, 2 Marginal, 3 Europe without EU |

See section II for a graphic visualization of the data.
For each of those 14,960 cells per year, the data breaks down by sector, region, and working time. An example for such a cell is the agriculture sector, Germany, 35 years old, active in the overall (positive) effect of these variables on wage growth.

We restrict the weighted sum of each cross-section, region, and working time jobs development of wages into the variable \( \sum_{t=1}^{19} \beta_{m} D_{m}^{sec} + \sum_{n=1}^{2} \beta_{n} D_{n}^{reg} + \sum_{s=1}^{3} \beta_{o} D_{o}^{wt} + b(mig/all)_{m,t} + e_{i,j,k,m,n,o} \), where mig/all is weighted by \( \sum_{i=1}^{2} weight_{i} \beta_{i} \) and \( weight_{i} = \frac{employees_{i=male or female}}{all \ employees} \).
In order to gain further insights into the wage effects of migration, we split the sample in two halves, below and above the median wage. Doing so allows us to measure the impact of \( \text{mig/all} \) on both higher and lower incumbent wages. This is of special interest since substitution and complementarity effects may be unevenly distributed across the wage structure.

**Table 3. WLS Panel Wage Equation – Germany 2012–2016**

|                                | 2013  | 2014  | 2015  | 2016  |
|--------------------------------|-------|-------|-------|-------|
| N                              | 43300 | 13963 | 43260 | 13925 |
| F(40, 43260)                   | 4331558.58 | 3689999.04 |
| Prob > F=                      | 0.000 | 0.000 | 0.000 | 0.000 |
| Root MSE=                      | 0.011 | 0.014 | 0.011 | 0.014 |

| migrant intensity (t-1)        | 0.001 | 0.001 | 0.153 | 0.007 | 0.003 | 0.011 |
|--------------------------------|-------|-------|-------|-------|-------|-------|
| dependent variable: log real wage |       |       |       |       |       |       |
| region                          |       |       |       |       |       |       |
| nationalitiy                    |       |       |       |       |       |       |
| sex                             |       |       |       |       |       |       |
| age                             |       |       |       |       |       |       |
| qualification                   |       |       |       |       |       |       |
| sector                          |       |       |       |       |       |       |
| job                             |       |       |       |       |       |       |
| year                            |       |       |       |       |       |       |

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Table 3 presents the results of the panel WLS estimation for the upper and lower half of the wage distribution. Focusing on nationality, our analysis suggests that – all things equal – being German is a positive for wages. The deviation with respect to the national wage average is +0.3 percent (it is small, due to the large share of native workers in the average).

All other nationality groups tend to have wages below the national average, even after controlling for the other characteristics mentioned in Table 3 such as level of qualification, or gender. For example, workers from the 8 most important asylum countries earn wages that are on average 8.7 percent below the average wage in the lower part of the wage distribution or, if in the upper part of the wage distribution, 12.4 percent below that average.

Similarly, wages of men are typically higher (controlling for everything else) and such are wages in the manufacturing sector.

B. Competition effect

Controlling for all factors, including that wages of foreigners are typically lower, the coefficient of the immigration variable is positive and equal to 0.0071 for the upper and 0.0014 for the lower wage half. The coefficients are to be interpreted as marginal effects: overall wages would increase by 0.71 (0.14) percent if the immigration rate increased by 1 percentage point of total population.

While increased immigration could in principle put downward pressure on wages of workers in direct competition with immigrants (see discussion in section II), the overall effect on wages is estimated to be positive. In other words, higher wages for workers that are complement to migrants more than compensate for potential declines in wages of workers that are substitute for immigrants. As expected, our results suggest that complementarity plays a more important role for the higher-wage jobs segment where skills complementarity with migrants is likely to be the largest.

On average, migration induced a yearly increase in the sectoral migrant’s share of 0.48 percentage point of total employment. Applying this value to the estimated coefficients in the two wage halves, this translates into an overall yearly wage increase of 0.26 percent.

