What accounts for the German Labor Market Miracle? A Comprehensive Approach*

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Abstract
This study examines the driving forces behind the strong decline in German unemployment from 2005 onwards and the exceptionally small increase during the Great Recession. Structural VARs with sign restrictions show that wage moderation as a result of labor market reforms was the dominant factor of the unemployment decline, and that improved matching and shrinking labor supply also contributed to it. The adjustment to business cycle shocks (Great Recession), on the other hand, is to a large extent borne by the intensive rather than the extensive margin, which can be explained by institutional aspects of the German labor market.

Keywords: German labor market miracle, structural VAR, sign restrictions.

JEL classification: C32, E24, E32.

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1 Introduction

In its recent past, the German economy has experienced a labor market miracle\(^1\): The unemployment rate, having trended upwards since the 1970s to record highs of what observers called the “sick man of Europe” (Dustmann, Fitzenberger, Schönberg, and Spitz-Oener 2014), halved within a decade; a decade in which the Great Recession hit and triggered the largest output loss in postwar German history (Figure 1).\(^2\) The German Labor Market Miracle consists of these two interrelated aspects: a strong and permanent fall in unemployment that set in in 2005, and an exceptionally low increase of unemployment during the Great Recession compared to other crisis hit countries like the US.

What makes this favorable development particularly interesting, in addition to its unprecedented character and the simultaneous occurrence of a serious economic crisis, is that it was preceded by significant labor market (“Hartz”) reforms. These reforms are an obvious candidate cause and often referred to. However, the literature is by no means unanimous on their effects; not least because the methodological approaches differ, because some studies focus on specific aspects while ignoring others and because the reform measures were not homogeneous, but had different macroeconomic effects (see the literature survey below). Beyond policy, other developments have also been put forward to explain the German Labor Market Miracle, ranging from favorable economic conditions (before and following the crisis) to general wage restraint. This paper is the first to strive for a comprehensive assessment of all potential factors that may have contributed to the Labor Market Miracle and to identify them within a single consistent macroeconomic framework.

To this end, we estimate vector autoregressions on quarterly German data ranging from 1970 to 2018 and identify demand, technology, labor supply, wage bargaining, and matching efficiency shocks through robust sign restrictions as proposed by Foroni, Furlanetto, and Lepetit (2018). These five structural shocks are particularly well-suited to investigate the German Labor Market Miracle: The identification of business cycle (aggregate demand and technology) shocks allows

\(^1\)The term “labor market miracle” was used by Bauer and King (2018), Hartung, Jung, and Kuhn (2018), Krause and Uhlig (2012), Burda and Hunt (2011), Boysen-Hogrefe and Groll (2010), among others.

\(^2\)Figure A1a shows that this development does not hinge on using the registered rate of unemployment. It is similar for the so-called “harmonized” rate of unemployment, another widespread measure which is survey-based. A1b and A1c, furthermore, show that there is no compositional effect: Unemployment declined in both West and East Germany, and both men and women were affected.

\(^3\)OECD based recession indicator for Germany from the period following the peak through the trough, compiled by the Federal Reserve Bank of St. Louis, retrieved from FRED; https://fred.stlouisfed.org/series/DEUREC, June 20, 2019.
us to carve out the effects of the Great Recession and the preceding and subsequent booms. The identified labor market shocks, on the other hand, capture well the variety of undertaken reforms: the improvement of matching efficiency through the re-organization of the Employment Agency (Hartz III), a fundamental change of the workers’ outside option through the reduction of wage replacement benefits and a movement from out of labor force into labor supply (both through Hartz IV). However, the identified labor market shocks also capture developments other than policy measures that are potentially relevant for the German Labor Market Miracle. These may include a general tendency to wage restraint and changes in labor supply due to demographic shifts.

We find that wage bargaining shocks account for most of the strong decline in unemployment. Wage restraint was exceptionally pronounced right after the im-
plementation of Hartz IV, pointing to a vital role of it in reducing reservation-wage related unemployment. However, we also find that wage moderation persisted far beyond the introduction of Hartz IV, albeit more muted. Our tentative exploration on this persistence points to the European monetary union (EMU): By running the model over different sample periods we are able to confirm the theoretical result that EMU has enhanced the positive real effects of idiosyncratic wage moderation due to the absence of a compensating exchange rate mechanism (appreciation). This might have made wage moderation a worthwhile strategy for both employers and workers in Germany to pursue. But the Labor Market Miracle is not monocausal. In our baseline specification, wage moderation reduced the unemployment rate by 3.5 percentage points, improvements of matching efficiency by 1.3 percentage points, and a contraction of labor supply by one percentage point.

Business cycle shocks reduced it by a further 0.7 percentage points, which is noteworthy because it shows that the recovery has outweighed the impact of the Great Recession on unemployment. However, we find that the response of unemployment to business cycle shocks is generally low in Germany. To be precise, business cycle shocks account for less than 20% of unemployment fluctuations, while in the US they are found to account for up to half of it in the short run (for a similar response of output). This essentially explains the small increase in unemployment during the Great Recession. While the extensive margin of labor barely reacts to business cycles, it is the intensive margin that bears the brunt of adjustment. In an extension of the baseline model we find that hours worked practically mirror the output fluctuations that are induced by business cycles fluctuations. The strong adjustment of hours worked during the Great Recession, which can be explained by the widespread use of short-time work arrangements in the German economy, helped to keep the rise in unemployment low.

