Labor Supply Shocks and the Beveridge Curve

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Labor Supply Shocks and the Beveridge Curve
Empirical Evidence from EU Enlargement

Stefan Schiman*

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Abstract

The accession of twelve Eastern European countries to the European Union between 2004 and 2007 led to an increase of migrant labor supply in some incumbent countries. By means of a structural VAR with sign restrictions I find that job-related immigration triggered a counterclockwise outward movement of the Beveridge Curve in Austria, a country that was particularly affected due to its geographical exposure and a high wage gap to the accession countries. A regional analysis shows that the prevalence of labor supply shocks abates from east to west. In contrast to standard theory but in line with existing empirical evidence, labor supply shocks are not found to be price dampening, but more likely inflationary. From this it follows that they cannot be properly identified without resorting to some restriction of the unemployment rate.

Keywords: labor supply shocks, Beveridge Curve, job-related migration, sign restrictions, structural VAR

JEL classification: C32, F66, J21, J63

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1 Introduction

In 2004, ten Eastern European countries joined the European Union: Poland, Hungary, the Czech Republic, Slovakia, Slovenia, Estonia, Latvia, Lithuania, Malta and Cyprus (henceforth: EU-2004); eight of them belonged to the former Communist bloc. This constituted the most fundamental enlargement in the history of the European Union and its predecessor organizations. In 2007, Romania and Bulgaria followed (henceforth: EU-2007), in 2013 Croatia. EU membership provided the citizens of these countries with the right of free movement of labor, a pillar of European integration. Incumbent EU countries were granted a transition period of up to seven years for opening their labor markets to citizens of the new members states. Some enacted the provision immediately, among them the UK, where the ensuing acceleration of immigration had substantial economic and political effects (Becker and Fetzer, 2018). Other countries implemented a transition period.

![Figure 1: Share of foreign workers in % of total employment](image)

The number of workers from EU-2004/2007 countries surpassed the number of workers from YUG and TK, who constituted the largest non-German speaking groups of foreign workers before. Labor immigration from there started in the 1960s with “guestworker” recruitment.

Germany and Austria exploited the maximum transition period of seven years, i.e. until May 2011 for EU-2004 countries and January 2014 for EU-2007 countries. One of the reasons for Germany and Austria to choose the maximum period was the perception that due to their geographical proximity to these countries they would be prime candidates for job-related migration. Austria was even more exposed to this risk than Germany, as its territory is closer to the accession countries than most of Germany’s territory, it shares a common border with four of these countries and the income gap
towards them is larger than the income gap of east Germany with e.g. adjacent Poland. Schmieder and Weber (2018) investigate migrant employment in Austria prior and after labor market liberalization in 2011 and 2014 and they find that it led to a substantial acceleration of job-related migration. This is visualized in the left panel of figure 1, where different coloring up to 2011 (black) and thereafter (red) and a dotted trend line emphasize the trend break. The right panel of the figure indicates that the acceleration was indeed due to workers from EU-2004 and EU-2007 member states. To sum up, the liberalization of labor market access in 2011 and 2014 seems to have constituted a significant shock of labor supply due to foreign workers in Austria.

At the same time as the upward trend of foreigners’ employment accelerated, a steady rise of unemployment set in, which was followed by an equally steady increase of vacancies; i.e. the Beveridge Curve, which had constituted a remarkably stable negative correlation between unemployment and vacancies for more than 20 years, shifted substantially outwards (figure 2). This paper investigates whether and to which extent the counterclockwise outward movement is related to labor supply shocks that originated from job-related migration.

While the Beveridge Curve has been an analytical tool for many subjects (Rodenburg, 2011), the literature on its relationship with labor supply shocks is sparse. Dow and Dicks-Mireaux (1958) formalized the idea of the British economist William Beveridge to extract information on the stance of the business cycle. The (neo-)classic renaissance used the Beveridge Curve as a tool to distinguish structural from cyclical unemployment.

Figure 2: Beveridge Curve, 1988 – 2017

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Eventually it became a constitutive element in search-and-matching models of the labor market (Mortensen and Pissarides, 1999). In recent years, Beveridge Curve dynamics have gained renewed interest with respect to labor market effects of the Great Recession (cf. Furlanetto and Groshenny, 2016 and Daly et al., 2012 for the US and Hobijn and Şahin, 2013 for other developed countries).

Research on the effects of labor supply shocks on the Beveridge Curve dates back to the seminal work of Blanchard and Diamond (1989). Based on the empirical observation that the unconditional correlation coefficient between employment and the labor force is relatively high (0.8 for US data), the authors conclude that causality might run not only from employment to the labor force (through endogenous responses of participation to economic shocks). But that causality must run in both directions: “We are led to conclude that an exogenous increase in the labor force is probably associated with some increase in employment, that some jobs are created because new workers enter, or suppressed as existing workers leave, the labor force” (p. 59). Hence, they postulate a positive conditional correlation of employment and unemployment in response to labor supply shocks. With this identifying assumption they find that higher labor supply leads to increased matching and, hence, on impact to a reduction of posted vacancies. Improved matching stimulates new hires (labor demand), such that vacancies increase in the medium run and unemployment declines (cf. their impulse responses in figure 9, p. 42).

