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A Allan, à Toni

A mes parents, à mon papi

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General introduction

> "The financial crisis of 2008 has thrown open the question of the interaction between capital and labour markets. Equilibrium matching models are built on the assumption of perfect capital markets. The implied arbitrage equations under perfect foresight and unlimited borrowing and lending are used to calculate a value for jobs and workers. These are good starting assumptions, and they have yielded important results. But future work needs to explore other assumptions about capital markets, and integrate the financial sector with the labour market." Christopher Pissarides, Nobel Prize Lecture (2010).

In decentralized economies, rational agents may have difficulties to meet on markets, to coordinate because of imperfect or incomplete information. They are led to anticipate behaviors of other economic agents to base their own decisions and actions. Imperfect information is at the roots of inefficiencies on different markets, especially in cases of asymmetric information.

The Great Recession highlighted potential interactions between labor and credit markets. As Christopher Pissarides noticed in 2010, these interactions have to be investigated deeply by economists taking into account the existence of frictions on those markets. The increase in unemployment rates in many countries following the Great Recession highlights the role that financial frictions (imperfect information on repayment capacity of borrowers) may play on labor markets. Labor markets are themselves subject to frictions between labor demand and supply (imperfect information on jobs characteristics, on jobs offer...) that may impact credit markets.

Due to imperfect information, frictions appear on credit and labor markets. These frictions would be the source of economic inefficiencies and could interact with each other to exacerbate theses inefficiencies.

Financial frictions have been a lot discussed in the literature (Bernanke and Gertler (1989), Bernanke and Gertler (1995), Bernanke et al. (1999), Carlstrom and Fuerst (1997), Carlstrom and Fuerst (2001), Fiore and Tristani (2013), Gertler et al. (2010) and Kiyotaki and Moore (1997) among others). These articles have been devoted to understand the relationship between financial markets and overall macroeconomic performances. Labor markets have been also considered as being frictional and thus integrated in macroeconomic models,

but without any financial frictions (Andolfatto (1996), Blanchard and Galí (2010), Campolmi and Faia (2011), Christiano et al. (2016), Christoffel et al. (2009), Galí et al. (2012), Gertler and Trigari (2009), Krause et al. (2008), Lechthaler et al. (2010), Merz (1995), Thomas and Zanetti (2009), Trigari (2009), Walsh (2005) among others).

However, as the Great Recession and Christopher Pissarides remind us, imperfect information and frictions exist on both markets. Macroeconomic models should integrate the whole frictions and analyze the various impacts of these frictions on macroeconomic performances. In this dissertation, I focus on a specific causality link, from credit markets to labor markets. My purpose is to analyze the impact of financial frictions on labor markets main variables, as wages, unemployment, vacancies, knowing that these labor markets are themselves frictional.

Furthermore, markets' institutions are crucial in terms of imperfect information level. Institutions are defined by North (1994) as:

> "the formal rules (constitutions, statute and common law, regulations...), the informal constraints (norms of behavior, conventions, and internally imposed codes of conduct), and the enforcement characteristics of each."

He adds that these institutions set the incentive structure of economies and define the way the "game is played." as institutions are the source of more or less information for economic agents. For examples, labor unions bring information to workers, or national employment agencies are aimed to ease the matching between employers and employees. Thus, they contribute to determine the equilibrium in which one economy will stand. And institutions could also modify the way economic agents react facing imperfect information. For example, if traditionally wages are bargained according to a right-to-manage regime, firms may use it to adapt themselves facing asymmetric information on credit markets. On labor markets, institutions are quite fundamental as they are often considered as a reason why labor markets are not functioning well.

Institutions on labor markets are numerous. One important institution worth to focus on is the degree of coordination of wage bargaining (Checchi and García-Peñalosa (2008), Amable et al. (2007)). In the literature, Trigari (2006) differentiate two degree of coordination in the bargaining process, the so-called efficient and right-to-manage bargaining.

Another fundamental institution on labor markets is the number and density of labor unions. In some countries, as Germany, there is a tradition of strong labor unions. For example, in Germany, in 2017 18% of workers were members of labor unions according to the OECD. In the United-States, in 2017 only 10% of workers were members of unions according to the Bureau of Labor Statistics.

As labor market institutions impact the level of information in one economy, as well as the way economic agents react to imperfect information, they influence labor markets frictions, and as a consequence, could interact with financial frictions. Depending on the institutional environment on labor markets, financial frictions may have different effects on frictional labor markets.

This brings up three questions:

- In an imperfect information environment, do financial frictions have an impact on labor markets? If so, through which mechanism does this impact take place?
- How different wage bargaining regimes modify the impact of financial frictions on labor market outcomes?
- From an empirical perspective, are there differences in labor market dynamics to credit shocks between Germany and the United-States (US)? How potential differences in labor market dynamics to credit shocks could be explained?

The imperfect information on credit and labor markets may bring to adverse interactions for the stability of economies and to mechanisms amplifying economic shocks. These particular interactions between the labor market and the credit market can take place through different channels of transmission. In particular, a shock in the credit market affecting the borrowing capacity of firms or the price of their credit may modify accordingly the search behavior of workers by firms and/or the level of unemployment in an economy. This is what we study in the first chapter of this dissertation. It is showed that financial frictions have an impact on the overall level of employment in an economy through a marginal cost channel. We develop a New-Keynesian DSGE model integrating asymmetric information in the credit market à la Bernanke et al. (1999) and a search and matching process in the labor market à la Mortensen and Pissarides (1994) associated with a Nash bargaining process.

Asymmetric information on labor and credit markets are fundamentally linked to the institutional environment of each economy. The bargaining regime is part of this institutional environment: laws for example may determine which bargaining regime will take place. This wage and employment bargaining regime can alter the degree of labor markets inefficiencies. The second chapter shows that financial frictions create a financial mark-up, which can be added to another mark-up related to imperfections in the labor market according to the existing regime of wage bargaining, either an efficient or a right-to-manage bargaining.

Finally, the last chapter challenges some previous results. It emphasizes that labor market institutions change the way credit shocks affect labor markets. In some countries, with specific labor market institutions, credit shocks may have no or particular impact on labor markets. I compare the impact of credit shocks on labor markets in Germany and in the United-Sates. I use a structural vector auto-regressive model. Empirical results for the United-States are consistent with theoretical results obtained in chapter I. However, for Germany, responses of labor markets variables to credit shocks are either not significant, or contrary to those expected. I find that the explanation could be found in the particular institutional functioning of the German labor market.

Roadmap of the dissertation

The dissertation is made of three different chapters on the interactions between financial frictions and labor markets. The two first chapters investigate in an imperfect information environment, how financial frictions interact with labor markets depending on labor markets institutions. The third chapter presents an empirical analysis of potential discrepancies on the way financial frictions interact with labor markets depending on countries, and labor markets institutions, considered.

Chapter I. Credit Imperfections, Labor Market Frictions and Unemployment: a DSGE approach[1]

This chapter studies the impact of costly external finance for firms on unemployment, vacancy posting and wages by focusing on shocks originating from credit markets. The theoretical model demonstrates the existence of a financial mark-up charged by financial intermediaries, that is transmitted to labor markets by firms via a marginal costs channel. Higher credit market frictions are the source of lower posting vacancies and higher unemployment level as it increases firms' marginal costs. The theoretical model is then calibrated by using quarterly United-States data for the sample period 1960:Q1 to 2007:Q4. We find that employment and vacancy posting increase following positive monitoring cost, net worth and idiosyncratic volatility shocks. Different channels of propagation from the financial sphere of the economy to the labor market are investigated and the results appear to be consistent with the theoretical model. These channels converge all to the role of the financial mark-up that is charged by banks to overcome agency problems. This financial mark-up is passed through the rest of the economy by higher marginal costs and higher inflation. That in turn reduces the levels of vacancies posting, employment, wages and consumption, and finally the level of output. The evolution of credit market conditions changes the opportunity cost for resources used to create new jobs. Thus, it alters the dynamics of job vacancies and unemployment.

Chapter II. Credit Constraints and Labor Market: the role of Wage Bargaining Regimes

In this chapter, I compare two bargaining regimes, the so-called 'efficient bargaining' (EB) and the so-called 'right-to-manage' (RTM) bargaining in a search and matching model integrating a collateral constraint. The impact of credit frictions on unemployment (extensive margin), wages and hours worked per employee (intensive margin) is not the same depending on the way hours and wages are bargained. Especially, this impact is modified through the bargaining power of workers relative to firms that is itself dependent on the level of financial frictions. With an EB regime, the wage splits the surplus of a match on the labor market according to the firm's bargaining power that depends negatively on the level of collateral constraints. So, credit frictions increase the bargaining power of workers: they extract a higher rent from the bargaining relatively to a framework without financial frictions. With a RTM regime, the impact of financial frictions

[1] This chapter is based on a co-written paper with Imen Ben Mohamed between 2012 and 2015 as it can be found as hal-01082491. The version in this dissertation is a revised version of which I am solely responsible for.

exists but it is mitigated by the fact that the firm is able to modify the level of hours worked by each worker. Thus, a firm compensates the existence of financial frictions by reducing the level of hours demanded for each worker. So in both cases, a higher level of collateral constraints leads to an increase in the worker's bargaining power. They ask for a bigger rent, but their capacities to extract a bigger part of the surplus depend on the bargaining regime: a RTM regime appears to restore partly the bargaining power of firms by giving them a higher degree of freedom in the bargaining process that is not internalized by workers. I identify to that purpose two inefficiency gaps compared to a case without any friction, a financial and a wage inefficiency gap, the last one being present only under a RTM regime. Firms use intensive margins to alleviate financial frictions. As a consequence, the bargaining regime prevailing on labor markets may modify the way financial frictions impact these labor markets.

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

In this chapter, I investigate the effects of technological and credit shocks on unemployment and vacancies in the United-States and Germany. I estimate structural VARs based on quarterly data, where shocks are identified through short-run restrictions. Shocks are identified by assuming that firms need external financing before production is realized and sold. First, I find a positive impact of technological shocks on employment and vacancies in both countries. Then, a common view widespread today is to consider that more credit in one economy will be the source of better labor market outcomes as it implies lower external financial constraints for firms. However, credit shocks appear to affect differently labor market variables in each country. In the United-States, a positive credit shock increases vacancies and decreases unemployment, while in Germany the opposite effect is obtained for unemployment and vacancies, with an insignificant result for vacancies. Effects of a credit shock on labor market variables are thus ambiguous for Germany. My empirical results suggest that the previous view can be challenged and discussed as an increase in the level of credit in one economy does not necessarily lead to better conditions on labor markets. Finally, a credit shock has a positive impact on output in the United-States, whereas this impact is ambiguous in Germany, consistent with the idea that good credit conditions are not sufficient to improve the economic dynamics in this particular country. To explain this result, I consider two explanations: a 'Schumpeterian' mechanism and a 'search for conciliation' mechanism. I find that German firms separate from workers when credit level is increasing in the economy. Firms adjust their wage bill when credit conditions are favorable. The role of labor unions could explain such results as labor union are strong in a country as Germany. This argument is finally partly reinforced by the fact that I illustrate the potentiality of non-linearity in the impact of credit shocks on labor markets that could be investigated deeply in future research.

Chapter I

Credit Imperfections, Labor Market Frictions and Unemployment: a DSGE approach

1 Introduction

Credit market imperfections are suspected of playing a key role in the worsening or improvement of labor markets position[1]. In recent years, especially following the Great Recession, there has been an increasing interest for macro-economists to analyze interactions between frictional credit and labor markets. Questions have been raised about the fact that higher credit imperfections may be the source of a slowdown of the economy, and not its consequence. By themselves, financial frictions could destabilize the whole economy. This chapter aims to study the potential destabilizing effect of financial frictions on real economy and particularly on labor markets, that were affected a lot during the previous crisis. In the United-States for example, the unemployment rate rises from 5% in 2008 to 10% in 2009. Thus, the question raised in this chapter is: *in an imperfect information environment, do financial frictions have an impact on labor markets? If so, through which mechanism does this impact take place?* We find that financial frictions have a negative impact on labor markets situations through a financial mark-up charged by financial intermediaries so as to tackle asymmetric information on credit markets.

The research tended to focus either on the impact of financial frictions on overall macroeconomic performances (Bernanke and Gertler (1989), Bernanke and Gertler (1995), Bernanke et al. (1999), Carlstrom and Fuerst (1997), Fiore and Tristani (2013), Gertler et al. (2010) and Kiyotaki and Moore (1997)), either on

[1] This chapter is based on a co-written paper with Imen Ben Mohamed between 2012 and 2015 as it can be found on hal-01082491. The version in this dissertation is a revised version of which I am solely responsible for.

the impact of labor market frictions on overall macroeconomic performances (Andolfatto (1996), Blanchard and Galí (2010), Campolmi and Faia (2011), Christiano et al. (2016), Christoffel et al. (2009), Galí et al. (2012), Gertler and Trigari (2009), Krause et al. (2008), Lechthaler et al. (2010), Merz (1995), Thomas and Zanetti (2009), Trigari (2009) and Walsh (2005)). However, a less but growing attention has been paid to the impact of financial frictions on labor markets, being themselves imperfect (Christiano et al. (2011), Petrosky-Nadeau (2014), Thomas and Zanetti (2009) and Zanetti and Mumtaz (2011) among others). This chapter aims to complement and improve previous works by using a general equilibrium approach, by modeling financial frictions in a particular way and by widening components firms are constrained to borrow.

Figures 1 and 2 shed light on the potential causal relationship that we propose to study and highlight. Evolution of unemployment rate, Baa-Aaa spread and default rate between 1970-Q1 and 2007-Q4 for the United-States are represented in figure 1[2]. A correlation is observed among these variables, especially for the unemployment rate and the Baa-Aaa spread (0.76). The higher the unemployment rate is, the higher the Baa-Aaa spread is and conversely. For the default rate, the correlation is less explicit, due to plausible structural forces between 1971 and 1982 linked to the Federal Reserve monetary policy. However, some periods of correlation still exist: 1979-Q1 until 1985-Q4 (0.6) and from 1990 (0.32).
Then, a negative correlation between the labor market tightness (vacancies[3] over unemployment) and the Baa-Aaa spread is shown on figure 2. The observed negative correlation between 1970.Q1 and 2007.Q4 is quite huge (-0.84). It induces that the higher vacancy posting are relative to unemployment, the lower is the Baa-Aaa spread and conversely. These very basic empirical correlations show that interactions between frictional credit and labor markets may exist: a high risk premium on credit markets is associated with a deteriorate labor market situation. To study these potential interactions, we construct and calibrate a new-Keynesien general equilibrium model integrating credit and labor market frictions. We focus on the impacts of higher credit market frictions on labor markets variables.

The model is a new-Keynesian model with asymmetric information in the credit market à la Bernanke et al. (1999) and a search and matching process in the labor market à la Mortensen and Pissarides (1994) associated with a Nash bargaining process. Capital spending, wage bill and vacancy posting costs are assumed to be paid in advance of production and revenues are realized, requiring partial external financing for firms. The model, based on these features, provides an explanation of cyclical fluctuations in key labor market variables (unemployment, vacancies, hours worked per employee and wages) and in credit market variables (risk premium and default rate). We find that the existence of a risk premium charged by financial intermediaries impacts the vacancy posting decisions, the wage bill and unemployment levels in the economy,

[2]The unemployment rate is the ratio of civilian unemployed persons to the civilian labor force. The default rate is the default rate for Moody's rated US speculative-grade corporate bonds. The Baa-Aaa spread is the Moody's seasoned Baa-Aaa corporate bond yield.
[3]Vacancies are obtained from Conference Board Help Wanted OnLine data series.

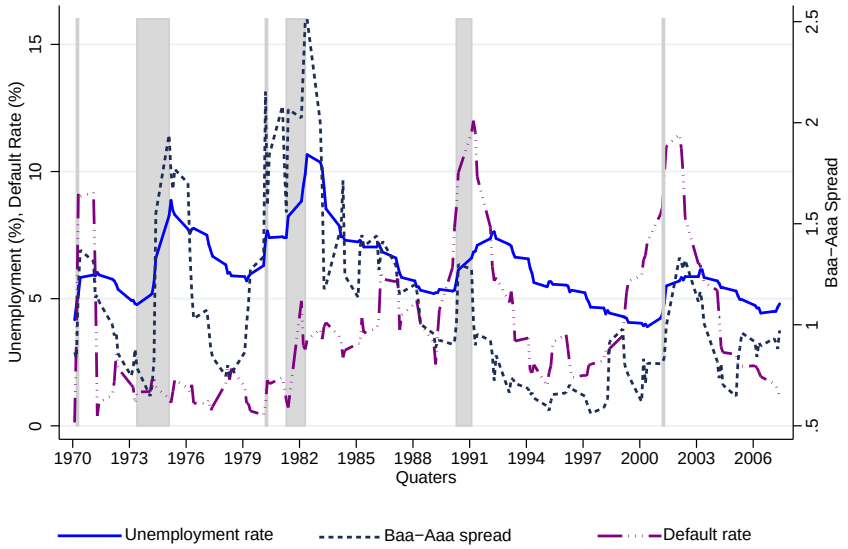


Figure 1: Unemployment, Baa-Aaa spread and default rate between 1970-Q1 and 2007-Q4 for the United-States

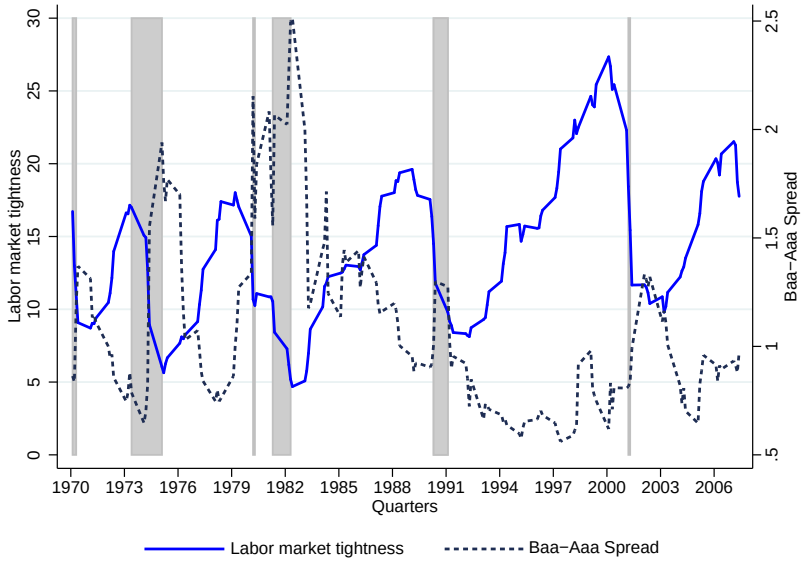


Figure 2: Labor-market tightness and Baa-Aaa spread between 1970-Q1 and 2007-Q4 for the United-States

as well as the level of inflation. When the risk premium increases, the net worth of entrepreneurs decreases. It increases their dependence on external funds, making job posting more expensive. So, less vacancies are posted and a higher equilibrium unemployment is obtained. More precisely, asymmetric information in the credit market pushes up marginal costs and prices, as well as hiring costs by a financial mark-up, depending on the levels of monitoring cost and break-even entrepreneur-specific productivity. The higher are monitoring cost and break-even entrepreneur-specific productivity, the higher is the financial mark-up. This financial mark-up is made to overcome the agency problem between financial intermediaries and firms. It is then bypassed by firms on prices and affects their hiring behavior, as well as wages, employment and inflation levels in the economy. As a consequence, financial frictions have a negative impact on labor markets through this financial mark-up.

A calibration exercise is then carried out to investigate the impacts of a net worth shock, a monitoring cost shock and an idiosyncratic volatility shock on macroeconomic variables, such as vacancies, unemployment rate and real wages. Quarterly data for the sample period 1960:Q1 to 2007:Q4 are used. The most striking result to emerge from this exercise is that employment rate and vacancies posting increase following positive monitoring cost, net worth and idiosyncratic volatility shocks. Different channels of propagation from the financial sphere of the economy to the labor market are investigated and appear to be consistent with the theoretical model. The key mechanism behind these results is that following positive shocks on the credit market, the financial mark-up charged by financial intermediaries decreases, leading to lower real marginal costs and real hiring costs paid by firms, that is passed through prices in the economy, and inducing firms to post more vacancies. The unemployment as a consequence decreases. Furthermore, after a positive net worth shock, a substitution effect appears between hours worked per employee and the number of employees, that to say between intensive and extensive margins. This element is verified in the data as the extensive margin is known to be always more reactive that the intensive one. This substitution effect does not appear following a positive monitoring cost shock or a negative idiosyncratic volatility shock, resulting in a higher positive effect for the economy compared to the net worth shock effect.

Section 2 consists of a related literature review. The theoretical model is developed in section 3. In section 4, we outline the quantitative exercise and present the results. Section 5 concludes.

2 Related literature

This chapter is at the intersection of different lines of research. Firstly, a number of research papers introduce search and matching frictions on labor markets in real business cycle (RBC) models or in new-Keynesian (NK) models. Other articles highlight the role of financial frictions for macroeconomic dynamics, without taking into account search and matching frictions on labor markets. Finally, more recent studies embody simultaneously frictions in labor and credit markets in partial equilibrium models or in dynamic stochastic general equilibrium (DSGE) models, to study interactions and implications of these two types of frictions.

The assumption of Walrasien labor markets is considered as a weakness of standard RBC and NK models. Indeed, these models do not take into account variations in the number of unemployed workers, the extensive margin that never changes. They allow only to study variations in hours worked per employee, the intensive margin. This may seem annoying to the extent that unemployment is an important indicator of performances of the economy in its use of resources and it is a major policy issue, especially since the Great Recession. Furthermore, this kind of models is ineffective to explain the effect of various shocks on

unemployment dynamics. As a consequence, many articles have introduced search and matching frictions in labor markets based on Mortensen and Pissarides (1994) framework in *RBC models* or in *NK models* (Andolfatto (1996), Blanchard and Galí (2010), Campolmi and Faia (2011), Christiano et al. (2016), Christoffel et al. (2009), Galí et al. (2012), Gertler and Trigari (2009), Krause et al. (2008), Lechthaler et al. (2010), Merz (1995), Thomas and Zanetti (2009), Trigari (2009), Walsh (2005) among others).

Papers, as those of Andolfatto (1996) and Merz (1995), study implications of search and matching frictions for economic fluctuations in *RBC models*. Both models show that labor market frictions are a mechanism of amplification and persistence for technological shocks. These frictions improve the empirical performance of RBC models, compared to a standard one, even if they do not predict enough cyclical movements in vacancies and output compared to data. Moreover, Andolfatto (1996), by introducing extensive and intensive margins, finds that most of the variability of total hours worked is due to changes in unemployment level rather than in hours worked per employee.

Then, several papers in the same spirit (Campolmi and Faia (2011), Lechthaler et al. (2010), Thomas and Zanetti (2009), Trigari (2009) and Walsh (2005)) examine the role of matching frictions in *NK models*. For example, Walsh (2005) develops a NK DSGE model with labor market frictions and with different potential sources of persistence (habit persistence, price stickiness and policy inertia). He founds through a calibrated model that it amplifies for US data the output response and decreases the inflation response to a monetary policy shock, as well as it generates persistence in output and inflation as observed in data and as standard NK models do not succeed to generate. In the same idea, Trigari (2009) considers cyclical fluctuations of output, inflation and labor market variables following a monetary policy shock. She studies the possibility of endogenous separation between firms and workers, and distinguishes extensive and intensive margins. Her estimated model is able to replicate well for US data the observed responses of output, inflation and labor market data to a monetary policy shock. Using a VAR, she finds as observed in data that in a model with labor market frictions, the response of inflation is less volatile and response of output more persistent after a monetary policy shock than in a standard NK model.

However, these Mortensen-Pissarides search and matching models of unemployment remains unable to match important stylized facts observed in data. In particular, these types of models are not performing well to explain high volatility and persistence of unemployment and vacancies, as well as the relative smooth behavior of real wages found in data. The framework of Nash bargaining appears to lead to an exaggerated procyclical movements in wages after a positive productivity shock for example, that dampens the firm's incentives to hire. Wages absorb much of the change in the expected benefit to a new worker induced by fluctuations in labor productivity. As a consequence, several papers try to tackle this issue by introducing wage rigidity mechanisms (Blanchard and Galí (2010), Christiano et al. (2016), Gertler and Trigari (2009) and Shimer (2004)) or hiring and firing costs (Lechthaler et al. (2010) for example). Firstly, Blanchard and Galí (2010) find that search and matching frictions modify the level of unemployment but the un-

employment rate stays invariant to productivity shocks. Thus, they study alternative wage-setting (Nash bargaining wage and more rigid real wages) and show that rigid wages enable to have inefficient fluctuations in unemployment after a productivity shock. Lechthaler et al. (2010) introduce in a new-Keynesian model labor market frictions, through hiring and firing costs but no wage rigidity. They find trough a calibration exercise more persistence in output and unemployment in response to real and monetary policy shocks and in inflation in response to real shocks, as well as a strong amplification effect of these shocks on unemployment and on the job finding rate.

On the other hand, frictions have been also studied on the credit market side (Bernanke and Gertler (1989), Bernanke and Gertler (1995), Bernanke et al. (1999), Carlstrom and Fuerst (1997), Carlstrom and Fuerst (2001), Fiore and Tristani (2013), Gertler et al. (2010) and Kiyotaki and Moore (1997)). These articles have been devoted to understand the relationship between financial markets and overall macroeconomic performances. Financial factors are indeed suspected to amplify and increase persistence of macroeconomic variables responses to aggregate shocks. The idea behind is that deteriorating credit conditions could be the source of poor economic activity and not the consequence of a declining real economy.

Bernanke and Gertler (1989), Bernanke et al. (1999), Carlstrom and Fuerst (1997) and Kiyotaki and Moore (1997) develop the concept of a financial accelerator in DSGE models integrating money and price stickiness. Without credit frictions, an entrepreneur can resort to external financing to raise capital at a risk-free interest rate. With credit market frictions, asymmetric information appears in the form of moral hazard between the lender and the borrower. Borrower is induced to report to the lender a lower real output produced than its true level.

As a consequence, this type of asymmetric information leads first to restrictions for borrowers on the amount of external financing available, based on the existence of collateral constraints to cover their potential inability to reimburse loans (Kiyotaki and Moore (1997)). In this framework used in the chapter *II* of this dissertation, agents face endogenous credit limits determined by the value of collateralized assets.

Then, asymmetric information between a lender and a borrower can lead to a second modelization of financial frictions (Bernanke and Gertler (1989), Bernanke et al. (1999) and Carlstrom and Fuerst (1997)), namely a higher cost of external financing compared to internal financing opportunity cost (the risk-free interest rate), that to say an external finance premium or a risk premium. The canonical RBC model of Carlstrom and Fuerst (1997) integrates such risk premium and enables to show that it leads the economy to return more slowly to the steady-state after being hit by a shock. Debt arises as an optimal financial contract between firms and banks such that firms borrow at a premium over the risk-free rate. The financial contract is designed to minimize the expected agency costs. It specifies returns when bankruptcy or success occurs and a monitoring threshold as developed in our upcoming model.

However, the previous papers assume standard Walrasien labor markets. Only few papers consider both

credit and labor markets frictions, except the ones of Christiano et al. (2011), Petrosky-Nadeau (2014) and Zanetti and Mumtaz (2011). Labor market frictions imply that it is costly to hire new workers. The functioning of frictional labor markets prevents the competitive allocation of labor resources, and thus it could interact with financial frictions to impact production, unemployment, investment and capital accumulation. Those models enhance the Bernanke et al. (1999) framework with a more realistic labor market. Christiano et al. (2011) show in a new-Keynesian model that financial and labor markets frictions are able to change the model dynamics in an open economy setting, and improve the forecasting properties of the model for Swedish data, in particular for inflation. Petrosky-Nadeau (2014) considers that firms finance only their job vacancy costs with external financing on frictional credit markets. He finds that the easing of financing constraints during an expansion (a productivity shock) reduces the opportunity cost for resources allocated to job creation (cost channel) because firms are able to accumulate net worth. Credit market frictions generate persistence in the dynamics of labor-market tightness. Zanetti and Mumtaz (2011) demonstrate through a Bayesian estimation that labor and financial frictions are supported by data and that they play together to amplify or reduce the variables' reaction to various shocks. Firms have in their model to paid only capital in advance of production.

In our comprehensive model, we introduce both credit and labor markets frictions. First, we assume that wages, job vacancy costs as well as capital are financed in advance of production. To our knowledge, no paper takes into account that the whole input costs are paid in advance in a DSGE framework. Then, we model extensive and intensive margins of employment to obtain a more precise idea of adjustments in the labor market. Calvo-price stickiness is also introduced in the model to observe the behavior of inflation in a model of this type. Finally, the research to date focus on technological or monetary policy shocks. Few paper tries to investigate direct shocks from the financial sphere, such as monitoring cost, net worth or idiosyncratic volatility shocks. This chapter tries to bring these gaps.

3 Model

3.1 Model overview

The model is populated by various types of agents: households, wholesale-good firms managed by entrepreneurs, retailers, final-good firms, financial intermediaries and a government that conducts fiscal and monetary policies together with a central bank. The model is build on the modeling of asymmetric information in the credit market à la Bernanke et al. (1999) and a modeling of the labor market with a search and matching process à la Mortensen and Pissarides (1994). Figure 3 delivers the timing of events in a synthetic way. Figure 4 reports the flow of funds for the private sector of the economy.

The household sector consists of a continuum of identical households of length unity. Each household is constituted of members who are either employed or unemployed searching for a job. They all supply inelastically hours of labor, consume final goods, rent capital to wholesale firms and save through their deposits to financial intermediaries.

Entrepreneurs manage and owned wholesale firms, that produce wholesale goods using a constant return-to-scale technology using labor and capital as inputs. Entrepreneurs have finite lifetime. Following Bernanke et al. (1999), each entrepreneur is assumed to have a given probability to survive to the next period. Surviving entrepreneurs carry their profits as a part of their net worth. Dying entrepreneurs consume everything. Total hiring costs, capital spending and wages are assumed to be paid by wholesale firms managed by entrepreneurs once capital and labor are rented, that to say before production and revenues are realized. External financing is required for wholesale firms. However, wholesale-good production is subject to an idiosyncratic shock privately observed by entrepreneurs after the financial contract arrangement, while financial intermediaries need to pay a monitoring cost to check the real output produced as well as the efficiency of the recruitment process. This agency problem will alter the marginal cost of production and the hiring costs.

Finally, the production sector has three different layers in the spirit of Bernanke et al. (1999). At the first layer, where agency problem and search and matching frictions occur, a continuum of perfectly competitive wholesale firms produce homogeneous goods using capital and labor. At the second layer, where price stickiness arises, wholesale goods are differentiated costlessly by a continuum of monopolistic firms. The realized profits are rebated lump-sum to households. The final good is then homogeneous and can be used for consumption, capital accumulation and government spending.

Agents are thus interacting in five different markets (labor market, capital market, credit market, money market and goods market), where the timing of events is given by figure 3.