Related literature. Our study contributes to the recent and still growing literature on the causes of the German Labor Market Miracle. According to Hartung, Jung, and Kuhn (2018) almost the entire decline of unemployment since 2005 can be accounted for by the Hartz reforms, if the transmission channel of lower separation rates is taken into account. Krebs and Scheffel (2013) find that the first three reform packages (Hartz I-III) reduced the noncyclical part of unemployment by 1.5 percentage points, while the fourth package (Hartz IV) reduced it by a further 1.4 percentage points. Fahr and Sunde (2009) confirm that Hartz I-III improved the matching process. According to Klinger and Rothe (2012) the reforms particularly reduced long-term unemployment. Krause and Uhlig (2012) find a large
reduction in German unemployment and its duration due to Hartz IV. According to Hochmuth, Kohlbrecher, Merkl, and Gartner (2019) Hartz IV reduced the unemployment rate by 2.2 percentage points. Launov and Wälde (2016), on the other hand, conclude that Hartz III, i.e. the improvement of the public employment agencies’ effectiveness, explains about 20% of the observed post-reform drop in unemployment, but that the reduction of unemployment benefits due to Hartz IV accounts only for 5%. This minuscule effect echoes the authors’ earlier results (Launov and Wälde 2013). In contrast, while acknowledging that the Hartz reforms shortened the typical duration of unemployment, Bradley and Kügler (2019) conclude that they did not reduce unemployment as a whole.

Bauer and King (2018) consider the labor market reforms in conjuncture with the Great Recession and they argue that there might have been offsetting effects. Burda and Hunt (2011) focus on the “missing” increase of unemployment during the Great Recession in Germany and they find that this was mainly a compensation for firms’ reticence to hire new staff during the preceding expansion, but that wage moderation and the widespread adoption of working time accounts also played a role. Recently, Gehrke, Lechthaler, and Merkl (2019) find that the labor market reforms were most likely the key drivers of a series of positive labor market performance shocks that hit the German economy prior to the Great Recession and prevented unemployment to increase by more during the recession. Boysen-Hogrefe and Groll (2010) emphasize the role of wage moderation for the small response of unemployment during the Great Recession, and they acknowledge that the preceding labor market reforms had a certain stake in it.

Structure of the paper. The paper is structured as follows. In Section 2, we describe the empirical approach and the identifying assumptions. Section 3 gives an overview of the properties of the model, focusing on impulse responses and forecast error variance decompositions. In Section 4, we study the underlying causes of the significant fall in unemployment. Section 5 takes a closer look at the unique period surrounding the Great Recession and the corresponding small increase of unemployment. Finally, Section 6 concludes.

2 Empirical Framework

In the following, we describe the empirical model and the identifying assumption of the structural shocks. Let

\[ y_t = c + \sum_{i=1}^{l} A_i y_{t-i} + u_t \]  

(1)
be the reduced-form model, where $y_t$ is a vector of endogenous variables, $c$ is a vector of constants, $A_i$ are matrices of reduced-form coefficients and $u_t \sim \mathcal{N}(0, \Sigma_u)$ is a vector of reduced-form residuals. In our baseline specification $y_t$ includes five variables: log real GDP, the year-on-year difference of log consumer prices, log real wages per capita, the unemployment rate and log vacancies. All data are at a quarterly frequency, seasonally adjusted and cover the period 1970q1 to 2018q1, which provides information on 193 observations (Figure A2). The model is estimated with variables in levels and Bayesian techniques, employing a Normal-Wishart prior on $\alpha = \text{vec} ([A_1, \ldots, A_l])$ and $\Sigma_u$. The baseline specification includes 5 lags.

To recover orthogonal innovations $w_t = B u_t$ (with $\Sigma_w$ diagonal) we resort to a method that has become popular in the empirical macro literature (Rubio-Ramírez, Waggoner, and Zha 2010). The structural impact multiplier matrices $B^{-1}$ are chosen as the product of the Cholesky factor of $\Sigma_u$, $\text{chol}(\Sigma_u)$, and orthogonal matrices $Q$ obtained via a QR decomposition of matrices sampled from a standard Normal distribution. From the infinite set of $Q$’s we chose those that lead to appropriate structural models, i.e. draws with structural shocks satisfying the impact sign restrictions given in Table 1. These sign restrictions have been proposed by Foroni, Furlanetto, and Lepetit (2018) who study the contribution of business cycle and labor market shocks in the US. The restrictions are derived from a New Keynesian DSGE model with search and matching frictions. The baseline model contains five orthogonal shocks: aggregate demand, technology, labor supply, wage bargaining, and matching efficiency shocks. The shocks are normalized such that they induce a positive on-impact GDP response. Sampling stops when one thousand appropriate draws are collected. The set of appropriate draws accounts for estimation uncertainty (by sampling $\alpha$ and $\Sigma_u$) and model uncertainty (by sampling $Q$ for a given pair of $\alpha$ and $\Sigma_u$).

