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Do Corporate Credit Conditions Alter Labor Market Dynamics? A SVAR Analysis in a Transatlantic Perspective

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Abstract

The purpose of this paper is to establish the effects of credit and technological shocks on unemployment and vacancies in United-States and Germany. A structural VAR methodology is used in a macro-econometric setting to achieve this. Shocks are identified based on the assumption that working capital is paid in advance of production as it is assumed in various theoretical papers. The results show that technological shocks have a positive impact on employment and vacancies in both countries, with a larger impact in United-States than in Germany. Credit shocks appear to affect differently both countries. In United-States, a positive credit shock leads to an increase in employment and vacancies, while in Germany the opposite effect is obtained for employment and vacancies, even if the impact on vacancies is insignificant. A common view widespread today is to consider that more credit in one economy will be the source of better labor markets conditions as it eases external financial constraints. My empirical results suggest that this view can be challenged and discussed as an increase in the level of credit in an economy does not necessarily lead to a better conditions on labor markets. Finally, a credit shock has a quite strong positive impact on output in United-States, whereas this impact is also positive for Germany but weaker and not significant, consistent with the idea that credit conditions is not sufficient to improve economic situations in this country.

JEL classification: E24

Keywords: SVAR, credit shocks, productivity shocks, labor market dynamics

1 Introduction

The Great Recession is associated with a sharp disruption in credit markets together with a marked deterioration in labor markets in a lot of developed countries. However, differences are observed between countries,

especially between two countries that are Germany and the United-States. The relationship between credit market conditions and labor markets is commonly seen as being positive, meaning that better credit market conditions lead to better labor markets conditions. Theoretical papers (Monacelli et al. (2011), Perri and Quadrini (2011), Zanetti et al. (2013), Iliopoulos et al. (2014), Petrosky-Nadeau (2014), Garin (2015)) are showing this result for the United-States. However, from a strict empirical point of view, it has not been yet found, especially for other countries than the United-States.

This paper aims to investigate the patterns of unemployment and vacancies dynamics in Germany and in United-States after a technological and a credit shock. So the paper is presenting evidence on labor market dynamics in each country and compares them by using a structural VAR model. The labor market dynamics vary substantially, in terms of magnitude, persistence, signs and significance, with the identified shocks depending on the country considered.

I find that technological shocks turn out to be relatively important for variations in unemployment and vacancies in both countries, leading to an increase of vacancies and a decrease of unemployment. The effect is more persistent and stronger for the United-States than for Germany. Finally, technological shocks impact positively the credit in both countries, even if it is not significant for Germany and quite weak and short lasting for the United-States.

For credit shocks, I find that they affect differently both countries. In United-States, a positive credit shock leads to an increase in employment and vacancies, while in Germany the opposite effect is obtained for employment and vacancies, even if the impact on vacancies is insignificant. A common view widespread today is to consider that more credit in one economy will be the source of better labor markets conditions. My empirical result suggests that this view can be challenged and discussed as an increase in the level of credit in an economy is not necessarily the source of a better situation in labor markets. Finally, a credit shock has a quite strong positive impact on output in United-States, whereas this impact is also positive for Germany but weaker and not significant, consistent with the idea that credit conditions is not sufficient to improve economic situations in this country.

First, to motivate the empirical analysis, I consider the following graphs. They depict the correlation between unemployment rate, vacancies and non-financial corporations credit between 1952:Q1 and 2014:Q4 for the United-States and 1971:Q1 and 2014:Q4 for Germany¹. For the United-States, a negative correlation (-0.38) between unemployment and corporations credit is found, as well as a positive correlation (0.33) between vacancies and corporations credit. The higher is the growth of credit for corporations in United-States, the lower is

¹Details on data are found in section 3 or in appendix A.

the unemployment rate and the higher are job vacancies. The relationship between these variables for Germany appears to be null for unemployment and corporations credit, and slightly positive for vacancies and corporations credit. It brings to ask whether corporate credit conditions alter always labor market dynamics in every countries, especially in Germany and in the United-States.

Figure 1: Unemployment, job vacancies and non-financial corporations credit growth between 1952-Q1 and 2014-Q4 for United-States

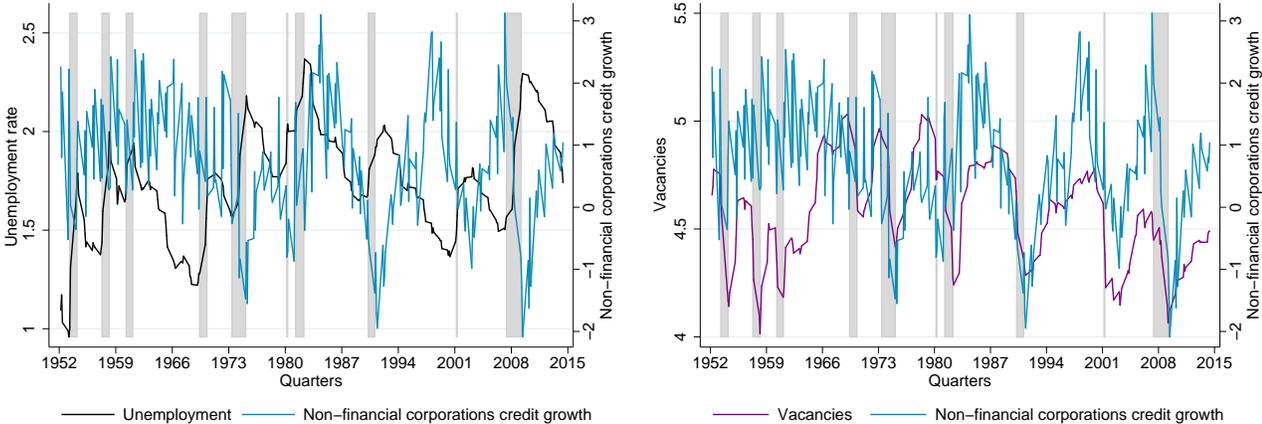
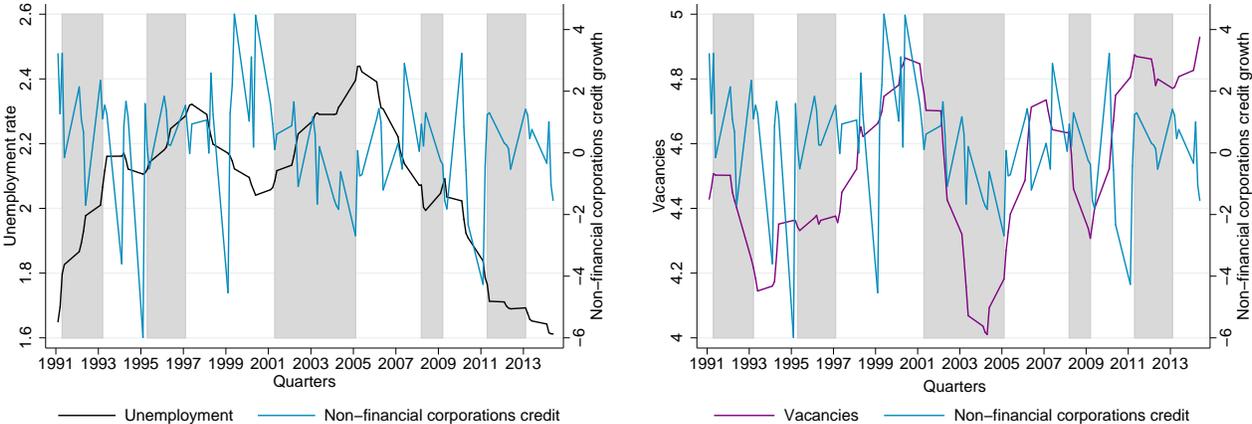


Figure 2: Unemployment, job vacancies and non-financial corporations credit growth between 1991-Q1 and 2014-Q4 for Germany



Germany is a country worth to consider due to availability of data and due to differences in labor market structures compared to the United-States. [Bachmann and Balleer \(2010\)](#) are also comparing Germany and United-States to determine the effects of technological shocks on labor market dynamics. They find significant differences between these two countries. [Sala et al. \(2013\)](#) investigate also differences across countries about labor market dynamics after the Great Recession. They show that Germany follows different dynamics compared to other countries and especially the United-States. From an empirical point of view, they show that unemployment in Germany tends to decline since 2005, as we observe on the previous graph, with just a relatively small increase during the crisis, at least compared to the United-States. Unemployment is even lower than before the

financial crisis. The authors claim that these countries may have been hit by different types of shocks, especially by the risk-premium shock. I investigate in this paper the role potentially played by a so-called credit shock defined latter.