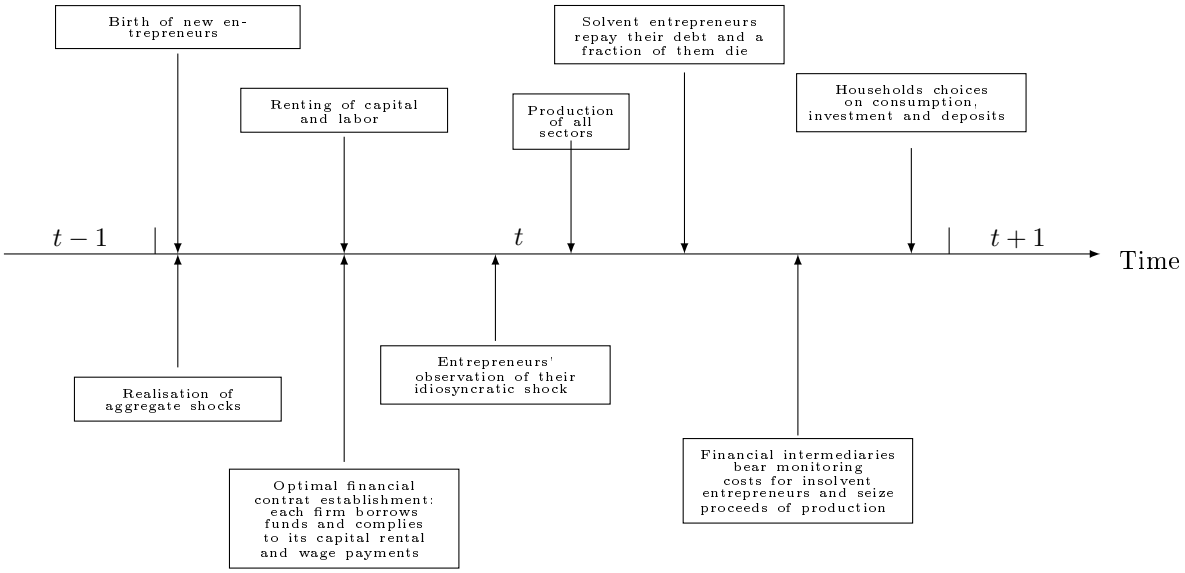


Figure 3: Timing of events

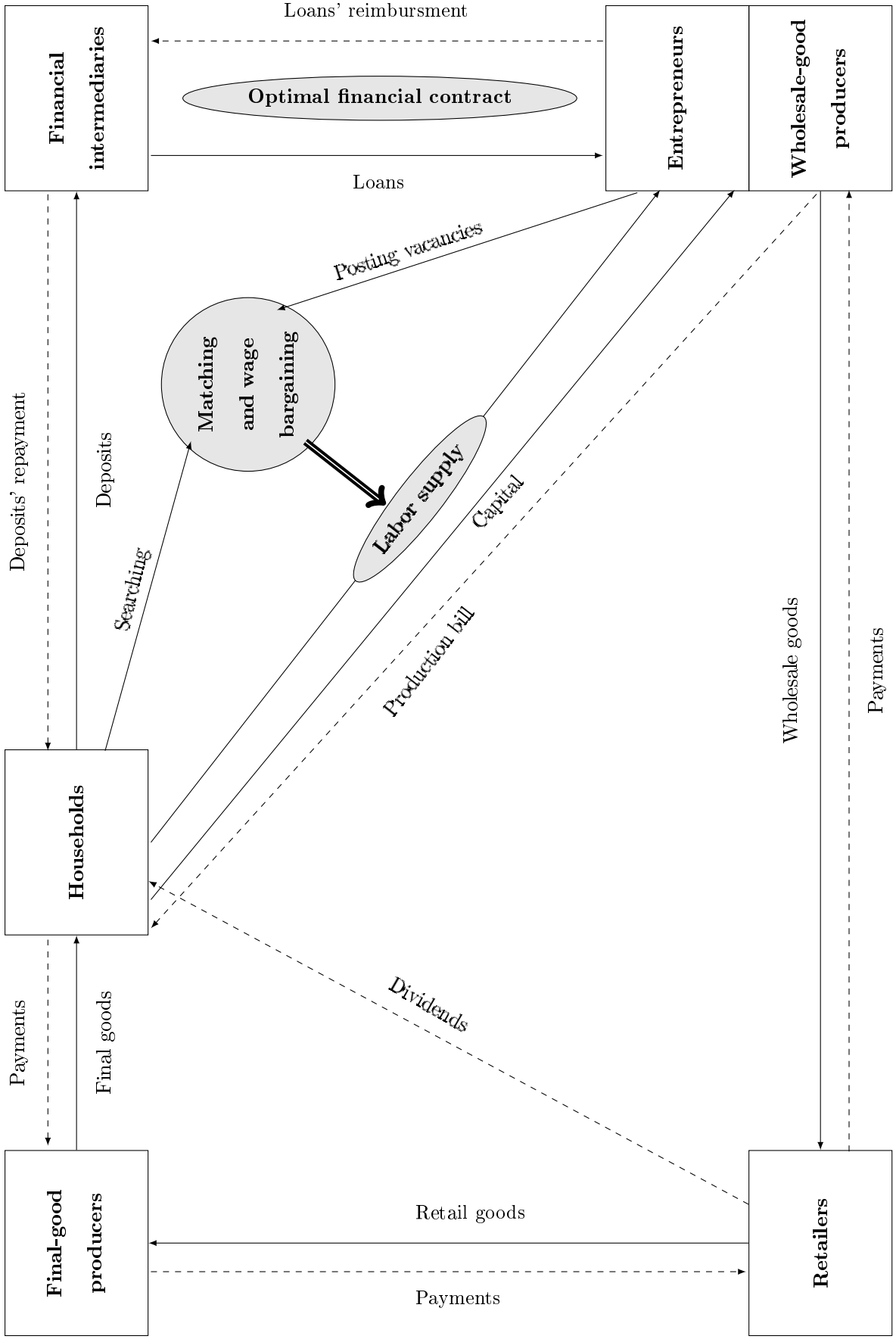


Figure 4: Private sector model overview and flows of funds

3.2 Households

Households are seen as a large representative family represented by the unit interval consisting of a continuum of members, either employed or unemployed searching for a job[4]. As in Andolfatto (1996) and Merz (1995), there is a full risk sharing of consumption in order to avoid distributional issues due to heterogeneity in incomes among family members. So, the family pools its income such that a perfect consumption is fully insured for all members[5]. The same notation is then used for the representative household and for the consumption of each member. In any period t, the number of employed family members is $n_t^h \in (0,1)$ and the number of unemployed family members searching for a job is U_t^h[6].

The representative household maximizes its expected discounted utility[7]:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\log(C_t - hC_{t-1}) - \frac{H_t^{1+\tau} n_t^h}{1+\tau} \right] \tag{I.1}$$

subject to a flow budget constraints sequence:

$$\begin{aligned} W_t n_t^h H_t + (1 - n_t^h)b + \frac{R_{t-1} D_{t-1}}{P_t} + r_t^K K_t^h + \frac{\Pi_t}{P_t} + \frac{T_t}{P_t} \\ = C_t + I_t + \frac{D_t}{P_t} \end{aligned} \tag{I.2}$$

and to a sequence of employment laws of motion:

$$n_t^h = (1-\delta) n_{t-1}^h + q(\theta_t) U_t^h \tag{I.3}$$

and to a sequence of physical capital laws of motion:

$$I_t = K_{t+1}^h - (1-\delta_K) K_t^h \tag{I.4}$$

$\beta \in (0,1)$ is the household intertemporal discount factor, C_t is the household's real final goods consumption (as well as each family member's consumption), h is a habit persistence parameter[8], H_t are the effective hours of work, τ denotes the inverse of the Frisch elasticity of labor supply, W_t is the real wage, b are the real unemployment benefits that each unemployed member receives from the government[9], K_t^h is the household's real physical capital stock at the beginning of period t as the household owns a part of the

[4] Full participation in the labor market is assumed. The transition between in and out the labor force is ignored.

[5] The family optimally allocates the same consumption for each member, regardless their respective labor market status and individual income. This assumption is quite strong. Some papers as the one of Iliopulos et al. (2014) are considering different levels of consumption depending on the respective members employment status.

[6] Only the unemployed members can search passively for a job and can be hired. Employed members are not allowed to look for another job.

[7] The form of the utility function is based on the ones used by Bernanke et al. (1999) and Gertler et al. (2008).

[8] When $h > 0$, the model allows for habit persistence in consumption preferences to take into account the necessary empirical persistence in the consumption process.

[9] b can be interpreted as home production or as unemployment benefits, as we do, provided by the government and financed by lump-sum taxes.

capital stock of the economy, I_t is the household's real investment, r_t^K is the real renting capital interest rate, δ_K is the capital depreciation rate, D_t is the nominal amount deposits the household carries to period $t+1$, R_t is the nominal risk-free interest rate, δ is the exogenous job destruction rate, $q(\theta_t)$ is the probability for an unemployed member to find a new job and P_t is the aggregate price level. The household also makes a nominal lump-sum transfer, T_t, to the government and receives a nominal lump-sum profit, Π_t, as the household has a diversified ownership stake in retail firms.

The household decides on its level of consumption, investment and deposits at the end of the period t. As a result, he knows all the variables of its optimization program when it takes its decisions. And it is why K_{t+1}^h and D_t are carried to the next period.

Back-and-forth between employment and unemployment for household members are carried out by search and matching processes in the labor market. The household takes as given the probability for an unemployed member to find a new job, $q(\theta_t)$. This probability depends on the ratio of total vacancies to unemployed workers, θ_t, the aggregate labor market tightness. Furthermore, the fraction δ of employed workers of period $t-1$ that are assumed to be separated from their jobs before period t is also taken as given by the household. So the number of searching unemployed members at the start of period t is defined as: $U_t^h = 1-(1-\delta)n_{t-1}^h$.

The first-order conditions of the representative household's problem are given by:

$$(C_t) \qquad \lambda_t = \frac{1}{C_t - hC_{t-1}} - \beta h E_t \frac{1}{C_{t+1} - hC_t} \tag{I.5}$$

$$(D_t) \qquad 1 = \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{R_t}{\pi_{t+1}} \right] \tag{I.6}$$

$$(K_{t+1}^h) \qquad \lambda_t = \beta E_t \lambda_{t+1} \left[(1-\delta_K) + r_{t+1}^K \right] \tag{I.7}$$

$$(n_t^h) \qquad \mathcal{W}_t^n - \mathcal{W}_t^U = W_t H_t - \frac{H_t^{1+\tau}}{(1+\tau)\lambda_t} - b + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \left[(1-\delta)(1-q(\theta_{t+1}))(\mathcal{W}_{t+1}^n - \mathcal{W}_{t+1}^U) \right] \tag{I.8}$$

where $\pi_t \equiv \dfrac{P_t}{P_{t-1}}$ is the inflation rate, λ_t is the Lagrange multiplier associated to the household's budget constraint and $\mathcal{W}_t^n - \mathcal{W}_t^U$ corresponds to the ratio between the Lagrange multiplier to the law of motion of n_t^h and the Lagrange multiplier of the budget constraint λ_t.

Equation (I.5) defines the marginal utility of consumption when there is habit formation. It states that the Lagrange multiplier equals the marginal utility of consumption. (I.6) corresponds to the household choices in terms of deposits. From equations (I.5) and (I.6), we derive the household's stochastic discount factor $\beta E_t \frac{\lambda_{t+1}}{\lambda_t}$. Equation (I.7) corresponds to the household choices in terms of renting capital. Finally, equation (I.8) designates the discounted net value in period t to the household of having a new employed worker in terms of current consumption. It is the sum of the real wage earned by the new employed worker in period t, reduced for the marginal disutility of working and for the unemployment benefits that are foregone, plus the expected discounted gain from being either employed or unemployed during the subsequent periods. A

worker is still employed at the period $t+1$ if the match has not been exogenously destroyed before period $t+1$ with a probability $(1-\delta)$; or if the match has been destroyed with the probability δ before period $t+1$, but that another matching occurs at the period $t+1$ with the probability $q(\theta_{t+1})$. And a worker becomes unemployed if the match is destroyed before period $t+1$ and if he or she does not find a job in the period $t+1$, that to say with the probability $\delta(1-q(\theta_{t+1}))$. Finally, an unemployed worker finds a job in period $t+1$ with a probability $q(\theta_{t+1})$.

3.3 Wholesale-good firms

There is a continuum of unit mass of wholesale firms indexed by $i \in [0,1]$. They are owned and managed by finite lived risk-neutral entrepreneurs. Wholesale-good firms need labor and capital to produce. Y_{it}^{ws} is the quantity of wholesale goods produced by a firm i using $N_{it}^{f} = n_{it}^{f} H_{it}$ total hours of labor and K_{it} units of physical capital, according to the following constant-returns production function:

$$Y_{it}^{ws} = A_t K_{it}^{\alpha} N_{it}^{f(1-\alpha)} \tag{I.9}$$

where α is the capital share in production and A_t is the aggregate technological shock, realized at the beginning of each period, source of systematic risk. Physical capital, K_{it}, is rented from households and other firms (as part of their net-worth as detailed hereafter) at a competitive price, r_t^K. Total hours worked, N_{it}^{f}, are paid to employed workers, n_{it}^{f}, through the wage, W_t.

Each period, wholesale firms draw an idiosyncratic shock, ω_{it}, defined as a productivity and management efficiency shock, reflecting management skills, hiring efficiency and input utilization skills of firms. This idiosyncratic shock is the source of wholesale firms heterogeneity. ω_{it} is i.i.d. with a time-varying mean, ω_{mt}, a continuous distribution function, $\Phi(.)$ and a density function, $\phi(.)$, being identical across firms. ω_{it} is defined over a non-negative support and $\Phi(0) = 0$. Moreover, its variance, reflecting the shock's volatility and the entrepreneurs' riskiness, is time-varying and its standard deviation, $\sigma_{\omega t}$, follows a first-order auto-regressive process identical across wholesale firms, given by:

$$\log(\sigma_{\omega t}) = (1-\rho_\sigma)\log(\bar{\sigma}_\omega) + \rho_\sigma \log(\sigma_{\omega t-1}) + u_t^{\sigma}, \quad \rho_\sigma \in (0,1) \text{ where } u_t^{\sigma} \overset{iid}{\sim} N(0,\sigma_\sigma^2)$$

where $\bar{\sigma}_\omega$ is the steady-state value of the standard deviation, $\sigma_{\omega t}$.

Entrepreneurs

Entrepreneurs and households have the same time preferences rate, β. The optimization problem of an entrepreneurs is:

$$\max_{C_{it}^e} \quad E_t \sum_{s=0}^{\infty} \beta^s (1-\varsigma_t) C_{i,t+s}^e \tag{I.10}$$

where C_{it}^e is the consumption of the entrepreneur managing the firm i.

An entrepreneur receives profits that are rebated from wholesale firm i that did not go bankrupt. These profits are used either for consumption, or for net worth accumulation, X_{it}, depending on a probability of survival entrepreneurs ς_t[10].

With a probability $1-\varsigma_t$, a solvent entrepreneur dies in a given period. He can then consume all his net worth just before death. With a probability ς_t, a solvent entrepreneur is able to carry a net worth to the next period as he is not dying. This accumulated net worth is carried out as physical capital, K_{it}^e, to the next period t.

Finally, as for the household, the entrepreneur decides on its level of consumption at the end of the period t.

Matching and hiring workers

Matching technology. A job creation occurs when an entrepreneur and an unemployed worker searching for a job meet on the labor market after search and matching processes à la Mortensen and Pissarides (1994). Total vacancies actively posted by entrepreneurs, V_t, are filled by unemployed workers passively searching for a job, U_t, via an aggregate constant return to scale matching function, $m(U_t, V_t) = U_t^{\rho} V_t^{1-\rho}$ where $\rho \in (0,1)$ is the elasticity of matches to unemployment[11].

Hiring workers is a costly and time-consuming process for entrepreneurs. To hire a new worker, entrepreneurs (managing wholesale-good firms) create vacancies at a real unit cost, γ. New hired workers in period t start working immediately[12]. Then, total matches that produce in period t are assumed to be destroyed at an exogenous rate, δ, before period $t+1$. So the evolution of aggregate employment is defined as:

$$n_t = (1-\delta)n_{t-1} + m(U_t, V_t) \tag{I.11}$$

The productive employment stock of period t corresponds to period $t-1$ surviving matches from the exogenous separation, $(1-\delta)n_{t-1}$, plus the new hires from the matching of period t, $m(U_t, V_t)$. As the labor force is normalized to one, unemployment corresponds to $u_t = 1 - n_t$.

As standard in the search and matching literature, matching probabilities are $q(\theta_t)$ and $p(\theta_t)$, corresponding respectively to job finding and filling rates[13].

[10] The same assumption is made by Bernanke et al. (1999) and Paustian (2004). Carlstrom and Fuerst (1997) make the different assumption, that consumers and entrepreneurs have different time-discount factors with entrepreneurs less impatient than consumers.

[11] Gertler et al. (2008) use the same specification. The Cobb-Douglas matching function is used in almost all macroeconomic models with search and matching frictions to represent the aggregate flows of hires. Furthermore, the constant returns to scale assumption (homogeneity of degree one) seems to be supported empirically according to Petrongolo and Pissarides (2001).

[12] Following Blanchard and Galí (2010), Gertler et al. (2008), Krause and Lubik (2007) and Thomas and Zanetti (2009), employed workers are assumed to be immediately productive after being hired.

[13] Matching probabilities are defined as $p(\theta_t) \equiv \frac{m(U_t,V_t)}{V_t}$ and $q(\theta_t) \equiv \frac{m(U_t,V_t)}{U_t}$ as the matching function is constant-return-to-scale. Note that $q(\theta_t) = \theta_t p(\theta_t)$ and $\partial p(\theta_t)/\partial \theta_t < 0$, $\partial q\theta_t/\partial \theta_t > 0$.

Hiring workers. A wholesale firm i begins each period t with an employment stock $(1-\delta)n^f_{it-1}$. To hire a new worker, the firm has to post vacancies, V_{it}, at a real unit cost. Each vacancy is filled with a probability $p(\theta_t)$. The firm takes as given this probability. So the employment laws of motion for firm i is:

$$n^f_{it} = (1-\delta)n^f_{it-1} + p(\theta_t)V_{it} \tag{I.12}$$

Optimal financial contract

The total input costs of a wholesale firm i correspond to capital rental costs, wage payments and hiring costs: $B_{it} = r^K_t K_{it} + W_t H_t n^f_{it} + \gamma V_{it}$. We assume that these costs are paid after the rental of production factors (labor and capital) but before the observation of firm's i idiosyncratic shock and before that production and revenues are realized. Furthermore, at the equilibrium, all workers at firm i earn the same wage and work the same number of hours as workers are assumed to be homogeneous. Thus, matches do not depend on any idiosyncratic component. Idiosyncratic efficiency for each firm is common across all workers working for each firm.

To finance a part of these costs, the firm uses the net worth accumulated by its entrepreneur from the previous period, X_{it}. This net worth is carried from a period to another in the form of capital:

$$X_{it} = K^e_{it}(1 + r^K_t - \delta_K) + W^e \tag{I.13}$$

where W^e is a real exogenous entrepreneurial wage[14].

But the firm's internal funds are insufficient to finance all input costs. Indeed, as assumed above, entrepreneurs have an exogenous probability to die each period. This assumption is made to limit the size of aggregate net worth in an infinite horizon set up[15]. So the firm needs external financing to finance its total input costs. A financial intermediation is realized through a large number of atomistic risk-neutral banks. Banks are assumed to hold enough large and diversified portfolios to ensure perfect risk pooling for their creditors, the households, carrying deposits to banks[16]. Intra-period loans are stipulated and established after the aggregate shock, A_t. To eliminate aggregate uncertainty from the lender-borrower relationship, the aggregate technological shock is assumed to be observed by all agents in the economy and it is realized before any loan contract is established.

[14]This endowment income ensures that each firm/entrepreneur i continues to produce in each period even if it becomes insolvent in a given period.

[15]Since the rate of return on internal funds is higher than the one of external funds due to asymmetric information on credit markets, risk neutral entrepreneurs may be willing to postpone consumption and would only accumulate net worth. The same assumption is made by Bernanke et al. (1999) and Paustian (2004) to ensure that firms need external financing. Carlstrom and Fuerst (1997) make the different assumption, that consumers and entrepreneurs have different time-discount factors with entrepreneurs less impatient than consumers.

[16]Infinitely-lived households are risk averse but they become risk neutral for the financial contract. Carlstrom and Fuerst (1997) explain this fact by the absence of uncertainty about the term of the one-period contract since the aggregate uncertainty is realized before the contract establishment. Furthermore, by the law of large numbers as banks are financing a continuum of different entrepreneurs, households know they will receive the expected return of the idiosyncratic shock.

Furthermore, entrepreneurs are subject to idiosyncratic shocks privately observed by them after the financial contractual arrangement, but not observed by banks. This private information creates a moral hazard problem as entrepreneurs may be encouraged to under-report the true value of their production when they have to reimburse the loan. So banks have to monitor wholesale firms which declare themselves bankrupt after the production occurs. This monitoring is costly for banks.

Under a costly state verification framework, the perfectly competitive financial intermediaries' setting ensures that each firm-bank pair writes the borrowing contract that maximizes the expected return of the borrower, the entrepreneur, under the constraint that the expected return to the lender, the bank, exceeds its opportunity cost, namely the risk free interest rate, R_t (participation constraint). So the optimal incentive-compatible financial arrangement is a risky debt contract, whose terms are the optimal solution to a standard principle-agent problem between entrepreneurs and banks[17].

A wholesale firm i borrows a nominal amount of $P_t(B_{it} - X_{it})$ from the bank at an implicit interest rate, R_t^l. The optimal short-term financial contract specifies contractually firm's leverage ratio and a break-even entrepreneur-specific productivity level, $\bar{\omega}_{it}$, satisfying:

$$R_t^l P_t(B_{it} - X_{it}) = \bar{\omega}_{it} P_t^{ws} Y_{it}^{ws} \tag{I.14}$$

Indeed, if $\omega_{it} \geq \bar{\omega}_{it}$, the entrepreneur pays back the value $\bar{\omega}_{it} P_t^{ws} Y_{it}^{ws}$, the loan amount augmented with interest.
If $\omega_{it} < \bar{\omega}_{it}$, the firm goes bankrupt and the bank confiscates the total output produced. The bank can observe this state of nature at a monitoring cost $\mu_t \in (0,1)$, a fraction of the total output produced by the firm. After the realization of shocks and production occurrence, it is given by $\omega_{it} P_t^{ws} Y_{it}^{ws}$.

Note that although we use the same costly state verification framework used in Bernanke et al. (1999) and Carlstrom and Fuerst (1997) for examples, asymmetric information is here introduced between wholesale-good producers, the entrepreneurs, and banks. Financial intermediaries and banks are used interchangeably in the model. As they are operating in a competitive market, only the behavior of a representative bank is considered below. Furthermore, note that unlike the costly state verification framework similar to Carlstrom and Fuerst (1997), credit contracts are here nominal.

Formally, the expected return earned by the wholesale firm i, E_{it}^f, is given by:

$$E_{it}^f = P_t^{ws} Y_{it}^{ws} \int_{\omega_{it} > \bar{\omega}_{it}} (\omega_{it} - \bar{\omega}_{it}) \phi(\omega_{it}) d\omega_{it} \tag{I.15}$$

[17] See Townsend (1979) and Gale and Hellwig (1985).

Using the statistic properties of the random idiosyncratic shock, equation (I.15) can be developed to see that the expected return of the wholesale firm is a fraction of its realized total output:

$$E_{it}^{f} = P_t^{ws} Y_{it}^{ws} f(\bar{\omega}_{it}) \tag{I.16}$$

where $f(\bar{\omega}_{it}) = \int_{\omega_{it}>\bar{\omega}_{it}} \omega_{it}\phi(\omega_{it})d\omega_{it} - \bar{\omega}_{it}[1-\Phi(\bar{\omega}_{it})]$. Note that $f(\bar{\omega}_{it}) \in (0,1)$[18] and $f'(\bar{\omega}_{it}) = \Phi(\bar{\omega}_{it},) - 1 \leq 0$. The wholesale firm's expected return is a decreasing function of $\bar{\omega}_{it}$. This result is quite intuitive since an increase of the default rate, $\Phi(\bar{\omega}_{it})$, reduces the gross share of return going to the firm.

Similarly, the expected return earned by the bank, E_{it}^{b}, is given by:

$$E_{it}^{b} = P_t^{ws} Y_{it}^{ws} \Big[\int_{\omega_{it}>\bar{\omega}_{it}} \bar{\omega}_{it}\phi(\omega_{it})d\omega_{it} + (1-\mu_t) \int_{\omega_{it}<\bar{\omega}_{it}} \omega_{it}\phi(\omega_{it})d\omega_{i} \Big]$$

It is straightforward to show that lender's expected return is also a fraction $g(\bar{\omega}_{it}) \in (0,1)$ of wholesale firm's output[19]. Then,

$$E_{it}^{b} = P_t^{ws} Y_{it}^{ws} g(\bar{\omega}_{it}) \tag{I.17}$$

where,

$$g(\bar{\omega}_{it}) = 1 - f(\bar{\omega}_{it}) - \mu_t \Gamma(\bar{\omega}_{it})$$

with $\Gamma(\bar{\omega}_{it}) = \int_{\omega_{it}<\bar{\omega}_{it}} \omega_{it}\phi(\omega_{it})d\omega_{it}$. So, an amount of the realized firm's total output is lost due to monitoring in cases of declaring bankruptcy. In this context, the monitoring cost spending is a synonym of bankruptcy and it is spent in terms of currency so that bankruptcy has no direct impact on the real output. As a consequence, the proportion of the total amount recovered by the bank in case of bankruptcy is $(1-\mu_t)\Gamma(\bar{\omega}_{it})$. $1-\mu_t$ is thus interpreted as the recovery rate. Following Livdan et al. (2009) and Petrosky-Nadeau (2014), this recovery rate is assumed to be time-varying and has the following specification:

$$1 - \mu_t = s_{0t} \exp s_1(\omega_{it} - 1) \tag{I.18}$$

s_1 is the elasticity of the recovery rate to the entrepreneurial productivity and management efficiency level and s_{0t} is interpreted as a monitoring cost shock, following a first-order auto-regressive process:

$$\log s_{0t} = (1-\rho_{s0}) \log \bar{s_0} + \rho_{s0} \log s_{0t-1} + u_t^{s0}, \quad \rho_{s0} \in (0,1) \text{ where } u_t^{s0} \overset{iid}{\sim} N(0, \sigma_{s0}^2)$$

where $\bar{s}_0$ is the steady-state value of the monitoring cost shock, s_{0t}.

[18] $f'(\bar{\omega}) \leq 0, \forall\, \bar{\omega} \in [0,\infty)$. In addition, $\lim_{\bar{\omega}\to 0} f(\bar{\omega}) = 1$ and $\lim_{\bar{\omega}\to\infty} f(\bar{\omega}) = 0$. Then, $f(\bar{\omega}) \in (0,1)$.

[19] Since $1 - f(\bar{\omega}) \in (0,1)$ and by definition we have $\int_{\omega<\bar{\omega}} \omega\phi(\omega)d\omega \in (0,1)$ and $\int_{\omega>\bar{\omega}} \bar{\omega}\phi(\omega)d\omega + \int_{\omega<\bar{\omega}} \omega\phi(\omega)d\omega \in (0,1)$, then $g(\bar{\omega}) \in (0,1)$, $\lim_{\bar{\omega}\to 0} g(\bar{\omega}) = 0$ and $\lim_{\bar{\omega}\to\infty} g(\bar{\omega}) = 1-\mu$.

Finally, the optimal debt contract is a solution to the maximization of wholesale firm's expected return under the constraint that expected return to the bank exceeds its opportunity cost, the risk-free interest rate.

The contractually firms' leverage ratio, $\mathcal{L}_{it}$, is given thus by:

$$\mathcal{L}_{it} \equiv \frac{B_{it}}{X_{it}} = \frac{1}{1 - R_t S_{it} g(\bar{\omega}_{it})} \tag{I.19}$$

where $S_{it} = \{1-\mu_t[\Gamma(\bar{\omega}_{it})+\bar{\omega}_{it}h(\bar{\omega}_{it})f(\bar{\omega}_{it})]\}^{-1}$, with $h(\bar{\omega}_{it})$ the hazard rate[20] defined by $h(\bar{\omega}_{it}) = \dfrac{\phi(\bar{\omega}_{it})}{1-\Phi(\bar{\omega}_{it})}$. Note that $\mathcal{L}_{\bar{\omega}} > 0$. And for a given level of net worth X_{it}, a higher leverage ratio is associated with a higher default rate. Indeed, the probability of default increases as the loan amount raises (in the spirit of Stiglitz and Weiss (1981)).

And the contractually bankruptcy threshold, $\bar{\omega}_{it}$, is given by:

$$\frac{R_t S_{it} f(\bar{\omega}_{it})}{1 - R_t S_{it} g(\bar{\omega}_{it})} = \frac{-f'(\bar{\omega}_{it})}{-g'(\bar{\omega}_{it})} \tag{I.20}$$

At the optimum, the bank participation constraint is binding. Using this result with equation (I.14), the risk premium, Δ_{it}, defined as the ratio of the lending rate to the risk free rate, R_t^l/R_t, is given by:

$$\Delta_{it} = \frac{\bar{\omega}_{it}}{g(\bar{\omega}_{it})} \tag{I.21}$$

Net worth evolution and dynamic profit function

Wholesale firms consider as given the financial contract when maximizing their profits to determine their labor and capital demand. They do not know at that time how much they will be able to produce and sell (the idiosyncratic shock has not been revealed) ; thus they base their labor and capital demand on their expected profits as developed hereafter.

Wholesale firms maximize their *expected* discounted value to the entrepreneurs. This value is decomposed in two parts due to the existence of financial asymmetric information. The intertemporal objective function of a firm i is defined as:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_{t+1}}{\lambda_t} [E_\omega \Pi_{it}^f + C_{it}^e] \tag{I.22}$$

First, there is the so-called 'standard' expected profits coming from the firm production, $E_\omega \Pi_{it}^f$. These profits correspond to the difference between the value of the expected total output produced by the firm and the total input costs. However, this profit is expected at the time decisions are made. Indeed, it occurs

[20] We assume that $\bar{\omega}h(\bar{\omega}, \sigma_\omega)$ is increasing in $\bar{\omega}$ in order to ensure the concavity of the lender's net share of return, $g(\bar{\omega})$, and avoid any credit rationing at the equilibrium. This regularity condition is without loss of generality and it is satisfied by most of the continuous probability distributions. See Bernanke et al. (1999) for details.

before the idiosyncratic shock is revealed to the firm. As a consequence, this 'standard' profit is defined as:

$$E_\omega \Pi_{it}^f = E(\omega_{it}) \frac{P_t^{ws}}{P_t} Y_{it}^{ws} - R_t S_{it} (W_t N_{it}^f + r_t^K K_{it} + \gamma V_{it}) \tag{I.23}$$

Firms take as given the renting capital interest rate r_t^K as well as the Nash wage, W_t. Furthermore, $E(\omega_{it}) = \omega_{mt}$ the time-varying mean of the idiosyncratic shock is identical across firms.

In addition, the objective of the firm is to maximize the entrepreneurs' consumption constituted through the financial expected returns earned by the wholesale firm they own. These financial expected returns are used as consumption, C_{it}^e, for entrepreneurs dying before period $t+1$ and for capital accumulation, K_{it+1}^e, so as to constitute a net worth for next period, X_{it+1}, for solvent entrepreneurs not dying before period $t+1$. Using equation (I.14) and equation (I.19), the expected returns earned by the wholesale firm i, E_{it}^f, are given by:

$$P_t^{ws} Y_{it}^{ws} f(\bar{\omega}_{it}) = R_t S_{it} f(\bar{\omega}_{it}) B_{it} \tag{I.24}$$

Taking into account the death probability ς_t for entrepreneurs, we obtain:

$$R_t S_{it} B_{it} = (1 - \varsigma_t) C_{it}^e + \varsigma_t K_{it+1}^e \tag{I.25}$$

Substituting now the definition of B_{it} from equation (I.19) and the definition of X_{it} from equation (I.13), we obtain a definition for the capital laws of motion of entrepreneurs:

$$(1 - \varsigma_t) C_{it}^e + \varsigma_t K_{it+1}^e = \frac{R_t S_{it} f(\bar{\omega}_{it})}{1 - R_t S_{it} g(\bar{\omega}_{it})} \left(K_{it}^e (1 - \delta + r_t^K) + W^e \right) \tag{I.26}$$

Solvent entrepreneurs who exit the economy at the end of the period will consume all their net worth. Thus, the entrepreneurial consumption, C_{it}^e, is given by:

$$C_{it}^e = \frac{R_t S_{it} f(\bar{\omega}_{it})}{1 - R_t S_{it} g(\bar{\omega}_{it})} \left(K_{it}^e (1 - \delta_K + r_t^K) + W^e \right) - \frac{\varsigma_t}{(1 - \varsigma_t)} K_{it+1}^e \tag{I.27}$$

$$= (1 - \varsigma_t) \frac{P_t^{ws}}{P_t} Y_{it}^{ws} f(\bar{\omega}_{it}) \tag{I.28}$$

Solvent entrepreneurs who do not exit the economy at the end of period t will keep accumulating net worth using their realized return. Consequently, from equation (I.24) the evolution of the entrepreneurial real net worth is given by:

$$X_{it+1} = W^e + \varsigma_t \frac{P_t^{ws}}{P_t} Y_{it}^{ws} f(\bar{\omega}_{it}) \tag{I.29}$$

Thus, ς_t is interpreted as a shock to entrepreneurs' net worth. It evolves according to:

$$\varsigma_t = \bar{\varsigma}\epsilon_t^{\varsigma} \tag{I.30}$$

$$\log(\epsilon_t^{\varsigma}) = \rho_{\varsigma}\log(\epsilon_{t-1}^{\varsigma}) + u_t^{\varsigma}, \quad \rho_{\delta} \in (0,1) \text{ where } u_t^{\varsigma} \overset{iid}{\sim} N(0,\sigma_{\varsigma}^2)$$

where $\bar{\varsigma}$ is the steady state value of the shock to entrepreneurs' net worth, ς_t.