While macroeconomic modeling has evolved greatly since then, Beveridge Curve dynamics are hardly captured in modern macro models. The unemployment rate has entered the New-Keynesian modeling canon rather recently, foremost due to the inability of previous frameworks to distinguish between (output gap neutral) labor supply shocks and (output gap affecting) wage bargaining shocks (Chari et al., 2007). Within the last decade, several New-Keynesian frameworks with detailed labor market dynamics emerged. However, inclusion of vacancies still remains rather the exception than the rule. Models that allow for the analysis of Beveridge Curve dynamics include Christiano et al. (2015), Lozej (2018), and Foroni et al. (2018a). The latter provide a detailed outline of their model in the online appendix to their paper (Foroni et al., 2018b) and they derive robust sign restrictions.

According to Foroni et al. (2018b), labor supply shocks have multiple macroeconomic effects that act on the Beveridge Curve. Their results are more comprehensive but in line with the findings of Blanchard and Diamond (1989): As the number of job seekers increases, competition for vacancies intensifies. This makes it more difficult for existing workers to find employment. However, the increase in competition also leads to more efficient matching, which reduces the number of open jobs and thereby decreases unemployment.
job seekers (unemployed) to be matched to a vacancy, bolstering the stock of unem-
ployment. On the other hand, higher supply of labor and a potentially richer variety of
skills enables firms to fill their vacancies faster, bolstering the stock of employment and
dampening the stock of vacancies. In a demand-supply context, the rightward shift of
the upward sloping labor supply curve elicits a downward shift on the downward sloping
labor demand curve, i.e. labor demand increases due to dampened wages. This lifts
employment further, it also fosters vacancy posting and dampens the heightened level
of unemployment. According to this mechanisms, labor supply shocks result in a coun-
terclockwise outward movement of the Beveridge Curve — a dynamic which resembles
the pattern observed in the Austrian case.

I use the parsimonious specification of Blanchard and Diamond (1989) as baseline
specification. It is sufficient to identify labor supply shocks within the Beveridge space
and it allows for a distinction between domestic and foreign workers and for a regional
analysis. I use the extended model of Foroni et al. (2018a) to gain further insights into
growth, price and wage effects of labor supply shocks. I advance the existing literature by
showing that (i) labor supply shocks are predominantly inflationary, already on impact,
not only in the medium run, and that therefore (ii) identification schemes that leave
unemployment unrestricted (Furlanetto and Robstad, 2019a) do in fact not distinguish
between labor supply shocks and aggregate demand shocks.

The analysis proceeds as follows: Section 2 sets out the empirical model and the iden-
tification assumptions. Section 3 presents the results for impulse responses, Beveridge
Curve counterfactuals, a specification that distinguishes between domestic and foreign
workers and a regional analysis. Section 4 introduces the extended models and section
5 concludes.

2 Empirical model

In their seminal work on the Beveridge Curve, Blanchard and Diamond (1989) differen-
tiate between two types of macroeconomic shocks: business cycle shocks and structural
shocks. They call them “aggregate activity shocks” and “reallocation shocks”. The
former move job creation (vacancies) and job destruction (unemployment) in opposite
directions: In an upturn, vacancies increase and unemployment declines. In a down-
turn, vacancies are reduced and unemployment rises. Reallocation, on the other hand,
entails that while jobs (and vacancies) are created in certain sectors of the economy,
at the same time some are lost in others (raising unemployment). This distinction en-
ables them to roughly describe the movements in the Beveridge space: either along the Beveridge Curve (due to “aggregate activity shocks”) or shifting the Beveridge Curve (due to “reallocation shocks”). Both shocks are defined on the assumption of a constant labor force. This implies that employment, the third variable in this setup, moves in the opposite direction of unemployment.

Allowing for variations of labor supply introduces a third shock to the system: exogenous movements of labor supply. Labor supply shocks are identified on the assumption that employment and unemployment move in the same direction on impact, while the response of vacancies is undetermined. This is motivated by the following reasoning: An exogenous increase of labor supply increases employment due to improved matching opportunities and lower search time for firms. At the same time the search time of job seekers increases, which raises unemployment. The impact response of vacancies is left unrestricted, as improved matching dampens the vacancy stock while lower recruiting costs and lower wages elicit further posts. This reasoning and the assumption that labor supply shocks are the only shocks that move employment and unemployment in the same direction is compatible with a wide range of New-Keynesian macro models with endogenous labor supply, like e.g. Galí et al. (2011). Labor supply may respond to aggregate activity shocks and reallocation shocks as well, but by less than employment to preserve the negative conditional correlation between employment and unemployment for these shocks.