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>Inflation</th>
<th>Real wages</th>
<th>Unemp. rate</th>
<th>Vacancies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Technology</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor supply</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Wage bargaining</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Matching efficiency</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

4We use inflation instead of prices for stationarity reasons. Results are robust to estimating the model with prices, but credible sets get larger.
A demand shock moves output and prices in the same direction, and output and unemployment in opposite directions. These dynamics are consistent with the effects induced by monetary policy, government spending, marginal efficiency of investment, discount factor, and most financial shocks. A productivity (technology) shock, on the other hand, moves output and prices in opposite directions and elicits a positive comovement of output and real wages. The effect on unemployment is unrestricted. An exogenous variation of labor supply, either at the extensive or at the intensive margin, affects the number of job seekers and the ability of firms to fill vacancies. This, in turn, affects hiring costs, wages and prices. A wage bargaining shock constitutes an exogenous variation in real wages originating from the wage bargaining process of workers (trade unions) and employers (firms). Similar to labor supply shocks, this affects firms’ marginal costs and, hence, prices and output. A matching efficiency shock is associated with similar dynamics but it moves unemployment and vacancies in the same direction, at least if prices are assumed to be sufficiently rigid (Furlanetto and Groshenny 2016).5

The identified demand and technology shocks represent traditional drivers of the business cycle in standard New Keynesian models. These innovations should be interpreted as shocks which induce fluctuations in real and labor market variables but do not originate from changes in the labor market. The labor supply shock captures innovations in the labor force due to demographic changes and migration flows. Moreover, because the Hartz reforms also increased the pool of unemployed officially registered, the labor supply shock might additionally cover parts of the labor market reforms. Wage bargaining shocks represent deviations from an average wage setting relation but also exogenous variations in unemployment benefits, which constitute the workers’ outside option in the wage bargaining process. Over the last years, German trade unions focused more strongly on other aspects than just wages and salaries (e.g., part-time work, flexible working hours, child care) which implies that the wage bargaining shock also represents more structural changes in negotiation processes. Finally, the matching efficiency shock captures variations in the ability of labor market institutions to match workers searching for a job and available vacancies. Improvements in matching efficiency represent better matching technologies in the private job market and public employment agencies.

5For positive matching efficiency shocks, vacancies decrease unambiguously on impact even if the sign restriction is set only in the second quarter. Similarly, vacancies increase unambiguously on impact in response to wage moderation shocks.
3 Properties of the Model

Before quantifying the importance of the different economic shocks for the German labor market miracle, we first gauge the properties of the baseline model by analyzing impulse responses and forecast error variances. Figure 2 shows median impulse responses (solid lines) together with 68% pointwise credible sets (shaded areas) from impact to five years after the respective shock. Overall, we obtain impulse responses that are very much in line with economic theory.

The effects of output, inflation and unemployment to a demand shock are transitory and last for about 1 to 3 years. GDP and inflation increase significantly with peak responses after around a year. Wages and vacancies, whose impact responses are not restricted, increase in the short run; in the medium run the effects fade out.\(^6\)

The technology shock differs from the demand shock through its divergent response of output and inflation. The shock elicits more permanent effects on several variables than the demand shock. Output and wages increase significantly and persistently. In contrast, inflation declines significantly with a peak response in the first year after impact. The impact response of unemployment, which is free of identifying restrictions, is small but negative and most draws indicate a persistent decline. Vacancies increase slightly and the increase lasts longer than in demand-fueled booms.

With respect to labor supply shocks, their output effect is initially modest. It strengthens after some time such that in the medium run a clear positive effect prevails. The imposed price dampening effect is short-lived. Also, the impact increase of unemployment abates quickly and the dampening effect on wages reverses at the end of the forecast horizon. The response of vacancies, which is unrestricted, is small on impact and becomes positive at later horizons. This set of impulse responses is well in line with the findings by Foroni, Furlanetto, and Lepetit (2018) for US data and points to the following macroeconomic nexus: An exogenous increase of labor supply and the corresponding reduction of the price of labor incentivize labor demand and, hence, the creation of new vacancies. This demand side repercussion acts as an accelerator of growth and, as a result, counteracts the initial wage and price decline. The labor demand effects follow-

\(^6\)If real wages are measured in per hour terms (conducted as a robustness exercise, cf. Figure A6 in the appendix), the median impact effect is ambiguous (but still at the edge of the credible set of the baseline specification). This suggests that total hours worked react stronger to demand shocks than employment and, hence, that both the extensive and the intensive margin of labor increase in response to a demand shock. We take a closer look at this observation in a latter section to explain the behavior of German unemployment during the Great Recession.
Figure 2: Median impulse responses and corresponding 68% credible sets (5 years)
ing the labor supply shock outweigh the reduction of prices and wages and bring
unemployment down again.

Wage bargaining shocks bear similarities to labor supply shocks in several di-

mensions: with respect to the qualitative response of output (initially modest, then
strengthening), vacancies (positive and persistent), inflation and wages (medium-
run compensation of initial decline). The compensating effect on prices seems
to be more pronounced for wage bargaining shocks than for labor supply shocks.
Correspondingly, the long-term effect of output is more muted. These nuanced
differences between the two shocks might follow from the fact that in the case of
an exogenous increase of labor supply firms draw from a larger pool of workers
(or a larger supply of working hours) when growth accelerates such that inflation
pressures are deferred. In case of a wage bargaining shock, on the other hand, un-
employment is reduced significantly even in the medium run, while it only settles
at its pre-shock level when labor supply expands exogenously.

Unemployment also decreases in a persistent manner in response to an im-
provement of the matching technology. The response is steadier and less cyclical
compared to a wage bargaining shock. In contrast, the impact decrease of vacan-
cies is not permanent. Again, this evidence is well in line with Foroni, Furlanetto,
and Lepetit (2018). Another feature of a matching efficiency shock is that the
rather blurred short run response of output turns unambiguously positive in the
medium run. The dampening price and wage effects fade out over time.