Firms optimality conditions

Optimality conditions for a firm i are delivered by maximizing equation (I.22) subject to equations (I.12) and (I.26):

$$(K_t) \qquad \omega_{mt}\frac{P_t^{ws}}{P_t}Y_K^{ws} = r_t^K R_t S_t \tag{I.31}$$

$$(K_t^e) \qquad 1 = \frac{1-\varsigma_t}{\varsigma_t}\beta E_t\frac{\lambda_{t+1}}{\lambda_t}\left[\frac{S_{t+1}f(\bar{\omega}_{t+1})}{1-S_{t+1}g(\bar{\omega}_{t+1})}(1-\delta_K+r_{t+1}^K)\right] \tag{I.32}$$

$$(V_t) \qquad \frac{Z_t}{P_t} = \frac{\gamma}{p(\theta_t)}R_t S_t \tag{I.33}$$

$$(n_t^f) \qquad \frac{Z_t}{P_t} = \omega_{mt}\frac{P_t^{ws}}{P_t}\frac{(1-\alpha)Y_t^{ws}}{n_t^f} - R_t S_t W_t H_t + (1-\delta)\beta E_t\frac{\lambda_{t+1}}{\lambda_t}\frac{Z_{t+1}}{P_{t+1}} \tag{I.34}$$

where Z_t is the Lagrange multiplier associated to the employment laws of motion constraint.
In order to keep the representative-firm context, we assume that the threshold value of the entrepreneurial productivity, $\bar{\omega}_t$, is the same for all wholesale firms. At the equilibrium, this is an important assumption since all firms will have the same financial mark-up, S_t. Consequently, according to this assumption, the subscript i is dropped[21].

Combining equations (I.33) and (I.34) delivers the job creation condition under financial frictions in the credit market:

$$\frac{\gamma}{p(\theta_t)}R_t S_t = \omega_{mt}\frac{P_t^{ws}}{P_t}\frac{(1-\alpha)Y_t^{ws}}{n_t^f} - R_t S_t W_t H_t + (1-\delta)\beta E_t\frac{\lambda_{t+1}}{\lambda_t}\frac{\gamma}{p(\theta_{t+1})}R_{t+1}S_{t+1} \tag{I.35}$$

The evolution of credit market conditions changes the opportunity cost for resources used to create new jobs through the role played by S_t. Thus, it alters the dynamics of job vacancies. Credit spreads are a key element to understand the cyclical behavior of job creation and the general dynamics of labor markets.
Indeed, from the first-order conditions obtained, asymmetric information in the credit market generates inefficiencies in all markets, the wholesale-good market, the capital market and the labor market. On the

[21] Paustian (2004) shows that thanks to linear monitoring technology and constant returns to scale in production, the heterogeneity in firms productivity does not require to keep track of the distribution of net worth of entrepreneurs.

one hand, marginal productivity of capital and labor are higher than their corresponding real marginal cost. And the final real price of the wholesale good is augmented by a financial mark-up, $S_t > 1$[22], used to overcome the agency problem between entrepreneurs and banks.

The higher are monitoring cost and break-even entrepreneur-specific productivity, the higher is this financial mark-up. Indeed, if monitoring costs are high, the bank bears a greater burden when it has to monitor the firms that declare themselves bankrupt, all other things being equal. Therefore, when reaching the optimal contract with a wholesale firm, knowing these high monitoring costs, the bank sets a high margin to cover these monitoring costs. And as a result, the firm passes on this financial mark-up on its own sales prices which will then increase.

Similarly, if break-even entrepreneur-specific productivity is high, the bank knows it will be difficult for wholesale firms to reach this threshold. The risk of default is high. Therefore, when signing the optimal contract with a wholesale firm, the bank sets a larger margin to compensate this high risk. And as previously, the wholesale firm passes on this financial mark-up on its own sales prices which will then increase.

As a consequence, credit market conditions matter because through the financial mark-up, they affect firms' marginal costs and they are transmitted to the rest of the economy through the selling price's mark-up. Banks have a margin behavior, that will pass through the rest of the economy by the wholesale-good price. This framework breaks down the Modigliani-Miller theorem and makes the firms' external borrowing costs higher than internal funds opportunity costs. Indeed, firms must borrow at a premium over the risk-free rate.

Figure 5 shows the evolution of the risk premium as a convex increasing function of the entrepreneurial productivity and management efficiency threshold, $\bar{\omega}$. This result is quite familiar in the financial accelerator literature. A higher default probability of firms induces a higher cost of lending for banks and consequently, a higher loan spread.

On the other hand, the cost of a new hire, Z_t, depends also on the financial contract conditions. Besides the unit cost stemming from hiring, γ, and the average duration of vacancies, $1/p(\theta_t)$, the total cost of recruitment is augmented by the same financial mark-up, S_t. For any positive monitoring cost, financial frictions increase the average cost of filling a vacancy. Financial contract conditions affect the labor market efficiency through the total vacancy posting cost, that becomes an endogenous variable. This relation is represented by figure 6, where the real posting cost is also an increasing and convex function of $\bar{\omega}$ and its slope raises with monitoring costs, μ. For a higher default likelihood (higher $\bar{\omega}$), banks charge a higher risk premium, Δ, so that entrepreneurs obtain their credit at a higher lending rate, R^l, which makes their external funds more expensive and reduces their willingness to open vacancies.

An increase of μ shifts the real vacancy posting cost upward. For a fixed level of $\bar{\omega}$, the real cost of a new hire raises with monitoring costs. As these costs are expressed in terms of currency, and not in terms of

[22]See appendix A for the proof.

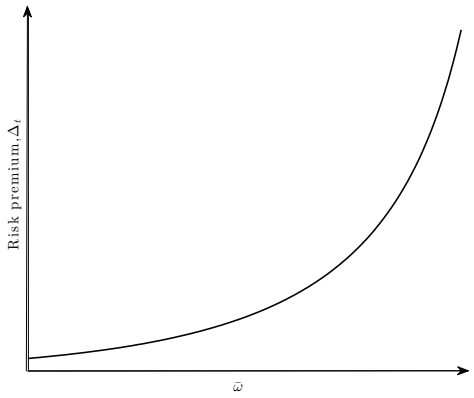


Figure 5: The risk premium as a function of $\bar{\omega}$

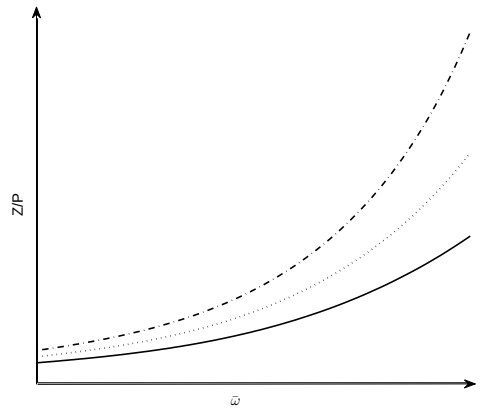


Figure 6: Vacancy posting cost as a function of $\bar{\omega}$ for different values of monitoring costs: $\mu = 0.15$ (solid line), $\mu = 0.2$ (dotted line) and $\mu = 0.25$ (dashed line)

physical goods, they do not generate a loss of resources through a destruction of goods, which could have been used for consumption. However, they generate an additional cost taken into account by banks when agreeing on an appropriate interest rate on loans. Fluctuations in monitoring costs and bankruptcy rates will have an impact on welfare only indirectly, through their implications on the mark-up pricing.

3.4 Wage and hours bargaining

Real hourly wages and hours worked per worker are determined through a period-by-period Nash bargaining[23]. This bargaining takes place after the financial contract determination. So entrepreneurs and households integrate in their bargaining the existence of a financial mark-up set up by banks. The Nash bargaining consists of maximizing the net surplus of the employment relationship for a representative firm, $(Z_t - J_t^V)$, and a representative household, $(\mathcal{W}_t^n - \mathcal{W}_t^U)$, depending on workers and entrepreneurs Nash bargaining powers respectively η and $1 - \eta$.

Bellman equations

The household's surplus of a new employment relationship in terms of current consumption at period t is given by:

$$\mathcal{W}_t^n - \mathcal{W}_t^U = W_t H_t - \frac{H_t^{1+\tau}}{(1+\tau)\lambda_t} - b + \beta E_t \frac{\lambda_{t+1}}{\lambda_t}\left[(1-\delta)(1-q(\delta_{t+1}))(\mathcal{W}_{t+1}^n - \mathcal{W}_{t+1}^U)\right] \quad \text{(I.36)}$$

The entrepreneur's surplus of a new employment relationship in terms of current consumption at period

[23] Whether workers are newly hired or not, they see their wages and hours bargained period-by-period.

t is given by:

$$Z_t - J_t^V = \omega_{mt} \frac{P_t^{ws}}{P_t} \frac{(1-\alpha) Y_t^{ws}}{n_t^f} - R_t S_t W_t H_t + (1-\delta) \beta E_t \frac{\lambda_{t+1}}{\lambda_t} (Z_{t+1} - J_{t+1}^V) \tag{I.37}$$

Since there is a free-entry condition on the labor market, at the equilibrium the value to the entrepreneur of an unemployed worker, J_t^V, is such that $J_t^V = 0$ is satisfied. Indeed, if $J_t^V > 0$, the entrepreneur has an incentive to post vacancies as the value of a vacant job is positive. As the number of vacancies increases relative to the number of unemployed workers, the probability to fill a vacancy job, $p(\theta_t)$, decreases. Indeed, the labor market tightness, θ_t, increases and $p(\theta_t)$ decreases since $\partial p(\theta_t)/\partial \theta_t < 0$. That reduces the incentive to post vacancies and diminishes the value of J_t^V until it equals zero.

Nash bargaining, wage and hours setting

The chosen real hourly wage and the chosen hours of work per worker are the ones that maximize[24]:

$$\max_{W_t, H_t} \quad (\mathcal{W}_t^n - \mathcal{W}_t^U)^{\eta} (Z_t - J_t^V)^{(1-\eta)} \tag{I.38}$$

Therefore, the first-order necessary condition for the Nash wage bargaining solution is given by:

$$\frac{\eta}{1-\eta} Z_t = \mathcal{W}_t^n - \mathcal{W}_t^U \tag{I.39}$$

The following Nash real hourly wage is thus obtained:

$$W_t H_t = \frac{\eta}{R_t S_t} \left[\omega_{mt} \frac{P_t^{ws}}{P_t} \frac{(1-\alpha) Y_t^{ws}}{n_t} + (1-\delta) \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \frac{\gamma}{p(\theta_{t+1})} R_{t+1} S_{t+1} \right] + \frac{(1-\eta)}{R_t S_t} \left[b + \frac{H_t^{1+\tau}}{(1+\tau)\lambda_t} \right] \tag{I.40}$$

The Nash real hourly wage splits by definition the joint surplus of the employment relationship between an entrepreneur and a worker according to the bargaining power of worker, η, associated here with the financial mark-up, S_t. Workers obtain a fraction η of the firm's revenues, as well as a fraction η of the firm's expected saving on total hiring costs, including the financial mark-up S_{t+1}, depending on the probability that the match will not be destroyed exogenously. If the matching is broken, workers and entrepreneurs have to look for another partner in the next period, which is costly for entrepreneurs, especially if financial frictions are high. This cost is thus incorporated in the wage. And workers are compensated for a fraction $1-\eta$ for the disutility they suffer from supplying hours of work and for the foregone unemployment benefits.

The first-order necessary condition for the Nash hours per worker bargaining solution is then given by:

$$\omega_{mt} \frac{P_t^{ws}}{P_t} Y_t^{ws} = \frac{H_{t+1}^{\tau}}{\lambda_t} \tag{I.41}$$

[24] Recall that matches do not depend on any idiosyncractic component.

3.5 Intermediate and final-good firms

Final-good production

Final-good firms proceed in a perfectly competitive market and are owned by households. They purchase a continuum of differentiated intermediate goods indexed by $j \in [0,1]$ and aggregate theses varieties to produce Y_t units of final goods. They have no other costs or inputs, except the one to buy to intermediate-good firms the different varieties. Final goods are produced using a standard constant return to scale technology given by:

$$Y_t = \left[\int_0^1 Y_{jt}^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}} \tag{I.42}$$

where $\epsilon > 1$ is a parameter governing the degree of monopolistic competition in the intermediate good sector (or the elasticity of substitution between intermediate goods).

Each competitive final-good firms choose their own input demand functions for each variety of intermediate goods, Y_{jt}, so as to maximize their nominal profits defined as:

$$P_t Y_t - \int_0^1 P_{jt} Y_{jt} dj$$

where P_t is the consumer's price index that corresponds to the aggregate price level. The solution to the maximization problem[25] yields the following demand function for the intermediate good of variety j:

$$Y_{jt} = \left[\frac{P_{jt}}{P_t} \right]^{-\epsilon} Y_t \tag{I.43}$$

So, the demand for each variety of retail goods is a downward sloping demand curve, which gives to the retail firms some pricing power as we will see below.

Then, as we are in a competitive setting, the zero-profit condition applies at the equilibrium for final-good firms and it yields:

$$P_t Y_t = \int_{j=0}^1 P_{jt} Y_{jt} dj \tag{I.44}$$

From this condition, the aggregate price level or the consumer's price index can be easily derived by plugging

[25] Final-good firms maximize their expected stream of profits, which is equivalent to maximize their profits period-by-period since they purchase intermediate goods at the same frequency.

the demand function (I.43) into the zero-profit condition (I.44), which gives:

$$P_t = \left[\int_{j=0}^{1} P_{jt}^{1-\epsilon} dj\right]^{\frac{1}{1-\epsilon}} \tag{I.45}$$

Intermediate-good production

There is a continuum of monopolistically competitive retailers. These retailers are owned by households[26]. They buy homogeneous wholesale goods at the price P_t^{ws}. They differentiate costessly each unit of these goods into a unit of retail goods, Y_{jt}. These firms are assumed to have no other inputs or costs than the homogeneous good. Following Yun (1996), Christiano et al. (2005) and Trigari (2009), a price stickiness for these firms is formulated in the spirit of Calvo (1983). Every period, only a random fraction $(1-\varrho) \in [0,1)$ of firms is able to fully re-optimize their nominal prices. The hazard rate, ϱ, is constant across firms and time. The remaining fraction of firms does not re-optimize their prices and following Christiano et al. (2016), they keep their prices unchanged. So the price set by a retailer j, P_{jt}, corresponds to:

$$P_{jt} = \begin{cases} P_{jt-1} & \text{with probability } \varrho \\ P_t^* & \text{with probability } 1-\varrho \end{cases} \tag{I.46}$$

where P_t^* is the optimal price set by the fraction ϱ of retailers who are able to re-optimize their prices at time t. Note that P_t^* does not depend on j because all firms that can re-optimize their prices at time t choose the same price as they are assumed to be symmetric. Then, for firms not able to re-optimize their prices, there is no price indexation to replicate the observation that many prices can remain unchanged over time (Eichenbaum et al. (2011) and Klenow and Malin (2010)). So, the price index (I.45) is thus given by:

$$P_t = \Big[\int_0^1 P_{jt}^{1-\epsilon} dj\Big]^{\frac{1}{1-\epsilon}} = \Big[(1-\varrho)\big(P_t^*\big)^{1-\epsilon} + \varrho\big(P_{t-1}\big)^{1-\epsilon}\Big]^{\frac{1}{1-\epsilon}} \tag{I.47}$$

The price index is a CES aggregate of all retail goods prices in the economy. The sum in equation (I.47) can be transformed into a convex combination of two prices because retail firms of each type are assumed to be respectively symmetric. And a costless price regulation mechanism is assumed, which guarantees that a consumer pays the same price whatever the firm at which he realizes his purchases[27]. So, the price index corresponds to a weighted average price of the fraction ϱ of firms who can re-optimize their prices after the aggregate shock, A_t, and the fraction $(1-\varrho)$ of firms who can not.

Let's now determine the optimal price P_t^*. Retail firms that can re-optimize their price, maximize the expected discounted value of their profits given the demand for the good they produce, since firms expect to keep this price for more than the current period. They take into account that the price may be fixed for

[26] So retailers have the same stochastic discount factor as households.
[27] The matching of consumers and firms is here ignored.

many periods. If the expected probability of price stickiness is high, firms able to re-optimize their price at the period t will be relatively more concerned about the future when they make their current pricing decisions.

Thus, the retail firm's problem is stated as:

$$\max_{P_{jt}} \quad E_t \sum_{s=0}^{\infty} (\varrho\beta)^s \frac{\lambda_{t+s}}{\lambda_t} \left[\left(\frac{P_{jt}}{P_{t+s}} \right)^{1-\epsilon} Y_{t+s} - \left(\frac{P_{jt}}{P_{t+s}} \right)^{-\epsilon} \left(\frac{P_{t+s}^{ws}}{P_{t+s}} \right) Y_{t+s} \right]$$

Note that ϱ is integrated in the discount rate because there is a probability ϱ^s that the price chosen is still applied in s periods of time.

The first-order condition of the problem is given by:

$$E_t \sum_{s=0}^{\infty} (\varrho\beta)^s \frac{\lambda_{t+s}}{\lambda_t} P_{t+s}^{(\epsilon-1)} Y_{t+s} \left(\epsilon P_{t+s}^{ws} P_t^*(-\epsilon - 1) + (1-\epsilon) P_t^*(-\epsilon) \right) = 0$$

The optimal price, P_t^* , sets by retail firms who are able to re-optimize their prices is:

$$P_t^* = \frac{\epsilon}{\epsilon - 1} \frac{E_t \sum_{s=0}^{\infty} (\varrho\beta)^s \frac{\lambda_{t+s}}{\lambda_t} P_{t+s}^{ws} P_{t+s}^{\epsilon-1} Y_{t+s}}{E_t \sum_{s=0}^{\infty} (\varrho\beta)^s \frac{\lambda_{t+s}}{\lambda_t} P_{t+s}^{\epsilon-1} Y_{t+s}} \tag{I.48}$$

The size of the mark-up depends on the time-varying elasticity of substitution between retail goods, ϵ. So flexible-price retail firms set their price such that it equals the present discounted value of marginal costs. The optimal price is a mark-up over a weighted average of future marginal costs. Note that if there is no price-stickiness, $\varrho = 0$, the monopoly standard mark-up formula is obtained:

$$P_t^* = \frac{\epsilon}{\epsilon - 1} P_{t+s}^{ws}, \qquad \text{where} \quad \frac{\epsilon}{\epsilon - 1} > 1 \tag{I.49}$$

3.6 Monetary and fiscal policy

Monetary policy

The monetary policy is decided and carried out by the central bank following an interest rate Taylor-type rule[28]. The nominal interest rate is set depending on deviations in output, inflation and nominal interest rate from their steady-state levels:

$$\frac{R_t}{\bar{R}} = \left(\frac{R_{t-1}}{\bar{R}} \right)^{\rho_r} \left[\left(\frac{\pi_t}{\bar{\pi}} \right)^{\rho_\pi} \left(\frac{Y_t}{\bar{Y}} \right)^{\rho_Y} \right]^{1-\rho_r} \tag{I.50}$$

where ρ_R is the degree of interest rate smoothing, ρ_Y and ρ_π are respectively the response coefficients to output and inflation variables. Variables without a time subscript are steady state values. R_t is the interest

[28] The same kind of Taylor rule is used by Krause et al. (2008) and Trigari (2009).

rate on deposits decided and set at time t that pay off in period $t+1$.

Fiscal policy

Unemployment benefits, $(1-n_t)b$, are provided by the government. He finances also other real exogenous spending, G_t, that are not used for any productive object. Government outlays are financed through nominal lump-sum taxes by households, T_t. The flow government budget constraint is:

$$G_t + (1 - n_t)b = \frac{T_t}{P_t} \tag{I.51}$$

3.7 Equilibrium

A dynamic equilibrium consists of state-contingent endogenous processes $\{C_t, C_t^e, n_t, H_t, U_t, V_t, K_{t+1}, K_{t+1}^e, K_{t+1}^h, Y_t^{ws}, r_t^K, W_t, P_t, T_t, R_t, S_t, \bar{\omega}_t\}$ that satisfy the following conditions: the vacancy creation condition (I.35), the Nash wage rule (I.40), the hours per worker rule (I.41), the household's Euler equation for deposits (I.6), the household's surplus of having a new employed worker (I.8), the household's Euler equation for capital (I.7), the entrepreneur's equation for consumption (I.27), the entrepreneur's Euler equation for capital (I.32), the bankruptcy threshold condition (2.5), the price index (I.47), the aggregate law of motion for employment (I.11), the aggregate capital market clearing $K_t = K_t^h + K_t^e$, the entrepreneur's leverage ratio (I.19), the firm's capital law of motion (I.26), the aggregate resource constraint $C_t + I_t = Y_t^{ws}$, the interest rate Taylor-type rule (I.50) and the government budget constraint (I.51). Stochastic processes are taken as given $\{s_{0t}, \sigma_{\omega t}, \varsigma_t\}_{t=0}^{\infty}$.

4 Quantitative exercise

The quantitative exercise is conducted through numerical approximation of the model by linearization around the steady state. We use Matlab to perform the model simulation. We relied on Matlab codes from different sources, especially those of Cristiano Cantore and Paul Levine, obtained during a Summer School "The Science and Art of DSGE Modelling" at the University of Surrey in 2015.

4.1 Calibration

Table 1 lists our parameters setting. Parameter values are chosen to be consistent with those standard in literature and to match some empirical facts observed in data for the United-States between 1960-Q1 and 2007-Q4.

Preference and technology parameters are standard in the literature. The household discount factor, β,

is set to 0.99 implying an annual real interest rate of 4%. The inverse of the elasticity of worked hours to real hourly wage (or the Frish elasticity), τ, is equal to 10. This value is chosen by Trigari (2009), that has in her paper extensive and intensive margins as we do. The external habit persistence parameter is fixed to 0.5 as in Gertler et al. (2008). The capital share in production function, α, is 0.36. The capital depreciation rate, δ_K, is fixed to 0.025 corresponding to an average annual depreciation rate of 10 per cent. This value is based on calculation of Kydland and Prescott (1982) using US time series data.

The labor market parameters are also standard in the recent literature. Elasticity of matches to unemployment, ρ, is set to 0.4 as in Blanchard and Diamond (1989), Merz (1995), Andolfatto (1996) and Mortensen and Nagypal (2007)[29]. The value, 0.4, is given to the bargaining power, η, to deliver Hosios efficiency. The vacancy posting cost, γ, is calibrated to 0.14, and the destruction rate parameter is set to 0.08. It is compatible with those used in the literature which range from 0.07 in Merz (1995) to 0.15 in Andolfatto (1996). The unemployment benefits, b, is equal to 0.71 as in Petrosky-Nadeau (2014).

For the intermediate-good sector, the monopolistic mark-up or the elasticity of substitution across inputs, ϵ , is fixed to 11 to have a conventional price-mark-up on marginal costs at 10% as in Walsh (2005) and Trigari (2009).

The steady state entrepreneurial survival rate is equal to 0.9728 derived from the default rate data from Moosdy's US speculative-grade. The gross external finance premium, s_1, is set to 4.97. The long-run mean of idiosyncratic productivity and management efficiency, ω_m, is normalized to 1.

Finally, the Calvo stickiness of prices, ϱ, is set to 0.66 as in Gertler et al. (2008). And for the Taylor rule, conventional value are also taken. The interest rate smoothing coefficient, ρ_R, is set to 0.75. Coefficients for the responses of interest rate to inflation, ρ_π and to the output gap as in are fixed respectively to 1.7 and 0.125 as in Gertler et al. (2008).

[29]This value is almost within the range of values of 0.5 to 0.7 reported by Petrongolo and Pissarides (2001) in their survey of the literature on the estimation of matching function. Others values are used such as 0.72 in Shimer (2004) and Petrosky-Nadeau (2014) or 0.5 in Gertler et al. (2008).

Table 1: Parameters values for quantitative analysis

Parameter	Value	Description
Preferences		
β	0.99	Households' quarterly discount factor
τ	10	Inverse of the elasticity of worked hours to real wage
h	0.5	External habit persistence
Technology		
α	0.36	Capital's share in production function
δ_K	0.025	Capital depreciation rate
Labor markets		
ρ	0.4	Elasticity of matches to unemployment
γ	0.14	Unit cost of job vacancies
b	0.71	Unemployment benefits
η	0.4	Nash bargaining power of workers
δ	0.08	Quarterly job separation rate
Entrepreneurs and	financial	markets
s_1	4.973	Gross external finance premium
$\bar{s_0}$	7.3678	Steady-state value of monitoring cost shock
$\bar{\varsigma}$	0.9728	Steady-state value of net worth shock
ω_m	1	Productivity and management efficiency mean
Intermediate-good	markets	
ϱ	0.66	Calvo price stickiness
Exogenous process		
ρ_{s_0}	0.95	Monitoring cost shock persistence
ρ_ω	0.97	Idiosyncratic volatility shock persistence
ρ_ς	0.5	Net worth shock persistence
ρ_R	0.75	Interest rate smoothing coefficient
ρ_π	1.7	Response to inflation
ρ_Y	0.125	Response to output

4.2 Results

We choose to consider three types of shocks: net-worth, monitoring cost and idiosyncratic volatility shocks to investigate the role played by financial shocks on labor market outcomes. Shocks originating from the financial sphere were indeed considered of prime importance during the Great Recession, as being at the source of damages on the real sphere of economies, especially on labor markets : higher credit imperfections may be the source of a slowdown of the economy, and not its consequence. The three shocks considered are interesting to consider as they are representative of different aspects of the financial frictions environment: the riskiness of the debtor, its degree of dependence on external financing and the cost the lender has to bear to tackle asymmetric information. It should be noted that, with the exception of the idiosyncratic volatility shock, public decision-makers can influence firms' net worth accumulation (for example through taxation, which is however not taken into account in this model), as well as monitoring costs (through banking regulations for example).

Other shocks could have been considered, especially those originating from labor markets, as job separation rate or bargaining shocks. Shocks originating from the labor market could be at the source of fluctuations in the financial sphere. For example, lower firms bargaining power or higher unemployment in the economy may induce banks to increase their financial mark-up as they may expect an increase in the default risk of firms: a kind of "unemployment accelerator" as called by Blanco and Navarro (2016) could be investigated. However, it is not the purpose of our paper (and of my dissertation) to consider this causality link, from labor markets to financial markets despite the interest of the question. It could however pave the way for future research.

Net worth shock

We assume a one-% expansionary shock to the entrepreneurs net worth (the net worth of entrepreneurs is 1% higher). According to the model, it corresponds to a positive increase in ς_t. The aggregate real net worth is increasing as the probability of dying for each entrepreneur is decreasing. A positive net worth shock induces that all entrepreneurs will carry on to the next period $t+1$ a higher net worth. Recall that surviving solvent entrepreneurs carry their profits as a part of their net worth. And entrepreneurs, based on their net worth amount and their expected production and returns, borrow funds from financial intermediaries to finance their capital rental costs, wage payments and hiring costs. So the net worth is a mean for entrepreneurs to lower their use of financial intermediaries' loans.

Figure 7 shows impulse response functions to a positive % net worth shock. Firstly, an increase in the aggregate real net worth has a positive effect on the financial sphere. By a positive effect, we mean that it decreases the financial mark-up, highlighting a financial accelerator mechanism. The higher is the level of the aggregate real net worth, the lower is the financial mark-up charged by banks to entrepreneurs as

found by Zanetti and Mumtaz (2011). As a consequence of the real aggregate net worth increase and of the financial mark-up decrease, the default rate is decreasing. This decrease induces an increase in the gross share of returns going to the firm according to the theoretical model.

These results on the financial sphere impact the real sphere of the economy, especially the labor market.

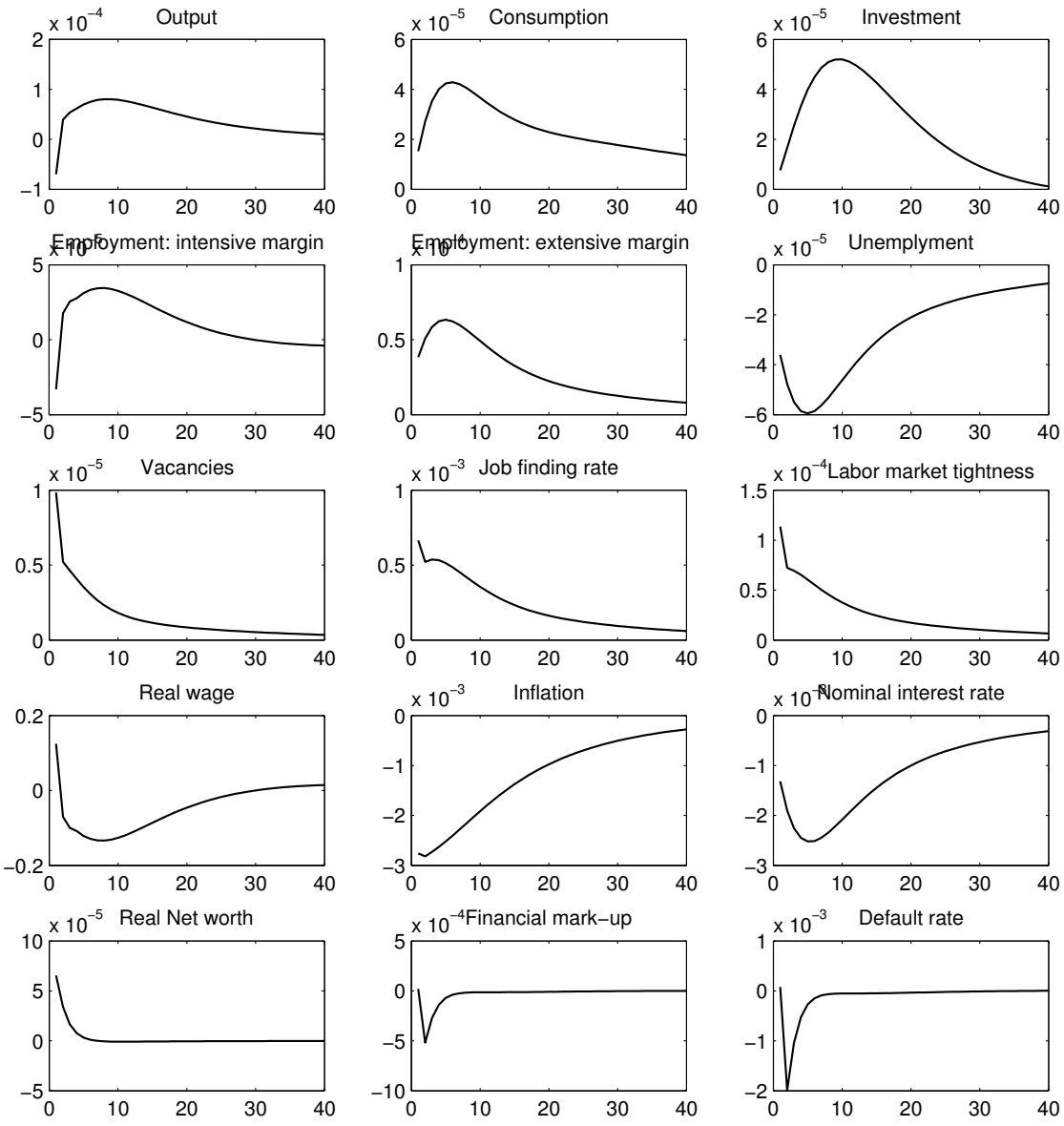


Figure 7: IRF to positive networth shock

An increase in the aggregate real net worth of entrepreneurs leads to a decrease in the unemployment rate, following a negative hump-shaped, thanks to an easing in their financing costs. Indeed, entrepreneurs are now able to finance by themselves a higher part of their production and vacancies costs, and for the part financed by loans, the financial mark-up charged by banks is reduced. So the aggregate real wholesale firm's

marginal costs are reduced according to the model. This reduction induces entrepreneurs to post more vacancies, and the unemployment rate decreases as a consequence as found in the estimation of Zanetti and Mumtaz (2011). The job finding rate for workers increases and the labor market tightness from the firm point of view increases.

More precisely, a substitution effect between hours worked per employee and the amount of employed workers appears for the labor market in this calibration exercise as in the estimation of Christiano et al. (2011). This phenomenon highlights the interaction between intensive and extensive margins on labor markets. As a consequence of the easing of financing costs, entrepreneurs are willing to hire more workers, but they decrease their demand for hours worked per employee. This fact is known to be observed in data. Extensive margin is indeed more reactive than the intensive margins when the economy is hit by a shock.

Furthermore, the link from the financial market to the labor market goes also through wages. An easing in financial constraints increases the labor market tightness from the firm point of view. And the reduction in aggregate real marginal costs is passed through prices according to our model, leading to a lower inflation rate as observed in the calibration exercise. These two facts contribute to an increase of the real wage in the economy. However, these results are different from the ones of Zanetti and Mumtaz (2011). The reason may be that they integrate only the capital stock as the production cost to pay in advance of production.

Obviously, the previous results on the financial sphere have also an impact on goods market. An increase in the net worth of entrepreneurs generates a positive hump-shaped in consumption, through according to the model, the higher wages, more vacancies posted and less unemployment. The net worth positive shock induces also a positive hump-shaped, larger than the one for consumption, in investment. This increase in investment can be explained by the model as the consequence of more employed workers and higher wages for households that are able to invest more, and through a higher demand for capital expressed by entrepreneurs, as the net worth increases and financial mark-up decreases (Zanetti and Mumtaz (2011)). The conjunction of higher consumption and higher investment leads to an increase in output, after a first decrease, possibly due to higher wages and higher vacancy posting costs.