To this purpose, I use a structural vector-autoregressive model where restrictions are imposed on the response of variables on each other based on an underlying VAR model with the objective to obtain a causal meaning with impulse response functions and variance decomposition. To identify properly each shock, I propose short-term restrictions that are based on assumptions made in various recent theoretical papers ([Kiyotaki and Moore \(1997\)](#), [Monacelli et al. \(2011\)](#), [Perri and Quadrini \(2011\)](#), [Jermann and Quadrini \(2012\)](#), [Zanetti et al. \(2013\)](#), [Iliopoulos et al. \(2014\)](#), [Petrosky-Nadeau \(2014\)](#), [Garin \(2015\)](#)), claiming that external financing is necessary prior to production to pay in advance working capital. Hence, the level of corporations credit in one economy is seen in those models as essential to enable firms' hiring and to determine the level of employment in the economy. I propose to confront this assumption to empirical data by considering two countries that have different institutional environment, both on labor markets as on credit markets.

2 How corporate credit conditions may alter labor market dynamics?

Corporations are using credit to finance their production costs in advance. They have to pay for vacancies posting costs and wages in particular for labor markets. A high credit level in one economy can be the source of higher employment and lower job vacancies as firms can finance externally easily costs linked to recruitment and wages. However, a high credit level in one economy can reflect as the same time a higher external financing dependency that can be seen by entrepreneurs as a risk for their financial structure. As a consequence they can decide to reduce their employment and to post lower vacancies so as to restore their financial situation. Furthermore, in a Keynesian point of view, a high credit level does not necessarily imply more hiring if corporations are not anticipating higher demand in the future.

Two opposite view in face of credit conditions are thus considered. The one that sees the credit as a way to relax the financial constraint on firm that has to be used to develop the economic activity in fine. This view appears to be widespread today and theoretical models show this result for the United-States, inviting to consider the credit level as a tool or as an indicator of economic well-being. Another view is to see the credit as a way to relax the financial constraint, as well as a signal to be cautious in the management of the labor force as the external financing dependence increase. It could lead to not increasing employment or job vacancies, or even to reduce them to reimburse previous loans, or to invest more in capital for example, if the labor market institutions are not enough flexible to ensure in the future an adjustment. As observed since the Great Recession, a high level

of credit in an economy do not lead necessary to an increase of employment. It could be the sign of a higher financial fragility.

3 Data description

Data used are quarterly data for the period 1952 – 2014 for the United-States and for the period 1991 – 2014 for Germany². The time period difference is due to data availability for Germany and to avoid the structural break due to reunification.

For the United-States, the unemployment rate is the civilian unemployment rate from the Bureau of Labor Statistics (BLS). It corresponds to the number of unemployed as a percentage of the labor force. Vacancies are the index of help-wanted advertising in newspapers and online from the paper of [Barnichon \(2010\)](#), divided by a labor force index. Unemployment rate and vacancies are both expressed in logarithm. The real output is the real gross domestic product, billions of chained 2009 dollars from the US. Bureau of Economic Analysis (BEA). It is divided by the labor force index and expressed in first-difference of logarithm. The non-financial corporations credit data are obtained from the BIS total credit statistics³. Data are divided by price level and labor force index and expressed in first-difference of logarithm. Finally, the price level is the GDP deflator from the BEA.

For Germany, unemployment rate is the unemployment rate for persons aged 15 and over from the Organization for Economic Cooperation and Development (OECD). It corresponds to the number of unemployed as a percentage of the labor force. Vacancies correspond to an index based on the total unfilled job vacancies from OECD⁴, divided by a labor force index. Unemployment rate and vacancies are both expressed in logarithm. The real output is the real gross domestic product, billions of chained 2010 euros from Eurostat. It is divided by labor force index and expressed in first-difference of logarithm. The non-financial corporations credit data are obtained from the BIS total credit statistics. Data are divided by price level and labor force index, and expressed in first-difference of logarithm. Finally, the price level is the GDP deflator from Eurostat.

As a preliminary check, I verify that series are stationary. Results of the augmented Dickey-Fuller tests are in

²See appendix A for data definitions and sources.

³From the BIS, credit is provided by domestic banks, all other sectors of the economy and non-residents. Non-financial corporations (both private-owned and public-owned) are defined according to the System of National Accounts 2008. In terms of financial instruments, credit covers loans and debt securities. The series have quarterly frequency and capture the outstanding amount of credit at the end of the reference quarter.

⁴From OECD, the job vacancies data provide estimates of the number of unfilled job vacancies. Series give an indication of the labor demand.

appendix C for variables expressed either in level or in first-difference. I include a number of lagged differences according to the Schwarz and Hannan-Quinn information criteria to eliminate serial correlation in the error terms of the Dickey-Fuller regression. When data show a clear trend, I use the trend option. Phillips-Perron tests lead to similar conclusions. All series of variables used in the VAR are shown to be stationary as the tests do not detect the presence of unit roots⁵.

4 Empirical model

I investigate the importance of credit and technological shocks empirically for two countries that have different economic institutions, namely the United-States and Germany. I use a four dimensional SVAR model (integrating the credit to non-financial corporations, real output, unemployment and vacancies) to achieve this by using a framework with a minimum of theoretical assumptions. Thus, it enables to address different ideas concerning the sources and patterns of labor market dynamics.

First, I specify the VAR model and then, I identify structural shocks based on theoretical assumptions. Indeed, unrestricted VAR is on reduced form and innovations generated are thus uninterpretable. So to go from the reduced form to a structural model, identifying restrictions has to be imposed on the variables of the model. So I develop a structural VAR where identifying restrictions are based on a structural assumption usually made in macroeconomic theory, meaning that working capital are paid in advance of production. As a consequence, this assumption can trigger new empirical insight on the relationship between labor and credit markets.

4.1 VAR specification

The labor market dynamics of a country is assumed to be given by the dynamic system whose structural equations are:

$$A_0 X_t = \alpha + \sum_{i=1}^p A_i X_{t-i} + \epsilon_t \quad \text{Var}(\epsilon_t) = \Sigma \quad (1)$$

where A_0 is an invertible ($n \times n$) matrix describing instantaneous relations among variables; X_t is a ($n \times 1$) vector of stationary endogenous variables; α is a vector of constants; A_i is a ($n \times n$) matrix of coefficients and ϵ_t is the vector of exogenous uncorrelated or orthogonal structural shocks to each variable. Σ is the matrix of variance-covariance of structural disturbances.

The vector of endogenous variables is defined as:

⁵However, as tests for unemployment and vacancies for Germany appear to be less significant, I test the results in robustness check for the inclusion of unemployment and vacancies in first-difference.

$$X_t = \begin{pmatrix} \Delta c_t \\ \Delta y_t \\ u_t \\ v_t \end{pmatrix}$$

and accordingly, the vector of the orthogonalized disturbances:

$$\epsilon_t = \begin{pmatrix} \epsilon_{c,t} \\ \epsilon_{y,t} \\ \epsilon_{u,t} \\ \epsilon_{v,t} \end{pmatrix}$$

In my benchmark specification, I include as variables for the VAR of each country the first-difference of the log of non-financial corporations credit (Δc_t), the first-difference of the log of the real output (Δy_t), the logs of unemployment rate (u_t) and vacancies rate (v_t)⁶. The use of first differences is determined by unit root tests whose results are found in appendix C. The augmented Dickey-Fuller (ADF) test indicates indeed a non-stationary behavior of non-financial corporations credit and real output for both countries.