Drilling down, we build on Figure 8.2, which shows a positive relation between the migrant share in 2012 and its change during 2012 and 2016. In other words, immigration seems to concentrate in sectors where the share of foreign workers is already high, pointing to higher competition and possible negative effect on wage growth among workers of foreign nationality (Brücker et al. 2014). We test this hypothesis by running another panel regression that looks at the effect of immigration on wages separately in the four non-German groups (Europe without EU, EU, 8 asylum counties, other migrants) and obtain a coefficient estimate of -0.033 (p-value = 0.00). Because the average migrant intensity of the four groups increased from 1.79 percent in 2012 to 2.37 percent in 2016, or 0.14 percentage points per 29

In the panel regression, the wage effects of immigration are identified using variation over economic sectors. Therefore, statements can be made by how much the wage in a sector changes due to migration. Since all sectors together make up the whole economy, the measured effects stand for identical total effects.

This result is also in line with Weber and Weigand (2018) who show – using an instrumental variables approach – that (non-refugee) migration does not dampen aggregate wage growth.

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Thus, while Table 3 shows that the overall wage effect of immigration is positive, competition within groups suggests negative wage pressure within respective migrant groups. So far our estimates suggest a positive overall effect of immigration on wages in Germany. But those calculations assume a constant share of the migrant’s population to the total. This assumption has to be relaxed to compute the overall effect of immigration on aggregate wages. Mechanically, a higher share of foreign workers with lower wages should have a negative effect on the overall wage sum. We turn to so-called composition effects in the next subsection.

C. Composition effect: shift share analysis

Foreigners tend to be paid less than German workers, all other things equal. Since immigrants also tend to be younger and lower-skilled than natives, increasing the share of immigrant workers in the total labor force mechanically weighs on wages. To compute the magnitude of this composition effect we resort to a traditional shift-share analysis. In a nutshell, we compute a counterfactual composition of the labor force under the assumption that no immigration had happened between 2012 and 2016. From this counterfactual structure, we calculate the impact of migration on all relevant dimensions (e.g., total variation in the share of men, foreign workers, workers in each of the sectors, and for each qualification).

In practice, to conduct the shift-share analysis, we multiply the coefficients for the dummy variables in equation 5 with the difference between the actual and counterfactual structure in 2016. This yields the total increment of wages with respect to changes in the gender or age distribution, sectoral composition, and so on. Results are summarized in the text table.

The shift-share analysis suggests that immigration has reduced average wage growth by 0.49 percent in Germany over the period 2012-16 (-0.12 percent per year), which can be broken down as follows. Migration increased the share of workers with foreign nationality who typically earn wages below average (-0.18 percent), but given that immigrants are mainly male and residents of Western Germany, this had a ceteris paribus minor but positive (+0.04 percent) effect on wages. The single most negative impact of increased migration on average wages is due to the concentration of migrant in low-paid sectors (-0.24 percent).

Shift-Share Analysis: Composition Effect Broken Down, 2012-2016

| Contribution of:  |  |
|------------------|--|
| nationality      | -0.18 |
| sex              | 0.02  |
| age              | -0.05 |
| qualification    | 0.01  |
| sector           | -0.24 |
| job/working time | -0.08 |
| region           | 0.02  |
| Total            | -0.49 |

31 We use the coefficients estimated from the whole sample, i.e., without splitting into two wage halves.
All in all, the composition effect for 2012-2016 amounts to -0.49 percent, i.e., wages would have been 0.49 percent higher in 2016 absent the effect from net migration. This has to be put in relation to a positive competition effect of +0.26 percent per year. Loosely, this would imply an overall effect on net wages of +0.14 percent per year (0.26 - 0.12 percent).

This result is in line with the conclusion from the analysis of Phillips curves in Section IV: there is no evidence of downward pressure on aggregate wages from immigration. If anything, the overall effect has been (very) slightly positive.

VI. Conclusion

Wage growth has been remarkably subdued in Germany over the last fifteen years despite uninterrupted decline in unemployment, casting doubt about the usefulness of traditional Phillips curves. Given that more than half of post-crisis employment growth can be attributed to foreign labor, it seems important to investigate the potential role of immigration on wage dynamics. Is the Phillips curve still relevant? What has been the role of immigration in explaining recent wage trends?

Relying on a two-pronged approach, our analysis confirms that the Phillips curve is alive and well in Germany and that immigration did not seem to have played an independent role in explaining aggregate wage fluctuations. In the short term, wage growth reacts to the degree of tightness in the labor market and to inflation expectations. In the longer term, real wage development is driven by productivity growth. We also establish that a large part of the secular decline in unemployment in Germany reflected a more efficient and not a tighter labor market: the NAIRU declined significantly throughout the 2000s on the heels of important labor market reforms.