So the economy is better off, at least in terms of consumption and employment, when all firms are able at the aggregate level to self-finance a higher part of their production and vacancies costs. Financial frictions are indeed less at stake as a consequence, through a decrease in the amount of loans demanded by firms and a decrease in the level of marginal costs, realized by a lower financial mark-up. The most important impact appears to be on the labor market, where vacancies increase and unemployment rate decreases as expected according to the theoretical model.

Monitoring cost shock

A positive monitoring cost shock is realized in the economy through a decrease in the monitoring cost, μ_t. More precisely, the recovery rate defined in the model following Livdan et al. (2009) and Petrosky-Nadeau

(2014) increases (so the monitoring cost decreases), by an increase of s_{0t} interpreted as a monitoring cost shock. Recall that in the model a monitoring cost appears because wholesale-good production is subject to an idiosyncratic shock observed privately by entrepreneurs and not by financial intermediaries. Thus, banks have to pay a monitoring cost for bankrupt entrepreneurs to check the real output produced.

Figure 8 shows impulse responses to a positive monitoring cost shock. As for the net worth shock, a positive monitoring cost shock has an impact on the financial sphere. A decrease of the monitoring cost leads to a reduction of the default rate. It was strongly expected as in the model, the monitoring cost spending is a direct synonym of bankruptcy. The lower are the monitoring costs, the lower is the default rate. Then, the positive monitoring cost shock leads to a reduction of the financial mark-up charged by banks to entrepreneurs. It could be easily explained through the model by the expression of the financial markup S_t that depends negatively on the recovery rate. A positive monitoring cost shock means that the recovery rate for banks increases. The proportion of the real amount recovered by banks is higher. So banks do not need to charge, everything else equal, the same amount of financial mark-up to entrepreneurs.

For the real part of the economy, following the model, the agency problem between banks and entrepreneurs alters the real hiring cost and the marginal cost of production for wholesale firms. We observe in this quantitative exercise that it is true: a positive monitoring cost shock induces an increase of vacancies and a decrease of unemployment following a negative hump-shaped with a peak at one year and half. Petrosky-Nadeau (2014) finds in the same spirit following a negative monitoring cost shock, called credit shock, a positive hump-shaped for unemployment with a peak just over a year after the shock, that is considered as comparable to the research of Jermann and Quadrini (2012), but with a specific insight into the labor market. So, lower marginal costs, thanks to lower financial mark-up, induce firms to post more vacancies and to hire more. The labor market tightness from the firm point of view increases and the job finding rate for households increases as a consequence as in Petrosky-Nadeau (2014).

The substitution effect between hours worked per employee and number of employed workers does not appear here after a positive monitoring cost shock. On the contrary, a complementary effect is observed: employed workers are more numerous, and each of them are working more. That is a first reason why we observe an immediate positive impact on the output compared to the previous case.

Concerning the output, in the model, we assume that the monitoring cost spending, synonym of bankruptcy is spent in terms of currency, and not in terms of physical goods. Bankruptcy has no direct impact on the real output. However, the simulation shows a clear indirect impact on output. Indeed, monitoring costs are additional costs taken into account by banks when agreeing on an appropriate interest rate on loans. A reduction in monitoring costs and bankruptcy rates has an impact on welfare indirectly, through their implications on the mark-up pricing. The calibration illustrates this phenomenon: the decrease in monitoring costs reduce real marginal costs of firms, reducing the level of inflation in the economy, as well as the level of nominal interest rate. It generates an increase in consumption and investment that in turns increase the output level.

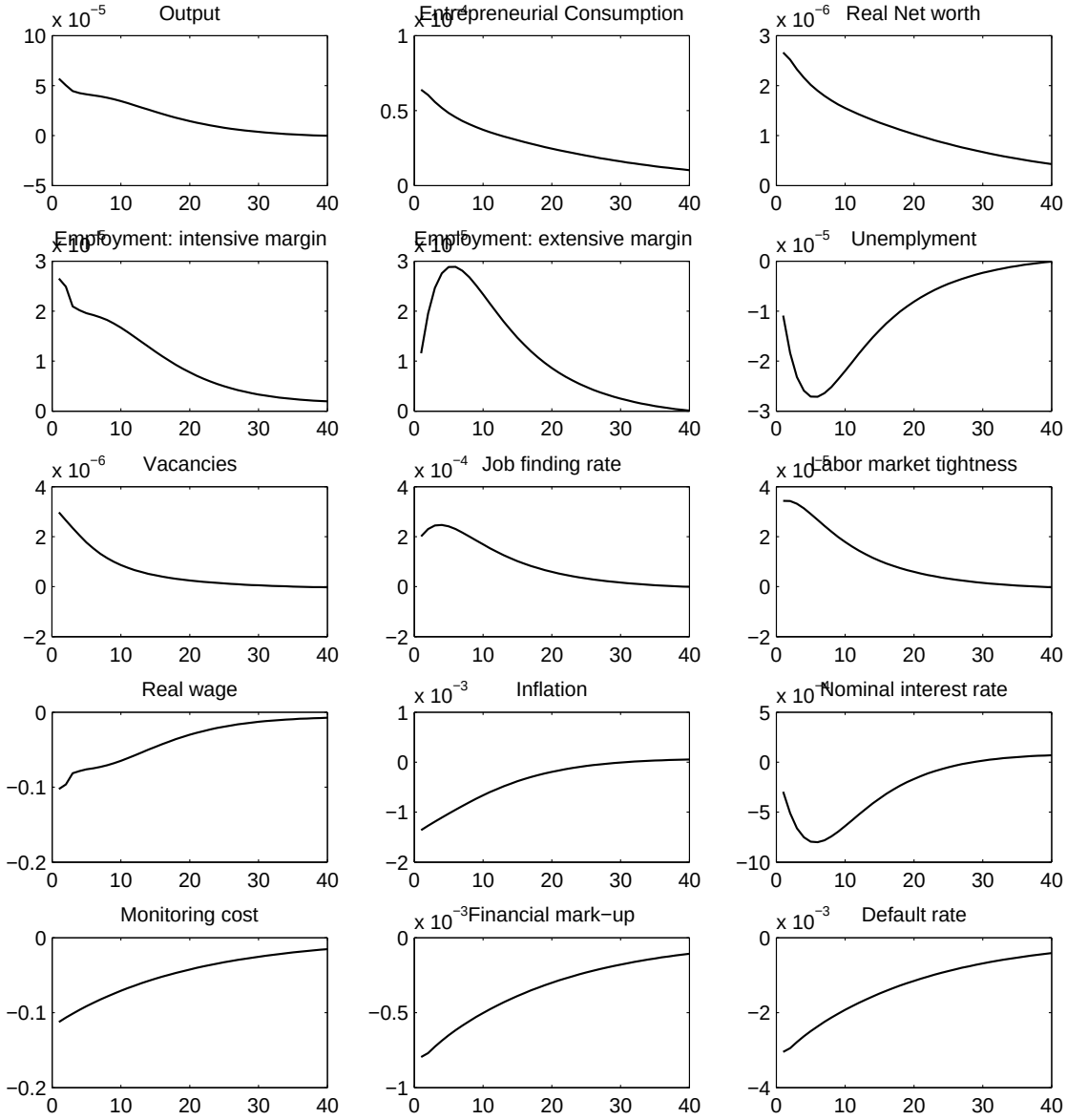


Figure 8: IRF to positive monitoring cost shock

Finally, the aggregate real net worth increases as a consequence of the reduction of the monitoring cost and of marginal costs. Solvent dying, and not dying, entrepreneurs have indeed a larger share of the net output to consume, and to save to the next period.

Thus, a positive monitoring cost shock pushes down marginal costs and prices, as well as hiring costs by a financial mark-up depending on the level of monitoring costs. A reduction of monitoring costs in an economy has a strong impact on the vacancies and employment levels as expected through the model. Finally, we obtain as observed on figure 1 a positive correlation between unemployment and monitoring costs (approximated in the figure by the risk premium, Baa-Aaa spread, in the economy).

Idiosyncratic volatility shock

An idiosyncratic volatility shock is defined as a variation in the variance of the idiosyncratic shock concerning entrepreneur's productivity[30]. According to the model, this variance reflects the entrepreneurs riskiness for banks. As a consequence, a positive idiosyncratic volatility shock means that banks are facing a higher risk when they decide to lend to entrepreneurs. Recall that banks do not observe firms idiosyncratic shocks, but they only know the cumulative and density functions of these idiosyncratic shocks.

Figure 9 shows impulse responses to a positive idiosyncratic volatility shock. As expected, after an increase in the level of firms idiosyncratic volatility, banks charge a higher financial mark-up to protect them against asymmetric information. The default rate increases in quite huge proportion due to the increase of idiosyncratic volatility in the economy, and due to the increase in the financial mark-up that increases firms real marginal costs.

On the real side, a higher idiosyncratic volatility decreases employment, output, consumption and investment. As a consequence, labor market tightness from the workers point of view increases. Indeed, firms are posting fewer vacancies. The reason is linked to the increase of the financial mark-up. After an increase in the level of idiosyncratic volatility, according to the model, the increase of the financial mark-up is passing through real marginal costs and prices in the economy. Firms are induced to post fewer vacancies, to hire fewer workers because of this increase in financing costs. Furthermore, inflation increases as well as the nominal interest rate. Intensive and extensive margins appear here to move in the same direction as after a monitoring cost shock. Hours worked per employee decrease also. So, fewer workers are employed in the economy and each employed workers are working less. It explains why consumption and investment are going down. Households have a less amount of resources to invest and the demand for capital by firms decreases due to the increase in the financial mark-up.

Thus, the economy reaches a negative position after an increase in the idiosyncratic volatility of wholesale firms. Facing higher risks of default, banks need, to overcome the agency problem they face with entrepreneurs, to increase the financial mark-up that they charge to them. The real marginal financing costs of entrepreneurs increase. It reduces as a consequence the value of a new hire and leads to lower vacancies. The unemployment goes down. Furthermore, the higher marginal costs are passed through prices to the rest of the economy, leading to higher inflation, less consumption and less output in a new-Keynesian perspective. Finally, we obtain as observed on figure 1 a positive correlation between unemployment and entrepreneurs riskiness for banks (approximated in the figure by the default rate in the economy).

[30]We took inspiration from financial economics literature (Fu (2009) for example who uses GARCH models to estimate expected idiosyncratic volatility) to name this shock.

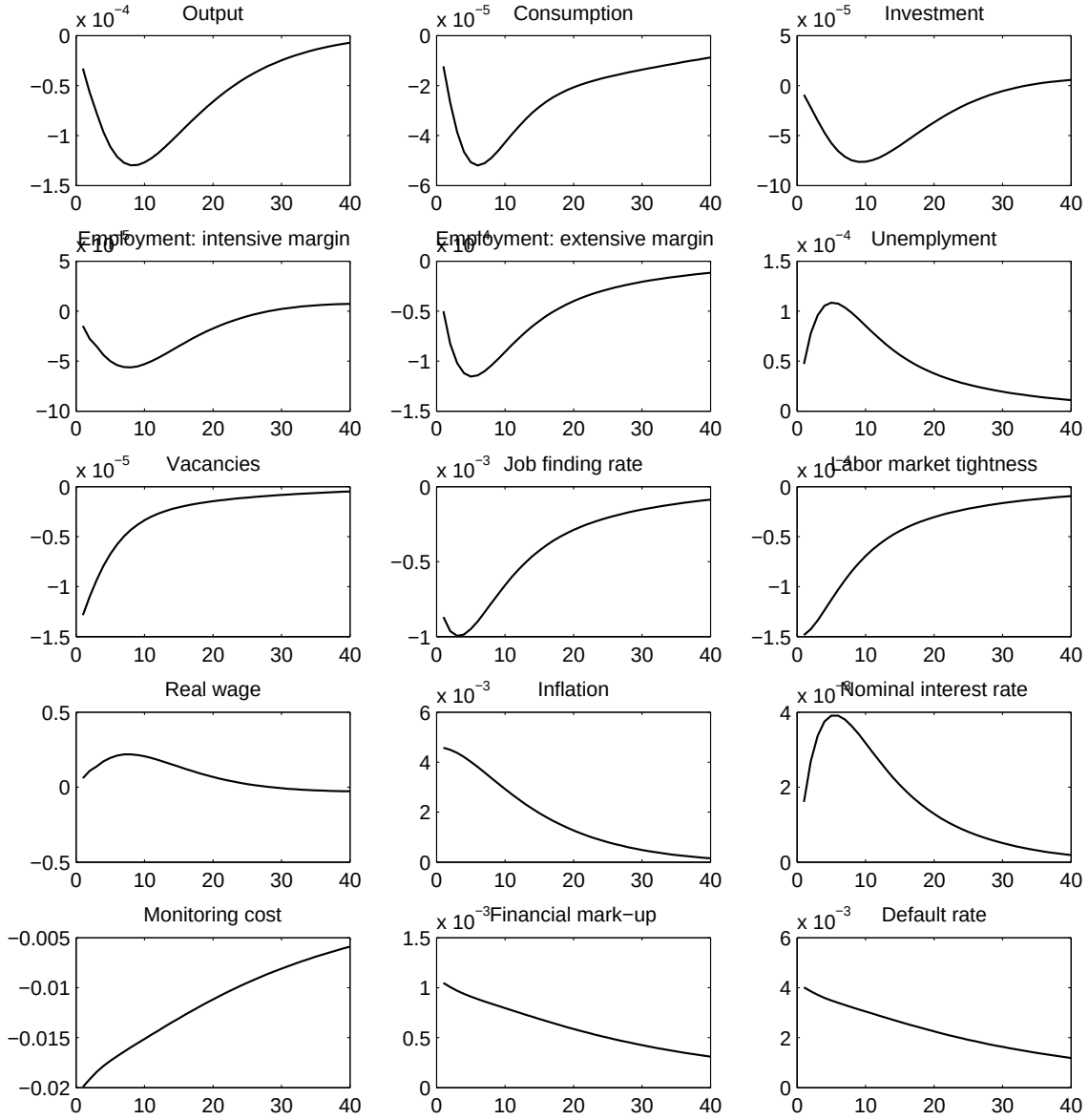


Figure 9: IRF to positive idiosyncratic volatility shock

5 Conclusion

We construct a new-Keynesien DSGE model integrating sticky prices, financial frictions on the credit market and asymmetric information on the labor market. We find that credit market frictions may be the source of lower posting vacancies and higher unemployment levels. Financial frictions push up wholesale firms' marginal costs as well as hiring costs by a financial mark-up charged by financial intermediaries. This financial mark-up is then transferred by these firms on prices. Thus, it affects their hiring behavior, as well as wage and employment levels in the economy. Then, we calibrate the model and we consider three

shocks: a net worth shock, a monitoring cost shock and an idiosyncratic volatility shock. By moving three dimensions involving different degrees of financial frictions, we observe through the quantitative exercise a clear impact from the financial market shocks to the labor market. Increasing asymmetric information in financial markets (through higher monitoring costs, higher idiosyncratic volatility or lower entrepreneurial net worth) leads clearly to higher unemployment in the economy through different channels. These channels converge all to the role of the financial mark-up that is charged by banks to overcome agency problems. This financial mark-up is passed through the rest of the economy by higher marginal costs and higher inflation. That in turn reduces the levels of vacancies posting, employment, wages and consumption, and finally the level of output. The evolution of credit market conditions changes the opportunity cost for resources used to create new jobs. Thus, it alters the dynamics of job vacancies and unemployment. For the three shocks, the unemployment jumps up or goes down to its highest level in the first period and then slowly converges back to its steady state level. The model could therefore also be able to generate the persistent evolution of unemployment following a shock on credit markets. This model could then be estimate with Bayesian methods to determine if it is able to to faithfully replicate unemployment, wages and vacancies data for the United-States.

Appendices

A Proof

In this appendix, we prove that $S_t \geq 1, \quad \forall\, \bar{\omega}_t \in [0, \infty)$, where $S_t = \{1 - \mu_t[\Gamma(\bar{\omega}_t) + \bar{\omega}_t h(\bar{\omega}_t) f(\bar{\omega}_t)]\}^{-1}$.

Using the assumption that $\bar{\omega}_t h(\bar{\omega}_t)$ is increasing in $\bar{\omega}_t$ and taking derivatives, we obtain:

$$S_t' = \frac{\mu_t}{1 - \Phi(\bar{\omega}_t)} \frac{d(\bar{\omega}_t h(\bar{\omega}_t))}{d\bar{\omega}_t} \frac{1}{S_t^2} > 0.$$

Given this result, S_t is an increasing function of $\bar{\omega}_t$.

Now taking limits of $\Gamma(\bar{\omega}_t)$ and $\bar{\omega}_t h(\bar{\omega}_t) f(\bar{\omega}_t)$ at the lower bound of $\bar{\omega}$, we get:

$$\lim_{\bar{\omega} \to 0} \Gamma(\bar{\omega}_t) = 0, \qquad \lim_{\bar{\omega} \to 0} \bar{\omega}_t \mathrm{h}(\bar{\omega}_t) \mathrm{f}(\bar{\omega}_t) = 0$$

Thus, $\lim_{\bar{\omega} \to 0} S_t = 1$.
Combining the previous results, $S_t \geq 1, \quad \forall\, \bar{\omega} \in [0, \infty)$.

Chapter II

Credit Constraints and Labor Market: the role of Wage Bargaining Regimes

1 Introduction

Labor market institutions of each country are diverse and are sources of potential rigidity leading to a multiplicity of equilibrium (Nickell and Layard (1999)). This chapter takes into account a specific labor market institutional form that are the wage bargaining schemes. Two bargaining schemes are considered, the efficient bargaining (EB hereafter) and the right-to-manage bargaining (RTM hereafter). I compare them in a labor search model with credit constraints on the credit market. The objective is to study under each type of bargaining regimes, the impact on unemployment, wages and hours worked per employee of labor and credit markets frictions. Many papers analyzing the effect of asymmetric information on labor and credit markets assume that wages and hours worked per employee are determined through an efficient bargaining between firms and workers. However in actual practice, firms have often the right-to-manage workers. Hours per workers are unilaterally chosen by firms rather than determined by a bargaining between firms and workers. So the question raised in this chapter is: *in a world with credit frictions, how different wage bargaining regimes affect labor market outcomes?*

Borrowing constraints are sources of higher unemployment when the bargaining is called 'efficient'[1]. By modifying the bargaining regime, where hours worked are chosen unilaterally by firms, I obtain different impacts of financial and labor markets frictions on wages, hours worked per workers and unemployment through the existence of a specific mark-up that increases the degree of markets inefficiencies.

This chapter merges two strands of the literature. First, it is related to the literature dealing with the

[1]The bargaining is not entirely 'efficient' anymore as soon as borrowing constraints are integrated as it will be showed in this chapter. However I use as in Trigari (2006) the term 'efficient' bargaining to identify a specific regime of bargaining, where workers and firms bargain over wages and hours worked per worker.

impact of financial frictions on macroeconomic performances[2], including labor market outcomes. In my upcoming model, financial frictions are modeled following Kiyotaki and Moore (1997), and more precisely Jermann and Quadrini (2012), where firms borrowing is limited by a collateral constraint. Jermann and Quadrini (2012) investigate the consequences of the use of debt or equity financing by capitalists on the dynamic of real and financial variables. Credit shocks here directly affect the borrowing capacity of economic agents.

Second, this chapter introduces labor market frictions à la Mortensen and Pissarides (1994), associated with the limited borrowing capacities. Christiano et al. (2016), Garin (2015), Monacelli et al. (2011) and Zanetti and Mumtaz (2011) introduce also these kinds of frictions in their models. They analyze the impact of financial shocks on labor markets. However they do not distinguish between intensive and extensive margins. And they are both using an efficient bargaining framework on labor markets.

Third, two bargaining regimes are considering in this chapter following the paper of Trigari (2006), that introduced the distinction between 'efficient' bargaining and 'right-to-manage' bargaining.

My model is a *partial* equilibrium model that features search-and-matching frictions in the labor market, enforcement constraints in the credit market and bilateral wage bargaining à la Mortensen and Pissarides (1994). I introduce credit frictions through a collateral constraint that is recognized to be a powerful tool to specify credit crunches. Then, I introduce a second layer of frictions in the labor market: the model integrates Non-Walrasian labor market features, namely matching frictions generating unemployment in equilibrium. I allow for variable hours per worker such that labor input can be adjusted along two margins, the extensive margin (employment) and the intensive one (hours per worker). Finally, two types of bargaining are considered, the Nash bargaining over both wages and hours per worker, the so-called 'efficient bargaining' (EB), and the so-called 'right-to-manage bargaining' (RTM) where firms adjust hours unilaterally[3].

Before production takes place, a firm needs an intra-period loan to be able to pay in advance the working capital[4]. However, due to asymmetric information, there is a risk of firm's default for the lender. To protect himself against this risk, the lender imposes an enforcement constraint to the firm. Then, knowing this enforcement constraint, the firm posts vacancies in the labor market at a unit vacancy posting cost, where unemployed workers are searching for jobs. Matching occurs. Wages are bargained either through an efficient bargaining or through a right-to-manage one. Hours per worker are determined jointly in an EB set-up, whereas they are determined unilaterally by the firm in a RTM set-up. In that case, it is said that wages are allocational for hours. With the intra-period credit, the firm has to pay vacancy posting costs and production costs (capital and wage bill). The production of the firm occurs. At the end of the period,

[2] A more developed literature review about this literature is developed in the chapter I of this dissertation.

[3] About the terminology, I follow Trigari (2006).

[4] See Garin (2015), Jermann and Quadrini (2012) for papers assuming a payment in advance of production of working capital.

production is sold to households and capitalists and the intra-period loan is reimbursed.

I find that the two bargaining regimes modify the extent to which financial frictions interact with labor market variables, meaning wages, hours worked per employee and unemployment. In EB and RTM set-ups, financial frictions reduce the relative bargaining power of the firm compared to a case without financial frictions. An inefficiency gap appears, the so-called financial mark-up. Workers are able to extract a bigger rent from the surplus. But, in a RTM set-up, financial frictions reduce the relative bargaining power of the firm to a lesser extent as the firm has a higher degree of freedom in the bargaining. Another source of inefficiency appears, the so-called wage mark-up. So with a RTM regime, the impact of financial frictions exists but it is mitigated by the fact that the firm is able to modify the level of hours worked by each worker. Thus, a firm compensates the existence of financial frictions by reducing the level of hours demanded for each worker, that increases aggregate markets inefficiencies.
Thus in both cases, a higher level of collateral constraints leads to an increase in the worker's bargaining power. They ask for a bigger rent, but their capacities to extract a bigger part of the surplus depend on the bargaining regime: a RTM regime appears to restore partly the bargaining power of firms by giving them a higher degree of freedom in the bargaining process that is not internalized by workers. I identify to that purpose two inefficiency gaps compared to a case without any friction, a financial and a wage inefficiency gap, the last one being present only under a RTM regime. Firms use intensive margins to alleviate financial frictions under a RTM bargaining regime, that triggers higher markets inefficiencies.

This chapter is organized as follow. Section 2 describes the model integrating labor and credit frictions with two possible bargaining regimes (EB and RTM). Section 3 analyses the implication of both models in terms of inefficiencies generated by the presence of labor and credit market frictions, under RTM and EB regimes. Section 4 concludes.

2 Model

2.1 Model overview

The model is an infinite horizon partial equilibrium model and is in discrete time. The economy features three sets of agents: households and capitalists that own and manage firms. Agents interact in three different markets: labor, credit and good markets.

Each household works, consumes and saves through a one-period riskless discount bond used to finance inter-temporal loans for firms. Household members are either employed or unemployed workers. Each capitalist consumes, owns and manages firms. They do not borrow or save in the form of bonds as it will be

done on their behalf by the firms they own. They only earn dividend incomes. Firms own the capital stock of the economy, post vacancies, recruit workers and produce goods. Labor is hired in a frictional labor market modeled as in Mortensen and Pissarides (1994).

So as to finance its activities, each firm has access to two sources of financing: debt and equity. For debt, there are an inter-period loan and an intra-period loan. The inter-period loan, financed with the one-period riskless discount bonds, is required for the lender to have an interest to keep the firm active in case of default of the firm on the intra-temporal loan[5]. This intra-period loan aims to finance in advance of production the production bill as in Jermann and Quadrini (2012), the dividends, as well as the cost of job vacancy posting since the firm does not possess its own cash. However, due to uncertainty related to recovering this loan, intra-period loan issuance is collateralized by the capital stock of the firm. So the idea behind this kind of financial frictions is that firm uses its capital stock as a collateral in order to finance their working capital requirements. After the sale of the production, the intra-period loan is reimbursed without default as it is always enforced (default is thus not possible at the equilibrium in this kind of model), and there is no interest.

On the labor market, the search and matching process for jobs is costly. A matching technology brings together unemployed workers to vacancies. Job creation occurs when a firm and a searching worker meet and agree to match at a bargained wage, which depends on the parties' bargaining power. This bargaining power is different under the different bargaining regimes (RTM or EB regimes). The match continues until the parties exogenously end the employment relationship at the beginning of each period.

The model builds on the work of Garin (2015), and the modeling of the labor market with an efficient or a right-to-manage bargaining follows the article of Trigari (2006).

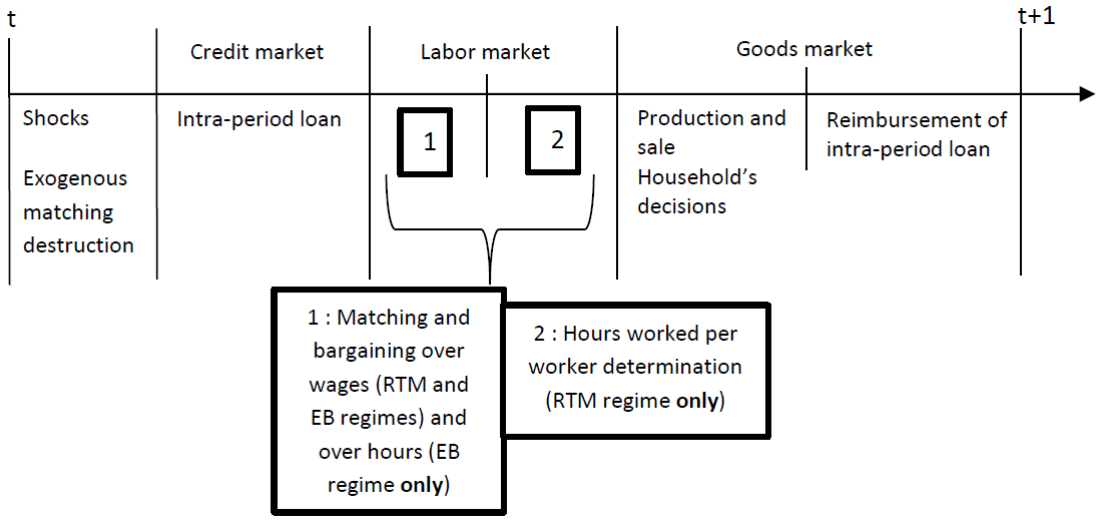


Figure 10: Timing of events

[5] As developed in appendix A.

Each period is decomposed in four steps. First, technological and credit shocks are realized[6] and a fraction of last period matches are destroyed exogenously. Second, an intra-period loan is contracted by the firm due to a cash-flow mismatch to finance its total working capital. The borrowing capacity of the firm is constrained by the amount of capital accumulated before as there exists a risk of firm's default. The firm decides, knowing this constraint, how much it wants to post vacancies, hire and invest. Third, after a matching process on the labor market, the firm bargains with the worker over the hourly wage, and over the hours worked in an EB regime. In a RTM regime, hours worked per employee are determined unilaterally by the firm, depending on the wage bargained. Then, the firm pays in advance the working capital. Fourth, the firm produces and reimburses the intra-period loan (as well as the inter-period loan from period $t-1$).

2.2 Labor market

The labor market is modeled using a standard Mortensen and Pissarides (1994) search and matching framework. At each period t, firms post vacancies, V_t, and unemployed workers, U_t, are searching for jobs. Each firm and each unemployed worker meet randomly. The matching of workers and firms is established by a standard matching function, M_t, measuring the aggregate flow of hires in a unit period : $M(U_t, V_t) = \nu U_t^{\sigma} V_t^{1-\sigma}$, where $\nu > 0$ is a scale parameter reflecting the efficiency of the matching process and $\sigma \in (0,1)$ is the relative weight the pool of unemployed workers receives in this matching process. As standard, the number of new hires increases with the number of unemployed, as well as with the number of vacancies.

Assumption 1. Transitions between in and out the labor force is not considered. There is full participation of household members at all times, that are either employed or searching for a job.

Assumption 2. Job-to-job transition is not considered. Only unemployed workers can look for a job. And an employed worker can be employed in at most one job.

The labor market tightness from the firm point of view is defined as the ratio between vacancy jobs and unemployed workers searching for a job: $\theta_t := \frac{V_t}{U_t}$. The probability that a vacancy gets filled during the matching process of time t, the job filling rate, is: $q_t := \frac{M_t}{V_t} = \nu \theta_t^{-\sigma}$. And the probability for an unemployed worker to find a job during the matching process of period t, the job finding rate, is defined as: $s_t := \frac{M_t}{U_t} = \nu \theta_t^{1-\sigma}$, such that $s_t = \theta_t q_t$ and $\partial q_t / \partial \theta_t < 0$, $\partial s_t / \partial \theta_t > 0$. The higher is the labor market tightness from the firm point of view, the higher is the probability for an unemployed worker to find a job and the lower the probability for a firm to fill a job. It represents the congestion externalities of new vacan-

[6] I introduce here two shocks that will not be used in this chapter for any empirical or quantitative exercise. However, as for future research it would be interesting to develop a general stochastic dynamic equilibrium model, I choose to set these two shocks.

cies or of new unemployed workers for respectively other firms and other unemployed workers searching for employment. Both unemployed workers and firms are assumed to take q_t and s_t as given.

The number of employed workers at the beginning of period t is denoted by N_{t-1}. Employment relationships may be severed for exogenous reasons at the beginning of any given period, before matching of period t takes place[7].

Assumption 3. Workers whose the match has been exogenously destroyed at the beginning of period t participate immediately to the matching process of period t, as the match destruction takes place before the matching process within the period. There is no need for them to wait until the next period.

Assumption 4. New hires of period t start working immediately once they are hired as the matching process takes place before production within the period. Unmatched unemployed workers remain jobless.

I denote by ρ the exogenous destruction probability, so that employment evolves according to the following law of motion:

$$N_t = (1-\rho)N_{t-1} + M(U_t, V_t) \tag{II.1}$$

According to the assumptions made, employment at time t, N_t, i.e. the number of workers who will participate to the production of period t, is given by the number of total matches from $t-1$ that survived to the next period, $(1-\rho)N_{t-1}$, plus the newly hires of period t, $M(U_t, V_t)$.

Finally, the number of unemployed household members searching for a job in period t is $U_t = 1-(1-\rho)N_{t-1}$[8]. As the labor force is normalized to one, the number of unemployed members at the end of period t or after the matching process of period t is given by $u_t = 1 - N_t$.

2.3 Households

There is a representative household seen as a large family composed of a continuum of members represented by the unit interval. Each period, each household member can be either employed by a firm or unemployed according to the process described in the previous section.

As in Merz (1995) and Andolfatto (1996), there is a full risk sharing of consumption in order to avoid distributional issues due to heterogeneity in incomes among household members. The household pools the income of all its members such that a perfect consumption is fully insured for all members[9]. So $C_{h,t}$ denotes the consumption enjoyed by a given household member as well as overall household consumption. Each

[7] As separation is exogenous, I omit the fact that a firm that finds a worker prior to period t decide to produce or not. The "no production" point is used as a threat point in the wage bargaining process. Implicitly, at equilibrium, the bargaining set will be always non-empty.

[8] This unemployment rate is evaluated after the exogenous matches destruction occurs at the beginning of period t.

[9] Unemployed members are better off than the employed ones since they have the same consumption but they enjoy all the leisure. It is a strong assumption, however commonly used in the literature.

household member has the following separable utility function:

$$v_h(C_{h,t}) - g(H_t) \tag{II.2}$$

where $v_h(C_{h,t}) = log(C_{h,t})$ and $g(H_t) = \varphi \frac{H_t^{1+\phi}}{1+\phi}, \varphi > 0, \phi > 0$. H_t is the measure of hours worked by each employed household members at time t, φ accounts for the weight on hours in labor disutility and ϕ is the inverse of the intertemporal elasticity of labor substitution.

The representative household has the following expected lifetime utility function:

$$E_0 \sum_{t=0}^{\infty} \beta_h^t [v_h(C_{h,t}) - G(H_t, N_{h,t})] \tag{II.3}$$

where β_h is the household's intertemporal discount factor, $N_{h,t}$ is the number of employed household members at time t and $G(H_t, N_{h,t})$ is the sum of disutilities from labor supply of employed members at time t, defined as $G(H_t, N_{h,t}) = N_{h,t} g(H_t)$. It is thus equal to the household's disutility from supplying labor hours.