In comparison with an unrestricted VAR, an additional matrix A_0 of parameters appears. It multiplies the vector of contemporaneous endogenous variables X_t and enables contemporaneous relationships between variables. From the structural equations (1), I consider the following reduced-form VAR model of order p :

$$X_t = \delta + \sum_{i=1}^p B_i X_{t-i} + e_t \qquad \text{Var}(e_t) = A_0^{-1} \Sigma (A_0^{-1})' \qquad (2)$$

where $\delta = A_0^{-1} \alpha$ is a vector of constants, $B_i = A_0^{-1} A_i$ and $e_t = A_0^{-1} \epsilon_t$. e_t is a $(n \times 1)$ vector of error terms.

Although estimating the equations of a standard VAR does not imply strong identification assumptions, computing impulse response functions or variance decomposition require identifying restrictions. A typical restriction takes the form of an assumption about the dynamic relationship between variables. So I have to transform the residuals from the reduced form VAR into structural residuals such that they can be interpreted. I define now the short-term restrictions based on theoretical assumptions to be able to interpret the results.

⁶See again appendix A for exact definitions and sources of variables.

4.2 Identification of shocks

The conditional distribution of X_t is completely characterized with the reduced-form VAR. The structural form of the model has thus n^2 additional parameters compared to the reduced form coming from the matrix A_0 . An identification problem appears. Indeed, given values of the reduced form parameters $\delta, B_i, Var(e_t)$, it is not possible to uniquely solve the system for the structural parameters α, A_0, A_i, Σ . To go from the reduced form to the structural one, n^2 identifying restrictions have to be imposed.

More precisely, innovations e_t from the reduced-form VAR are typically correlated. It represents the unpredictable shock in each endogenous variable of X_t . So they could be correlated with one another because of contemporaneous causal relationships for example or because exogenous structural shocks are correlated with one another. It is as a consequence not possible to interpret them as structural shocks. Identifying restrictions are thus necessary.

The matrix A_0 relates the structural shocks to the reduced-form innovations:

$$A_0 e_t = \epsilon_t \tag{3}$$

So A_0 represents the immediate effects of shocks on X_t .

The aim of the paper is to provide evidence on unemployment, vacancies dynamics in response to technological and credit shocks. The identification of the structural shocks is done through the imposition of zero short-term restrictions. Short-run restrictions contain assumptions about contemporaneous relations between shocks and variables and are thus imposed on matrix A_0 ⁷.

It is now common to normalize the main diagonal of A_0 to 1 and to consider Σ as being a diagonal matrix. It ensures that each variables of X_t is allocated to its own structural equation and allows to give an economic interpretation to each shock. With this 10 restrictions of normalization, I have to find $\frac{n(n-1)}{2}$ other restrictions to identify technological and credit shocks.

I define in the benchmark model the following matrix A_0 :

$$A_0 = \begin{pmatrix} 1 & 0 & 0 & 0 \\ a_{yc} & 1 & a_{yu} & a_{yv} \\ a_{uc} & 0 & 1 & a_{uv} \\ a_{vc} & 0 & 0 & 1 \end{pmatrix}$$

⁷Long-run restrictions are imposed on impulse responses.

By imposing that some of the elements of A_0 are zero, I am assuming that some of the orthogonalized disturbances have no immediate impact on some of the variables. To identify properly a four dimensional system, I need at least six restrictions. So I need to impose that at least four elements are zero. To build the short-term restrictions, I use the following assumption: credit is necessary for firms to pay in advance of production the production costs, especially the hiring costs as well as wages. However, it is where credit frictions occurs and financial constraints may appear as a consequence. So a credit shock may have a direct and immediate impact on the level of employment, vacancies posting and thus on real output. It is a fundamental assumption made here, stipulating that an exogenous shock on credit has a direct impact on labor market variables as the credit is used immediately to finance working capital. The identification scheme assumes that credit is predetermined and does not react to other shocks in the model within the same quarter. It depends only on its own history and on lagged values of other variables.

Thus, I propose as short-term restrictions consistent with this assumption, leading to the previous matrix:

1. Credit conditions evolve exogenously, technological and other shocks cannot affect contemporaneously the credit. Therefore, $a_{cy} = a_{cu} = a_{cv} = 0$.
2. Innovations to productivity affect credit, unemployment and vacancies with one period lag. So $a_{uy} = a_{vy} = 0$.
3. The residual shocks to employment and vacancies are identified using a non-structural triangular restriction that requires that $a_{vu} = 0$.

These restrictions enable to interpret $\epsilon_{y,t}$ as innovations to technology, $\epsilon_{c,t}$ as innovations to the availability of credit, $\epsilon_{u,t}$ and $\epsilon_{v,t}$ as innovations to unemployment and vacancies⁸.

No restrictions are imposed on the effect of credit shocks on real output, vacancies and unemployment to not exclude short-term effects from credit shocks on the real economy as it may be when producers adjust their working capital depending on their access to external financing.

Thus, unemployment is allowed to respond contemporaneously to innovations in credit and vacancies. There is no contemporaneous impact of output, unemployment and vacancies on credit. Output responds contemporaneously to innovations to credit, unemployment and vacancies. Finally, vacancies react contemporaneously to innovations in credit only.

I do not impose more restrictions that required by the just identification necessity⁹.

⁸An other way to obtain a just-identified system is to assume for residual shocks that $a_{uv} = 0$. Results based on this alternative identification scheme are similar as shown in robustness analysis.

⁹Sims (1980) considers in his famous critic that over-identifications are entirely unrealistic.

5 Results

The results are based on an optimal lag order of $p = 2$ for both countries. Appendix C delivers the results of the selection criteria (final prediction error (FPE), Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC), and the Hannan and Quinn information criterion(HQ)) that lead to choose this lag length. However, for the United-States tests are also selecting a higher lag order of 4. As a consequence, in robustness analysis, I discuss the results for 4 lags.

5.1 Impulse Responses

Impulse responses illustrate the dynamic response of a variable to a structural shock. The impulse are normalized to a one standard deviation in the underlying variable. Responses of the labor market variables are presented in percentage points.

Technology shock.