To assess the role of immigration with greater precision, we also exploit a unique set of administrative micro-level data on German workers collected by IAB. The analysis shows that pure composition effects were negative from 2012-2016 reflecting the relatively lower level of migrants' wages. There is also some evidence that strong immigration led to additional competition and downward wage pressure within respective migrant groups in low-wage sectors. But these two dampening forces were more than offset— at the aggregate level—by wage increases for better-skilled and better-paid workers that are typically complementary to migrants in the production process. Overall, competition effects resulted in upward pressures on wages—especially in the upper half of the wage distribution—and more than offset composition effects, resulting in a negligible (if positive) impact of immigration on wage growth. These findings corroborate earlier studies for Germany that relied on time series analysis and are in line with similar research conducted in the United States.
Appendix A: Deriving the Wage Phillips Curve from First Principles

AA.1. The General Case

Starting from a representative household model where individual members are forward-looking, rational and derive positive utility from consumption and negative utility from work, Gali (2011) shows that when households maximize intertemporal utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, \{N_t(i)\})$$

$$U(C_t, \{N_t(i)\}) = \log C_t - \int_0^1 \frac{N_t(i)^{1+\phi}}{1+\phi} di$$

$$P_t C_t + Q_t B_t \leq B_{t-1} + \int_0^1 W_t(i) N_t(i) di + \Pi_t$$

$$W_t(i) B_t \leq W_t(\hat{W}_t^*)$$

$$C_t \leq B_t - 1 + \int_0^1 W_t(i) N_t(i) di + \Pi_t$$

$$P_t \beta \leq \beta^{1-\theta_w}$$

$$\sum_{k=0}^{\infty} (\beta \theta_w)^k E_t \left\{ \frac{N_{t+k|t}}{C_{t+k}} \left( \frac{W_t^*}{P_{t+k}} - M^w \text{MRS}_{t+k|t} \right) \right\}$$

$$\text{MRS}_{t+k|t} = C_{t+k} N_{t+k|t}^{\phi}$$

$$M^w$$ is the worker’s desired wage markup.

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Log linearizing the preceding first order condition yields (around a perfect foresight zero steady-state inflation condition) we obtain the wage setting rule:

\[ w_t^* = \mu_w + (1 - \beta \theta_w) \sum_{k=0}^{\infty} (\beta \theta_w)^k E_t \{ mrs_{t+k} | t \} + p_{t+k} \]

where \( \mu_w = \log(M^w) \) and \( mrs_t = c_t + \phi n_t \).

\[ w_t = \theta_w w_{t-1} + (1 - \theta_w)w_t^* \]

\[ \pi_t^w = \lambda_w (\mu_t^w - \mu^w) \]

\[ \pi_t^w = -\lambda_w \sum_{k=0}^{\infty} \beta^k E_t \{ (\mu_t^w - \mu^w) \} \]

meaning that today's wage inflation is a function of future expected deviations of average wage markups from their desired levels. Intuitively, if markups are above (below) the desired level, workers that get the chance to adjust their wage will tend to adjust it downward (upward) pushing wage inflation down (up).

\[ u_t = l_t - n_t \]

\[ w_t - p_t \geq c_t + \phi l_t \]

\[ \pi_t^w = \beta E_t \{ \pi_{t+1}^w \} - \lambda_w (\mu_t^w - \mu^w) \]

\[ \pi_t^w = \alpha + \gamma \pi_{t-1}^P + \beta E_t \{ \pi_{t+1}^w - \gamma \pi_t^P \} - \lambda_w \phi (u_t - u^n) \]
For the indexation rule

\[ w_{t+k|t} = w_{t+k-1|t} + \gamma \bar{p}_{t+k-1} + (1 - \lambda) \pi^p + g \]  
\[ \bar{\alpha} = (1 - \beta)((1 - \gamma) \pi^p + g) \]

\[ \pi^w_t = \alpha(1 - \beta)^{-1} + \gamma \bar{p}_{t-1} + \lambda w \varphi \sum_{k=0}^{\infty} \beta^k E_t \{(u_t - u^n)\} \]

following Gali (2011) we derive an empirical counterpart to \((A1.7)\) by assuming that the unemployment gap \(u_t = u_t - u^n\) follows an AR(2) process (a good approximation for Germany):

\[ \hat{u}_t = \phi_1 \hat{u}_{t-1} + \phi_2 \hat{u}_{t-2} + \varepsilon_t \]

then \((A1.7)\) can be rewritten as:

\[ \pi^w_t = \alpha(1 - \beta)^{-1} + \gamma \bar{p}_{t-1} + \psi_0 \hat{u}_t + \psi_1 \Delta \hat{u}_t \]