To investigate the quantitative importance of the various structural shocks
in driving the endogenous variables, Figure 3 presents the average forecast error
variance decomposition of our baseline model. Regarding the unemployment rate,
there are substantial differences between Germany and the US. In particular, in
Germany, the most dominant driver of the unemployment forecast error variance
over all horizons are wage bargaining shocks. A similar pattern can be observed
for vacancies with wage bargaining shocks explaining a slightly smaller share.
Contrary, as shown by Foroni, Furlanetto, and Lepetit (2018), in the US the
dominant driver of unemployment are matching efficiency shocks. Furthermore,
business cycle (i.e. demand and technology) shocks account for much more of
the short-run variation in the unemployment forecast error than in Germany (a
crucial element for understanding the evolution of unemployment rates during
the Great Recession, as we will discuss below). For wages and inflation, there
is also a single dominant driver. Inflation is primarily driven by demand shocks,
wages by technology shocks. The dominant short-run driver of German GDP are
demand shocks accounting for almost half of the contribution in the first quarters
after the shock materializes. In the medium-run sources of unexpected output
fluctuations are more diverse; this result is again well in line with the findings of Foroni, Furlanetto, and Lepetit (2018) for the US.

All these findings are robust to several modifications of the baseline model: decreasing the lag length to \( l = 3 \), increasing it to \( l = 7 \), replacing the consumer price index by the GDP deflator, and replacing per capita wages by wages per hours worked. All median impulse responses of the modified specifications lie within the corresponding 68\% credible sets of the baseline specification, as Figures A3, A4, A5, and A6 in the Appendix show.

4 Labor Market Miracle, Part I: The Steady Decline of Unemployment

The first aspect of the German Labor Market Miracle is about the steady decline of unemployment that set in in 2005 and persists until today. Germany has never experienced such a large and persistent drop of the unemployment rate in its
postwar history. The unemployment rate more than halved, declining from a peak of 12 percent in 2005 to below five percent in 2018; a development that was not governed by regional nor gender effects and that is robust to the measurement of unemployment (cf. Figure A1 in the Appendix). In the following, we use the VAR model to investigate the quantitative importance of the different economic shocks in explaining the steady decline of unemployment.

4.1 Historical Decomposition

Our approach enables us to conduct a historical decomposition of the unemployment rate and, hence, to analyze which factors contributed to its decline. A favorable statistical prerequisite for this endeavor is that unemployment was almost zero at the start of the sample period, so that the problem of initial values is mitigated and we have

\[ ur_t \approx c + \sum_{i=0}^{t-1} \phi_{k,i} w_{k,t-i}, \]  

where \( u_r \) is the unemployment rate at time \( t \), \( c \) is a constant, \( \phi_{k,i} \) is the response of the unemployment rate to shock \( k \) in period \( i \), and \( w_k \) are structural innovations. The main results of the historical decomposition are summarized in Table 2. It presents the average contributions of each structural shock to the cumulative decline of the unemployment rate between 2005 and 2018. The individual contributions add up to 6.5 percentage points, the realized total decline of the unemployment rate over this period.

Several interesting results emerge from this exposition: First, the decline of the unemployment rate is not monocausal. Each of the identified shocks contributes to it to some extent (there are no negative signs except for the constant). Obviously, the negative impact of business cycle shocks (demand and technology shocks) during the Great Recession was more than compensated over the whole period. Labor supply shocks and matching efficiency shocks contributed more significantly to the decline in unemployment (1 and 1.3 percentage point, respectively), meaning that labor supply contracted and matching efficiency improved. The largest contribution comes from wage bargaining shocks, accounting for more than half of the unemployment decline in the baseline specification (3.5 percentage points). All three labor market shocks together explain the fall in unemployment between 2005 and 2018 almost entirely while aggregate demand and technology
Table 2: Cumulative decline of the unemployment rate from 2005 to 2018 (in percentage points) and historical decomposition

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>( l = 3 )</th>
<th>( l = 7 )</th>
<th>GDP defl.</th>
<th>hourly wages</th>
<th>6-dim. VAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed decline</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td>Of which:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demand shock</td>
<td>0.2</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Technology shock</td>
<td>0.5</td>
<td>1.0</td>
<td>0.6</td>
<td>0.3</td>
<td>0.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Labor supply shock</td>
<td>1.0</td>
<td>0.9</td>
<td>0.9</td>
<td>0.8</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Wage bargaining shock</td>
<td>3.5</td>
<td>2.9</td>
<td>3.4</td>
<td>3.9</td>
<td>4.1</td>
<td>3.0</td>
</tr>
<tr>
<td>Matching efficiency shock</td>
<td>1.3</td>
<td>1.6</td>
<td>1.3</td>
<td>1.1</td>
<td>1.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Residual shock</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.7</td>
</tr>
<tr>
<td>Constant</td>
<td>0.0</td>
<td>–0.2</td>
<td>0.0</td>
<td>0.1</td>
<td>0.0</td>
<td>0.2</td>
</tr>
</tbody>
</table>

In % of all structural shocks:

|                              |          |             |             |           |            |
| Wage bargaining shock        | 54%      | 43%         | 52%         | 61%       | 63%         | 54%        |
| Labor market shocks          | 89%      | 81%         | 86%         | 91%       | 91%         | 80%        |

shocks contribute only to a marginal extent. These qualitative findings hold for all modifications of the model introduced before.\(^7\)