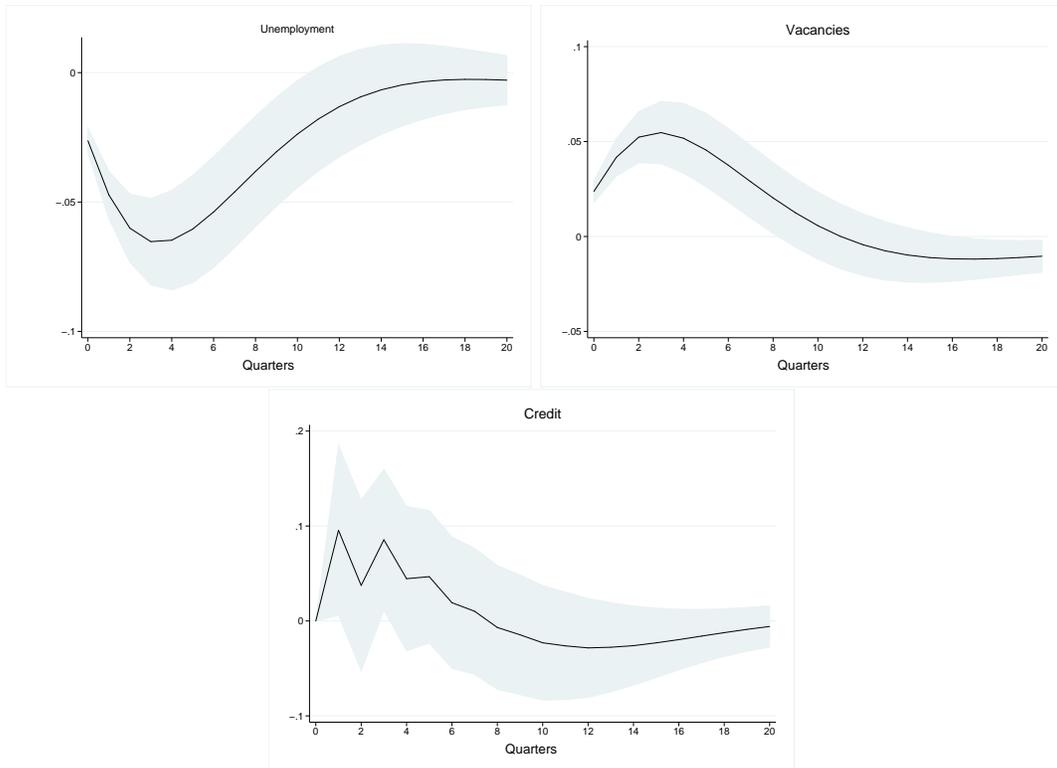


Figure 3: United States - Orthogonalized IRF to a positive technological shock

Figures 3 and 4 show dynamic responses to a technological shock of unemployment and vacancies for the United-States and Germany.

In United-States, a positive technological shock (increase in the real output) lowers unemployment for 3 years. The effect is largest after one year where the one standard error technological shock reduces unemployment by

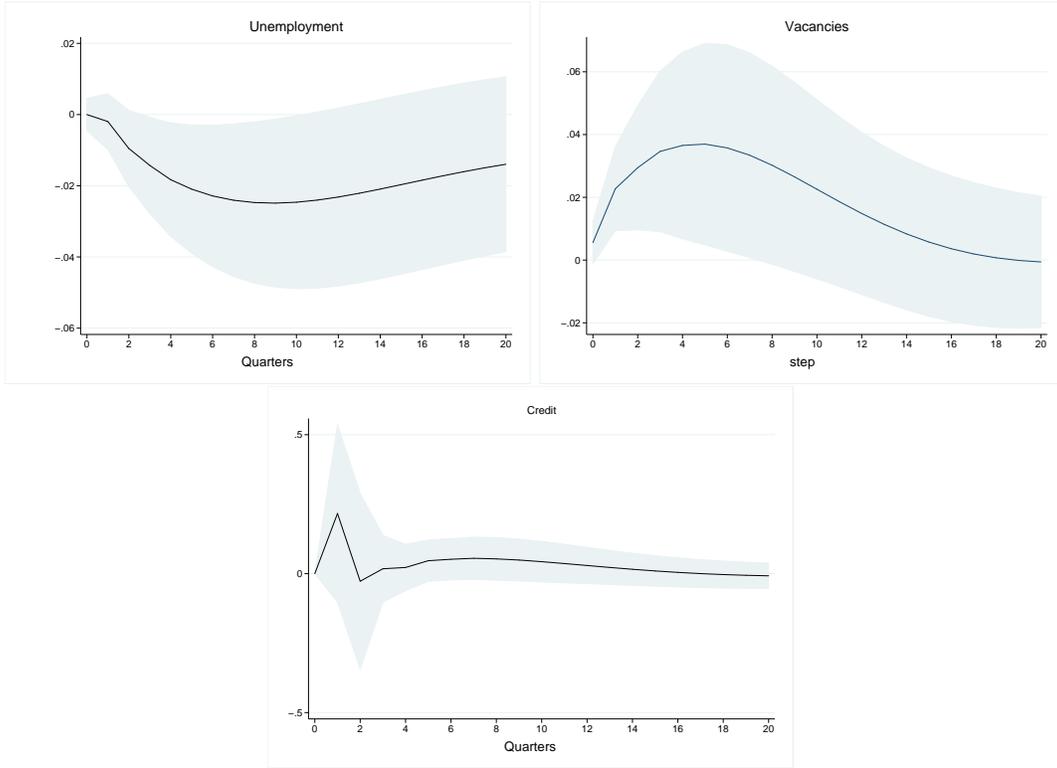


Figure 4: Germany - Orthogonalized IRF to a positive technological shock

0.05 percentage point (pct). The effect hereafter dies out. This shock increases vacancies for 2.5 years with a peak at 3 quarters, where the shock increases vacancies by 0.06 percentage point. The effect hereafter dies out. For the response of non-financial corporations credit, technological shock triggers a significant slight increase of one quarter. However, as the one standard error band includes zero and becomes wider with the horizon increase, this result may not be significant in the long run.

For Germany, the sign of results are similar even if one standard error bands are larger. After a technological shock, unemployment decreases for almost 3 years with a peak at 2 years (-0.025 pct). For the two first quarters, the response of unemployment is borderline significant. [Nordmeier and Weber \(2013\)](#) find also that the unemployment rate goes down after a positive technological shock. Vacancies increase for two years after the shock with a peak one year and half at nearly 0.04 pct. Both effects on unemployment and vacancies die out hereafter. Finally, as for the United-States, the impact on non-financial corporations credit is ambiguous as the one standard error band includes zero.

The mechanisms are the following consistent with standard Real Business Cycle models integrating search and matching frictions. A positive technological shock increases the expected profits from a match such that firms decide to post more vacancies and unemployment decreases as a consequence of the increase of labor

market tightness from the firm point of view.

Credit shock. Figures 5 and 6 present the dynamic adjustment process after a positive credit shock, implying an increase of non-financial corporation credits.

Vacancies and employment increase after a positive credit shock in the United-States. A shock that increase the availability of credit positively affects the entire economy in that corporations have a higher access to credit to finance job vacancies and employment, and this leads to an increase in production and hence the gross domestic product increase with an immediate peak at 0.3 pct. The unemployment decreases significantly until 5 quarters in response to a rise in the non-financial corporations credit and it then adjusts gradually to the steady state.

For Germany, a positive credit shock leads to an increase in unemployment and a decrease in vacancies. The response of unemployment is significant for almost five quarters and is quite persistent, while the response of vacancies is insignificant, suggesting to not overstate the impact of credit shock on vacancies in Germany, but I can notice that the response is shown to be negative. Finally, the impact of a positive credit shock on the output in Germany is surprisingly insignificant, even if the impact is positive but weaker compared to the result founded for the United-States.

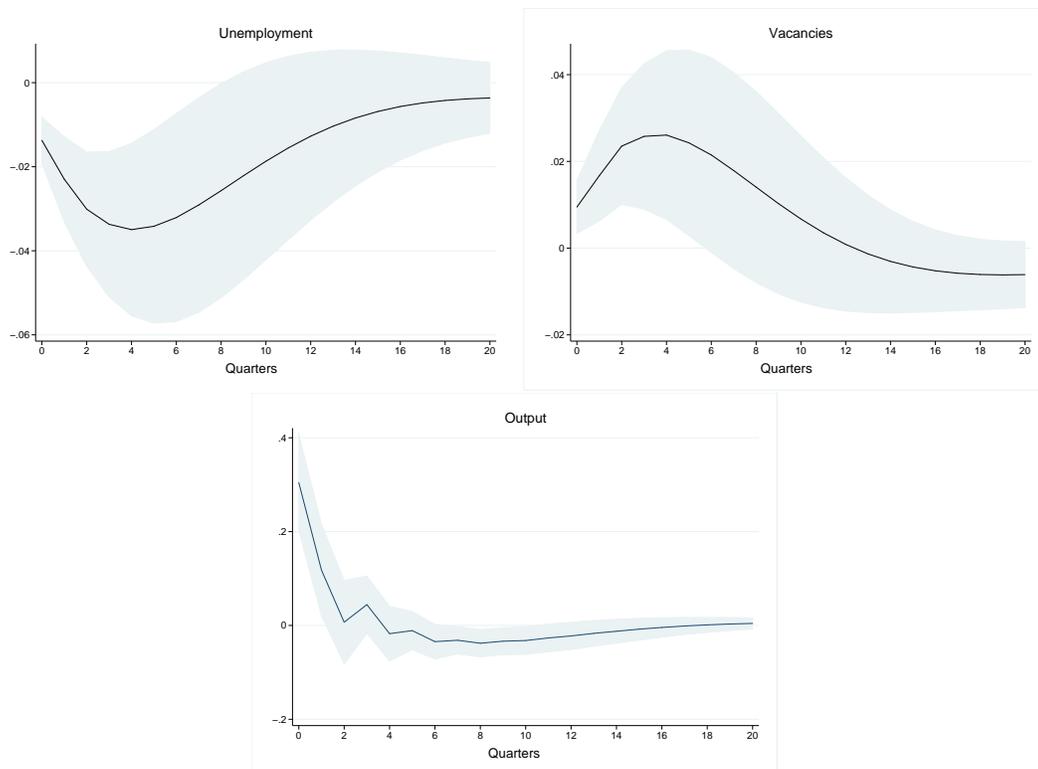


Figure 5: United States - Orthogonalized IRF to a positive credit shock

Sala et al. (2013) find a similar result where Germany appears to have been less directly hit by financial