In the representative household, $N_{h,t}$ household members are employed and each of them earns a total wage $W_t H_t$. $1 - N_{h,t}$ household members are unemployed as the labor force is normalized to one and each of them earns unemployment benefits, b_t. Unemployment benefits are defined as $b_t = b_w W_t H_t$, where $b_w \in (0, 1)$ corresponds to the ratio of unemployment benefits or period t to the wage bill of period t. Finally, the household is holding one-period discounted bonds, B_t. These revenues are used by the household to finance its expenditures. The household consumes, $C_{h,t}$, contributes to unemployment benefits trough lump-sum taxes, T_t, and purchases in period t the riskless bonds that pay off in period $t+1$, B_{t+1}.

Conditional on $\{H_t\}_{t=0}^{\infty}$ and taking as given the set of prices $\{W_t, R_t\}_{t=0}^{\infty}$, the representative household chooses sequences of consumption $\{C_{h,t}\}_{t=0}^{\infty}$, the number of employed workers $\{N_{h,t}\}_{t=0}^{\infty}$ and discounted bonds $\{B_{t+1}\}_{t=0}^{\infty}$ to maximize its expected discounted utility (II.3) under the following budget constraint:

$$W_t H_t N_{h,t} + (1 - N_{h,t}) b_t + B_t \geq C_{h,t} + \frac{B_{t+1}}{R_t} + T_t \tag{II.4}$$

The household does not choose hours of work per worker. These hours are determined at the labor market equilibrium with search and matching frictions, through decentralized bargaining between a representative firm (described in section 2.5) and a representative household (efficient bargaining, EB) or unilaterally by the firm (right-to-manage, RTM). The wage, W_t, is in both cases set through decentralized Nash bargaining between representatives firm and household.

Finally, the household takes the job finding rate as given, hence perceiving employment evolving according

to:

$$N_{h,t} = (1-\rho)N_{h,t-1} + M(U_t, V_t) = (1-\rho)N_{h,t-1} + s_t U_{h,t} \tag{II.5}$$

The problem of the representative household is written recursively. The vector of individual states is $\omega_{h,t} = \{B_t, N_{h,t-1}\}$. These variables are also called control variables, meaning that they are the ones that have been chosen by the household. The vector of aggregate states is $\Theta_t = \{K_t, N_{t-1}; A_{t-1}, \xi_{t-1}\}$. K_t denotes the capital stock of the economy for period t decided in $t-1$ by firms. A_{t-1} is the aggregate technological shock and ξ_{t-1} is the credit shock, that will be defined in the subsequent section.
The vector of aggregate states is a set of variables that influences the agent's return within the period but by assumption these variables are outside of the agent's control within the period t. These state variables evolve over time in a way that can be influenced by the control variables. Given a current aggregate state and current individual states, the aggregate states vector for the subsequent period is determined. The aggregate state vector completely summarizes all of the information from the past that is needed to make a forward-looking decision. The idea is to replace the attempt to locate equilibrium sequences of contingent functions with the search for time-invariant equilibrium decision rules. These decision rules specify current actions as a function of a limited number of state variables which fully summarize the effects of past decisions and current information. Knowledge of these state variables provides the economic agents with a full description of the economy's current state. Their actions, together with the realization of the exogenous uncertainty determine the values of the state variables in the next sequential time period.
The value function for the representative household, $\Omega_t(\omega_{h,t}; \Theta_t)$, is defined as:

$$\begin{aligned} \Omega_t(\omega_{h,t}; \Theta_t) = \max_{C_{h,t}, B_{t+1}, N_{h,t}} \quad & v_h(C_{h,t}) - G(H_t, N_{h,t}) + \beta_h E_t \Omega_{t+1}(\omega_{h,t+1}; \Theta_{t+1}) \\ \text{subject to} \quad & W_t N_{h,t} H_t + (1 - N_{h,t}) b_t + B_t \geq C_{h,t} + \frac{B_{t+1}}{R_t} + T_t \\ & N_{h,t} = (1-\rho)N_{h,t-1} + M(U_t, V_t) \end{aligned} \tag{II.6}$$

which yields the two standard efficiency conditions, relative to consumption and discounted bonds:

$$\lambda_{h,t} = v_h^{'}(C_{h,t}) \tag{II.7}$$

$$\frac{\lambda_{h,t}}{R_t} = \beta_h E_t \lambda_{h,t+1} \tag{II.8}$$

where $\lambda_{h,t}$ is the Lagrange multiplier of the household' budget constraint.
These conditions lead to the usual consumption Euler equation that describes the consumption decision:

$$\frac{1}{R_t} = \beta_h E_t \frac{v_h^{'}(C_{h,t+1})}{v_h^{'}(C_{h,t})} \tag{II.9}$$

The last efficiency condition relative to employment is useful to determine because it gives a measure of the surplus value of a marginal worker for the household:

$$S_t^h = W_t H_t - b_t - \frac{g(H_t)}{\lambda_{h,t}} + (1-\rho) E_t \Lambda_{t+1|t}^h (1 - s_{t+1}) S_{t+1}^h \tag{II.10}$$

where S_t^h is the ratio between the Lagrange multipliers relative respectively to the law of motion for $N_{h,t}$ and to the budget constraint, $\lambda_{h,t}$. S_t^h represents the marginal contribution of a newly created job to the household in terms of utility, that is given by the wage net of the disutility of work and unemployment benefits that are foregone (the outside option), plus the expected discounted surplus from continuing the matching in $t+1$. $1-\rho(1-s_{t+1})$ employed household members continue to match with a firm in the next period and s_{t+1} unemployed members find a job in the next period[10].

Finally, the discounted intertemporal marginal rate of substitution defined in equation (II.9) is equal at the equilibrium to the household's stochastic discount factor $\Lambda_{t+1|t}^h \equiv \beta_h \frac{v_h^{'}(C_{h,t+1})}{v_h^{'}(C_{h,t})}$.

2.4 Capitalists

Capitalists have a lifetime utility $v_c(C_{c,t})$. They are the only ones to have access to the ownership of firms in respective individual shares z_t[11]. d_t are the aggregate dividends paid by all firms. Capitalists' optimization problem is written recursively as:

$$\begin{aligned} \Gamma_t(z_t;\Theta_t) = \max_{z_{t+1},C_{c,t}} \quad & v_c(C_{c,t}) + \beta_c E_t \Gamma_{t+1}(z_{t+1};\Theta_{t+1}) \\ \text{subject to} \quad & z_t d_t = C_{c,t} + z_{t+1} \end{aligned} \tag{II.11}$$

where $\Gamma_t(z_t;\Theta_t)$ is the value function for capitalists which depends on the aggregate state Θ_t and on the individual state, the share of firms owned by each capitalist, z_t.

β_c is the capitalist discount factor. I assume that capitalists are more impatient than households, so that $\beta_h \geq \beta_c$[12]. Furthermore, as standard in the literature, I assume that capitalists do not borrow or save in the form of bonds because it will be done on their behalf by the firms they own as described in section (2.5).

The first-order conditions of the optimization problem give the typical Euler equation:

$$v_c^{'}(C_{c,t}) = \beta_c E_t v_c^{'}(C_{c,t+1}) d_{t+1} \tag{II.12}$$

Capitalists are homogeneous agents and they earn only dividend incomes from firms. Therefore, in equi-

[10] The net matching value of a marginal worker for the household can be also expressed as $S_t^h \equiv W_t^h - U_t^h$ where $W_t^h = W_t H_t - \frac{g(H_t)}{\lambda_{h,t}} + E_t \Lambda_{t+1|t}^h \left[(1-\rho(1-s_{t+1}))W_{t+1}^h + \rho(1-s_{t+1})U_{t+1}^h\right]$ and $U_t^h = b_t + E_t \Lambda_{t+1|t}^h \left[s_{t+1}W_{t+1}^h + (1-s_{t+1})U_{t+1}^h\right]$.

[11] Workers save only in the form of bonds. The market is segmented.

[12] This condition allows to insure that at the steady state the firm borrows from the household and that the borrowing constraint faced by the firm is always binding at the steady state. See appendix B for more details.

librium $z_t = z_{t+1} = 1$ (all the representative capitalists have indeed a fraction of all the representative firms) and thus $C_{c,t} = d_t$. It follows that the representative capitalist discounts future dividends by $\Lambda^c_{t+1|t} = \beta_c E_t \frac{v_c'(d_{t+1})}{v_c'(d_t)}$. Since the capitalist owns the firm, this will also be the discount factor used by the representative firm.

2.5 Firms

Firms produce a homogeneous good, Y_t, following a decreasing return to scale function[13], using capital, K_t, and labor, $N_{c,t}H_t$:

$$Y_t = A_t K_t^{\alpha} (N_{c,t} H_t)^{1-\alpha} \tag{II.13}$$

where A_t is an aggregate technological shock. As there is no idiosyncratic shocks, all firms choose the same allocations in equilibrium. So all firms are identical and symmetry among them is assumed ex-ante.
The representative firm is owning the capital stock of the economy. Consistent with the standard timing convention, the capital stock used in t is selected at time $t-1$. Therefore it is predetermined at time t. Instead the labor force can be changed in period t, at the extensive margin as well as at the intensive margin. The law of motion for capital accumulation is:

$$K_{t+1} = (1-\delta)K_t + I_t \tag{II.14}$$

where δ is the capital depreciation rate and I_t is the investment.

The objective of the firm is to maximize the sum of its expected discounted dividends:

$$\max_{d_t} \quad E_0 \sum_{t=0}^{\infty} \Lambda^c_{t+1|t} d_t \tag{II.15}$$

where $\Lambda^c_{t+1|t}$ is the stochastic discount factor of the capitalist as it owns the firm.
The firm faces the following budget constraint:

$$Y_t + \frac{a_{t+1}}{R_t} = d_t + W_t H_t N_{c,t} + I_t + a_t + \kappa V_t \tag{II.16}$$

where κ is unit vacancy posting costs, a_t is the amount of the matured inter-temporal debt and a_{t+1}/R_t is the value of the new debt.
The firm's budget constraint equals the difference between revenues from production, Y_t, plus the new inter-temporal liabilities, $\frac{a_{t+1}}{R_t}$, net of equity payout, d_t, labor wages, $W_t H_t N_{c,t}$, investment, I_t, vacancies posting costs, κV_t and the reimbursement of inter-temporal liabilities, a_t.

[13] The same production function is defined by Faccini et al. (2011).

Credit market

The firm begins each period with inter-temporal liabilities a_t. The payments to workers, capitalists, expenses related with capital accumulation, with creating a vacancy and current debt net of the new issue is assumed to be made before the production occurs. To be able to do so, the firm contracts an intra-period loan, l_t, to cover the cash flow mismatch during the period. The intra-period loan is written as:

$$l_t = d_t + W_t H_t N_{c,t} + \kappa V_t + I_t + a_t - \frac{a_{t+1}}{R_t} \tag{II.17}$$

This loan has to be entirely repaid at the end of the period t after the production and sale take place. As it is repaid within the period, there is no interest. Note from equation (II.16) that $l_t = Y_t$, meaning that the intra-period loan equals the total expected revenue.

As in Kiyotaki and Moore (1997), financial frictions arise due to a costly contract enforcement relative to the intra-period loan. The firm is subject to collateral requirements because it can default on its reimbursement obligations. Indeed, the lender can not force the firm to repay its debt unless this debt is secured by collateral assets. The collateral constraint finally limits the amount that is borrowed as a function of the firm's financial wealth.

In my framework, the repayment obligation of the firm may not exceed a fraction ξ_t of the value of the capital stock accumulated by the firm. ξ_t measures the degree of credit frictions. It is interpreted as a credit shock, or more precisely as a collateral shock, since it affects the firm's capacity to borrow from the lender[14]. As in Jermann and Quadrini (2012), this shock is assumed to be stationary and evolves according to[15]

$$\log(\xi_t) = \rho_\xi \log(\xi_{t-1}) + u_t^\xi, \qquad \rho_\xi \in (0,1) \text{ where } u_t^\xi \overset{iid}{\sim} N(0, \sigma_\xi^2)$$

A negative shock implies a deterioration in credit market conditions.

Assumption 1. Following a default, production can not be seized by the lender.

Assumption 2. Following a default and before next period's capital incorporation, the lender confiscates the firm and sells each unit of capital at $\xi_t q_{K,t}$.

Assumption 3. Following a default, the lender has no bargaining power in the debt bargaining and it does not value the stock of workers within the firm[16].

[14] The financial behavior of the lender is not described here. It is done in appendix A where the borrowing constraint is derived.

[15] This shock is here specified in the perspective of future research where a general dynamic stochastic equilibrium could be developed and estimated.

[16] It could be interesting to modify this assumption in future research so as to take into account a potential "unemployment accelerator" as in Blanco and Navarro (2016) where workers value directly affect the firms' financial conditions.

Formally with these assumptions, the collateral constraint faced by the firm is given by[17]:

$$l_t \leq \xi_t q_{K,t} K_t - \frac{a_{t+1}}{R_t} \tag{II.18}$$

The expected value of the recoverable capital net of inter-temporal debt must be at least higher than the intra-period loan needed to produce. In this constraint, the lender uses the shadow value of the capital, given by the marginal Tobin's Q, $q_{K,t}$, to assess the collateral value and set the borrowing limit accordingly. This constraint represents a firm's borrowing capacity restriction in the credit market. The firm is limited by the collateral constraint when it wants to invest, hire workers or pay dividends to capitalists, which is a function of firm's beginning of period capital stock.

From now on, I distinguish the firm's decisions depending on the bargaining regime that is considered on the labor market. Indeed, the choice variables are different for the firm in the different regimes. In EB, the firm does not choose the hours worked per workers, whereas under RTM, it is the case.

Firm's optimization decisions with a right-to-manage bargaining

The firm chooses dividends $\{d_t\}_{t=0}^{\infty}$, new inter-temporal debt $\{a_{t+1}\}_{t=0}^{\infty}$, investment $\{I_t\}_{t=0}^{\infty}$, hours worked per employee $\{H_t\}_{t=0}^{\infty}$ and vacancies $\{V_t\}_{t=0}^{\infty}$ so as to maximize the discounted sum of dividends (II.15) subject to the budget constraint (II.16), the collateral constraint (II.18), laws of motion of capital, K_{t+1} (II.14) and of employment, $N_{c,t}$.

The problem of the representative firm is written recursively. The vector of individual states is $\omega_{c,t} = \{a_t, N_{c,t-1}, H_{t-1}, K_t\}$. $\Delta_t(\omega_{c,t}; \Theta_t)$ is the value function for the firm under a right-to-manage bargaining, that is defined as:

$$\begin{aligned}
\Delta_t(\omega_{c,t}; \Theta_t) = \max_{d_t, K_{t+1}, I_t, a_{t+1}, N_{c,t}, H_t, V_t} \quad & d_t + \beta_c E_t \Delta_{t+1}(\omega_{c,t+1}; \Theta_{t+1}) \\
\text{subject to} \quad & A_t K_t^{\alpha} (N_{c,t} H_t)^{1-\alpha} + \frac{a_{t+1}}{R_t} = d_t + W_t H_t N_{c,t} + I_t + a_t + \kappa V_t \\
& l_t + \frac{a_{t+1}}{R_t} \leq \xi_t q_{K,t} K_t \\
& N_{c,t} = (1-\rho) N_{c,t-1} + q_t V_t \\
& K_{t+1} = (1-\delta) K_t + I_t
\end{aligned}$$

[17] The derivation of this constraint is given in appendix A.

The first-order conditions are respectively:

$$(d_t) \qquad \mu_{c,t} = 1 - \mu_{b,t} \tag{II.19}$$

$$(a_{t+1}) \qquad \frac{1}{R_t} = E_t \Lambda^c_{t+1|t} \left(\frac{1}{1-\mu_{b,t}}\right) \tag{II.20}$$

$$(K_{t+1}) \qquad \mu_{k,t} = E_t \Lambda^c_{t+1|t} \left[\mu_{b,t+1} \xi_{t+1} q_{K,t+1}\right] \tag{II.21}$$

$$+E_t \Lambda^c_{t+1|t} \left[(1-\mu_{b,t+1}) A_{t+1} \alpha K^{\alpha-1}_{t+1} (N_{c,t+1} H_{t+1})^{\alpha} + \mu_{k,t+1}(1-\delta)\right]$$

$$(I_t) \qquad \mu_{k,t} = \mu_{b,t} + \mu_{c,t} \tag{II.22}$$

$$(N_{c,t}) \quad S^c_t = (1-\mu_{b,t})(A_t(1-\alpha) K^{\alpha}_t H_t (N_{c,t} H_t)^{-\alpha}) - W_t H_t + (1-\rho) E_t \Lambda^c_{t+1|t} S^c_{t+1} \tag{II.23}$$

$$(V_t) \qquad S^c_t = \frac{\kappa}{q_t} \tag{II.24}$$

$$(H_t) \qquad W_t = (1-\mu_{b,t})(1-\alpha) A_t K^{\alpha}_t (N_{c,t} H_t)^{-\alpha} \tag{II.25}$$

where $\mu_{c,t}, \mu_{b,t}$ and $\mu_{k,t}$ are respectively the Lagrange multipliers associated to the budget constraint, the borrowing constraint and the law of motion of capital.

S^c_t is the Lagrange multiplier on the law of motion of employment and measures the net matching value of a marginal worker for the firm. The surplus for the firm from having a new worker corresponds to the profit generated by a worker at each period, given by $(1-\mu_{b,t}) A_t K^{\alpha}_t H_t (N_{c,t} H_t)^{-\alpha} - W_t H_t$ and this matching continues to next period with a probability $(1-\rho)$. The profit generated by an individual worker integrates here the shadow value of the use of external financing, $\mu_{b,t}$.

The expected productivity of capital and labor are augmented by a wedge that depends on the tightness of the enforcement constraint. A tighter credit constraint increases the cost of having an extra unit of labor and capital and reduces as a consequence their demands.

Then, equation (II.24) implies that the unit cost of filling a vacancy, κ, times the average vacancy duration, q_t must equal the surplus value of employment for the firm. With the equation (II.23), I obtain the standard hiring condition:

$$\frac{\kappa}{q_t} = (1-\mu_{b,t})(A_t(1-\alpha) K^{\alpha}_t H_t (N_{c,t} H_t)^{-\alpha}) - W_t H_t + (1-\rho) E_t \Lambda^c_{t+1|t} \frac{\kappa}{q_{t+1}} \tag{II.26}$$

A firm posts vacancies until the cost of posting and maintaining a vacancy equals the benefit of having a new employment match. The benefit for the firm of hiring a new worker is his shadow value integrating the tightness of the credit constraint, plus the vacancy posting costs saved if the employment relationship continues.

Hours per worker are determined here through the equation (II.25) as the firm has the right-to-manage hours for a given wage that will be determined in the next section. The firm unilaterally chooses the hours of work for a given bargained wage to maximize the shadow value of a new worker, S^c_t. I find that the wage

is equal to the marginal product of an hour worked by a worker augmented by a wedge that depends on the tightness of the collateral constraint. After rearranging the equation, I obtain the hours demand under right-to-manage bargaining conditional to W_t^{RM}:

$$H_t^{RM} = \left(\frac{(1-\mu_{b,t})(1-\alpha) A_t K_t^{\alpha} N_{c,t}^{-\alpha}}{W_t^{RM}} \right)^{\frac{1}{\alpha}} \tag{II.27}$$

Firm's optimization decisions with an efficient bargaining

With an efficient bargaining, the only difference in the firm's optimization decisions is the absence of the equation (II.25) relative to hours, as hours worked per workers are determined through Nash bargaining between workers and firms. So the firm chooses dividends $\{d_t\}_{t=0}^{\infty}$, number of riskless bonds $\{a_{t+1}\}_{t=0}^{\infty}$, investment $\{I_t\}_{t=0}^{\infty}$ and vacancies $\{V_t\}_{t=0}^{\infty}$ so as to maximize the discounted sum of future dividends (II.15) subject to the budget constraint (II.16), the enforcement constraint (II.18), the law of motion of capital, K_{t+1} (II.14) and the law of motion of employment, $N_{c,t}$.
The problem of the representative firm is written recursively. The vector of individual states is here $\omega_{c,t} = \{a_t, N_{c,t}, I_t\}$. I obtain for the first-order conditions the same equations: (II.19)-(II.24).

2.6 Wage contracts

Once a worker is matched with a vacancy, the representative firm and the representative worker bargain through a generalized Nash bargaining, so that the outcome of the bargaining process maximizes the Nash product:

$$\max \ (S_t^h)^{\eta} (S_t^c)^{1-\eta} \tag{II.28}$$

where the first term in brackets is the household surplus value from an employment relationship defined in equation (II.10) and the second term in brackets is the firm surplus from an employment relationship defined in equation (II.23). η reflects the relative bargaining power of workers.

The efficient bargaining concerns the wage and working hours per workers, whereas the right-to-manage bargaining covers only the wage, hours worked having been implicitly defined by the equation (II.25).

The right-to-manage bargaining

A firm and a worker bargain over the wage through the generalized Nash bargaining (II.28), as the firm unilaterally chooses the optimal hours of work determined by equation (II.25) for a given bargained

wage. In practice, the firm is able to adjust the total hours worked by changing the worked hours per workers. Indeed, the efficient bargaining solution derived below where every adjustment in working hours is associated with a renegotiation of wages seems out of step with reality. A large proportion of wages in Europe for example are covered by collective bargaining agreements at the sectoral level, leaving the firm with the optimal decision on the demand for hours only (part time or full time jobs for example). As a consequence, the right-to-manage model seems to characterize the institutional setup in Europe better than the efficient bargaining model.

There are two stages in the right-to-manage bargaining in each period. First, wages are determined by Nash bargaining between a worker and a firm so as to maximize their joint surplus. Second, expected this wage, the firm chooses the level of hours per worker so as to maximize the matching value for the firm, S_t^c, as derived in equation (II.25). So before the firm sets the hours worked per employee, the firm and the worker choose the wage so as to maximize the Nash product, taking as given the effect of wages on hours. The wage chosen by the match satisfies the following optimal condition:

$$\eta \delta_t^h S_t^c = (1-\eta)\delta_t^c S_t^h \tag{II.29}$$

where δ_t^h and δ_t^c denote respectively the marginal surplus from an increase in the wage to the worker and to the firm. Thus, the wage is set to equate the proportional marginal surplus to each party, weighted by each party's bargaining power. Given W_t, the marginal contribution of wages to the value of a match to the worker is:

$$\delta_t^h = \frac{\partial S_t^h}{\partial W_t} = H_t + \frac{\partial H_t}{\partial W_t}(W_t - mrs_t) \tag{II.30}$$

The marginal contribution of wages to the value of a new worker to the firm is:

$$\delta_t^c = -\frac{\partial S_t^c}{\partial W_t} = H_t + \frac{\partial H_t}{\partial W_t}(W_t - (1-\mu_{b,t})mph_t) \tag{II.31}$$

where $mrs_t = \varphi \frac{H_t^\phi}{\lambda_{h,t}}$ and $mph_t = (1-\alpha)^2 \frac{Y_t}{N_t H_t}$, corresponding respectively to the marginal rate of substitution for the worker and to the marginal product of hours worked per worker for the firm.

Finally, I derive from equation (II.29) the wage equation for the right-to-managed bargaining regime:

$$\begin{aligned} W_t^{RM} = \chi_t \left[(1-\mu_{b,t}) A_t (1-\alpha) K_t^\alpha (N_t H_t)^{-\alpha} + (1-\rho) E_t \Lambda_{t|t+1}^c \frac{\kappa}{q_{t+1} H_t} \right] \\ +(1-\chi_t) \left[\frac{b_t}{H_t} + \frac{mrs_t}{1+\phi} - (1-\rho) E_t \Lambda_{t|t+1}^h (1-s_{t+1}) \frac{\chi_{t+1}}{1-\chi_{t+1}} \frac{\kappa}{q_{t+1} H_t} \right] \end{aligned} \tag{II.32}$$

where

$$\chi_t = \frac{\eta\delta_t^h}{\eta\delta_t^h + (1-\eta)\delta_t^c} \tag{II.33}$$

The efficient bargaining

A firm and a worker determine jointly the wage, W_t, and the hours worked, H_t, so as to maximize the Nash product (II.28). The outcome can be seen as privately efficient as a consequence and is equivalent to a model where hours are chosen to maximize the joint surplus of a match, while the wage is set to split the surplus according to the parameter η, the worker bargaining power.

Wage Bargaining. The wage for the efficient bargaining satisfies the following optimal condition:

$$\eta S_t^c = (1-\eta) S_t^h \tag{II.34}$$

Here, $\delta_t^h = H_t$ and $\delta_t^c = H_t$, so that these terms disappeared. It is the consequence of the fact that hours worked per worker and the wage are now determined jointly (hours do not depend here on the wage). Substituting the expressions for the matching values, S_t^h and S_t^c yields:

$$\begin{aligned} W_t^{EB} = \eta\left[(1-\mu_{b,t})A_t(1-\alpha)K_t^{\alpha}(N_tH_t)^{-\alpha}\right] + (1-\eta)\left[\frac{b_t}{H_t} + \frac{mrs_t}{1+\phi}\right] \\ +\eta(1-\rho)\left[E_t\Lambda_{t|t+1}^c\frac{\kappa}{q_{t+1}H_t} - E_t\Lambda_{t|t+1}^h(1-s_{t+1})\frac{\kappa}{q_{t+1}H_t}\right] \end{aligned} \tag{II.35}$$

Condition (II.35) splits the wage into costs and benefits of an employment match according to the bargaining power η. The wage compensates the worker up to a fraction η of its marginal productivity and the saving of hiring costs from subsequent periods, and up to a fraction $1-\eta$ of the endogenous outside option of a worker that is disutility of labor and the foregone unemployment benefit. The labor marginal productivity is reduced by the tightness of the collateral constraint, $\mu_{b,t}$.

Hours Bargaining. Hours worked per worker are chosen according to the following optimal condition derived from the Nash product (II.28):

$$(1-\mu_{b,t})mph_t = mrs_t \tag{II.36}$$

The marginal rate of substitution equals the marginal product of hours worked per worker, times a wedge that depends on the tightness of the collateral constraint. Any change in hours will be associated with a change in the wage so that any renegotiation of hours and wages will yield an agreement on the contract

curve. Equation (II.36) corresponds to:

$$(1-\mu_{b,t})(1-\alpha)^2 A_t K_t^{\alpha}(N_t H_t)^{-\alpha} = \frac{\psi H_t^{\phi}}{\lambda_{h,t}} \tag{II.37}$$

which gives finally for the hours worked per worker under efficient bargaining:

$$H_t^{EB} = \left(\lambda_{h,t}\frac{(1-\mu_{b,t})(1-\alpha)A_t K_t^{\alpha} N_t^{-\alpha}}{\psi}\right)^{\frac{1}{\phi+\alpha}} \tag{II.38}$$

2.7 Market clearing

The good market clearing, including posting vacancy costs, is given by:

$$C_t + I_t + \kappa V_t = Y_t \tag{II.39}$$

where $C_t = C_{c,t} + C_{h,t}$.

The credit market clearing is given by:

$$a_{t+1} = B_{t+1} \tag{II.40}$$

I abstract from modeling government spending for simplicity, and assume that all unemployment benefits are financed by lump-sum taxes:

$$b_t(1-N_t) = T_t \tag{II.41}$$

The recursive equilibrium is defined by the following equilibrium conditions: the household's Euler equation (II.9), the household's surplus of having a new employed worker (II.10), the capitalist's Euler equation (II.12), the firm's Euler equation for capital (II.21)-(II.22), for dividends and bonds (II.19)-(II.20), the firm's capital law of motion (II.14), the vacancy creation condition (II.26), the aggregate law of motion for employment (II.1), the credit market clearing constraint (II.40), the aggregate resource constraint (II.39), the government budget constraint (II.41), and for the EB regime, the EB wage rule (II.35) as well as the EB hours per worker rule (II.38), or for the RTM regime, the RTM wage rule (II.32) as well as the RTM hours per worker rule (II.25). The stochastic process are taken as given $\{\xi_t\}_{t=0}^{\infty}$.

3 Sources of aggregate inefficiencies under right-to-manage and efficient bargaining regimes

As stipulated by Gali et al. (2007), market frictions can trigger inefficient fluctuations in the allocation of resources. I use their measure of aggregate inefficiency to examine under both wage bargaining regimes, the impact of credit and labor market frictions on the economy. This measure is called 'inefficiency gap' compared to the standard equilibrium conditions. It corresponds to the wedge between the marginal product of hours worked per worker and the the marginal rate of substitution between consumption and leisure. Indeed, if the marginal product of hours is equal to the marginal rate of substitution, hours per worker are at their efficient level. Hence, deviations from zero represent an inefficient allocation of hours worked per worker.

Let define the 'inefficiency gap' as:

$$gap_t = \frac{mph_t}{mrs_t} \tag{II.42}$$

As explained by Gali et al. (2007), the gap variable represents the distance between the perfectly competitive hours supply and hours demand curves, evaluated at the current level of hours. I decompose this inefficiency gap between two mark-ups : a wage and a financial mark-up.

I define the financial mark-up as the ratio between the marginal product of hours worked per worker and the wage, $\omega_{f,t} = \frac{mph_t}{W_t}$ and the wage mark-up as the difference between the wage and the marginal rate of substitution, $\omega_{w,t} = \frac{W_t}{mrs_t}$. Basically, the wage mark-up corresponds to a measure of search and matching frictions, whereas the financial mark-up corresponds to a measure of financial frictions. So frictions are here associated to variations in the aggregate level of macroeconomic efficiency. These two kind of frictions are supposedly going to divert from the equilibrium standard conditions, the hours of work per worker, as well as equilibrium wages. The question is thus to determine if these mark-ups exist and are significantly different under both bargaining regimes, and to what extent.

Proposition. The inefficiency gap under EB and RTM can be decomposed as:

$$\frac{mph_t}{mrs_t} \equiv (\omega_{f,t}\omega_{w,t}) = \begin{cases} (1-\mu_{b,t})^{-1}\dfrac{1+\phi}{1-\chi_t} & \text{under RTM} \\ (1-\mu_{b,t})^{-1} & \text{under EB} \end{cases} \tag{II.43}$$

where financial and wage mark-ups are respectively:

$$\omega_{f,t} = \begin{cases} (1-\mu_{b,t})^{-1} & \text{under RTM} \\ (1-\mu_{b,t})^{-1}(1-\alpha)^{-1}\left(1+\frac{S_t^c-(1-\rho)E_t\Lambda_{t+1|t}^c S_{t+1}^c}{W_t H_t}\right) & \text{under EB} \end{cases} \tag{II.44}$$

$$\omega_{w,t} = \begin{cases} \dfrac{1+\phi}{1-\chi_t} & \text{under RTM} \\ (1-\alpha)\left(1+\frac{S_t^c-(1-\rho)E_t\Lambda_{t+1|t}^c S_{t+1}^c}{W_t H_t}\right)^{-1} & \text{under EB} \end{cases} \tag{II.45}$$

In the efficient bargaining regime, the inefficiency gap comes from only financial frictions measuring inefficiency in credit markets, $(1-\mu_{b,t})$. Indeed, a financial mark-up exists related to asymmetric information on credit markets that increases the cost of a new hiring for firms. The higher is the shadow value of the use of external financing, the higher is the inefficiency gap under efficient bargaining.

In the right-to-manage bargaining regime, the inefficiency gap includes in addition to the financial mark-up, an endogenous wage mark-up regarding the inefficiency in labor and credit markets. This wage mark-up depends on the effective bargaining power of workers, that is itself function of financial frictions. So in a right-to-manage bargaining framework, the firm puts up a wage mark-up depending on the level of borrowing constraints they face. Financial frictions interact here clearly with labor markets frictions.

Under an efficient bargaining regime, firms are not able to modify the hours worked per employee as it is determined through the bargaining with workers. Thus it is not possible for them to use this degree of freedom to tackle the existence of financial frictions.

Under a right-to-manage bargaining regime, firms are able to adjust unilaterally the number of hours worked per worker (the intensive margin). They are able so to compensate the existence of financial frictions by using the intensive margin as a tool to alleviate extra-costs due to asymmetric information on credit markets. Indeed, under RTM, a financial mark-up still exists, but another mark-up appears that is the wage mark-up linked itself to financial frictions through the effective bargaining power of workers. Finally, hours worked per employee under RTM are lower than under EB and standard equilibrium.

Figure 11 delivers a synthetic way to see how labor and financial frictions do not have the same impact in terms of labor market allocations depending on the bargaining regime that takes place:

Figure 11: Sources of inefficiencies depending on bargaining regimes



In both bargaining regimes, a financial mark-up exists due to asymmetric information between the lender and the firm. Under a right-to-manage regime, an other mark-up exists, a wage mark-up due to the way hours per worker are determined. It leads to lower hours worked per worker compared to efficient bargaining or standard equilibrium conditions.