Given the eminent role of wage bargaining shocks, we investigate their chronology in more depth to inform our understanding of the mechanisms behind them. It is useful to remember that a wage bargaining shock represents a deviation from the estimated wage setting behavior. A prevalence of positive (negative) wage bargaining shocks means that workers get a smaller (larger) fraction of total income than in similar macroeconomic circumstances in the sample period. “Positive” and “negative” refer to the the shock’s initial impact on output. Figure 4 provides a graphical summary of the prevalence of identified wage bargaining shocks. The first of three box plots shows that in the period from 1999 until and including 2005, negative wage bargaining shocks dominated. This means that on average workers were paid more than in similar macroeconomic circumstances over the full sample. This evidence is in contrast to Dustmann, Fitzenberger, Schönberg, and Spitz-Oener (2014) who claim that wage restraint set in with the decentralization of the wage bargaining process in the 1990s.

\(^7\)The 6-dimensional VAR will be introduced in section 5.3.
Before we discuss the prevalence of wage bargaining shocks from 2006 onwards, as visualized in the second and third boxplots, we briefly investigate the evolution of the wage share in Germany and compare it to that in the entire Euro area. We differentiate between wage shares in industry and wage shares in the service sector. The upper panel of Figure 5 shows that in the decade from 1997 to 2007 industrial wage shares evolved quite similarly in the two territories. They both followed a downward trend, which was most probably owed to increased global competition and outsourcing at that time. In the service sector, wage shares did not trend down on average, and up to 2005 the wage share in Germany followed the one in the Euro area quite closely, with no more than half a percentage point of deviation (lower panel of Figure 5). In 2006, however, German wages fell significantly short of the Euro area reference value. The gap widened even further in 2007, so that the wage share in the German service sector was almost 2 percentage points lower than in the entire currency union.

This development is identified as a wage bargaining shock by our model: According to the second box plot in Figure 4 a strong positive wage bargaining shock hit the economy in 2006. Given the chronology of labor market reforms, it seems that Hartz IV, enacted in January 2005, has a certain stake in this outcome. While earlier reform measures, especially Hartz III, aimed at improving labor market matching, Hartz IV constituted a reduction of wage-replacement benefits. As such it consisted of reducing benefits payments for long-term unemployed and
merging Unemployment and Social Assistance (Krebs and Scheffel 2013). The substantial reduction of wage-replacement benefits depressed reservation wages. This, in turn, affected wage negotiations in 2005, and ultimately dampened wage outcomes in 2006, but only in the service sector. The common downward trend in industry, meanwhile, suggests that wage setting there is oriented to global conditions and that price competitiveness was not impaired before 2005 such that wage setting did not change thereafter. Hartz IV more likely worked via a domestic channel by reducing reservation wages in the service sector.

While wage moderation was heavy in 2006, it was not limited to that year. Less dramatic but steady, it persisted from then onwards over the entire remaining sample period: As the third box plot in Figure 4 shows, in the period from 2007 to 2017 positive wage bargaining shocks dominated, pointing to persistent wage
moderation in the years that followed the Hartz IV reform. From the analysis of impulses responses we know that the reduction of wages following a wage bargaining shock is only a short-run phenomenon. In the medium run, it is reversed thanks to rising labor demand, which dampens unemployment further. This mechanism seems compelling: first pay less, then produce more, subsequently catch up with earnings, and end up with lower unemployment. But it also seems unsustainable on a national scale.

4.2 Euro Area Mechanisms

We conjecture that Euro Area mechanisms play a role in this regard. Hochmuth, Moyen, and Stähler (2019) find that wage moderation raised the German current account significantly. Bettendorf and Leon-Ledesma (2019) confirm this effect and they point to different adjustment processes before and since the establishment of the European Monetary Union (EMU). In the pre-EMU period, real effects of wage moderation were offset by the appreciation of the Deutschmark. Within the monetary union, idiosyncratic wage moderation raises (net) exports and output more persistently, as a compensating exchange rate response is not in place.

We can corroborate these differences when we estimate the model on the pre-EMU sample, i.e. from 1970 to 1998: According to the impulse responses, wage bargaining and matching efficiency shocks affect the unemployment rate in the pre-EMU regime much less persistently than in the entire sample (cf. figure A7 in the appendix). In the entire sample estimation, the unemployment rate remains significantly below its pre-shock level even five years after the impact of a wage bargaining shock. When estimation is restricted to the pre-EMU sample, its decline is fully offset. Also for matching efficiency shocks, the unemployment decline is purely transitory in the pre-EMU regime, while it is more persistent over the entire sample. Equivalent, but less pronounced results hold for output.