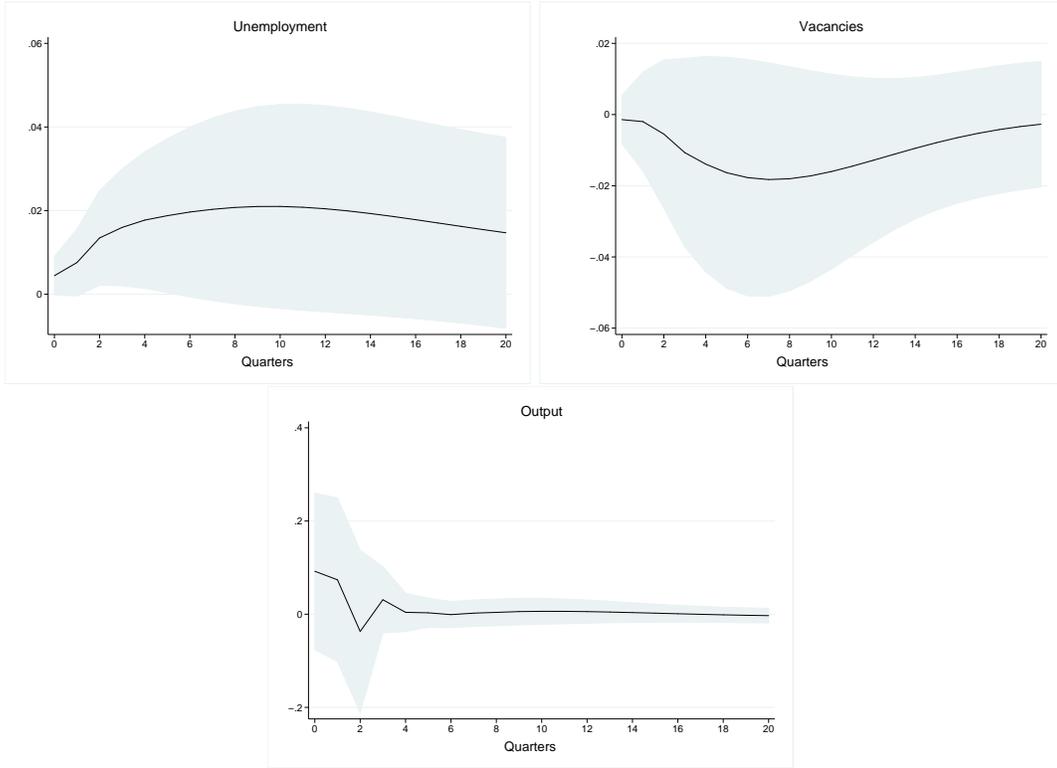


Figure 6: Germany - Orthogonalized IRF to a positive credit shock

shocks than United-States.

Finally, I plot the cumulative effect of a permanent shock to real output and non-financial corporations credit¹⁰. For United-States, a permanent positive shock of one standard deviation to real output causes unemployment to be about 0.4 percentage points lower. This magnification comes from two effects. First, shocks to technology tend to persist for periods after the shock, so unemployment decreases more as a result. Second, a positive shock to technology increases employment, which feeds back positively on real output. Then, a permanent positive shock to real output causes vacancies to be about 0.15 percentage points higher. For the credit, the impact is about 0.4 percentage points but not significant anymore after 4 quarters.

For Germany, a permanent positive shock of one standard deviation to real output triggers unemployment to be about 0.3 percentage point lower and vacancies 0.3 higher. Results for credit are not significant. A permanent shock to credit has a significant negative impact on unemployment of 0.3 percentage points in United-States and a positive impact on vacancies of almost 0.2 percentage points, whereas for Germany, it leads to a significant positive impact on unemployment of 0.3 percentage points and no significant impact on vacancies, even if the impact is negative.

¹⁰Figures are found in appendix D.

High levels of credit in an economy are surely a tool for American firms to recruit more and it leads to an increase in real output thanks to new production that is possible. However, for Germany according to our results, the effect of credit on labor market and on output is not clear. I find no significant impact of credit on output, nor on vacancies. I find however a significant positive impact on unemployment.

On the other side, a positive technological shock is found to have a statistically significant negative impact on unemployment in both countries, higher in United-States, and a significant positive impact on vacancies. For both countries, no significant impact (except a positive one for the United-States) of a technological shock on credit is found.

5.2 Variance Decomposition of Unemployment and Vacancies

The variance decomposition of the forecast errors establishes the relevance of shocks for variations in unemployment and vacancies. It shows the extent to which shocks contributes to unexpected movements in each variables.

Tables 1 and 2 give the proportions of variations in unemployment and vacancies due to the two different structural shocks. The two shocks account for respectively approximately 20% and 18% of the forecast error variance in unemployment and vacancies in Germany, and for respectively 61% and 36% of the forecast error variance in unemployment and vacancies in United-States. In both countries, technological shock plays a key role.

A technological shock has only a small effect on unemployment initially in Germany. However, after two years, technological shock explain 11.4 pct. of the unemployment fluctuations in Germany, increasing to 13 pct. after 3 years.

In the short term, technological shock is the most important source of labor market fluctuations in United-States with 33-45 pct. of the variance in unemployment explained the first year, and 23-35 pct. of the variance in vacancies. The relative contribution of technological shock continues to increase until 2 years and then begins to decline slowly. Especially for unemployment dynamic in United-States credit disturbances become more important with the forecast horizon, reaching 15.3 pct. However, for vacancies dynamics, the impact is surprisingly almost negligible (less than 1 pct.).

Hence, between both countries, the positive effects of a credit shock on unemployment and vacancies appear larger in the United-States than in Germany. This large contribution of credit shocks to the United-States economy stands in coherence with the way firms are financing their working capital in both countries. The structure of economies play probably an important role for the macroeconomic adjustments to credit shocks. A

country where firms have a low dependence to external financing may suffer less from a credit shock. Germany seems to use the lever of the credit as a way to reduce their working capital to face future periods of difficulties.

Table 1: Forecast error variance decomposition for Germany

Forecast horizon	Unemployment		Vacancies	
	Techn. shock	Credit shock	Techn. shock	Credit shock
1	3.8e-08	3.744	2.7416	0.1769
2	0.2422	4.8395	11.6231	0.1251
3	2.9165	7.9704	13.303	0.3369
4	5.5232	9.4975	14.2708	0.8195
8	11.4518	10.4231	15.4623	2.5239
12	13.0614	10.5995	15.803	3.643
16	13.5164	11.0323	15.8102	4.1463
20	13.5916	11.4518	15.7422	4.2686

Table 2: Forecast error variance decomposition for United-States

Forecast horizon	Unemployment		Vacancies	
	Techn. shock	Credit shock	Techn. shock	Credit shock
1	33.3495	9.0572	23.0065	0.36479
2	39.8723	9.7548	29.8035	0.47706
3	43.1568	10.708	33.7515	0.61736
4	44.9307	11.4704	35.6363	0.70329
8	46.9259	13.9232	36.4409	0.88127
12	46.7163	15.1946	35.1079	0.89746
16	46.0845	15.4617	34.7019	0.87743
20	45.4726	15.3838	34.7127	0.8777

6 Robustness analysis

This section tests the previous results along various dimensions. First, I address some data issues by considering unemployment and vacancies in first-difference, labor productivity instead of real output and non-financial corporations credit as a percentage of the GDP. Then, I proceed by modifying the lag length. Finally, I inspect the identifying assumption.