<table>
<thead>
<tr>
<th>$b_{ij} \in B^{-1'}$</th>
<th>employment</th>
<th>unemployment</th>
<th>vacancies</th>
</tr>
</thead>
<tbody>
<tr>
<td>reallocation shock</td>
<td>+</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>aggregate activity shock</td>
<td>+</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>labor supply shock</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

**Table 1:** Impact sign restrictions, baseline model

Blanchard and Diamond (1989) assume fixed elasticities and a unique impact multiplier matrix for identification. Identification by sign restrictions is less restrictive (e.g. 1

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1In this model, the positive conditional covariance of employment and unemployment also applies to price mark-up shocks to some extent. However, Ferroni et al. (2018) show that price mark-up shocks do not generate statistically significant dynamics.
it does not rely on specific assumption for employment elasticities, etc.) and, given the definitions above, straight-forward (table 1). Let

\[ \mathbf{y}_t = \mathbf{C} + \sum_{i=1}^{l} \mathbf{A}_i \mathbf{y}_{t-i} + \mathbf{u}_t \]  

(1)

be the reduced-form model, where \( \mathbf{y}_t \) is a vector of endogenous variables, \( \mathbf{C} \) is a matrix of deterministic terms, \( \mathbf{A}_i \) are reduced-form coefficient matrices and \( \mathbf{u}_t \sim \mathcal{N}(\mathbf{0}, \Sigma_u) \) is a vector of reduced-form residuals. Data are in monthly frequency, seasonally adjusted and range from 1988m1 to 2017m12 (360 observations). The model is estimated with Bayesian techniques, employing a Normal-Wishart prior on \( \mathbf{a} = \text{vec}([\mathbf{A}_1, \ldots, \mathbf{A}_l]) \) and \( \Sigma_u \). The lag order \( l \) is set to 6.

To recover orthogonal innovations \( \mathbf{w}_t \) (i.e. \( \mathbf{w}_t = \mathbf{B} \mathbf{u}_t \), such that \( \Sigma_w \) is diagonal) I resort to a method that has become standard in the literature (Rubio-Ramírez et al., 2010). The structural impact multiplier matrices \( \mathbf{B}^{-1} \) are chosen as the product of the Cholesky factor of \( \Sigma_u \), \( \text{chol}(\Sigma_u) \), and orthogonal matrices \( \mathbf{Q} \) obtained via a QR decomposition of matrices sampled from a standard Normal distribution. From the infinite set of \( \mathbf{Q}'s \) those that lead to appropriate structural models, i.e. draws with structural shocks satisfying the impact sign restrictions given in table 1, are chosen. Sampling stops when one thousand appropriate draws are collected. The set of appropriate draws accounts for estimation uncertainty (by sampling \( \mathbf{a} \) and \( \Sigma_u \)) and model uncertainty (by sampling \( \mathbf{Q} \) for a given \( \mathbf{a} \) and \( \Sigma_u \)).

3 Results

Figure 3 presents impulse responses to the structural shocks over a horizon of ten years. Shocks that shift the Beveridge Curve (“reallocation shocks”) exhibit a pattern typical for structural change: The impact effect on employment is reversed in the medium-run. Technological regress saves jobs in the short run, but lowers employment in the long run.

\[ \text{Other authors that have used sign restriction to identify labor market shocks include Foroni et al. (2018a), Hairault and Zhutova (2018) and Fujita (2011).} \]

\[ \text{The unadjusted series are accessible via the statistical databases of the Federal Reserve Bank of St. Louis (FRED) and the Organization for Economic Cooperation and Development (OECD). Level of vacancies: LMJVTUVATM647N (FRED), LMJVTUUV (OECD); level of unemployment: LMUNRLTATM647N (FRED), LMUNRLTT (OECD); unemployment rate: LMUNRRRTATM156N (FRED), LMUNRRRTT (OECD). The construction of the level of employment follows from the latter. Data are seasonally adjusted using the Tramo/Seats procedure, an ARIMA based seasonal adjustment method (Gómez and Maravall, 1996), and the trend cycle component is retained.} \]
By the same token, technological progress destroys jobs in the short run, but eventually fosters job creation. This result is in line with Blanchard and Diamond (1989) and it also echoes the pattern of New-Keynesian technology shocks in the spirit of Galí (1999). The business cycle shock (“aggregate activity shock”) elicits transitory effects on all three variables. These effects prevail for a typical business cycle horizon of 2 – 3 years.

![Figure 3: Impulse responses, baseline model](image)

Labor supply shocks have a pronounced, but transitory effect on unemployment and a muted, but steady effect on employment. In line with the presumed counteracting effects, the impact response of vacancies is not clear-cut; the (vacancies dampening) effect of improved matching and the (vacancies increasing) effect of lower recruitment and labor costs coincide. In the medium run, the latter effect dominates. This behavior dovetails with the medium-run acceleration of employment and the reversal of unemployment. Taken together, it suggests that the initial labor supply shock elicits a response of labor demand.
These results hold up to various specifications: to using a Minnesota prior instead of a Normal-Wishart prior\(^4\), to extending the lag length to \(l = 12\) and to extending the sample period back to 1960. The median impulse responses of these robustness checks are given in figure 13 in the appendix, together with the credible sets from the baseline specification.

Point-wise medians and corresponding 68% credible sets are traditional summary measures that are not without problems when set-identification is used, as different \(B^{-1}\) and, hence, different structural models are mixed. A measure that copes with this issue is the so-called “median target” proposed by Fry and Pagan (2011). It amounts to choosing the structural model with impulse responses closest to the point-wise median. To make responses comparable across impulses and variables, they are standardized according to

\[
\tilde{\phi}_{j \times k, t} = \frac{\phi_{j \times k, t} - \text{med}(\phi_{j \times k, t})}{\text{std}(\phi_{j \times k, 0})},
\]

where \(\phi_{j \times k, t}\) is the response of variable \(j\) to shock \(k\) in period \(t\), \(\text{med}(\phi_{j \times k, t})\) is the point-wise median response in each period \(t\) and \(\text{std}(\phi_{j \times k, 0})\) is the standard deviation of the impact responses. The draw closest to the point-wise median is the one that minimizes the sum of all squared standardized responses over the chosen horizon,

\[
\min \left( \sum_{j \times k} \sum_{t} \tilde{\phi}_{j \times k, t}^2 \right).
\]

Impulse responses for the median target are shown in figure 12 in the appendix. These responses are very close to the point-wise medians and, hence, an acceptable alternative in the following counterfactual exercise.