This means that real effects of autonomous labor market shocks are more persistent since the introduction of the common currency than they were before. One might wonder whether price adjustments can compensate for the exchange rate mechanism, i.e. whether “external appreciation” is replaced by “internal appreciation”. Our results suggest that this is not the case. In the entire sample, prices respond even less to the positive demand repercussions of wage moderation than in the pre-EMU period. This might explain why wage moderation in Germany was so persistent: Absent exchange rate adjustments both firms and workers benefit from wage moderation, because higher demand for German products lifted profits and dampened unemployment.
4.3 Counterfactual Unemployment Rate

Given the importance of wage bargaining shocks for the German Labor Market Miracle, we want to know how the unemployment rate would have evolved in their hypothetical absence. Figure 6 presents the realized unemployment rate and the range of its hypothetical counterfactuals. In 1999, the effect of wage bargaining shocks on unemployment, that had accumulated since 1970, was negative according to most draws. The gap widened until 2005 because a series of negative wage bargaining shocks hit the economy. Thus, in the first years after the millennium, tight wage negotiations put an upward pressure on salaries which led to increases of the unemployment rate. In 2006, negative wage bargaining shocks started to materialize and dampened unemployment. At the time of the Great Recession their cumulative effects were largely compensated. From then onwards, small but steady positive wage bargaining shocks kept dragging unemployment down. In the absence of wage bargaining shocks, the unemployment rate would be up to 2 percentage points higher at the end of the sample.

**Figure 6:** Counterfactual unemployment rate excluding wage bargaining shocks

- black solid line: realized values
- red dotted line: median values absent wage bargaining shocks
- red area: quartile credible set

Two other observations are worthwhile to mention: First, the jump of unemployment in 2005 (by approximately 1 percentage point) was not due to wage bargaining shocks. Instead according to our model it was to a large extent due to a labor supply shock. We attribute this labor supply shock to the effects of Hartz IV. Certain groups of the population, who were not eligible for pre-reform benefits, registered for unemployment under the new regime because they were eligible for post-reform benefits; including in particular young adults up to the age of 25 (Brenke 2010). Beyond that, municipalities had a strong interest in declaring as many pre-reform welfare recipients as possible fit for work, because it made them eligible for the post-reform benefits which were financed by the federal
government. Burda and Seele (2016) confirm that the Hartz reforms raised labor supply, in particular in West Germany.

The second observation worthwhile to mention is that wage bargaining shocks, while accounting for much of the secular decline of unemployment, are not related to its small hike during the Great Recession. We focus on this second part of the German Labor Market Miracle in the following section.

5 Labor Market Miracle, Part II: The Great Recession

The second part of the German Labor Market Miracle is the exceptionally low increase of unemployment during the Great Recession given the large output loss. While GDP dropped by almost 5% in Germany in the first quarter of 2009, the maximum quarterly loss in the US was 2%. Meanwhile, unemployment soared from below 5% in the US before the crisis to almost 10% thereafter, while in Germany it increased only temporarily and by less than 1 percentage point. Hence, the negative spillovers from real activity to unemployment look marginal, and the decline of unemployment persisted beyond the Great Recession.

To investigate this issue in more details, we summarize the five structural shocks of our VAR into two broad categories: business cycle shocks, consisting of aggregate demand and technology shocks, and labor market shocks, comprising labor supply, wage bargaining, and matching efficiency shocks. This allows us to approach this part of the Labor Market Miracle in the following way: First, we construct GDP growth counterfactuals to show that the Great Recession (and the ensuing recovery) were pure business cycle phenomena, that did not originate from the labor market. Second, we compare forecast error variance decompositions of GDP and the unemployment rate for Germany and for the US. We find that they are almost identical for GDP but substantially different for unemployment. This leads us, third, to investigate the intensive margin of labor in more detail and its response to business cycle shocks, to which end we extend the model to incorporate also the intensive margin, namely hours worked.

5.1 Counterfactual GDP Growth

In a first step, we conduct a counterfactual analysis of GDP growth to investigate which shocks contributed to its strong decline during the Great Recession. According to our model the Great Recession was indeed a business cycle phenomenon:
in 2009, GDP would have hardly declined in the absence of business cycle shocks (left panel of Figure 7), while absent labor market shocks the drop would have been practically unaltered (right panel).\footnote{Business cycle shocks account for most of the output loss during the Great Recession, but a small fraction was due to labor market shocks or, to be more precise: due to negative labor supply shocks. To be clear, the structural shocks are orthogonal and the identified labor supply shocks are independent of the recession. The endogenous response of labor supply to the Great Recession is fully accounted for by the respective business cycle shock. The series of negative labor supply shocks started in the first quarter of 2008 and lasted until the third quarter of 2010.} The Figure also shows that the same applies to the recovery that followed the Great Recession: it constituted a cyclical recovery primarily driven by business cycle innovations. Without strong positive impulses from business cycle shocks GDP growth over the period 2009 to 2012 would have been at most subdued, but it would not have fluctuated as heavily as it actually did.

Figure 7: Counterfactual y-o-y GDP growth rate

- black solid lines: realized values
- red dotted lines: median values absent respective shocks
- red areas: quartile credible sets

The recession was not only followed by an expansion but it was also preceded by a period of above-average growth rates. The preceding expansion was very different in kind compared to the recovery: According to the counterfactuals in Figure 7 the growth acceleration before the crisis was largely a labor market phenomenon that kicked in around 2005 when the Hartz IV reform measures were implemented. There were hardly any business cycle impulses to GDP growth. Indeed, business sentiment indicators were muted in the years preceding the Great Recession, as observed by Burda and Hunt (2011). But while these authors argue that there was a business cycle surprise contrary to firms’ expectations (so that firms hired fewer workers and, hence, had to fire fewer during the recession), we find that firms’ expectations were perfectly in line with what we identify as a weakness of the business cycle. If growth had surprised firms back then, it was growth emanating from shocks originating on the labor market. This, not a wrong
assessment of the stance of the business cycle, explains the evolution of the unemployment rate prior, during, and following the crises, which we show in a next step by means of forecast error variance decompositions.