4 Conclusion

The impact of credit frictions on unemployment, wages and hours worked per employee is not the same depending on the way hours and wages are bargained. With an EB regime, the wage splits the surplus of a match on the labor market according to the firm's bargaining power that depends negatively on the level of collateral constraints. So, credit frictions increase the bargaining power of workers: they extract a higher rent from the bargaining relatively to a framework without credit frictions. With a RTM regime, the impact of financial frictions exists but it is mitigated by the fact that the firm is able to modify the level of hours worked by each worker. Thus, a firm compensates the existence of financial frictions by reducing the level of hours demanded for each worker. So in both cases, a higher level of collateral constraints leads to an increase in the worker's bargaining power. They ask for a bigger rent, but their capacities to extract a bigger part of the surplus depend on the bargaining regime: a RTM regime appears to restore partly the bargaining power of firms by giving them a higher degree of freedom in the bargaining process that is not internalized by workers. I identify to that purpose two inefficiency gaps compared to a case without any friction, a financial and a wage inefficiency gap, the last one being present only under a RTM regime. Firms use intensive margins to alleviate financial frictions. This mechanism has been potentially being used in particular countries, as Germany after the Great Recession by the use of part-time jobs.

Note that the model developed in this chapter is a *partial* equilibrium model. It may be relevant to develop in future research a stochastic general equilibrium model in order to be able to implement a calibration, or even an estimation of this enriched model to see for example if a credit shock has a differentiated impact on labor markets outcomes depending on the way hours and wages are bargained.

Appendices

A Borrowing constraint computation

Following Jermann and Quadrini (2012), the firm has the possibility to default after the production is realized but before the intra-period loan is reimbursed. After the selling of its production, the firm's total liabilities are the intra-period loans and the new debt acquired: $l_t + \frac{a_{t+1}}{R_t}$.
So the firm holds liquidity l_t in period t. I assume that the firm is able to divert the liquidity holdings, l_t but not the capital stock, K_t. So, the lender can only recover the capital stock with a probability ξ_t, which is stochastic. With a probability $(1 - \xi_t)$, the lender recovers nothing. This probability, ξ_t, can be interpreted as resulting from the decision of regulators in terms of default regulation or as the probability of finding a buyer for the capital stock of the firm or as an uncertainty on the liquidation value of the capital.

Let's now derive the collateral constraint. Recall the assumptions made in this chapter II:
Assumption 1. Following a default, production can not be seized by the lender.
Assumption 2. Following a default and before next period's capital is incorporated, the lender confiscates the firm and sells each unit of capital at $\xi_t q_{K,t}$.
Assumption 3. Following a default, the lender has no bargaining power in the debt bargaining and they do not value the stock of workers within the firm.

In case of default, the lender and the firm can decide to bargain a payment after the liquidation value of the capital stock is realized.
First, if the liquidation value of the capital stock is zero, the lender decides to keep the firm as he is waiting for the reimbursement of the intertemporal loan, a_{t+1}. So the firm keeps the liquidity, l_t. The total value of default for the firm when the liquidation value is zero is:

$$l_t + E_t \Lambda^c_{t+1|t} \Delta_{t+1} \tag{46}$$

where $E_t \Lambda^c_{t+1|t} \Delta_{t+1}$ is the expected present value of the firm if the firm continues to operate.

Now, if the liquidation value is $\xi_t q_{K,t} K_t$, the firm bargains over a payment P_t to deter the lender to close the firm. The net surplus to the firm of avoiding the liquidation is:

$$l_t + E_t \Lambda^c_{t+1|t} \Delta_{t+1} - P_t \tag{47}$$

And for the the lender, the net surplus from reaching an agreement with the firm is:

$$P_t + \frac{a_{t+1}}{R_t} - \xi_t q_{K,t} K_t \tag{48}$$

If the firm has all the bargaining power, the threat value is obtained by the lender, either $P_t = \xi_t q_{K,t} K_{t+1} - \frac{a_{t+1}}{R_t}$, so as to ensure that the firm will not be closed.

The expected total net surplus of reaching an agreement between the firm and the lender is therefore equal to:

$$l_t + E_t \Lambda^c_{t+1|t} \Delta_{t+1} - P_t = l_t + E_t \Lambda^c_{t+1|t} \Delta_{t+1} + \frac{a_{t+1}}{R_t} - \xi_t q_{K,t} K_t \tag{49}$$

Incentive compatibility requires that the expected surplus of defaulting for the firm does not exceed the value of not defaulting, $E_t \Lambda^c_{t+1|t} \Delta_{t+1}$:

$$E_t \Lambda^c_{t+1|t} \Delta_{t+1} \geq l_t + E_t \Lambda^c_{t+1|t} \Delta_{t+1} + \frac{a_{t+1}}{R_t} - \xi_t q_{K,t} K_t \tag{50}$$

$$l_t + \frac{a_{t+1}}{R_t} \leq \xi_t q_{K,t} K_t \tag{51}$$

B Binding borrowing constraint

I follow Garin (2015) to show that the credit constraint is binding in the steady state.
The Euler equation for the household is:

$$\frac{1}{R_t} = \beta_h \frac{v_h^{'}(C_{h,t+1})}{v_h^{'}(C_{h,t})} \tag{52}$$

The Euler equation of the firm is:

$$\frac{1}{R_t} = E_t \Lambda^c_{t+1|t} \left(\frac{1}{1 - \mu_{b,t}} \right) \tag{53}$$

where $\mu_{b,t}$ is the Lagrange multiplier on the credit constraint. Combining these two equations at the steady state, it follows that for all t:

$$\mu_b = \frac{\beta_h - \beta_c}{\beta_h} \tag{54}$$

Thus, as I assume that households are more patient than capitalists ($\beta_h > \beta_c$), the borrowing constraint is binding in the steady state, $\mu_b > 0$.

C Proof

Financial mark-up under efficient bargaining

The standard hiring condition (II.23) can be expressed as:

$$(1-\mu_{b,t}) = \frac{S_t^c-(1-\rho)E_t\Lambda_{t+1|t}^c S_{t+1}^c N_t + W_t H_t N_t}{(1-\alpha)Y_t} \tag{55}$$

$$= \frac{S_t^c-(1-\rho)E_t\Lambda_{t+1|t}^c S_{t+1}^c N_t W_t H_t}{(1-\alpha)Y_t W_t H_t} + \frac{W_t H_t N_t}{(1-\alpha)Y_t} \tag{56}$$

$$= \frac{W_t H_t N_t}{(1-\alpha)Y_t}\left(1 + \frac{S_t^c-(1-\rho)E_t\Lambda_{t+1|t}^c S_{t+1}^c}{W_t H_t}\right) \tag{57}$$

$$= \frac{W_t}{(1-\alpha)mph_t}\left(1 + \frac{S_t^c-(1-\rho)E_t\Lambda_{t+1|t}^c S_{t+1}^c}{W_t H_t}\right) \tag{58}$$

which gives:

$$\omega_{f,t}^{EB} = \frac{\left(1 + \frac{S_t^c-(1-\rho)E_t\Lambda_{t+1|t}^c S_{t+1}^c}{W_t H_t}\right)}{(1-\alpha)(1-\mu_{b,t})} \tag{59}$$

Financial mark-up under right-to-manage bargaining

In addition to the previous hiring condition, the efficiency condition at the intensive margin (II.25) is given by:

$$W_t = (1-\mu_{b,t})mph_t \tag{60}$$

Therefore, $\omega_{f,t}^{RTM} = \frac{1}{(1-\mu_{b,t})}$.

Wage mark-up under efficient bargaining

The bargaining between a firm and a worker over hours per worker yields the efficiency condition (II.36) for the intensive margin:

$$(1-\mu_{b,t})mph_t = mrs_t \tag{61}$$

It implies that the aggregate inefficiency gap, ω_t^{EB}, under efficient bargaining is equal to $(1-\mu_{b,t})^{-1}$.

I know that the financial mark-up, $\omega_{f,t}^{EB}$, under efficient bargaining is equal to $\frac{\left(1+\frac{S_t^c-(1-\rho)E_t\Lambda_{t+1|t}^c S_{t+1}^c}{W_t H_t}\right)}{(1-\alpha)(1-\mu_{b,t})}$.

So, as $\omega_t^{EB} = \omega_{f,t}^{EB}\omega_{w,t}^{EB}$,

$$\omega_{w,t}^{EB} = (1-\alpha)\left(1 + \frac{S_t^c-(1-\rho)E_t\Lambda_{t+1|t}^c S_{t+1}^c}{W_t H_t}\right)^{-1} \tag{62}$$

Wage mark-up under right-to-manage bargaining

Under RTM, equation (II.36) is not valid any more. I use equation (II.32) that linked marginal rate of substitution to right-to-manage wages:

$$W_t = \omega_{w,t}^{RTM} mrs_t \tag{63}$$

$$= mrs_t \frac{1-\chi_t}{1+\phi} \tag{64}$$

It follows:

$$\omega_{w,t}^{RTM} = \frac{1+\phi}{1-\chi_t} \tag{65}$$

Chapter III

Do Corporate Credit Conditions alter Labor Market Dynamics? A SVAR analysis in a Transatlantic Perspective

1 Introduction

The Great Recession is characterized by a sharp disruption in credit markets together with a deterioration in labor markets in a lot of industrialized countries. The relationship between credit market conditions and labor market dynamics is usually seen as being positive. Better credit market conditions, as a higher level of credit in one economy, is associated with better labor market outcomes as firms have a better access to external financing. They are less financially constrained and are thus able to post more vacancies and hire more workers. Theoretical papers (Garin (2015), Iliopulos et al. (2014), Monacelli et al. (2011), Perri and Quadrini (2018), Petrosky-Nadeau (2014), Zanetti et al. (2015) or the chapter I of this dissertation) are finding this positive causal relation for the United-States.

However, after the Great Recession, differences on labor markets outcomes have been observed among countries (Sala et al. (2012)). Furthermore, the positive relation between credit market conditions and labor market dynamics has not been empirically confronted to many countries other than the United-States[1].

Countries may differ deservedly in the way their respective labor markets react after a sharp fall in credit conditions especially depending on their institutional and legal environment. To fill this gap, this chapter studies labor markets dynamics in two different countries that are Germany and the United-States after credit shocks by using structural VARs.

[1] In their theoretical paper, Christiano et al. (2011) are using Swedish data and find the same result as for the United-States.

To motivate my empirical analyses about potential discrepancies between these two countries on their labor markets dynamics after credit shocks, I consider figures 12 and 13. They depict rates of unemployment, vacancies and the growth rate of non-financial corporations credit between 1952:Q2 and 2016:Q2 for the United-States and 1991:Q1 and 2016:Q2 for Germany[2]. For the United-States, a negative correlation (-0.4) between unemployment and corporations credit is found, together with a positive correlation (0.42) between vacancies and corporations credit. The higher is the credit for corporations in the United-States, the lower is the unemployment rate and the higher are job vacancies (and *vice versa* as I observe here correlations and not causality links). For Germany, relationships among variables are weaker and intriguing for unemployment. A slightly positive correlation between unemployment and corporations credit (0.0071) is observed, as well as for vacancies and corporations credit (0.1612).

Germany is a country worth to consider due to data availability and due to differences in labor market structures compared to the United-States especially concerning the governance of labor market institutions. In Germany labor unions keep an active role in the bargaining process with firms compared to the United-States. In Germany, in 2017 18% of workers were members of labor unions according to the OECD. In the United-States, in 2017 only 10% of workers were members of unions according to the Bureau of Labor Statistics. Furthermore, some empirical papers notice potential differences between these countries with regard to labor market and output dynamics to credit and technological shocks (Bachmann and Balleer (2010), Belke and Osowski (2017) and Sala et al. (2012) among others). Bachmann and Balleer (2010) compare the effects of technological shocks on labor market dynamics in Germany and in the United-States. They find significant differences between these two countries concerning job finding and separation rates' responses to technological shocks. Belke and Osowski (2017) find a positive response of German output to an increase in the Euro area uncertainty whereas for the United-States the response is negative. Sala et al. (2012) investigate labor market outcomes differences across various countries after the Great Recession. They show that Germany follows different dynamics compared to other countries and especially to the United-States. From an empirical point of view, they show that unemployment in Germany tends to decline since 2005 (figure 13) with a relatively small increase during the Great Recession, 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 and differently by the so-called risk-premium shock. These three empirical papers suggest that differences seem to exist between Germany and the United-States in the light of their economy' responses to credit or technological shocks. In this chapter, I try to pursue the investigation by studying how their respective labor markets react to these shocks.

The following empirical investigation aims to determine whether non-financial corporations credit conditions may alter or not labor market dynamics and to what extent, in countries having different larbor

[2]See appendix A for a detailed description of data.

market institutional environments. Thus, this chapter asks the following questions: *Are there differences in labor market dynamics to technological and credit shocks between Germany and the United-States (US)? How differences in labor market dynamics to credit shocks could be explained?* As there is already some literature about the impact of technological shocks on these economies, I use them as a natural benchmark against which I assess the impact of credit shocks.

Figure 12: Unemployment, job vacancies and non-financial corporations credit growth between 1952-Q1 and 2016-Q1 for the United-States

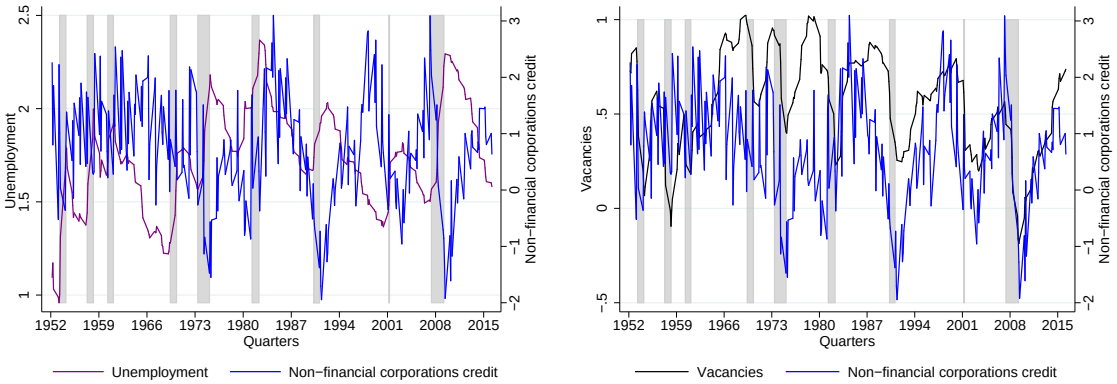
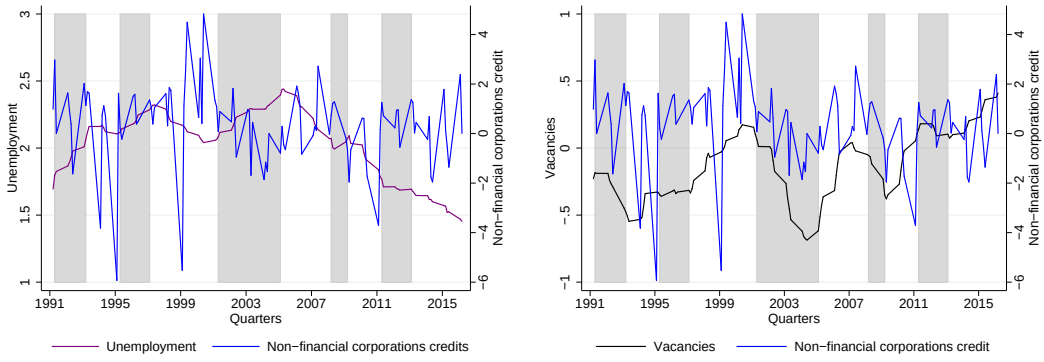


Figure 13: Unemployment, job vacancies and non-financial corporations credit growth between 1991-Q1 and 2016-Q1 for Germany



Firstly, I find that a positive one-standard deviation shock to technology in both countries leads to a decrease in unemployment and an increase in vacancies. This result is consistent with theoretical models integrating search and matching frictions as well as financial frictions on labor and credit markets. Second, a positive one-standard deviation shock to the level of corporations credits in the United-States leads in the short-run to a statistically significant decrease in unemployment and an increase in vacancies, as well as in output. It is consistent with findings of theoretical papers (as the ones of Garin (2015), Iliopulos et al. (2014), Monacelli et al. (2011), Perri and Quadrini (2018), Petrosky-Nadeau (2014), Zanetti et al. (2015) and results of the chapter I of this dissertation). Better credit conditions allow corporations to take on external debt more easily, either through a lower risk premium or through the relief of collateral constraints, to finance the posting of vacancies and the hiring of new employees. That in turn induces an increase

in production. Conversely in Germany, results are ambiguous: a one-standard deviation shock to level of corporations credits leads in the short-run to a significant increase in unemployment and to insignificant impacts on vacancies and output. In this particular country, an increase in the level of non-financial corporations credits does not necessarily lead to better conditions on labor markets.

To understand what may happen, I investigate two potential explanation: a 'Schumpeterian' effect or a 'search for conciliation' effect. Through a Schumpeterian effect, German firms may substitute after a positive credit shock labor for capital, hence explaining why unemployment increases after a positive credit shock. This explanation, although attractive, is not confirmed by empirical results. Another explanation has its roots in the particular functioning of the German labor market institutions. German firms have a tradition of great negotiations with labor unions. When corporations credit is high, labor unions are less demanding to German corporations. Laid-off workers could potentially more easily find an other job when credit is abundant in the economy. Conversely, when corporations credit is restricted in the economy, labor unions know it will be difficult for a laid-off worker to find a new job. Labor unions and corporations reach agreements in order to keep jobs, as part-time jobs for example. A phenomenon of 'labor retention' emerges. This retention of labor will then come to an end when the level of credit increases. The excess payroll constituted during low credit levels periods will then be reduced, resulting in a counter-intuitive result of rising unemployment during a period of high credit in Germany. I tend to validate this explanation using data of rates of inflow and outflow of unemployment in Germany.

Finally, the so-called 'search for conciliation' explanation is reinforced by a result given by robustness checks of the benchmark analysis. I find non-linear impacts in the way the German labor market reacts to credit shocks depending on whether the state of nature is normal or in crisis. In times of crisis, I observe the 'search for conciliation' mechanism just exposed. In normal times, this mechanism no longer appears and the German labor market returns to a functioning more consistent with theoretical models, where a positive credit shock leads to a decrease in unemployment. Non-linear potential effects pave the way for further theoretical and empirical researches.

Results are delivered by structural vector auto-regressive (SVAR) models for the United-States and Germany. Restrictions are imposed on responses of variables on each others based on an underlying VAR model with the objective to interpret as causality links the contemporaneous relationships among variables (Stock and Watson (2001)). I identify technological and credit shocks by using short-term restrictions relying on economic theory. I use a shared denominator from various theoretical frameworks (Garin (2015), Iliopulos et al. (2014), Jermann and Quadrini (2012), Kiyotaki and Moore (1997), Monacelli et al. (2011), Perri and Quadrini (2018), Petrosky-Nadeau (2014), Zanetti et al. (2015)) that assume that external financing is inevitable prior to production for firms to pay in advance wages as well as vacancies posting costs, reminiscent of the so-called 'wage-fund doctrine'. Hence the level of credits assigned in one economy is seen in those models as critical *ex-ante* to enable firms' hiring and determine the level of employment and output in the

economy. I specify more precisely a positive credit shock as an increase in the level of credit in the economy, that can be due to a decrease in the risk premium (making the credit less expensive for firms and thus more available) or an increase in the fraction of collateral that firms are allowed to borrow (lenders are less demanding). In both mechanisms used to model financial frictions in the literature (financial accelerator or collateral constraints), the same assumption is made about the need for firms to borrow before paying employees or hiring new ones, and then producing. Assuming firms have to borrow before producing and observing their productivity level enables to create asymmetric information between lenders and borrowers. So I use this timing assumption to identify shocks in SVAR models and to confront the theoretical results to empirical data by considering two countries that have different labor market institutional environments.

The remaining of this chapter is organized as follows. Section 2 presents data, empirical models and identification choices. Section 3 displays estimated structural impulse responses and variances decomposition. Section 4 provides robustness analyses. Sections 5 and 6 explore the likely explanations of the results previously obtained by considering succinctly a Schumpeterian effect and a so-called 'search for conciliation' effect. Finally, section 7 concludes.

2 Empirical investigation

Firstly, I justify why I use of a short-term SVAR model after presenting the basis of the VAR analysis. Second, I present the data and the SVAR models used. Third, I discuss my identification strategy based on short-term restrictions.

2.1 VAR and SVAR methodology

Vector auto-regressive (VAR) models are a multi-variate way to model time series introduced by Sims (1980). These models explain the evolution of each variable with its own past realizations and past realizations of other variables included in the VAR. The general dynamic of the system is estimated. The originality compared to standard regression models is to not distinguish between endogenous and exogenous variables (even if it is also possible in VAR models to specify exogenous variables). A VAR model can be used to describe and summarize time series, to compute forecasts and mainly to understand the effect of a shock over time on variables, to understand how they interact and to understand the contribution of each shock to the behavior of the different variables.

A VAR(p) process can be defined as:

$$X_t = \delta + \Sigma_{i=1}^{p} B_i X_{t-i} + e_t \tag{III.1}$$
$$\text{where} \quad E(e_t) = 0, E(e_t e_t^{'}) = \Omega \ \text{ and } \ E(e_t e_s^{'}) = 0 \ \ \forall t \neq s$$

where p is the lag length, X_t is a $(n \times 1)$ vector of stationary endogenous variables, δ is a $(n \times 1)$ vector of constants, B_i is a $(n \times n)$ matrix of coefficients, e_t is the $(n \times 1)$ vector of exogenous shocks to each variable and Ω the variance-covariance matrix of these error terms. The correlation of the error terms reflects the contemporaneous relation between endogenous variables. Here, each variable in X_t is expressed as a linear function of its own past realizations and past realizations of all other variables. The VAR process is thus defined in its reduced-form.

By defining a VAR process through its reduced-form, the error terms (e_t) can not be interpreted as structural shocks. Indeed, if the endogenous variables are contemporaneously correlated with each others, then error terms will also be correlated. Reduced-form VAR models have parameters that are not explainable: nothing can be said about the structure of the described economy. To make it possible, some economists since Sims et al. (1986) are looking at orthogonal shocks with an economic sense. Shocks are identified by setting reasonable identifying restrictions based on economic theory. These models are called structural vector auto-regressive models (SVAR).

In a SVAR model, restrictions are set on the responses of variables on each others based on the underlying VAR model. These restrictions are established according to conventional economic reasoning and theory instead of using an automatic procedure lacking of economic sense. Structural parameters are hence obtained out of the estimated reduced-form model by orthogonalizing the shocks in accordance with economic reasoning. The objective is, of course, to be able to interpret impulse response functions and variance decomposition in terms of causality and not only in terms of correlation. A precise number of restrictions is required to make it possible as developed in section 2.3.

Various restrictions have been introduced in the literature: zero short-run restrictions as in Sims et al. (1986), zero long-run restrictions (or Blanchard and Quah (1989) restrictions), both of them as in Gali (1992) and sigh restrictions as in Uhlig (2005). The variety of possible restrictions implies that there are as many structural models as restrictions exist. That is why the justification of restrictions used is particularly important.

Long-term restrictions are set on the long-run accumulated effects of shocks. They have been introduced by Blanchard and Quah (1989). They chose to put restrictions on the long-term dynamic of the system to study the impacts of demand and supply shocks. They assumed that demand shocks have no influence in

the long-run whereas supply shocks have.

Sign restrictions are set on the expected signs effects of shocks. An example of sign restrictions proposed by Uhlig (2005) consists of a contractionary monetary policy shock that should raise the federal funds rate and lower prices. The effect of this monetary policy shock on the output is contrariwise unrestricted in terms of sign as it corresponds to the research question Uhlig (2005) wanted to answer.

Finally, short-term restrictions are set on the contemporaneous variance-covariances between shocks. I use these restrictions in this chapter.

I define SVAR models with short-run restrictions to identify technological and credit shocks. The identification of both shocks is relying on the assumption made for the credit variable. Indeed, the identification of credit shocks has been a lot discussed in the literature. I choose to develop structural VAR models with short-term restrictions and credit and technological shocks for three reasons.

First, the use of a structural model appears to be fundamental as the traditional Cholesky identification of financial variables does not rely on economic theory[3]. Financial variables are usually placed after slow-moving macroeconomic variables only because they are supposed to move faster. However, there is *a priori* no reason to consider that it is true for the level of credit in one economy. So I choose to rely on economic theory (and to use structural VARs instead of recursive or unrestricted VAR) inferring a specific order for variables used as a lens to look at the data.

Then, in the literature, papers are considering either credit shocks as I do (Helbling et al. (2011)), credit spread shocks (Gilchrist et al. (2009), Gilchrist and Zakrajšek (2012), Meeks (2012)) or uncertainty shocks (Belke and Osowski (2017), Bloom (2009), Bloom et al. (2012), Caggiano et al. (2014), Popescu and Smets (2010) among others) to model 'financial' shocks. I choose to consider the so-called 'credit' shock as it allows an identification scheme compatible with a large range of theoretical papers. These papers model financial frictions in different ways (financial accelerator or collateral constraints) but they all assume that external financing is needed for firms prior to hiring and producing (Garin (2015), Iliopulos et al. (2014), Jermann and Quadrini (2012), Kiyotaki and Moore (1997), Monacelli et al. (2011), Perri and Quadrini (2018), Petrosky-Nadeau (2014), Zanetti et al. (2015)). So I define the credit shock as a shock to the level of corporations credit in one economy without considering if the shock comes from a collateral constraint channel or from a credit spread channel. My objective being to develop an identification strategy fully supported by various theoretical frameworks, I use a type of shock on which I am able to apply the same assumption, which is that firms need external financing before hiring and producing.

Finally, using zero short-term restrictions appears to be the most appropriate and agnostic choice for my empirical analyses. I do not want to impose sign-restrictions as it would imply to specify reactions of macroeconomic variables to credit shocks. However, it is not possible *ex-ante* to infer particular signs

[3]The Cholesky identification using the recursive ordering of variables has been however a lot used as in Bassett et al. (2014) without any theoretical support. I propose to go a step further by looking at a structural model relying on theoretical assumptions.

of causality between unemployment, vacancies and non-financial corporations credit as figure 13 suggests. Moreover, it is precisely the explicit purpose of this chapter to determine these signs of causality between those variables for the two countries that are Germany and the United States. It would therefore make no sense to restrict the expected signs of effects of technological and credit shocks on unemployment, vacancies and output. Lastly, I do not use long-term restrictions as I am not able to determine which shock has more long- than short-term effects on variables included in the VAR. It would be possible to consider that credit shocks have short-term effects compared to technological shocks with long-term effects. However, it is known in particular since the Great Recession that less external financing can have long-term impacts through hysteresis effects (Ball (2014)) by reducing investment and hiring capacities for firms. Furthermore, we are not able for now to determine if credit shocks are demand or supply shocks.

2.2 Data and SVAR definition

I investigate impacts of technological and credit shocks on labor market variables in the United-States and Germany via structural vector auto-regressive models (SVAR). The economic dynamic of a given country is assumed to be represented by a dynamic system whose structural equations are:

$$A_0 X_t = \alpha + \Sigma_{i=1}^{p} A_i X_{t-i} + \epsilon_t \tag{III.2}$$
$$\text{where} \quad E(\epsilon_t) = 0 \ \text{ and } \ E(\epsilon_t \epsilon_t^{'}) = \Sigma$$

where X_t is a $(n \times 1)$ vector of stationary endogenous variables, A_0 is an invertible $(n \times n)$ matrix describing contemporaneous relations among endogenous variables, α is a vector of constants, p is the lag length, 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 these structural shocks.

The vector of endogenous variables is defined as:

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

In the benchmark specification, following Ravn and Simonelli (2007) endogenous variables included in the VAR for each country are the first-difference of the log of non-financial corporations credit (Δc_t), the first-difference of the log of real output (Δy_t), logs of unemployment rate (u_t) and job vacancy rate (v_t). I use quarterly data from 1952:1 to 2016:2 for the United-States, and for Germany quarterly data from 1991:1 to 2016:2. The time period difference is first due to data availability and second to avoid the structural

break due to reunification in Germany[4]. The non-financial corporations credit data are obtained from the BIS total credit statistics. The credit is provided by domestic banks, all other sectors of each economy and non-residents. Non-financial corporations are both private-owned and public-owned. In terms of financial instruments, credit covers loans and debt securities. Precise definitions and sources of all variables are given in appendix A.

As a preliminary check, I test if series are stationary. To estimate a VAR model properly, data need to be stationary. I use for this purpose the augmented Dickey-Fuller (ADF) test, a unit-root test. Results of these tests are in appendix C for variables expressed either in levels or in first-difference. I include a number of lagged differences following the Schwarz and Hannan-Quinn information criteria to eliminate auto-correlation in the error terms of the Dickey-Fuller regression. When data show a clear trend, I use the trend option. As for all data, their means appear to be greater than zero, I use the constant option. Philips-Perron tests lead to the same conclusions as ADF tests. All series of variables used in the VAR are shown to be stationary as tests do not detect the presence of unit roots[5].

Compared to an unrestricted VAR (equation (III.1)), an additional matrix A_0 of parameters appears in equation (III.2). This matrix multiplies the vector of contemporaneous endogenous variables, X_t, allowing contemporaneous relationships between variables.
From the structural equation (III.2), I derive the following VAR model of order p:

$$X_t = \delta + \Sigma_{i=1}^{p} B_i X_{t-i} + e_t \tag{III.3}$$
$$\text{where} \quad E(e_t) = 0, E(e_t e_t^{'}) = \Omega \ \text{ and } \ E(e_t e_s^{'}) = 0 \ \ \forall t \neq s$$

and $\delta = A_0^{-1}\alpha$ is a vector of constants, $B_i = A_0^{-1}A_i$ and $e_t = A_0^{-1}\epsilon_t$.
So matrix A_0 represents the contemporaneous relationships between reduced-form, e_t, and structural shocks, ϵ_t:

$$\epsilon_t = A_0 e_t \tag{III.4}$$

Although estimating the equations of an unrestricted VAR does not imply identification assumptions, interpreting impulse response functions or variance decomposition requires identifying restrictions. Indeed, the residuals from the reduced-form VAR (e_t) have to be transformed into structural residuals (ϵ_t) such that they can be interpreted. So I define now the short-term restrictions based on theoretical assumptions to be able to interpret the empirical results obtained.

[4] As a robustness check, I restrict the time period analysis for the United-States from 1991:1 to 2016:2.
[5] As tests for unemployment and vacancies for Germany are less significant, I test the results in a robustness check for the inclusion of unemployment and vacancies in first-difference.

2.3 Identification of shocks

The conditional distribution of X_t is completely characterized by a reduced-form VAR (equation (III.1)). However, the structural form of the model has n^2 additional parameters coming from the matrix A_0 compared to the reduced-form. An identification problem appears. Indeed disturbances e_t from the reduced-form VAR are typically correlated. They represent the unpredictable shocks in endogenous variables of X_t. They could be correlated with one another because of contemporaneous causal relationships among the variables included in the VAR estimation. It is as a consequence not possible to interpret e_t as structural shocks. Given values of the reduced-form parameters δ, B_i, Ω, 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 (and so to be able to interpret the results), n^2 identifying restrictions have to be imposed, that is 16 restrictions as $n = 4$ here.

Firstly, it is now common to consider Σ as being a diagonal matrix as structural shocks are by definition uncorrelated (if structural shocks were not independent, it would say that unexplained causal relationships between them remain) and to normalize the main diagonal of A_0 to 1 as it has been done by Sims (1980). It ensures that each variable 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 determine $\frac{n(n-1)}{2}$ other restrictions to identify technological and credit shocks, that is 6 restrictions. I choose to use short-term restrictions relying on theoretical assumptions[6].