Data definitions. Because the ADF test cannot reject optimally the null hypothesis of non stationnarity for the unemployment and vacancies in Germany¹¹, I check the results by including these variables in first-differences. Results are available upon request. For Germany, signs are not changing. However, I loose completely the

¹¹The null hypothesis can be rejected at the 5% level.

results significance. By computing the cumulative impulse response functions, I find some significant results for the impact of a technological shock on vacancies and unemployment as found previously. For the United-States, results are in line of what previously obtained being significant.

Then, I use another definition than the real output by considering the labor productivity. For the United-States¹², it corresponds to the first-difference of the logarithm of the real GDP divided by the product of the average hours per worker in the non-farm business sector and the employment population¹³. I obtain the same results. No significant change can be observed.

For Germany, I use as labor productivity the real labor productivity per hours worked from Eurostat. I limit the analysis to 2014:1 due to data availability. I obtain the same signs for results, even if they are again less significant.

Finally, I test the results by using the non-financial corporations credit as a percentage of the GDP from the BIS. Results obtained are also coherent with the previous one and available upon request.

Lag length. I re-estimate the benchmark model with a higher lag of $p = 4$ for the United-States, as suggested by three selection criteria.

The key results remain unchanged. The only notable change concerns the impact of a credit shock on unemployment that is more long-lasting. Indeed, the effect is significant until 14 quarters (compared to 9 quarters in the benchmark specification).

Sub-sample analysis. I investigate here the sub-sample stability of the preceding results. I restrict the data until the beginning of the crisis at the end of 2007¹⁴. The aim is to avoid the introduction of specific effects due to the Great Recession and to see how much this specific period played a key role. Responses for United-States do not change. However, for Germany, no result are significant (even for the technological shock), and responses of unemployment and vacancies to a credit shock change notably. I observe a slight decrease of unemployment (less than -0.01 pct. at the peak at 6 quarters) and an increase of vacancies (reaching a peak at 0.02 pct. at 4 quarters). As a consequence, it appears that the crisis may have modify the way firms are considering the credit in Germany.

¹²I test for two sources of labor productivity, comprising the first-difference of the logarithm of the real output per hour of all persons from the U.S Bureau of Labor Statistics. As results were similar, I choose to include here only one

¹³See appendix A for data definitions and sources.

¹⁴According to NBER recessions date. The Great Recession begins according to OECD recessions date in February 2008 in Germany. I decide to restrict the data for Germany also at the end of 2007.

Identifying assumptions. First, I test the following restrictions:

$$a_{cy} = a_{cu} = a_{cv} = a_{uy} = a_{vy} = a_{uv} = 0 \quad (4)$$

The results are absolutely identical for both countries.

Then, I tried other identifying strategies based on a different assumption. Credit is not pre-determined anymore and all other shocks can impact this variable. On the other side, credit shocks and other shocks cannot affect the level of the output within the same period. Finally, I test for various schemes for the last two other variables. However, either the regressions do not converge, or identification problems appear.

7 The effect of a credit shock on other macro variables

I investigate here the influence of a credit shock on other macroeconomic variables that are not initially in the benchmark model. I order this variable at last, meaning that they have no contemporaneous impact on other variables.

Consumption. For the United-States, consumption is defined as the personal consumption expenditures from the Bureau of Economic Analysis. For Germany, it corresponds to the private final consumption expenditure from OECD. Consumption is deflated and divided by labor force index to obtain real per capita consumption¹⁵. Four identifying restrictions have to be set to identify the five dimensional SVAR model. I make the following restrictions:

1. Consumption impacts other variables with one period lag. Therefore, $a_{cC} = a_{yC} = a_{uC} = a_{vC} = 0$
2. Consumption is affecting contemporaneously by all shocks.

The matrix A_0 becomes:

$$A_0 = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{yc} & 1 & a_{yu} & a_{yv} & 0 \\ a_{uc} & 0 & 1 & a_{uv} & 0 \\ a_{vc} & 0 & 0 & 1 & 0 \\ a_{Cc} & a_{Cy} & a_{Cu} & a_{Cv} & 1 \end{pmatrix}$$

Figures 7 and 8 show the impulse response of both shock on consumption for both countries for SVAR models of lags 2 according to selection criteria.

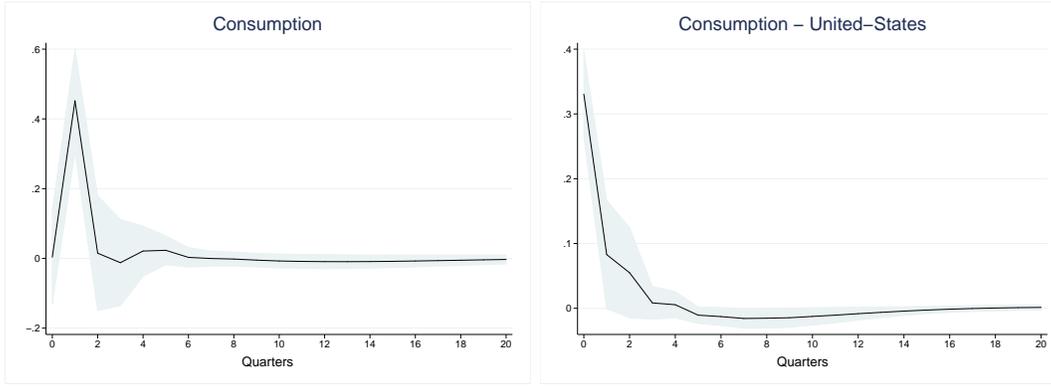


Figure 7: Orthogonalized IRF to a positive technological shock

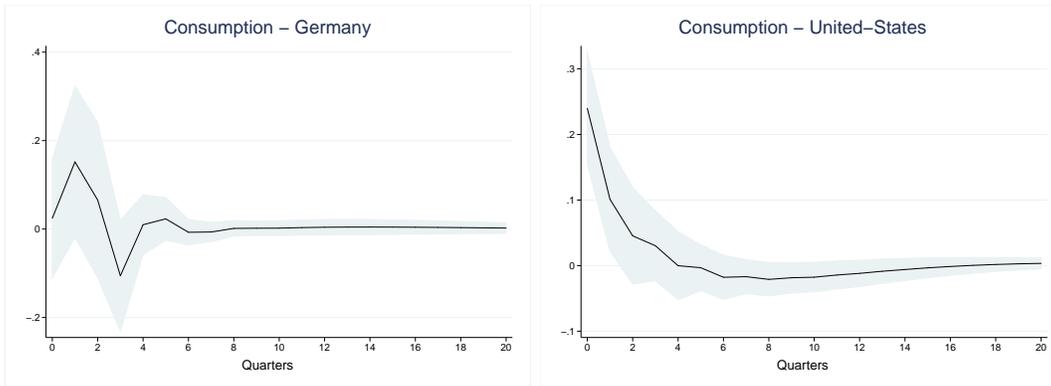


Figure 8: Orthogonalized IRF to a positive credit shock

In both countries a positive technological shock impacts positively consumption for 2 quarters. The effect quickly dies out. The effect reaches a peak at more than 0.4 percentage point (pct) for Germany and 0.3 for United-States. A positive credit shock has a positive significant impact for 2 quarters on consumption in United-States with a peak at more than 0.2 pct. For Germany, the impact is positive but insignificant, that is coherent with the previous findings on real output of a credit shock.