5.2 Forecast Error Variance Decompositions

We have already conducted a forecast error variance decomposition and compared it to the results of Foroni, Furlanetto, and Lepetit (2018) for the US. In this section we first rearrange the results to highlight the similarities and the substantial differences between the two countries. Then we compare the full-sample behavior of forecast error variances with results for a sample excluding the Great Recession.

**Figure 8:** Contributions of business cycle shocks (red) and labor market shocks (gray) to forecast error variances

In the upper panels of Figure 8 the forecast error variance decompositions for output and the unemployment rate are reproduced with different colors such that the broad categories of business cycle shocks (red) and labor market shocks (gray) can be distinguished. The lower panels show the corresponding graphs from Foroni, Furlanetto, and Lepetit (2018) for the US. Forecast error variances of output share remarkably similar structural patterns. In both countries, business cycle shocks are the most important short-run drivers of output, accounting for
three quarters of the respective forecast errors. In the medium run, the relevance of business cycle shocks declines.

The results are very different for the unemployment rate. In the US, business cycle shocks play a much larger role for unemployment fluctuations than in Germany. This is true for all horizons, but particularly in the short run, where business cycle shocks account for up to a half of the forecast error variance in the US. In the medium term, its relevance declines to a quarter. In Germany, in contrast, it never reaches such a high value. It accounts for at most a fifth of the unemployment forecast error variance. Importantly, business cycle shocks do not account for a higher unemployment forecast error in the short run than in the medium run. These differences are particularly relevant as output forecast error variances behave so similarly. We conclude from this observation that the adjustment of labor input to business cycle induced output variation is weak on the extensive margin in the German economy. As a result, the small increase in unemployment during the Great Recession should be interpreted as the combination of a severe business cycle shock that triggered the marked decline of GDP and the limited spillovers from GDP growth to unemployment.

Figure 9: Full sample (left) and pre-EMU (right) contributions of business cycle shocks (red) and labor market shocks (gray) to forecast error variances.

We now turn to the question, whether the muted response of unemployment to business cycle fluctuations in Germany was different prior to the Great Recession, i.e. whether the Great Recession was an exceptional event that drives the results. To answer this question, we resort to the model estimated on the pre-EMU sample. The contributions of business cycle and labor market shocks to the unemployment forecast error variance for this sample are presented in the right panel of Figure 9 along with the results for the full sample in the left panel. In the pre-EMU sample business cycle shocks accounted for a larger fraction of the unemployment forecast error variance than in the full sample, implying that the response of unemployment to the business cycle became more muted in the last two decades. Still, in the
short run its contribution in the pre-EMU sample was at most a quarter, nor is there a larger contribution in the short run.

In sum, unemployment in Germany might have increased by less during the Great Recession than during earlier downturns relative to the size of the recessions in terms of output loss. But the short-run response of unemployment to business cycle fluctuations is much more muted in Germany than in the US. We conjecture that this is due to circumstances, institutions or characteristics that are inherent to the German economy and to a large extent unrelated to the Great Recession itself. This raises the question of whether and to which extent the intensive margin adjusts. We explore this in the third and final step of this analysis. It turns out that the intensive margin is indeed an important cushion to business cycle fluctuations.

5.3 The Intensive Margin

So far, our analysis focused on changes in the extensive margin and we provided evidence that aggregate demand and technology shocks have only a modest impact on unemployment in Germany. However, also the intensive margin adjusts to economic innovations. The small increase in the unemployment rate during the Great Recession might be explained by a comparably stronger adjustment in hours worked which seems plausible because short-time work and other flexible working time arrangements are a common feature of the German labor market. Consequently, the question arises of how hours worked respond to our identified business cycle and labor market shocks. To investigate this issue we re-estimate the baseline model and include log hours worked per capita in the set of variables. As we add a variable to the model, we obtain another orthogonal shock. We leave this shock unidentified (“residual shock”).

For each identified structural shock, the response of hours worked is left unrestricted, so we impose the same set of restrictions as in the 5-dimensional baseline model. The impulse responses of hours worked are presented in Figure 10, the full set of impulse responses of the 6-dimensional VAR is provided in the appendix (Figure A8). In spite of not imposing additional sign restrictions we observe that, on impact, per capita hours worked co-move positively with total output except for technology shocks. The share of draws that exhibit an impact increase of per capita hours worked in all valid draws amounts to 80% for aggregate demand shocks, 78% for matching efficiency shocks, 77% for labor supply shocks, 73% for wage bargaining shocks, and 44% for technology shocks.
These results corroborate some aspects of a model recently put forward by Cacciatore, Fiori, and Traum (2019). They introduce adjustment costs for hours worked and non-separable preferences in an otherwise standard New-Keynesian business cycle model with search-and-matching frictions to allow for greater flexibility with regard to the “wealth effect” (i.e. the degree of substitution between leisure and work) on labor supply decisions. Our results confirm the following three aspects of their model. First, hours worked respond procyclically to aggregate demand shocks. Secondly, they respond only modestly and on average countercyclically to technology shocks. Third, hours worked respond procyclically to labor supply shocks. With regard to wage bargaining shocks, the response of the intensive margin is dampened in the model of Cacciatore, Fiori, and Traum (2019) compared to the standard model with costless hours adjustment and additively separable preferences. It is nevertheless countercyclical, something that we cannot confirm from our empirical results. Instead, wage bargaining shocks and matching efficiency shocks elicit a positive co-movement of the intensive margin and output.