### 3.1 Counterfactuals

The locus in Austria’s Beveridge Space has moved considerably to the upper right in recent years. It did not do so immediately, however. An initial rightward movement ended abruptly in mid-2015, it was followed by a marked upward movement and, eventually, a shift to the upper left (figure 2). This temporal sequencing dovetails with the estimated effects of labor supply shocks. In order to quantify these effects for the period

\(^4\)The Minnesota prior shrinks the VAR estimates towards a multivariate random walk, which is a reasonable assumption for the variables at hand. Prior variances on own and lagged coefficients are set to 1, which is very flat. The prior on the deterministic terms is also flat, with mean zero and variance 100.
of interest, the variables $y_j$ at time $t$ are decomposed into the contributions of each shock $w_k$ in each preceding period $i$ up to $t - 1$ and of the deterministic terms $c_j$,

$$y_{j,t} \approx c_j + \sum_{i=0}^{t-1} \phi_{j \times k,i} w_{k,t-i}. \tag{4}$$

The first line of figure 4 presents Beveridge Curve counterfactuals for the median target, i.e. the draw with impulse responses closest to the point-wise median (according to Fry and Pagan, 2011). Gray dots are historic data from 1988m1 to 2011m4, blacks dots from 2011m5 onwards (remember that the labor market was liberalized in 2011m5). Red dots represent counterfactual outcomes that would have prevailed, if from 2011m5 onwards only one specific shock, mentioned in the graph title, had hit the economy. Labor supply shocks account for a large fraction of the movement in the Beveridge space, with regard to the size as well as the pattern of the movement. However, the exercise is somewhat impaired by the fact that the deterministic terms of the empirical model account for a non-negligible fraction of the outward movement. Since deterministic terms are not informative about the economic forces that pulled the Beveridge Curve outwards, I instead choose a draw with impulse responses also very close to the point-wise medians (but not as close as the median target), but with a minimal contribution of deterministic terms.

To achieve this, the set of models is shrunk to a small set (1% of all draws) with impulse responses close to the point-wise medians. Out of these draws the one that minimizes the Euclidian distance of the deterministic terms’ contribution to the change of the locus in the Beveridge space is chosen, i.e. $\min \sum_j (\tilde{c}_{j,2017m12} - \tilde{c}_{j,2011m5})^2$, where $j$ includes the unemployment rate and vacancies and $\tilde{c}$ are standardized contributions (i.e. scaled by their respective standard deviations) to establish comparability among them. This model, which is presented in the second line of figure 4 (pink dots) largely confirms the results of the median target. It seems that the reduced impact of the deterministic term is captured by reallocation shocks, which gain relative importance in accounting for the size of the outward shift. The identified labor supply shock again fits the pattern of the realized outward shift and it is confirmed that the latter cannot be rationalized without resorting to the impact of labor supply shocks. The results hold up to the robustness checks introduced before. The corresponding counterfactuals are presented in figure 14 in the appendix.

5The results are the same for a set of 5% and qualitatively similar for larger sets, i.e. if less weight is put on the Fry-Pagan measure.
Figure 4: Beveridge Curve counterfactuals, baseline model

gray dots: realized data up to 2011m4, black dots: realized data as of 2011m5, red dots: counterfactuals as of 2011m5 if only the shock mentioned in the title had prevailed, based on the median target draw, pink dots: counterfactuals based on the draw close to the point-wise median and with the minimal contribution of deterministic terms to movements in the Beveridge space

3.2 Foreign workers

So far, it has been shown that a considerable share of the outward shift of the Beveridge Curve in recent years was caused by labor supply shocks. Furthermore, it was pondered that the latter might have intensified since labor market access was liberalized for certain groups of foreign workers. Monthly data on foreign employment enables me to investigate this hypothesis by distinguishing labor supply shocks caused by domestic workers from labor supply shocks caused by foreign workers\(^6\). The identification assumption is in the vein of Furlanetto and Robstad (2019a), who distinguish labor immigration shocks from domestic labor supply shocks by imposing different signs on the impact ratio of immigrants over participants. Imposing the sign on the ratio leaves the direction of the absolute response undetermined, i.e. domestic employment might well increase in response to a supply shock of foreign workers, but the increase must be smaller than the increase of foreign employment.

\(^6\)Domestic labor supply shocks include demographic variations, changes towards the attitude to wage-work, pension reforms and school reforms, such as e.g. the extension of compulsory schooling from 8 to 9 nine years in 1966/67.
The specification of Furlanetto and Robstad (2019a) differs in several aspects from the parsimonious baseline specification applied here. Most importantly, these authors leave the response of unemployment unrestricted and impose identifying restrictions on the participation rate instead. This detail of their approach is discussed later (section 4). But their concept of distinguishing between labor supply shocks of domestic workers and of foreign workers can be applied to the specification at hand: Total employment is split into employment of domestic workers and employment of foreign workers. These variables enter the model separately, total employment drops from the specification, while vacancies and unemployment (comprising both domestic and foreign citizens) remain unchanged.