These restrictions consist of assumptions on the dynamic contemporaneous relationships between shocks and variables and are thus imposed on matrix A_0. I interpret credit shocks as shocks to the level of non-financial corporations credit in one economy. To build the short-term restrictions, I rely on a fundamental assumption of various theoretical papers: credit has to be delivered *ex-ante* to firms, before posting vacancies, hiring and producing as they have to pay in advance vacancy posting costs and wages. Despite various modeling assumptions, this assumption is common to a set of theoretical papers exhibiting asymmetric information between lenders and borrowers (Garin (2015), Iliopulos et al. (2014), Jermann and Quadrini (2012), Kiyotaki and Moore (1997), Monacelli et al. (2011), Perri and Quadrini (2018), Petrosky-Nadeau (2014), Zanetti et al. (2015)). This assumption is mandatory to obtain credit frictions and financial constraints. Indeed, financial frictions appear between lenders and borrowers because a lender is not sure to be reimbursed as the production and the sale occur only after credits are delivered and used. To protect himself against a risk of default, the lender extracts either an external finance premium (Bernanke and Gertler (1989), Petrosky-Nadeau (2014)) or asks for a collateral constraint (Garin (2015), Kiyotaki and Moore (1997), Zanetti et al. (2015).). The higher are external finance premium or collateral constraints, the higher are financial frictions and the lower is the level of credits in the economy. As external financing

[6] In appendix B, I show how the identification is properly obtained thanks to zero short-term restrictions.

is needed prior to production[7], a credit shock may have a direct and contemporaneous impact on the level of employment, job vacancies and thus on real output[8]. So an exogenous shock to the level of credit has an immediate impact on labor market variables and output as the credit is used forthwith to finance wages and vacancy posting costs. Thus, in the identification scheme I assume that credit is predetermined and does not react to other shocks within the same quarter. It depends only on its own history and on lagged values of other variables. Note that the previous cited papers are using a version of the 'wage-fund doctrine' to build their theoretical models. The wage-fund doctrine implies that working capital have to be deducted from a fixed amount of funds available to employers at each period, here corresponding to the credit level. The wage-fund corresponds to wages firms have to pay before the production is sold. I extend this idea by including also the vacancy posting costs.

Then, to be consistent with this wage-fund doctrine, I assume that the output responds contemporaneously to innovations to credit, unemployment and vacancies. So an exogenous shock to the technology impacts other variables with one-period lag[9].

Finally, I assume that job vacancies react contemporaneously to innovations in credit only and unemployment responds contemporaneously to innovations in credit and vacancies shocks[10].

To conclude, I identify a shock on credit markets by imposing restrictions that appear to be reasonably shared by various theoretical models[11]. Caggiano et al. (2014) or Nodari (2014) for examples choose also to put first their 'financial shock', that is in their paper an uncertainty shock (VIX index and FRPU shock respectively) even if they do not use a theoretical support to justify it.

Thus, I propose as short-term restrictions consistent with the previous assumptions:

1. 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. All the other variables start to respond in the first quarter. So the non-financial corporations credit variable is ordered as first variable.

   Credit conditions evolve exogenously, technological and other shocks can not affect contemporaneously the credit. Therefore, $a_{cy} = a_{cu} = a_{cv} = 0$, where a_{ij} are coefficients of matrix A_0.

2. Technological shocks affect other variables after one quarter. The growth rate is ordered as the last variable. So $a_{uy} = a_{vy} = 0$.

[7] In these models, firms inevitably resort to credit: they can not fully finance themselves. For this reason it is also technically assumed either that entrepreneurs/firms die at a constant rate at the end of each period or that entrepreneurs/firms have a lower discount factor than consumers (firms are less impatient).

[8] The assumption made in some theoretical papers to be sure that credit shock will impact the output immediately is that new hired workers are productive within the same period as it is assumed in Blanchard and Galí (2010), Garin (2015), Iliopulos et al. (2014), Zanetti et al. (2015)

[9] In robustness checks, I test for different ordering of variables with notably credit ordered last.

[10] In robustness checks, I test also for different order of variables.

[11] In the spirit of Uhlig (2005), even if I am not working with sign restrictions, I try to be minimalist in the sense that restrictions are based on a straightforward idea that before producing, firms need a given amount of external financing to finance this production.

3. The residual shocks to unemployment and vacancies are identified using a non-structural triangular restriction that requires that $a_{vu} = 0$[12].

With this identification scheme, I define for the benchmark models the matrix A_0 as follow:

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

where the remaining a_{ij} coefficients are the ones being estimated. I do not impose more restrictions that required by the just identification necessity[13].

3 Results

SVAR benchmark models are estimated using an optimal lag order of $p = 2$ for both countries. Appendix C delivers results of 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[14]. After each estimation, I test for the stability of the obtained SVAR model by looking at moduli of the eigenvalues being or not less than one. All lie inside the unit circle, so estimated models are stable.

I document various sets of results, impulse responses functions, cumulative impulse responses and the variance decomposition conditional on the technological and credit shocks for the United-States and Germany.

3.1 Credit shock

Structural impulse response functions (SIRF). Impulse responses illustrate dynamic responses over time of all variables to a structural shock. Impulses are normalized to a one-standard deviation in the underlying variable. Responses of endogenous variables to this deviation are presented in percentage points (pct). Figure 14 presents the dynamic adjustment process of unemployment, vacancies, credit and real output to a positive credit shock for respectively the United-States (US) and Germany.

Responses of US vacancies and employment are statistically significant and suggest an increase in the number of vacant jobs and in the number of people employed after an increase in non-financial corporations credit. This result is consistent with theoretical papers of Garin (2015), Petrosky-Nadeau (2014) and Zanetti

[12] An 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.

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

[14] For the United-States, a lag order of 6 could be also selected. In robustness analysis, I discuss the results obtained.

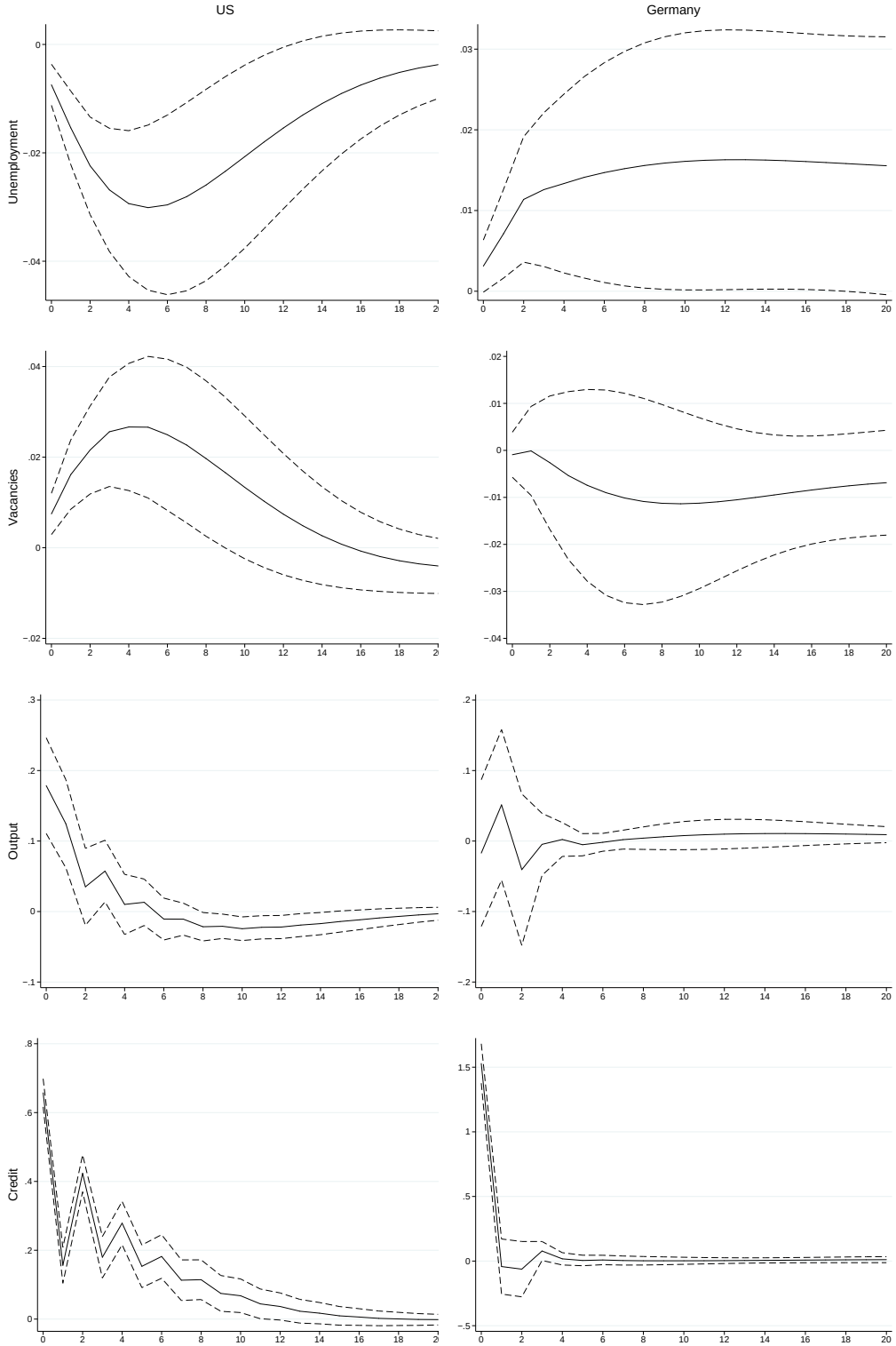


Figure 14: Structural impulse responses to credit shock. Benchmark model.

Notes: The figure reports structural impulse responses to an unanticipated credit shock. Columns report the SIRFs for the United-Sates (US) and Germany. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

et al. (2015). A shock increasing the level of credits[15] positively affects the real economy as corporations are able to use more credit to finance job vacancies and employment (the marginal value of an open vacancy is higher). It leads to an increase in production and hence the real gross domestic product increases with an immediate peak at nearly 0.2 pct that dies out very quickly. Garin (2015) and Zanetti et al. (2015) find also in the empirical section of their papers that a credit shock has no persistent dynamics on output in the United-States as well as Gilchrist and Zakrajšek (2012) and Meeks (2012) in their respective papers.
Unemployment rate decreases significantly and persistently[16] until almost three years with a peak at 0.03 pct after one year and a half in response to a rise in the non-financial corporations credit. It then adjusts gradually back to their pre-shock level. I find as in Caggiano et al. (2014) (who are using an uncertainty shock) a hump-shaped path for unemployment after a credit shock in the United-States. The impact on vacancies is shorter at two years reaching a peak at 0.025 pct after five quarters.
So a positive credit shock in the United-States generates an economic upturn with a positive effect on output statistically significant and short-lived, and positive effects on employment and vacancies statistically significant and quite persistent.

For Germany, a positive non-financial corporations credit shock leads to ambiguous responses of unemployment and vacancies. The positive response of unemployment is significant for almost two years and is quite persistent. A peak is reached at 0.015 pct after six months. The impact on vacancies is a lot of more ambiguous as the one-standard error band includes zero, suggesting to not overstate the impact of credit shock on vacancies in Germany. The impulse response for vacancies is within $[-0.03; 0.015]$ interval around zero at any point during the first five years after the credit shock. So the reaction of vacancies is either positive or negative after such a shock. While it could be consistent with theoretical models results of increasing vacancies after a positive credit shock, the data does not seem to give full weight to this result. Finally, the impact of a positive credit shock on real output in Germany is also ambiguous. A one-standard deviation credit shock in Germany may leave the output unchanged or may drive it up to 0.05 or down to 0.03.
These results raise questions: expansionary credit shocks do not necessarily have expansionary effects on vacancies and output in Germany unlike the United-States. Firstly, I find that a credit shock has particularly 'non-real' impacts in Germany compared to the United-States as impacts on vacancies and output of a credit shock appear to be insignificant. Second, an increase in the level of non-financial corporations credit leads to a slight increase of unemployment and not to a decrease as it could be expected according to theoretical models (as the one developed in chapter I), and how as it is observed in the United-States. The idea that something different is going on for Germany in face of credit shocks is actually not entirely

[15] According to financial frictions literature, corporations borrow more either because the risk premium is reduced (Petrosky-Nadeau (2014)) or because they can borrow a larger fraction of their collateral (Garin (2015), Zanetti et al. (2015)).
[16] I find in the chapter I of this dissertation in section (4.2) a persistent evolution of unemployment following a shock on credit markets in the United-States.

new. Belke and Osowski (2017) find a slight significant positive impact on German output of an increase in the Euro area uncertainty and a significant negative impact on the US output. Sala et al. (2012) suggest in their paper that Germany has been less directly hit by financial shocks than the United-States. In next sections, I investigate ways to explain these differences.

Cumulative impulse responses. I plot the cumulative effects of a permanent shock to non-financial corporations credit[17].

For Germany, a permanent shock to credit has a significant positive impact on unemployment (0.3 pct) and an ambiguous impact on vacancies and real output as expected. For the United-States, a permanent positive credit shock of one-standard deviation triggers unemployment to decrease by 0.4 pct, vacancies to increase by 0.2 pct and output to increase by 0.4 pct.

3.2 Technological shock

Structural impulse response functions. Figure 15 shows dynamic responses to technological shocks of unemployment, vacancies, real output and credit for respectively the United-States and Germany.

For the United-States, a positive technological shock lowers unemployment for more than three years. The effect is the largest after one year where the shock reduces unemployment by 0.023 pct. This shock increases vacancies for two years and half with a peak at one year where the shock increases vacancies by 0.02 pct. Effects hereafter die out. Ravn and Simonelli (2007) find the same impacts for the United-States after a *permanent* technological shock that increases vacancies and employment with large and marked hump-shaped responses. For the response of non-financial corporations credit, technology shock triggers a significant increase during two years consistent with the idea that credit is pro-cyclical in the United-States.

For Germany, results are similar even if standard error bands are larger. After a technological shock, unemployment decreases for four years with a peak at two years and half by 0.015 pct. Nordmeier and Weber (2013b), Popescu and Smets (2010) find also for Germany that the unemployment rate goes down after a positive technological shock. Vacancies increase for three years after the shock with a peak at one year and half at 0.022 pct. Finally, the impact on non-financial corporations credit is ambiguous as the standard error band includes zero.

[17] Figures are found in appendix D.

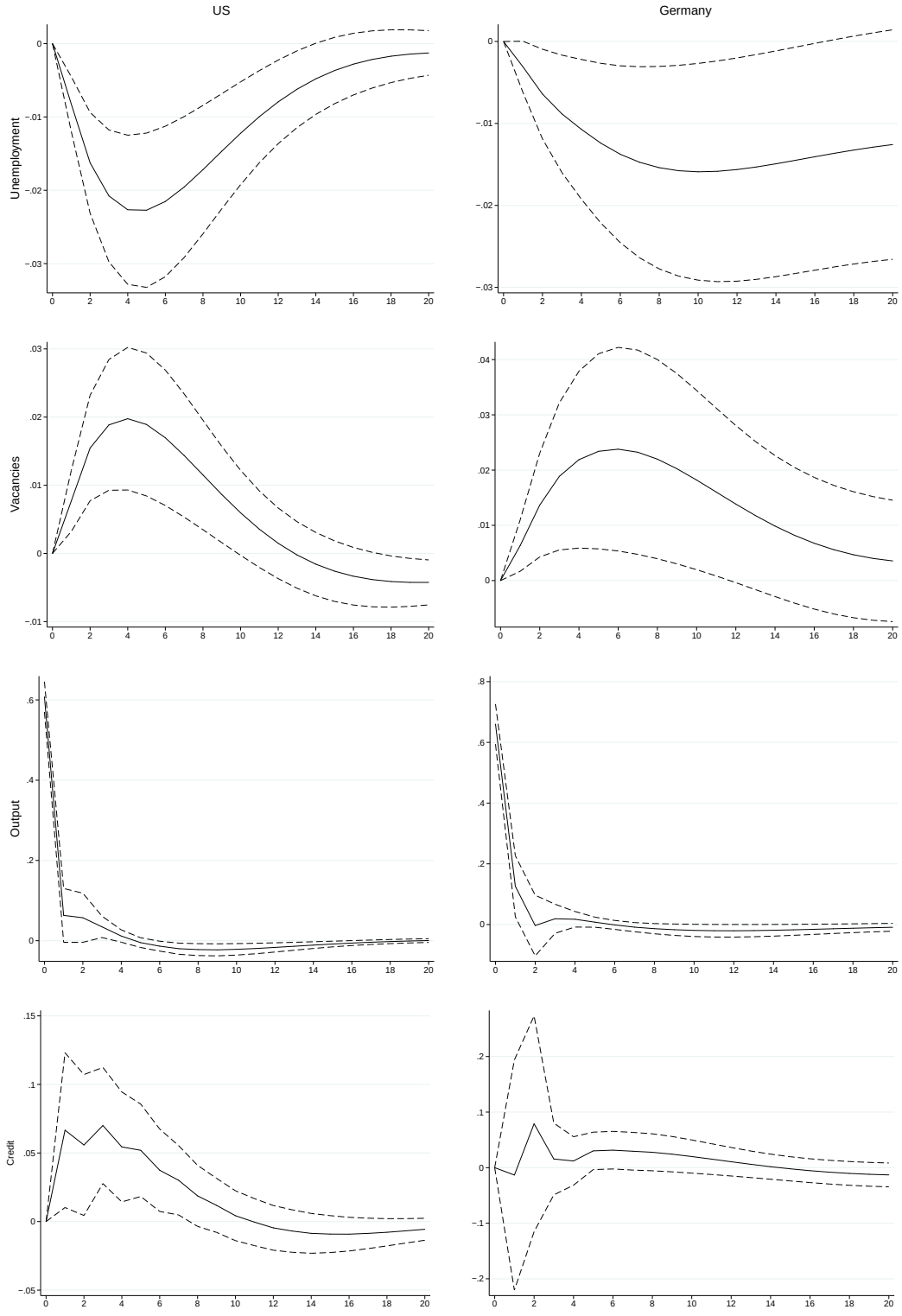


Figure 15: Structural impulse responses to technological shock. Benchmark model.

Notes: The figure reports structural impulse responses to an unanticipated technological shock. Columns report the SIRFs for the United-Sates (US) and Germany. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

These results for both countries are consistent with standard theoretical models integrating search and matching frictions as well as financial frictions where working capital needs to be paid in advance of production (as the ones of Garin (2015), Petrosky-Nadeau (2014) and Zanetti et al. (2015)). In those models, a positive technological shock increases the expected surplus from a match such that firms decide to post more vacancies and unemployment decreases as a consequence of the increase in labor market tightness from the firm point of view.

Cumulative impulse responses. For Germany, a permanent positive shock of one-standard deviation to real output causes unemployment to be about 0.6 pct lower and vacancies to be about 0.6 pct higher. For the United-States, the unemployment rate is about 0.2 pct lower and vacancies 0.15 pct higher. This magnification comes from two effects. First, shocks to technology tend to persist for periods after the shock, so unemployment decreases more and vacancies increase more as a result. Second, a positive shock to technology increases employment, which finally feeds back positively on real output.

3.3 Forecast errors variance decomposition

The variance decomposition of the forecast errors establishes the relevance of shocks for variations in endogenous variables at a given horizon. Even if I find insignificant results for the impact of credit shocks on labor markets variables for Germany, it does not mean that this shock could not be important for variables dynamics (Helbling et al. (2011)). Table 2 highlights the contribution of technological and credit shocks in explaining short-run fluctuations in labor markets variables for Germany and the United-States. Note that variance decomposition is certainly based on orthogonal shocks but I do not obtain 100% as it exists other potential unidentified shocks completing the rest of the variance[18].

At very short forecast horizons, only small fractions of forecast error variance decomposition of unemployment and vacancies are accounted for by credit and technological shocks. Beyond the six years horizon, both shocks contribute relatively more to unemployment and vacancies volatility.

More precisely in the shortrun, the volatility of unemployment for both countries is more dominated by credit shocks, especially for the United-States. At a six quarters horizon, credit shock accounts for 6% of the forecast error variance of unemployment in Germany, whereas the technological shock account for 3%. For the United-States, percentages are respectively 8% compared to 4.6%. Thus, it suggests that credit shocks play a key role in employment fluctuations, even more than technological shock.

Then, at a six quarters horizon, credit shock explains 0.4% of the volatility in vacancies in Germany, conversely to the United-States where it is equal to 7%. For the United-States, the credit shock plays a stronger

[18] As monetary policy or government spending shocks that are found by Ravn and Simonelli (2007) to contribute to unemployment and vacancies volatility in the United-States. However, it is not the purpose of this chapter to investigate the impact of such shocks.

role in explaining vacancies fluctuations than technological shock. Credit shock explains 7% of the variation in vacancies, whereas the technological shock counts for 3.5%. The inverse is observed for Germany: credit shock does not matter a lot for vacancies fluctuations.

Table 2: Forecast error variance decomposition of labor market variables - Germany and United-States technological and credit shocks (percentage)

Germany	Unemployment		Vacancies	
Forecast horizon	Techn. shock	Credit shock	Techn. shock	Credit shock
1	0	0.018	0	0
6	0.033	0.061	0.043	0.004
12	0.047	0.058	0.057	0.012
18	0.05	0.062	0.059	0.017
20	0.051	0.063	0.059	0.018
United-States	Unemployment		Vacancies	
Forecast horizon	Techn. shock	Credit shock	Techn. shock	Credit shock
1	0	0.029	0	0.02
6	0.046	0.085	0.035	0.07
12	0.059	0.121	0.038	0.089
18	0.06	0.129	0.038	0.088
20	0.06	0.129	0.038	0.087

4 Robustness analysis

This section assesses the sensitivity of previous results along various dimensions to confirm that results do not depend on a given specification. First, I proceed by modifying the lag length for the United-States (6 lags). Identifying assumptions are after inspected. Then, I address some data issues by considering unemployment and vacancies in first-difference for Germany and non-financial corporations credit as a percentage of the GDP. I modify also the data time period notably by taking into account the Great Recession. This point is of particular importance as this will infer on a potential explanation to the previous results. Finally, I introduce an extra-variable in the benchmark model. Robustness checks are available in appendix E.

Lag length. I re-estimate the benchmark model with a higher lag of $p = 6$ for the United-States as suggested by three selection criteria (Appendix C). Indeed, using short lag length can induce spurious significance of parameters (unexplained information could be left in error terms). The results for a higher lag length are quantitatively and qualitatively identical. Differences concern impacts of the technological shock on unemployment and vacancies that are larger and longer-lasting. The drop in unemployment reaches -0.03 at 6 quarters (versus -0.023 at 4 quarters in the benchmark model) and vacancies increased by 0.023 to 6 quarters (compared with 0.02 to 4 quarters). Responses are however less significant: that is not surprising as a higher number of parameters is estimated.

Identifying assumptions. First, an other way to obtain a just-identified system is to assume for residual shocks that $a_{uv} = 0$. Job vacancies react contemporaneously to innovations in credit and unemployment, whereas unemployment responds contemporaneously to innovations in credit only. Results are consistent for both countries, except for the impact of a technological shock on credit for the United-States where the positive result is slightly significant.

Then, I set the non-financial corporations credit variable at the end in the recursive order and real output first. Credit is not pre-determined anymore and all other shocks can impact this variable. On the other side, credit shock and other shocks can not affect the level of the output within the same period. Results are similar in terms of signs. I lose in terms of significance and magnitude for the impact of the credit shock for both countries, but the impact of the technological shock is of greater significance and magnitude.

Data definitions. The ADF test can reject the null hypothesis of non stationarity only at the 5% level for the unemployment and vacancies in Germany. I check the results by including these variables in first-differences. Results are the same in terms of signs. However, I lose the result significance also for unemployment. It reinforces the idea that the impact of credit shocks on labor markets variables in Germany is highly ambiguous. A contractionary credit shock does not have necessarily a negative impact on labor markets variables.

Then, I use for the credit variable, the non-financial corporations credit as a percentage of the GDP. This measure facilitates data comparability. However, it necessarily modifies the identification scheme. Credit expressed as a percentage of the GDP has to be ordered last and the output first. Indeed, a shock to the output has an immediate impact on the credit to GDP ratio by construction. Results are robust to this change, except for the impact of credit shock on unemployment that is also not significant anymore for Germany. Furthermore, impacts of technological shock in both countries are stronger on labor markets variables. And I obtain a significant decrease of credit after a technological shock in both countries.

Extra-variable introduction. I test the robustness of my results to the introduction of an extra-variable, consumption[19]. Four additional identifying restrictions have to be set to identify the five dimensional SVAR models. I assume that consumption is made at the end of each quarter, after the production takes place, that appears to be an uncontroversial assumption. So I set the following restrictions:

1. Consumption is affecting contemporaneously by all shocks.

2. Consumption impacts other variables with one period lag. $a_{cC} = a_{yC} = a_{uC} = a_{vC} = 0$

[19] Data definition and source are found in appendix A

The matrix A_0 becomes:

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

SVAR models are estimated using an optimal lag order of $p = 2$ for both countries[20]. Results are robust to the introduction of consumption. I note that after technological shocks in both countries, consumption increases (0.3 pct for the United-States and 0.22 pct for Germany). Ravn and Simonelli (2007) find also a positive impact on consumption of technological shocks in the United-States. After credit shocks, consumption increases also in both countries (up to 0.15 pct in both countries). These empirical results are in contradiction with some mechanisms of theoretical models with financial and labor markets frictions. Indeed, as in Garin (2015), after a positive credit shock consumption should decrease as a consequence of the increase in interest rates, increasing the incentives to save. Finally, impacts of technological and credit shocks on unemployment, vacancies and output are robust to the introduction of an extra-variable.

Sub-sample analysis. I restrict the data period for the United-States so as to use the same data period as Germany (1991.1 to 2016.2). I estimate the SVAR model with an optimal lag order of $p = 4$ according to selection criteria. The results obtained are consistent with the benchmark model where the date period is 1952.2 to 2016.2. Responses of US vacancies and employment to credit shock are statistically significant. The number of vacant jobs increases reaching a peak at 0.02 pct after 3 quarters (compared with 0.021 pct at 4 quarters in the benchmark model) and the number of people unemployed decreases with a peak at -0.018 pct at 5 quarters (compared to -0.03 at 4 quarters in the benchmark model). I note that the impact of the credit shock is shorter (5 quarters for the impact on unemployment and vacancies, compared to 12 and 8 quarters respectively in the benchmark model). Output increases after the shock with an immediate peak at 0.15 pct that dies out very quickly as in the benchmark model. Finally, the positive technological shock lowers unemployment with a peak at -0.03 pct at 8 quarters and increases vacancies reaching a peak at 0.03 pct at 8 quarters. The major difference here compared to the benchmark model is that the impact of technological shocks on unemployment and vacancies is longer lasting (15 and 12 quarters for the impact on unemployment and vacancies, compared to 14 and 10 quarters in the benchmark model).

[20] For the United-States, a lag order of $p = 4$ could be also chosen. Results are not modified taking into account this lag order.

Do labor markets react in the same way in times of crisis and in normal times?

I extend the sub-sample analysis by considering a question of particular interest in Germany: Do labor markets react in the same way in times of crisis and in normal times? It may be argued that credit shock is fundamental in crisis periods but not or less otherwise (Caggiano et al. (2014)). Especially in Germany, bargaining of wages and working times is done at branch level, and even at firms level. Thus, in a period of crisis after a negative credit shock, firms and labor unions could bargain to put in place for example measures of partial unemployment, to resort to internal flexibility and limit the increase in unemployment. In the United-States, external flexibility is more widely used either in normal or in crisis periods as labor unions are weaker in this country. For example, in Germany in 2017 18% of workers are members of labor unions according to the OECD. In the United-States, in 2017 only 10% of workers were members of unions according to the Bureau of Labor Statistics. Hence, in normal times in Germany, a credit shock may have standard 'new-Keynesian' features whereas in crisis period, a credit shock may have different impacts on labor markets variables. In the United-States, 'new-Keynesian' features would be observed in crisis and normal times as labor unions are quite weaker in this country to play a key role in bargaining processes.

One drawback of VAR exercises is that they are based on a linear structure. In reduced-form VAR models, coefficients as well as the variance-covariance matrix of error-terms are assumed to be constant over time. It does not take into account the state of the nature (financial crisis period versus normal times). As a very first attempt to discuss this argument, I consider how results depend on crisis periods as opposed to normal times. I investigate here the sub-sample stability of the preceding results[21]. I restrict the data period until the beginning of the crisis, at the end of 2007[22]. 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 the United-States do not change, except for the response of credit to a technological shock that is not significant anymore. For Germany, responses of unemployment and vacancies to technological shocks are less significant and shorter-lasting. Furthermore, responses of unemployment and vacancies to a credit shock change notably. I observe a decrease of unemployment (at -0.01 pct with a peak at 7 quarters) and an increase of vacancies (reaching a peak at 0.03 pct at 5 quarters). It illustrates the potentiality of non-linearity. As a consequence, it appears that in crisis period German firms adopt a different management of their payroll compared to normal periods. The different labor market institutional environment in Germany compared to the United States could be an explanation, the so-called 'search for conciliation'. I propose to investigate deeper this explanation in section (6).

[21] For future research, more sophisticated tools could be used as Markov-Switching VAR or Threshold VAR.

[22] According 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.

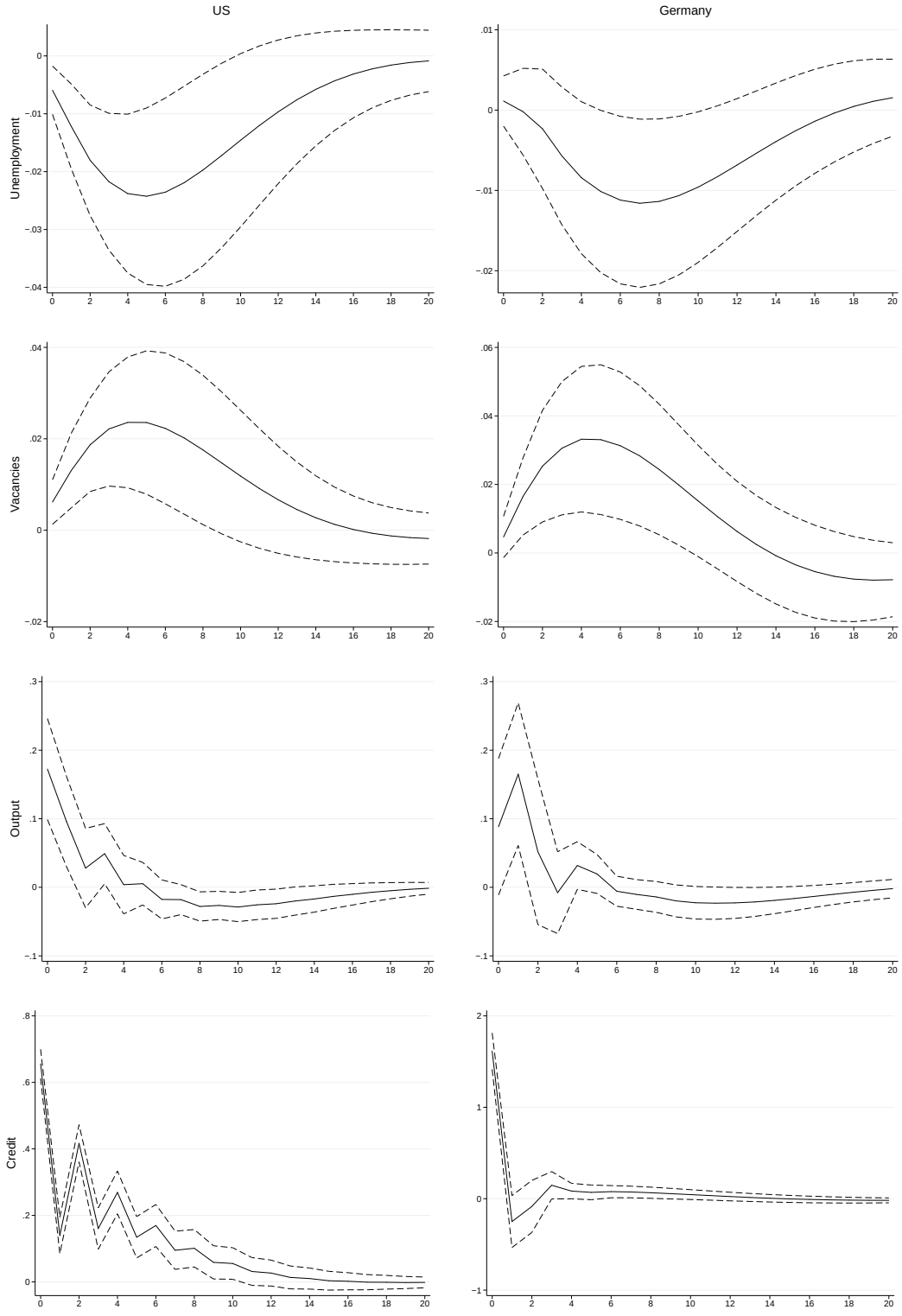


Figure 16: Structural impulse responses to credit shock. Data period to 2007-Q4.