8 Conclusion

This paper investigates the labor market dynamics in Germany and United-States after a technological and a credit shock. Higher levels of non-financial corporate credit have various impact on labor markets depending on countries. In United-States, a positive credit shock has a positive impact on the labor market, through a decrease of unemployment and an increase in vacancies. In Germany, a positive credit shock has a negative impact on the labor market, through an increase of unemployment and a decrease of vacancies, even if the impact on vacancies is insignificant. A common view widespread today is to consider that more credit in one economy will be the source of better labor markets conditions. My empirical result suggests that this view can

¹⁵Appendix A for data definitions and sources.

be challenged and discussed as an increase in the level of credit in an economy is not necessarily the source of a better situation in labor markets.

Appendices

A Data definitions and sources

Table 3: Definitions and sources of data - Germany

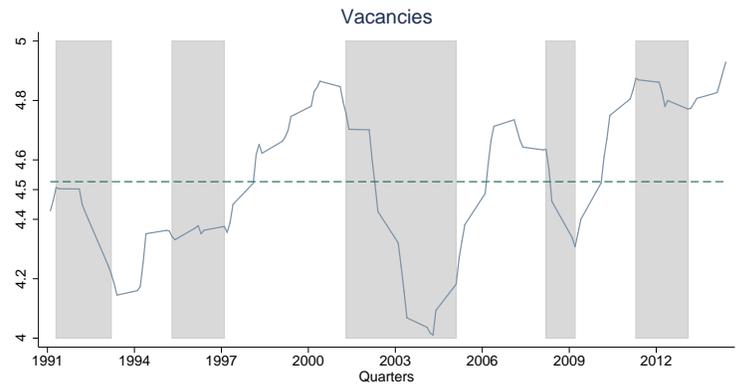
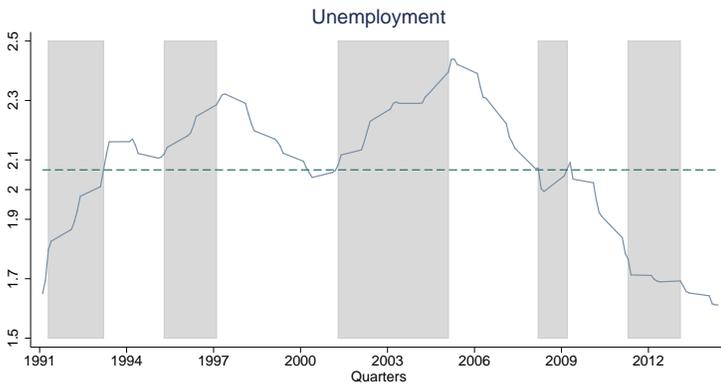
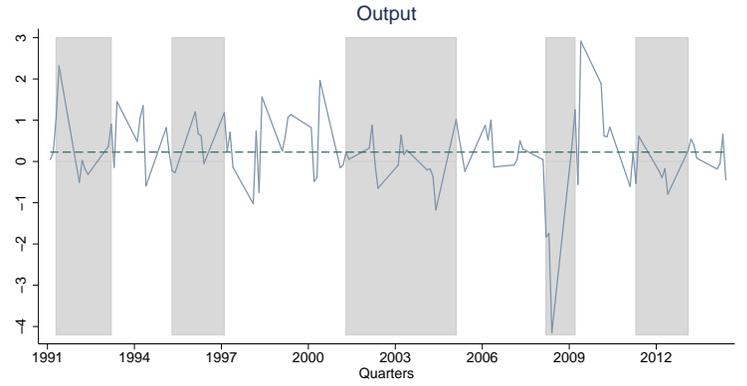
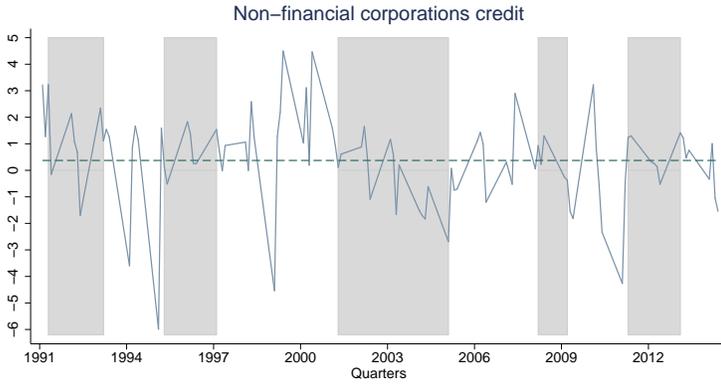
Variable	Definition	Source
Population	Index (2009:3=1) of the labor force aged 15 and above Seasonally adjusted (s.a)	OECD
Output	First difference of the logarithm of real gross domestic product Billions of chained 2010 euros divided by population, s.a	Eurostat
Unemployment	Logarithm of the unemployment rate, s.a	OECD
Vacancies	Logarithm of index of total unfilled job vacancies divided by population, s.a	OECD
Price level	Gross domestic product, Implicit price deflator 2010=100, s.a	Eurostat
Corporations credit	First difference of the logarithm of total non-financial corporations credit divided by price level and population, s.a	BIS total credit statistics
Labor productivity	First difference of the logarithm of real productivity of labor per hours worked 2010=100, s.a	Eurostat
Consumption	First difference of the logarithm of private final consumption expenditure divided by price level and population, s.a	OECD

Table 4: Definitions and sources of data - United-States

Variable	Definition	Source
Population	Index of civilian labor force aged 16 and above, s.a	BLS (LNS11000000(2009:3)=1)
Output	First difference of the logarithm of real gross domestic product Billions of chained 2009 dollars divided by population, s.a	BEA (GDPC1, A191RX1)
Unemployment	Logarithm of the civilian unemployment rate, s.a	BLS (LNS14000000)
Vacancies	Logarithm of index of help-wanted advertising in newspapers and online divided by population	Barnichon (2010)
Price level	Gross domestic product, Implicit price deflator 2009=100, s.a	BEA (GDPDEF, A191RD3)
Corporations credit	First difference of the logarithm of total non-financial corporations credit divided by price level and population, s.a	BIS total credit statistics
Employment	Civilian employment divided by population 16 and above, s.a	BLS (CE160V)
Average hours	Product of average weekly hours duration and employment Non-farm business index 2009=100, s.a	BLS (PRS85006023)
Labor productivity	First difference of the logarithm of real output divided by average hours	BLS
Consumption	First difference of the logarithm of personal consumption expenditure divided by price level and population, s.a	BEA (PCEC, DPCERC1)

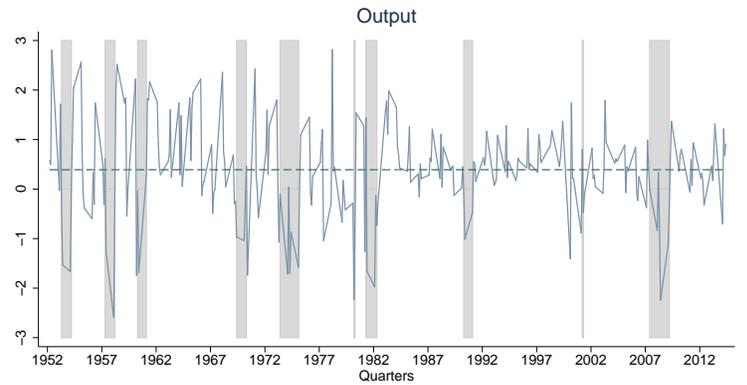
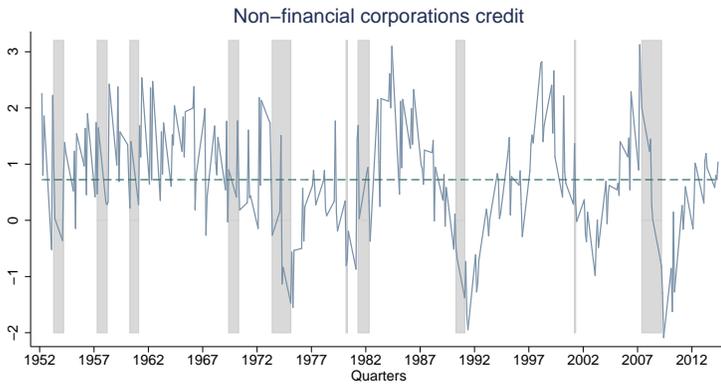
B Data description