The corresponding sign restrictions are given in table 2: Total employment (i.e. the sum of domestic and foreign workers) increases on impact in response to all shocks. The number of foreign (domestic) workers increases in response to a positive foreign (domestic) labor supply shocks. The number of domestic (foreign) workers may increase as well, but by less than the number of foreign (domestic) workers. This restriction is equivalent to restricting the response of the ratio of foreign over domestic workers. On the other hand, the number of domestic (foreign) workers may (and will) decrease, if there are substitution effects between the two groups. However, net substitution must not exceed the size of the labor force increase provided by the labor supply shock, which seems to be a fairly reasonable restriction. For example, if a supply shock raises the number of foreign workers by 5,000, the stock of domestic workers must not decline by more than 5,000. This restrictions is necessary to ensure that total employment responds positively to labor supply shocks and, hence, to uniquely distinguish labor supply shocks from reallocation shocks. To sum up, the coefficients on domestic and foreign workers are not only bounded above, but also bounded below.

\[ b_{ij} \in B^{-1} \]

<table>
<thead>
<tr>
<th></th>
<th>employment</th>
<th>domestic</th>
<th>foreign</th>
<th>unemployment</th>
<th>vacancies</th>
</tr>
</thead>
<tbody>
<tr>
<td>reallocation shock</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>aggregate activity shock</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td></td>
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<tr>
<td>foreign l.s. shock</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(&lt; b_{32})</td>
<td>+</td>
<td></td>
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</tr>
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<td>domestic l.s. shock</td>
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<td></td>
<td>+</td>
<td></td>
<td>(&lt; b_{41})</td>
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</table>

**Table 2:** Impact sign restrictions, 4-dim. VAR
Figure 5: Impulse responses to different labor supply shocks
horizon: 10 years (120 months), units: thousands, point-wise medians and credible sets

The distinction between domestic and foreign workers enrich the findings of the baseline model by some intriguing aspects (figure 5). Supply shocks by foreign workers exert substantial substitution effects, at least on impact: The response of total employment is ambiguous, while domestic employment decreases and the difference between domestic and foreign employment decreases by even more (since foreign employment rises). Domestic labor supply shocks exert a weak, but unambiguously positive effect on total employment, which stems from the increase of the number of domestic workers. There is hardly any effect of domestic labor supply shocks on foreign workers.

The two labor supply shocks are also different with respect to their effects on unemployment. Foreign worker shocks have a much more pronounced and more persistent effect. The rise of unemployment is transitory and, for most draws, it is not entirely reversed. There is also some tentative additional information with respect to vacancies. Their response to foreign labor supply shocks is similar to the response within the baseline 3-dimensional specification, while the response of vacancies to domestic labor supply shocks follow a different pattern. So, the response of vacancies in the 3-dimensional model seems to be driven by foreign workers. This result might be due to the characteristic and composition of reported vacancies. Vacancies are chronically under-reported and they are more likely reported for standardized jobs with lower skill requirements. As labor immigrants are lower skilled than domestic workers on average, foreign job seekers might be more likely matched to reported vacancies, while domestic
job seekers might be more likely matched to non-reported vacancies. This observation is corroborated by Schmieder and Weber (2018) who, based on Austrian social security data, find that the liberalization of labor market access did not only accelerate immigration but that it led to a “shift in the composition of migrant workers toward lower-qualified and younger groups” (p. 114).

**Figure 6**: Beveridge Curve counterfactuals, 4-dim. VAR
gray dots: realized data up to 2011m4, black dots: realized data as of 2011m5, pink dots: counterfactuals based on the draw close to the point-wise median and with the minimal contribution of deterministic terms to movements in the Beveridge space

Figure 6 corroborates that the movement in the Beveridge space that was induced by labor supply shocks since mid-2011 was indeed due to supply shocks of foreign workers. Again, the counterfactual exercise is based on the draw with the minimal contribution of deterministic terms that is very close to the point-wise median impulse responses.

<table>
<thead>
<tr>
<th></th>
<th>Dom. employment</th>
<th>For. employment</th>
<th>Unemployment</th>
<th>∑</th>
</tr>
</thead>
<tbody>
<tr>
<td>On impact</td>
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<td>0.45</td>
<td>0.75</td>
<td>1 (0.25)</td>
</tr>
<tr>
<td>After 6 months</td>
<td>−0.6</td>
<td>0.85</td>
<td>0.75</td>
<td>1 (0.90)</td>
</tr>
<tr>
<td>After 3 years</td>
<td>−0.1</td>
<td>0.7</td>
<td>0.4</td>
<td>1 (1.45)</td>
</tr>
<tr>
<td>After 10 years</td>
<td>0.0</td>
<td>0.7</td>
<td>0.3</td>
<td>1 (1.00)</td>
</tr>
</tbody>
</table>

**Table 3**: Composition and size of the labor force surplus induced by foreign labor supply shocks

Table 3 provides a more detailed overview of the labor force effects of a foreign-worker supply shock. The number of domestic employees, foreign employees and unemployed sum up to the total labor force. On impact, the response of unemployment is very pronounced (75% of the net labor force increase) and it exceeds the negative impact on domestic employment. This means that unemployment among foreign workers rises as well (or that domestic citizens that were out of labor force enter into unemployment.
in response to immigration, which seems unlikely). After six months the share of foreign employment in the total labor force surplus has significantly increased in favor of domestic employment.