\(A8\)

for

\[ \delta = - (\psi_0 + \psi_1) > 0 \]

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AA.2. A Micro-founded Phillips Curve with Immigration

\[ Q_t = N_t^{1-a}M_t^a \]

\[ N_t^p = \delta_1 N_{1t}^p + \delta_2 N_{2t}^p \]

\[ Q_t = \frac{N_t^{1-a}M_t^a}{\delta_1 N_{1t}^p + \delta_2 N_{2t}^p} \]

\[ mc_{Q,t} + \mu^p + \omega_t - (q_t - n_t) - \ln(1 - \alpha) + \mu_t^p \]

\[ U_{i,t} = \ln c_{i,t} - e^{\xi} \frac{N_{i,t}^{1+\phi_i}}{1 + \phi_i} \]

\[ mr_{s_{i,t}} = c_{i,t} + \phi_in_{i,t} + \xi_t \]

\[ n_t = \bar{\lambda}n_{1,t} + (1 - \bar{\lambda})n_{2,t} \]

\[ \omega_t = \bar{\lambda}\omega_{1,t} + (1 - \bar{\lambda})\omega_{2,t} \]

\[ ir_{l_t} = l_{2,t} - l_{1,t} \]
\omega_t = q_t + \psi l_t + \phi_{21}ir_t + \xi_t + \bar{\mu} \omega

\Delta(m_{iQ,t} + \mu^p)

\Delta(m_{iQ,t} + \mu^p)

= - \frac{1 - \Gamma}{\Gamma} \left[ \psi u_t + (\phi_{21} + \nu)(u_{2,t} - u_t) + \rho \phi_{21}u_{2,t}ir_t + \frac{\rho^2}{2} \phi_{21}u_{2,t}ir_t^2 \right] + a \Delta S_{Q,t}

\pi_t \equiv \tau_0 + \tau_1 \hat{\pi}_{t-1} + \tau_2 \hat{u}_t + \tau_3 \Delta \hat{u}_t + \tau_4 (u_{2,t} - u_t) + \tau_5 u_{2,t}ir_t + \tau_6 u_{2,t}ir_t^2 + \epsilon_t

\pi_t^w = \tau_0 + \tau_1 \hat{\pi}_{t-1} + \tau_2 \hat{u}_t + \tau_3 \Delta \hat{u}_t + \tau_4 (u_{2,t} - u_t) + \tau_5 u_{2,t}ir_t + \tau_6 u_{2,t}ir_t^2 + \epsilon_t
Appendix B: Short and long-term determinants of wage dynamics in Germany

Over the long term, wage growth follows productivity growth and inflation quite closely in Germany. Ignoring short to medium-term fluctuations, nominal compensation per hour worked follows total output per hour quite closely. From 1991 to 2017, output per hour roughly doubled. Labor compensation increased at the same pace for most of the period with the exception of 2003-2010 when the relation seemed to temporarily break down. The Hartz reforms combined with a general effort to improve German competitiveness through wage moderation are clearly visible in the temporarily divergent paths between compensation and productivity (see Figure 10.1).

Figure 10. Wages are Driven by Slack, Inflation Expectation and Productivity Growth

1. Labor Productivity and Wages
(Index: 2004=100, per hour worked)

2. Unemployment and Wage Inflation, 1992Q1 - 2017Q3

3. Unemployment and Real Wage Inflation, 1992Q1 - 2017Q3

4. Unemployment Gap and Real Wage Inflation, 1992Q1 - 2017Q3

Sources: Destatis, Bundesbank, Haver Analytics; and IMF staff calculations.
have played an important role in explaining the relative stability of nominal wage growth in the face of dropping unemployment. Real wage growth, in contrast, has picked up from negative levels to reach a peak of 3.5 percent in the immediate aftermath of the crisis. Finally, 9.4 goes one step further and shows that the negative relationship between real wage growth and labor market slack seems alive and stable over time when due account of the large drop in the natural level of unemployment in Germany is taken. Figure 10 shows a clear and rather stable relationship between real wage growth and the unemployment gap measured as the deviations of unemployment from the NAIRU.
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