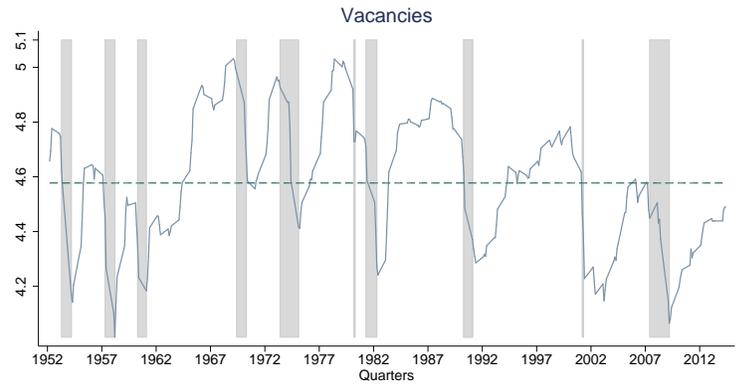
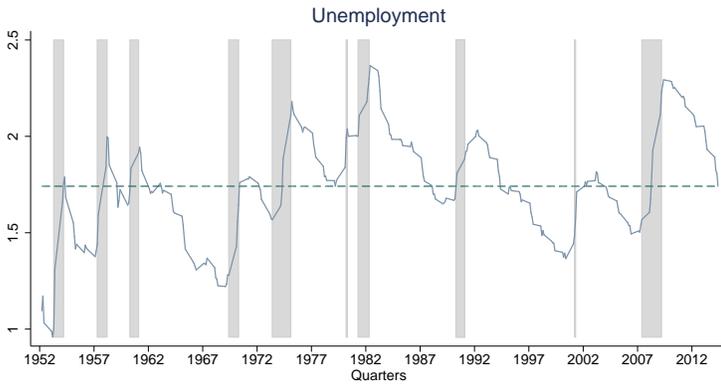
B.1 Germany



Notes: recession periods correspond to grey areas according to OECD Germany business cycle dates.

B.2 United-States





Notes: recession periods correspond to grey areas according to NBER US business cycle dates.

C SVAR Model Specification

Table 5: Augmented Dickey-Fuller (ADF) Tests for the United-Sates

	Level		First difference	
	Model Specification	Level	Model Specification	Test statistic
Credit	t, c, p = 3	-2.945	c, p = 2	-4.390***
Output	t, c, p = 3	-2.280	c, p = 2	-8.475***
Unemployment	c, p = 3	-4.472***		
Vacancies	c, p = 3	-4.536***		

Notes: The ADF regressions cover a number of lags (L) according to the Schwarz and Hannan-Quinn information criteria. Regressions may include a trend (t) and/or a constant (c). ***, ** and * indicate significance at the 1%, 5% and 10% levels.

Table 6: Augmented Dickey-Fuller (ADF) Tests for Germany

	Level		First difference	
	Model Specification	Level	Model specification	Test statistic
Credit	t, c, p = 2	-1.260	c, p = 2	-5.380***
Output	t, c, p = 2	-2.4	c, p = 2	-4.770***
Unemployment	c, p = 2	-3.891**		
Vacancies	t, c, p = 2	-3.695**		

Notes: The ADF regressions cover a number of lags (p) according to the Schwarz and Hannan-Quinn information criteria. Regressions may include a trend (t) and/or a constant (c). ***, ** and * indicate significance at the 1%, 5% and 10% levels.

Table 7: SVAR Lag Order Selection by Selection Criteria for United-States

Maximum Lag Length	LR	FPE	AIC	SBIC	HQ
2	2	2	2	2	2
4	4	4	4	2	2
6	6	4	4	2	2
10	10	4	4	2	2

Notes: LR = Likelihood ratio test statistics, FPE = Final prediction error, AIC = Akaike information criterion, SBIC = Schwarz bayesian information criterion, HQ = Hannan-Quinn information criterion.

Table 8: SVAR Lag Order Selection by Selection Criteria for Germany

Maximum Lag Length	LR	FPE	AIC	SBIC	HQ
2	2	2	2	2	2
4	4	2	2	2	2
6	5	2	2	2	2
10	9	2	2	2	2

Notes: LR = Likelihood ratio test statistics, FPE = Final prediction error, AIC = Akaike information criterion, SBIC = Schwarz bayesian information criterion, HQ = Hannan-Quinn information criterion.

D Cumulative impulse responses

D.1 Germany



Figure 9: Cumulative Orthogonalized IRF to a technological credit shock

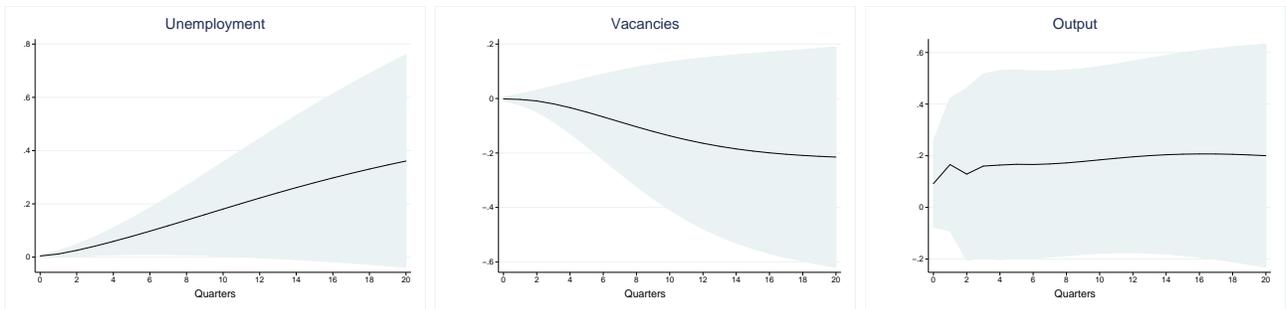


Figure 10: Cumulative Orthogonalized IRF to a positive credit shock

D.2 United-States



Figure 11: United-States - Cumulative Orthogonalized IRF to a positive credit shock

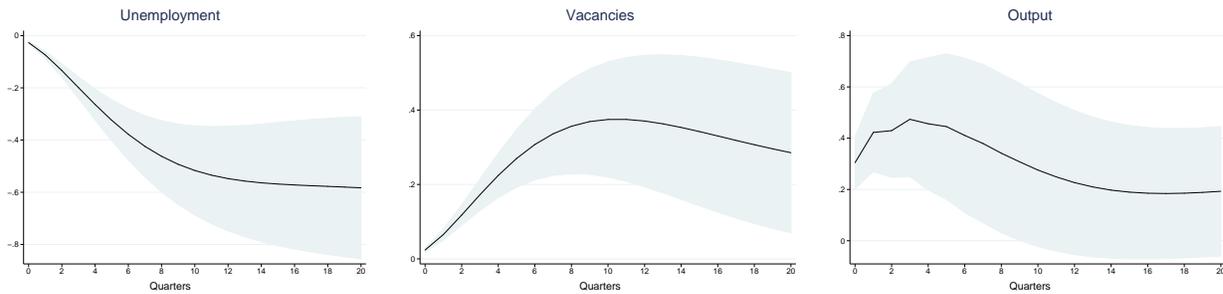


Figure 12: United-States - Cumulative Orthogonalized IRF to a positive credit shock

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