Not only the composition of the labor force surplus changes. Its total size increases as well within the first six months: from 25% of its long-run median value (i.e. after 10 years) to 90% of it. I assume that the long-run labor force surplus is entirely due to supply factors, i.e. that induced labor demand effects fade out in the long run. But the relatively small initial size of the surplus (a quarter of its long-run value) points to another feature of labor supply shocks: They are not a short-lived event, like e.g. an unexpected monetary policy decision. Migration takes time and there are network and family effects, so that in the first month only a quarter of the shock materializes. For later periods, though, the number is hard to interpret as labor demand effects kick in. The overlap of demand and supply effects transitorily raises the labor force surplus above its long run value (145%). In the long run, the replacement of domestic workers is compensated and heightened unemployment is reduced. Domestic employment is back at its pre-shock level and unemployment remains somewhat above it.

### 3.3 Regional Beveridge Curves

Given that the labor supply shocks that shifted the Beveridge Curve in recent years emanated from job-related immigration from east neighboring countries, one might expect heterogeneous effects within Austria: larger effects in the east and smaller effects in the west. Schmieder and Weber (2018) find that migrant workers from EU-2004 countries “are more likely to work in Vienna or the east of the country than in other parts” (p. 119) and that “the concentration of CESEE-8 immigrants has increased along Austria’s border with CESEE EU Member States. This makes sense given geographic proximity” (ibid.). However, they also assess that “with free labor market access, a shift of CESEE-8 workers from east to west occurred” and that “the number of immigrants has increased in the western tourism regions of the country” as well (ibid.).

Monthly data on employment, unemployment and vacancies for Austria’s provinces enables me to conduct a Beveridge Curve analysis on a regional scale. For this purpose, the nine provinces are grouped into three regions (figure 7). The Eastern region is made up of Vienna, Lower Austria and Burgenland. These provinces constitute an interdependent regional labor market as there is a lot of commuting between them and

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7CESEE-8: 8 Central, Eastern and Southeastern European countries that joined the EU in 2004, i.e. EU-2004 excluding Malta and Cyprus
especially to Vienna, the metropolitan center. Beyond that, these are the provinces that — from a geographical perspective — are most exposed to immigration from Poland, Hungary, Slovakia, and the Czech Republic. On the other side of the country, there are three provinces — Vorarlberg, Tirol, and Salzburg — which do not share a border with any of these countries. They constitute the Western region and from a geographical point of view they are supposed to be least affected by labor supply shocks; although the employment data compiled by Schmieder and Weber (2018) suggests otherwise. In between the Eastern and the Western region, the three provinces of Upper Austria, Styria, and Carinthia constitute the core. They ought to be less affected by labor supply shocks than the east, and more affected than the west.

The empirical results confirm these presumptions. Figure 8 shows the Beveridge Curves for all three regions (gray up to 2011m4, black thereafter) and counterfactuals if only labor supply shocks would have prevailed since 2011m5 (pink). The counterfactuals calculation is based on the baseline specification outlined in section 2, identified by the draw that exhibits the minimal contribution of deterministic terms and with impulse responses very close to the point-wise median.

Realized Beveridge Curves already offer some insightful details: The more to the west, the lower the unemployment rate in general (scaling of the x-axis is harmonized to establish comparability between the regions) and the lower the increase of unemployment since 2011. In contrast, vacancies increased in all regions by a similar magnitude. In the Eastern region, the stark counterclockwise outward movement of the Beveridge Curve
is entirely attributable to labor supply shocks. This applies also to the core, but there the rise of unemployment was more muted than in the east. In the west, labor supply shocks or their effects on the Beveridge Curve were practically absent. The shift of the Beveridge Curve in the west was more an upward than an outward shift and it was predominantly due to reallocation shocks (respective counterfactuals not shown).

How can these results be reconciled with the finding of Schmieder and Weber (2018) that the employment of migrant workers increased substantially not only in the east but also in the west? The results at hand suggest that only in the east the acceleration of migrant employment was due to labor supply shocks. In the west it increased due to increased labor demand emanating from reallocation shocks. Migrant workers who did not limit themselves to commuting but who were willing to migrate further observed that there was rising labor demand in the west, in particular due to a flourishing tourism sector, and they took their chance.

Overall, these results suggest that geographical proximity is an important factor, which may not come as a surprise, as the Eastern region is so close to the neighboring countries that migrant workers can commute and, hence, profit from both higher wages in Austria and lower living costs in their home country.

4 Extended models

The 3-dimensional baseline model has several benefits. It is parsimonious and it allows for the identification of labor supply shocks with minimal assumptions, while remaining
universal with respect to other shocks. The inclusion of employment allows to disentangle
domestic and foreign worker shocks. Availability of the three variables on a subnational
level provides regional estimates and, hence, further insights.