Figure 11 presents the contributions of business cycle and labor market shocks (and the residual shock) to the forecast error variance of unemployment and hours worked. It shows that business cycle shocks explain more of the unexplained variation of the intensive margin than of the extensive margin. Hence, the bulk of labor adjustment in response to business cycle shocks occurs at the intensive margin. This explains the modest reaction of German unemployment during the Great recession in contrast to the sizable response of per capita hours worked.
Figure 11: Contributions of business cycle shocks (red), labor market shocks (gray), and residual shock (white) to forecast error variances

Figure 12: Counterfactuals excluding labor market shocks
- black solid lines: realized values
- red dotted lines: median values absent labor market shocks
- red areas: quartile credible sets

The counterfactual analysis (Figure 12) corroborates this finding. What is more, counterfactual per capita hours evolved very similarly to counterfactual GDP growth: The pre-recession increase is identified as originating from the labor market, while the decline in 2009 and the ensuing recovery where driven by the business cycle. Unemployment, on the other hand, was almost entirely driven by labor market shocks over the last two decades. Without labor market shocks it would have evolved substantially flatter. This reinforces the evidence that in Germany the intensive margin of labor is the primary cushion of business cycle variations, i.e. that it is much more responsive to demand and technology shocks than the extensive margin.

To summarize, our findings imply that movements in the extensive margin in Germany are mainly driven by labor market shocks. Especially wage bargaining shocks are responsible for the persistent and strong decline in unemployment that started in 2005. In contrast, changes in the intensive margin are driven by both business cycle and labor market innovations. The strong adjustment of the intensive margin during the Great Recession helped to keep the rise in unemployment
low. Short-time work regulations anchored in German labor law might have played a certain role. By subsidizing wages, they encouraged firms which are forced to reduce labor input to do so on the intensive rather than on the extensive margin.

6 Conclusion

In this article we study the macroeconomic driving forces of the German Labor Market Miracle, which includes (i) the strong decline of unemployment since 2005 and (ii) the small increase of unemployment during the Great Recession. We contribute to the existing literature by gauging the impact of various factors within a consistent macroeconomic framework. In particular, we estimate VARs on quarterly German data and identify different business cycle and labor market shocks based on robust sign restrictions.

Our results indicate that the decline of unemployment was not monocausal, but that wage moderation was the dominant driver. The effect of wage bargaining shocks was particularly pronounced right after the implementation of Hartz IV, which reduced wage replacement benefits and, hence, the reservation wage. Improved matching efficiency, targeted by other reform measures, also contributed to the decline of unemployment.

We also identify shocks that are not related to labor market policy reforms. In particular, a shortage of labor supply helped to bring unemployment down. While the Hartz reforms raised labor supply, other developments must have pushed it in the opposite direction, most likely demography. So far, however, studies on the unemployment effects of the shrinking working-age population in Germany are rare (e.g. Fuchs 2016). This issue might provide a promising area for future research.

We also find that wage moderation was not limited to the immediate aftermath of Hartz IV, it rather persisted far beyond the reform and the Great Recession. It seems that trade unions perceived wage moderation a worthwhile strategy because of its beneficial medium to long run effect on unemployment and wages. The sustainability of this effect is hard to reconcile on a national level and our results show that the implementation of the monetary union could have enhanced the positive real effects of idiosyncratic wage moderation.

With respect to the Great Recession, we find that German unemployment did not respond significantly different than to previous business cycle downturns. Instead, the small impact of business cycle shocks at the extensive margin of labor is an inherent feature of the German economy and likely related to favorable labor market institutions, such as short-time work arrangements. This presumption is
based on the finding that the intensive margin (hours worked per capita) is a more important cushion for business cycle fluctuations than the extensive margin. Rather than firing and hiring staff in downturns and upturns, German firms vary the working time of their workers in response to business cycle fluctuations. Apart from the unemployment smoothing effect this labor hoarding might also help firms preserving human capital.

In sum, the German Labor Market Miracle seems to be to a large extent policy-driven. The timing of wage bargaining shocks suggests that Hartz IV played a decisive role. It was not only followed by significant wage restraint in the short run but also by a protracted period of wage moderation, which turned out to benefit firms and workers as the newly established monetary union did not eradicate output gains through exchange rate appreciation. Earlier reform measures that were targeted at improving the matching technology, such as Hartz III, most likely also contributed to the decline of unemployment as we identify positive matching efficiency shocks. Moreover, Germany-specific labor market institutions such as short-time work arrangements favor the intensive margin as a cushion to business cycle fluctuations, and helped to keep the increase of unemployment low during the Great Recession.
References


Figure A1: Further aspects of unemployment

(a) Registered vs. survey-based rate harmonized along ILO definitions

(b) Unemployment rates in West and East Germany

(c) Total number of unemployed (left axis) subdivided into gender (right axis)
Figure A2: Time series of included variables
Figure A3: Robustness #1: $l = 3$ with baseline ($l = 5$) credible sets
Figure A4: Robustness #2: $l = 7$ with baseline ($l = 5$) credible sets
Figure A5: Robustness #3: CPI replaced by GDP deflator, baseline credible sets
Figure A6: Robustness #4: wages per capita replaced by wages per hours worked, baseline credible sets
Figure A7: Pre-EMU (1970 – 1998) median responses, baseline credible sets
Figure A8: Impulse responses, 6-dim. VAR