But these benefits could come with potential deficiencies: Parsimoniousness could
lead to mis-specification if the model lacks important variables, like e.g. wages. The use
of few assumption could weaken the identification of labor supply shocks; Canova and
Paustian (2011) find that it’s easier to recognize the data generating process when more
variables are restricted, for a given number of shocks, or if more shocks are identified.

4.1 Foroni, Furlanetto, and Lepetit (2018)

To address these concerns, I apply a very recent framework developed by Foroni et al.
(2018a), who derive robust sign restrictions from a New Keynesian model with endoge-
nous labor supply.

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Table 4: Impact sign restrictions, Foroni et al. (2018a, table 3)

Compared to the baseline specification, it amounts to dropping employment and
adding real GDP, inflation and real wages. Data frequency is quarterly, the sample
period hence 1988q1 – 2017q4. Inflation is measured as log change of the GDP deflator
(results are robust to using the consumer price index). Real wages are measured in per
capita terms (results are robust to using real wages per hours worked). In contrast to
the baseline model, the unemployment rate enters directly instead of being calculated ex
post. Apart from labor supply shocks, four other macroeconomic shocks are identified:
demand shocks, technology shocks, wage bargaining shocks and matching efficiency
shocks. The respective sign restrictions are given in table 4, which corresponds to table
3 in Foroni et al. (2018a).

In the 3-dimensional baseline model, labor supply shocks are identified on the assump-
tion of a positive conditional covariance of employment and unemployment on impact.
In the 5-dimensional framework a positive conditional impact covariance of real GDP
Figure 9: Impulse responses to labor supply shocks, 5-dim. VAR
horizon: 10 years (40 quarters), point-wise medians and credible sets

and the unemployment rate is imposed instead. Furthermore, a negative impact response of wages is set to separate labor supply shocks from technology shocks. On top of that, a negative impact response of prices is set. This restriction, however, is not necessary for identification, it might merely serve as an improvement of identification in the sense of Canova and Paustian (2011). But this is questionable given the pattern of impulse responses: Figure 1 in Foroni et al. (2018a, p. 1496) shows that the response of prices to a labor supply shock reverses quickly after its negative impact response to which it is restricted. The sign reversal applies to the entire credible set, not only for some draws. Furlanetto and Robstad (2019a) find a similar pattern in Norwegian data (cf. figures 11 and 12 on p. 22-23 in the online appendix to their paper, Furlanetto and Robstad, 2019b).

A quick sign reversal of price responses to labor supply shocks is also confirmed in Austrian data, as can be seen from the upper row in figure 9. As the price restriction is not necessary for the identification of the labor supply shock another estimation is performed without it. The respective impulse responses are presented in the lower row of figure 9. It turns out that in the majority of draws the price response to labor supply shocks is positive; only a minority of draws displays negative effects. The other impulse responses remain unaltered, both those to labor supply shocks and to the other identified

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8I use inflation instead of prices for stationarity reasons. Results are robust to estimating the model with prices, but confidence bands get larger. The response of prices is equal to the accumulated response of inflation; it stays strictly positive after the quick sign reversal ensuing a labor supply shock.
structural shocks (cf. figures 15 and 16 in the appendix). From this observation it follows that the negative impact restriction on prices to labor supply shocks represents only the tail of the distribution. Labor supply shocks seem to be predominantly inflationary, which might hold not only for Austrian data, but also for Norwegian and US data, as discussed above. In this case, theoretical models should be re-parametrized and, if necessary, extended to account for this empirical regularity.

Apart from this apparent “prize puzzle” of labor supply shocks, the other results of this estimation exercise are fairly innocuous. The positive response of production (GDP) is sluggish. It takes some quarters for the growth enhancing effect of labor supply shocks to unfold; it peaks at around 4 – 5 years after the initial impulse. The imposed negative effect on wages is transitory and reversed in the medium run – a result that is also in line with the work on the US and Norway cited above. Similarly to the results from the 3-dimensional baseline specification, the rise of unemployment is transitory and reversed in the medium run. Also consistent with the previous result is the weak initial response of vacancies. The medium run increase of vacancies is more pronounced than in the baseline model – a potential merit of higher identification precision.

While these results all hold up to theoretical expectations, they also provide interesting insights for advancing theoretical models. The deviation of empirical impulse responses
from standard theoretical results all point to a particular shortage of these models: an underestimation of labor demand effects ensuing labor supply shocks. Labor demand is fostered by dampened wages and it results in an increase of vacancy postings. In particular the sign reversal of wages is not captured by theoretical models but ubiquitous in empirical work, and it fits the notion of substantial demand effects. These would, eventually, explain the increase of the price level in response to labor supply shocks, too.

The counterfactual analysis confirms that the counterclockwise outward movement of the Beveridge Curve since 2011 was mainly due to labor supply shocks. The rest of the outward movement is either due to demand or technology shocks. So, it is not clear whether the reallocation shock towards tourism in west Austria identified within the 3-dimensional framework was demand-driven or due to technological supply-side factors. Other structural shocks originating from the labor market, i.e. wage bargaining shocks and exogenous changes of matching efficiency, did not move the Beveridge Curve in recent years.

4.2 Furlanetto and Robstad (2019)

Furlanetto and Robstad (2019a) borrow the specification of Foroni et al. (2018a) that includes the participation rate instead of vacancies and change it slightly, but with considerable consequences. Foroni et al. (2018a) use the participation rate to improve the identification of labor supply shocks and wage bargaining shocks; both variables move in the same direction in response to these shocks (cf. table 2, p. 1502). Furlanetto and Robstad (2019a) instead set restrictions on the participation rate only and drop the restriction on unemployment (cf. table 1, p. 4). They find that the unemployment rate decreases in response to an immigration shock, not only in the medium run but already on impact, as well as to domestic labor supply shocks (fig. 3, 4).

This result is counterintuitive, and it is hardly backed by their theoretical model, which the authors kindly provide in the online appendix to the paper (Furlanetto and Robstad, 2019b). Within this model, which extends Foroni et al. (2018b) to distinguish between migrant and domestic workers, the authors differentiate between immigrating employees and immigrating job-seekers. In the latter case, the unemployment rate increases unambiguously (Furlanetto and Robstad, 2019b, fig. 1, p. 12). In the former, the impact effect tends to be predominantly unemployment increasing, too, and it is followed by a transitory decline (fig. 2, ibid.). In neither case does unemployment strictly decline in response to immigration or in response to an expansion of the domestic labor force.
From the empirical finding that labor supply shocks do not have a clear (or even predominantly positive) effect on prices it follows that they might in fact not be sufficiently identified in the framework of Furlanetto and Robstad (2019a). To see this, observe that while Foroni et al. (2018a) set an impact restriction on the response of unemployment to labor supply shocks (table 5), Furlanetto and Robstad (2019b) don’t (table 6). The price response remains as the only restriction to separate demand shocks and labor supply shocks. If this restriction is violated, identification is not ensured. In their baseline specification, Furlanetto and Robstad (2019a) combine demand shocks and technology shocks into a single “business cycle shock”. This shock does not allow for a negative conditional comovement of GDP and wages, although the wage response to demand shocks is typically not restricted to be positive. The inadmissible share of demand shocks that results from this combination might be mis-identified as labor supply shocks, aggravating the bias introduced by dropping the impact restriction of unemployment to labor supply shocks.

Figure 11 presents impulse responses for labor supply shocks when identification is attempted by restricting participation only and leaving unemployment unrestricted. The unemployment rate does not exhibit a clear response. The response of the other variables weakens, too. Given that the foregoing analysis demonstrated in detail the role of the positive comovement of labor supply shocks and the unemployment rate for the outward movement of the Beveridge Curve in recent years, this result is interpreted with reference to Canova and Paustian (2011) that restricting too few variables weakens or even biases identification. Hence, labor supply shocks cannot be adequately identified without imposing a restriction on the unemployment rate, which entered New-Keynesian models precisely for that purpose.
Figure 11: Impulse responses to labor supply shocks à la Furlanetto and Robstad (2019b)
horizon: 10 years (40 quarters), point-wise medians and credible sets

5 Conclusion

In this article I study the effects of labor supply shocks on Beveridge Curve dynamics with a focus on shocks exerted by foreign workers which emanate to a large extent from job-related immigration. European integration has fostered labor migration, since free movement is one of the core principles of the EU treaty, entailing free movement of labor. Labor market integration gained momentum in mid-2011, when Germany and Austria granted this principle to the Central and Eastern European countries that joined the European Union in 2004. I study the effects on the Austrian labor market, which was particularly affected due to its geographical exposure and high income gap to these countries.

It turns out that the counter-clockwise outward shift of the Beveridge Curve is to a large extent related to labor supply shocks due to job-related immigration. In the short run labor supply shocks caused by foreign workers churn labor markets and the burden of adjustment is spread unevenly across regions. Regions close to the Eastern border suffer most from an increase of unemployment, the further to the west the smaller the effect. Apart from that, I confirm results for the US and for Norway that labor supply shocks are most likely inflationary, in contrast to standard theory. Given the unequivocal empirical evidence I argue that the negative impact restriction on prices may not be justified. From this it follows that labor supply shocks cannot be properly identified without resorting to some restriction of the unemployment rate.
Future research should investigate the impact of labor supply shocks on prices in more detail and, if necessary, amend theoretical models accordingly. In addition, further empirical evidence on labor supply shocks in other countries is needed as migration remains a key issue, for economists as well as for humanity as a whole.

References


Figure 12: Impulse responses, baseline model

horizon: 10 years (120 months), units: thousands, black lines: point-wise medians, red lines: median target draw, pink lines: draw close to the point-wise median and with the minimal contribution of deterministic terms to movements in the Beveridge space (cf. section 3.1), gray areas: 68% point-wise credible sets
Figure 13: Impulse responses to labor supply shocks, various specifications
Minnesota prior, lag length $l = 12$ and long sample starting at 1960, respectively

Figure 14: Labor supply shock Beveridge Curve counterfactuals, various specifications
Minnesota prior, lag length $l = 12$ and long sample starting at 1960, respectively
Figure 15: Impulse responses, 5-dim. VAR, identification as in Foroni et al. (2018a, table 3)

horizon: 10 years (40 quarters), point-wise medians and credible sets
Figure 16: Impulse responses, 5-dim. VAR, without price restriction on labor supply shock

horizon: 10 years (40 quarters), point-wise medians and credible sets