Notes: the figure reports structural impulse responses to an unanticipated credit shock. Columns report the SIRFs for the United-Sates (US) and Germany. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

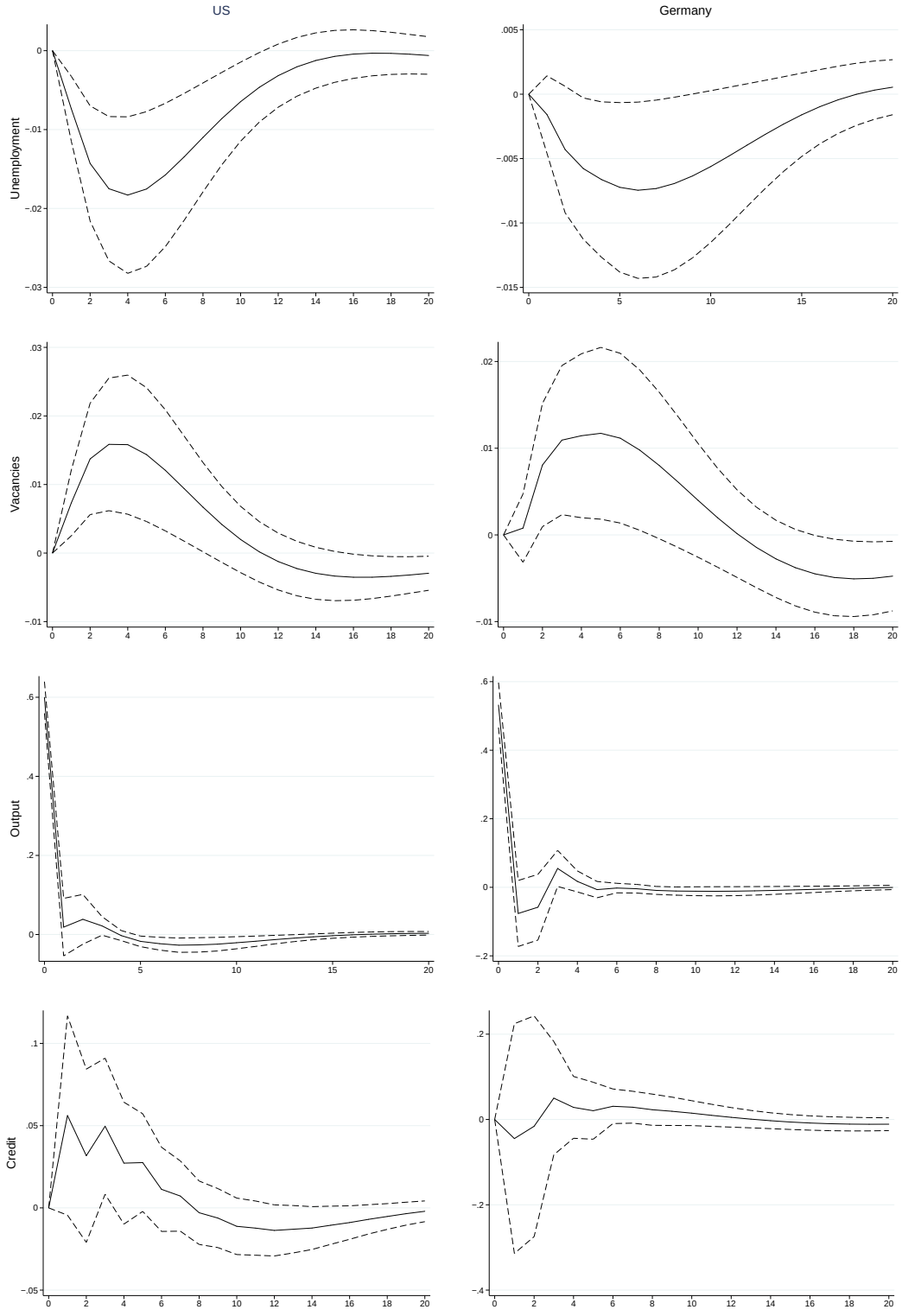


Figure 17: Structural impulse responses to technological shock. Data period until 2007-Q4.

Notes: the figure reports structural impulse responses to an unanticipated technological shock. Columns report the SIRFs for the United-Sates (US) and Germany. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

5 Are credit shocks for Germany generating Schumpeterian creative destruction effects?

In Germany, according to the benchmark model, credit shocks have no robust impact on vacancies and output and have a positive impact on unemployment. Schumpeterian features of credit shocks in Germany is one potential explanation for this result. German firms may substitute capital for labor. A positive credit shock would therefore have a positive impact on capital investment, as well as on the level of unemployment. Workers are replaced by capital.

To test this assumption, I add to the benchmark model the investment variable[23]. I develop this new model for Germany but also for the United-States to see if I get the result I expect for this country. For the United-States, I expect that a positive credit shock increase capital investment. There would be no substitution mechanism as strong as in Germany (factors of production would therefore be more complementary at the aggregate level).

Four additional identifying restrictions have to be set to identify the five dimensional SVAR model. Following my previous assumptions, investment is partly financed by external credit. I make the following restrictions:

1. Investment impacts contemporaneously all variables except credit, $a_{ci} = 0$.

2. Investment is affecting contemporaneously by only credit shock. Therefore, $a_{iy} = a_{iu} = a_{iv} = 0$.

The matrix A_0 becomes:

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

Figures 18 and 19 show the impulse responses of credit and technological shocks for SVAR models with investment, of lags 2 for both countries according to the standard selection criteria[24].

For both countries, a positive technological shock impacts positively investment for 2 quarters with a peak at 0.6 pct for Germany and for 6 quarters with a peak at 0.3 pct for the United-States. This result is consistent with the findings of Ravn and Simonelli (2007) for the United-States. Then, the effect dies out. For the United-States, a positive credit shock impacts positively also investment for 3 quarters with a peak at 0.22 pct. However I do not find a significant impact of credit shock on investment for Germany. As a

[23] See appendix A for data definition and source.

[24] I test the results for other identifying restrictions (investment impacts contemporaneously output, and is affecting contemporaneously by credit, unemployment and vacancies shocks ; investment is affecting contemporaneously by all variables). Results are not modified for all these orderings choices.

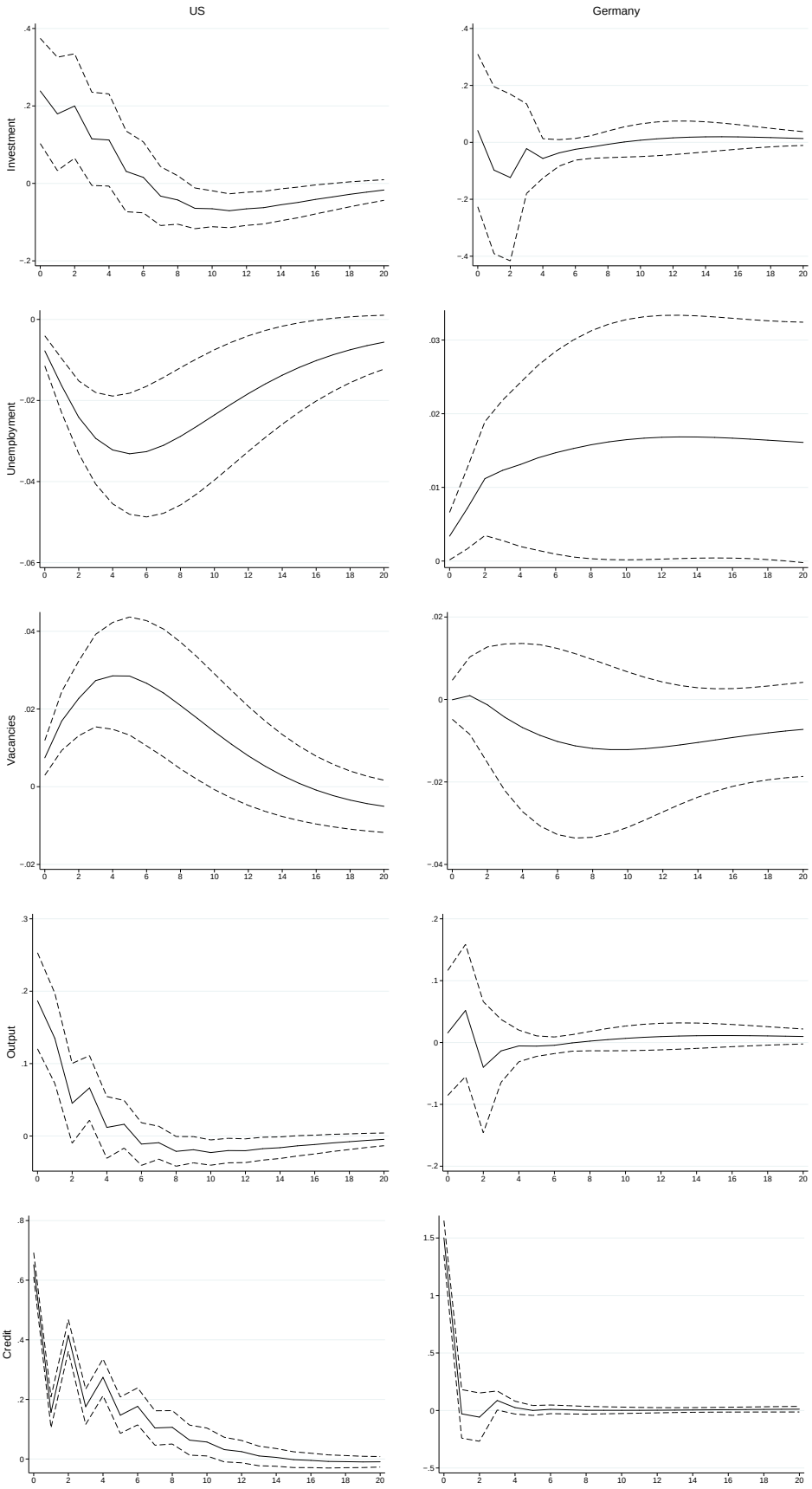


Figure 18: Structural impulse responses to credit shock. Investment added.

Notes: The figure reports structural impulse responses to an unanticipated credit shock. Columns report the SIRFs for the United-Sates (US) and Germany. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

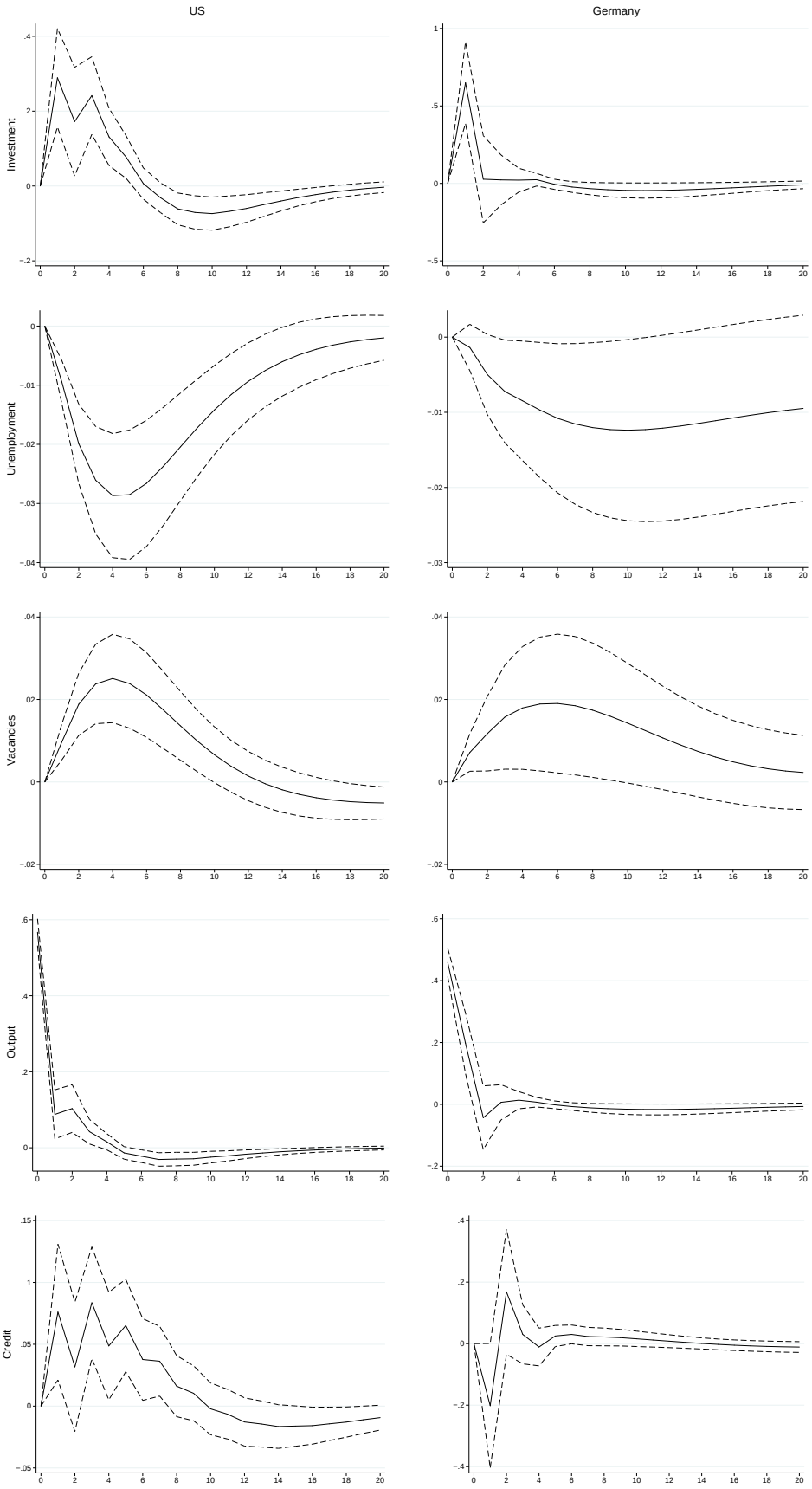


Figure 19: Structural impulse responses to technological shock. Investment added.

Notes: The figure reports structural impulse responses to an unanticipated technological shock. Columns report the SIRFs for the United-Sates (US) and Germany. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

consequence, I reject the assumption of Schumpeterian creative destruction effects of credit shock in Germany. Credit shock in Germany have no significant impact on the real sphere according to these results.

As I do not find Schumpeterian effects of credit shocks in Germany, I choose to investigate deeply the unemployment dynamics aroused by a credit shock in Germany. Trough which channels an increase in credit in Germany could lead to a potential increase in unemployment?

6 What drive the unemployment dynamics in the United-States and in Germany?

To study the unemployment dynamics in the United-States and in Germany, I develop a new SVAR model with data of unemployment inflow and outflow rates from Elsby et al. (2010)[25] for the United-States and from Hartung et al. (2016)[26] for Germany. I use quarterly data from 1952:Q1 to 2013:Q2 for the United-States and for Germany quarterly data from 1991:Q1 to 2016:Q4. I choose to use data from Elsby et al. (2010) because these data are on quarterly frequencies (that is not the case in Elsby et al. (2013) where data are found for Germany and the United-States but only on a annual basis).

The impacts on unemployment of credit shocks observed before may be the result of variation in the rates at which workers flow into unemployment, variation in the rate at which unemployed workers exit unemployment or a combination of the two. I use unemployment inflow and outflow rates because of the following stock-flow relationship:

$$\dot{u}_t = s_t(1 - u_t) - f_t u_t \tag{III.5}$$

where u_t is the unemployment rate in period t, and f_t and s_t are respectively the outflow and inflow rates in period t. The outflow rate, f, corresponds to the number of hires divided by the number of unemployed workers. The inflow rate, s, corresponds to the number of layoffs divided by the number of employed workers. I do not take into account flows in and out of the labor force and provide according to Nordmeier and Weber (2013a) the '*pure* response of the unemployment rate that arises from the worker reallocation process within the labor force'. Furthermore, I do not use the terms 'separation' and 'job finding' rates because as well explained by Elsby et al. (2010), separations from employers do no necessarily lead to a flow into unemployment, as unemployed workers may either find a new job or flow to non participation population.

[25] They compute these hazard rates according to the method of Shimer (2007). The method is based on the use of time series for the number employed, unemployment and unemployed less than five weeks.

[26] I thank Professor Jung for giving me access to these data.

Accordingly, the steady state unemployment rate is given by:

$$\bar{u} = \frac{\bar{s}}{\bar{s} + \bar{f}} \tag{III.6}$$

As a consequence, the steady state unemployment rate will change if either f or s or both change.

I assume according to the chapter I of this dissertation that outflows from unemployment are realized after credits are delivered. And inflows into unemployment are realized after the production takes place[27]. So I set the following short-term restrictions:

1. Outflows from unemployment (f) impact all other variables except the credit. $a_{fy} = a_{fs} = 0$.

2. Inflows into unemployment (s) impact other variables with one period lag.

The matrix A_0 becomes:

$$A_0 = \begin{pmatrix} 1 & 0 & 0 & 0 \\ a_{fc} & 1 & 0 & 0 \\ a_{yc} & a_{yf} & 1 & 0 \\ a_{sc} & a_{sf} & a_{sy} & 1 \end{pmatrix}$$

SVAR models are estimated using an optimal lag order of $p = 2$ for both countries according to the standard selection criteria.

According to figure 20, in the United-States, a technological shock has a positive impact on outflows from unemployment, reaching a peak at 0.028 pct at one quarter. Inflows into unemployment decrease with an immediate drop to -0.024 pct. Thus, after a technological shock, unemployment decreases in the United-States (figure 15) because more unemployed find a job and less employed workers loose their jobs. And I found a positive impact of technological shocks on corporations credit as in section (3.2).

From figure 21, I observe a significant impact of credit shock on outflows from unemployment and a barely non significant impact on inflows into unemployment. As a consequence, in the United-States, credit shock impacts negatively the unemployment (as observed on figure 14) mainly through the outflows rate: after a positive credit shock, more unemployed are finding a job leading to a decrease in unemployment. I found also positive impacts of credit shocks on output.

[27] I test the results with different ordering specifications (namely by setting the inflow rate at the end and just after the outflow rate). Results do not change.

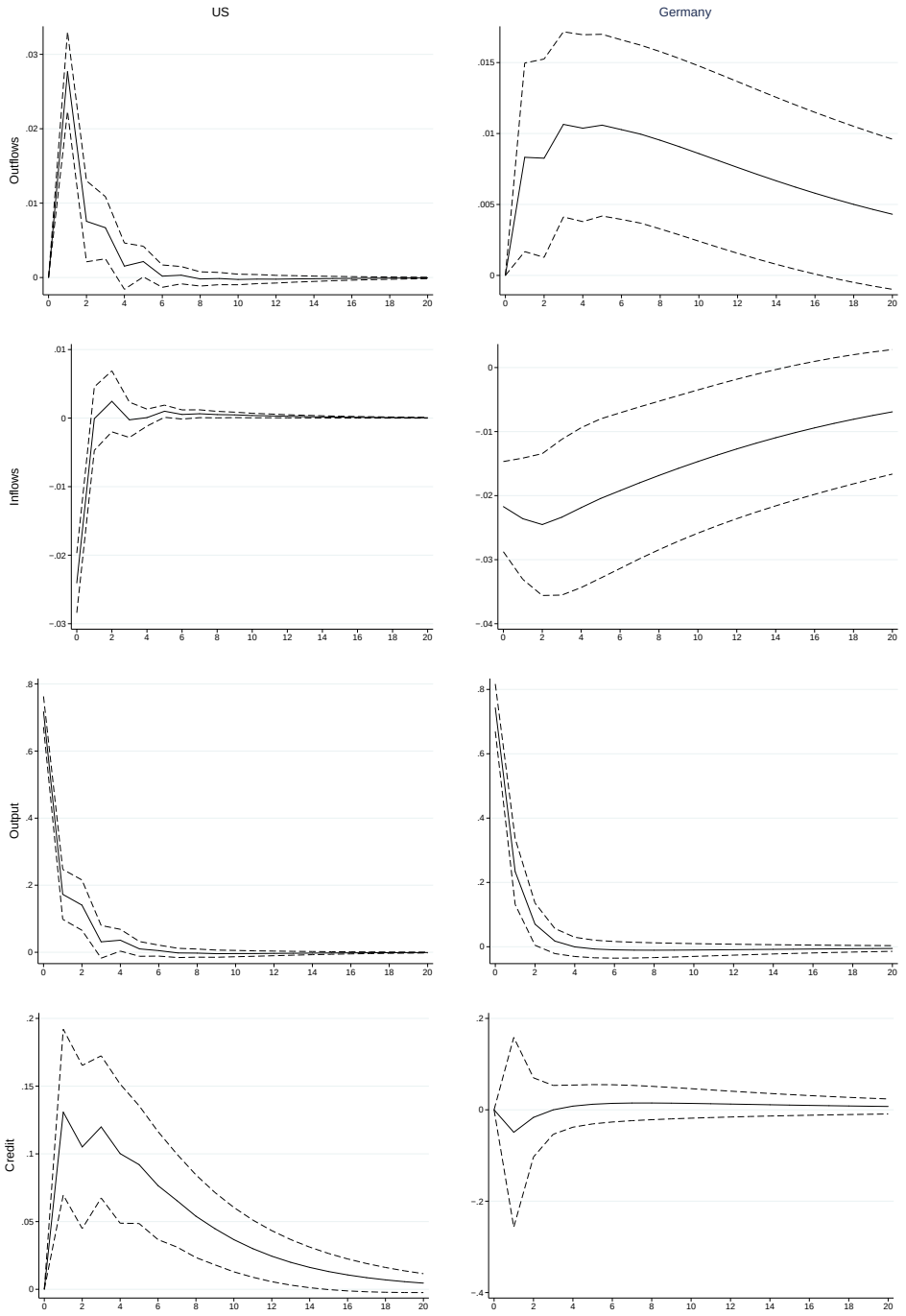


Figure 20: Structural impulse responses to technological shock. Unemployment dynamics.

Notes: The figure reports structural impulse responses to an unanticipated technological shock. Columns report the SIRFs for the United-Sates (US) and Germany. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

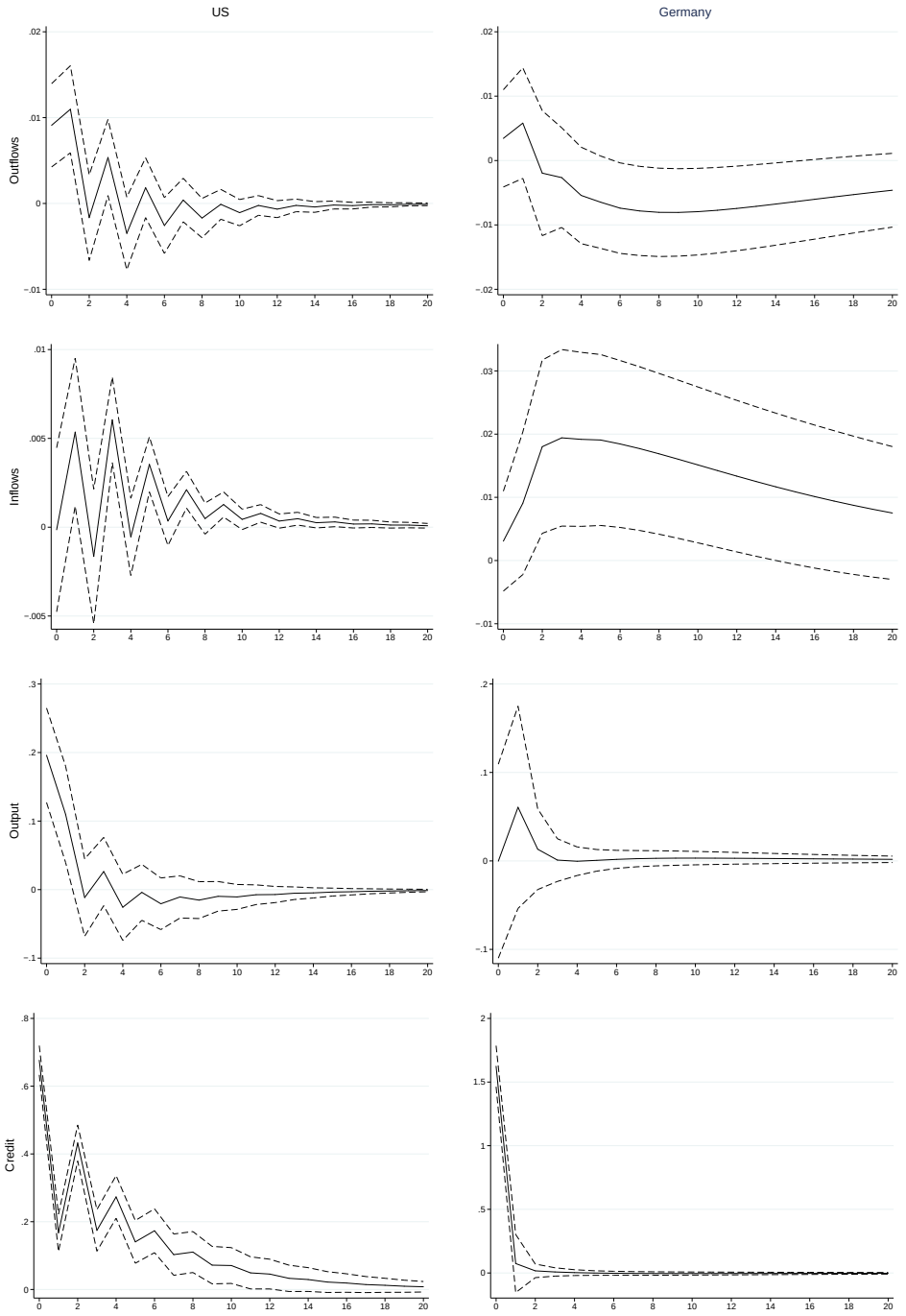


Figure 21: Structural impulse responses to credit shock. Unemployment dynamics.

Notes: The figure reports structural impulse responses to an unanticipated credit shock. Columns report the SIRFs for the United-Sates (US) and Germany. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

In Germany, a positive technological shock leads to an increase in the outflow rate and a decrease in the inflow rate into unemployment. That is why I found previously on figure 15 that unemployment rate goes down after a positive technological shock in Germany. The response of the outflow rate is significant for 4 years, reaching a peak at 0.01 pct at 3 quarters. The response of the inflow rate is significant for 14 quarters, reaching a peak at -0.024 at 2 quarters.

Nordmeier and Weber (2013b) using long- and short-run restrictions, found in the same vein that job finding rate increases after a positive technological shock, whereas the separation rate decreases (with an insignificant result for the separation rate). In our case, both margins appear to react to technological shocks in Germany and not only the outflow rate.

Finally, inflow rate into unemployment in Germany goes up after a positive credit shock and outflow rate goes down. As a result, as I observed on figure 14, unemployment increases after a positive credit shock in Germany. Here, the response of outflow rate is borderline significant and should not be overstated. Hence, in Germany, the increase in unemployment after a positive credit shock appears to be mainly due to an increase in the inflow rate into unemployment. This result may illustrate a kind of 'search for conciliation' argument playing for German firms. More credit in the economy could be seen as a sign of good health of the economy (more projects are carrying on by firms as they have access to more external financing for example). Labor unions are considering that workers will find easily new jobs in this context. So firms and labor unions allow themselves to dismiss, leading finally at the aggregate level to an increase in unemployment. Conversely, less credit in the economy is a bad news for the employment perspectives. Labor unions tend to bargain with firms so as to make them keeping workers with part-time jobs for example. As a result, unemployment goes down for a while.

German firms have a tradition of great bargaining with labor unions. When corporations credit is high, labor unions are finally less demanding to German corporations. Laid-off workers could potentially more easily find an other job when credit is abundant in the economy. Conversely, when corporations credit is restricted in the economy, labor unions know it will be difficult for a laid-off worker to find a new job. A phenomenon of 'labor retention' emerges. This retention of labor will then come to an end when the level of credit increases. The excess payroll constituted during low credit levels periods will then be reduced, resulting in a counter-intuitive result of rising unemployment during a period of high credit in Germany. The 'search for conciliation' argument could explain why in period of crisis especially (as shown in section 3), the German labor market dynamics may be counter-intuitive. It would be linked to the labor market institutional environment.

7 Conclusion

This chapter investigates the labor market dynamics in Germany and in the United-States after technological and credit shocks. Higher levels of non-financial corporates credit have various impacts on labor markets depending on countries. In the United-States, a positive credit shock has a positive impact on the labor market, through a decrease of unemployment and an increase in vacancies. This result is consistent with theoretical models developed in recent years. In Germany, a positive credit shock has a negative impact on the labor market, through an increase of unemployment. The impacts on vacancies and output are ambiguous: I find no evidence of a robust effect of credit shock on these variables. So theoretical frameworks

modeling credit and labor markets frictions should not overestimate the role of credit shocks on labor markets dynamics, without taking into account the institutional specificity of each country as for the German case. 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 on the employment front. In Germany, a 'search for conciliation' mechanism seems to appear. German firms tend to adjust their wage bill when credit conditions are favorable, and thus they will separate from the excess workers at that time. This argument is reinforced by the fact that I found non-linearity effects: the German labor market reacts differently in normal periods compared to periods of crisis. More investigation about these non-linear effects would be interesting to be able then to improve theoretical models by integrating regimes switching for example.

Appendices

A Data definitions and sources

Table 3: Definitions and source of data - Germany

Variable	Definition	Source
Population	Index of total population 2010:2=1 Seasonally adjusted (s.a)	OECD
Output	First difference of logarithm of real gross domestic product. Billions of chained 2010 euros divided by population, s.a	Eurostat
Unemployment	Logarithm of unemployment rate, s.a	OECD
Vacancies	Logarithm of index of total unfilled job vacancies divided by labor force, s.a	OECD
Price level	Gross domestic product, Implicit price deflator 2010=100	Eurostat
Corporations credit	First difference of logarithm of total non-financial corporations credit divided by price level and population, s.a	BIS credit statistics
Consumption	First difference of logarithm of private final consumption expenditure divided by price level and population, s.a	OECD
Investment	First difference of logarithm of gross fixed capital formation divided by price level and population, s.a	OECD
Outflow rate	Number of hires on number of unemployed	Hartung et al. (2016)
Inflow rate	Number of benefit claims on number of employed workers	Hartung et al. (2016)

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

Variable	Definition	Source
Population	Index of civilian non institutional population, n.s.a	BLS
Output	First difference of the logarithm of real gross domestic product. Billions of chained 2009 dollars divided by population, s.a	BEA (A191RX1)
Unemployment	Logarithm of civilian unemployment rate, s.a	BLS (LNS14000000)
Vacancies	Logarithm of composite help-wanted index	Barnichon (2010)
Price level	Gross domestic product, Implicit price deflator 2009=100	BEA (A191RD3)
Corporations credit	First difference of logarithm of total non-financial corporations credit divided by price level and population, s.a	BIS credit statistics
Consumption	First difference of logarithm of personal consumption divided by price level and population, s.a	BEA (PCEC, DPCERC1)
Investment	First difference of logarithm of fixed non-residential private investment expenditure divided by price level and population, s.a	BEA (A008RC)
Outflow rate	Number of hires on number of unemployed. Computed according to the method of Shimer (2007)	Elsby et al. (2010)
Inflow rate	Number of layoffs on number of employed workers. Computed according to the method of Shimer (2007)	Elsby et al. (2010)

B Identification of short-term SVAR models

The structural VAR model is defined as:

$$A_0 X_t = \alpha + \Sigma_{i=1}^{p} A_i X_{t-i} + \epsilon_t \qquad E(\epsilon_t) = 0, \;\; E(\epsilon_t \epsilon_t^{'}) = \Sigma \tag{7}$$

Note that Σ is a diagonal matrix as structural shocks are by definition uncorrelated (if structural shocks were not independent, it would say that unexplained causal relationships between them remain).

The reduced-form SVAR model is obtained by multiplying the equation (7) by A_0^{-1}:

$$A_0^{-1} A_0 X_t = A_0^{-1}\alpha + \Sigma_{i=1}^{p} A_0^{-1} A_i X_{t-i} + A_0^{-1}\epsilon_t \tag{8}$$

which gives:

$$X_t = \delta + \Sigma_{i=1}^{p} B_i X_{t-i} + e_t \qquad E(e_t) = 0, E(e_t e_t^{'}) = \Omega, \;\; E(e_t e_s^{'}) = 0 \;\; \forall t \neq s \tag{9}$$

where $\delta = A_0^{-1}\alpha$, $B_i = A_0^{-1} A_i$ and $e_t = A_0^{-1}\epsilon_t$.

If A_0^{-1} is known, we are able to deduce δ, B_i and e_t. The problem it thus to determine how to obtain A_0^{-1}.

The identification problem for $n = 4$ is presented as follow:

$$E(e_t e_t^{'}) = A_0^{-1}\Sigma(A_0^{-1})' = \Omega$$

$$\begin{pmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} & \sigma_{14} \\ \sigma_{12} & \sigma_{22} & \sigma_{23} & \sigma_{24} \\ \sigma_{13} & \sigma_{23} & \sigma_{33} & \sigma_{34} \\ \sigma_{14} & \sigma_{24} & \sigma_{34} & \sigma_{44} \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{pmatrix}^{-1} \begin{pmatrix} \sigma_{11} & 0 & 0 & 0 \\ 0 & \sigma_{22} & 0 & 0 \\ 0 & 0 & \sigma_{33} & 0 \\ 0 & 0 & 0 & \sigma_{44} \end{pmatrix} \begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{pmatrix}^{-1'}$$

There are 16 unknowns for the matrix A_0 and 4 unknowns for the matrix Σ but only 10 equations as the variance-covariance matrix, Ω, is symmetric. The system is not identified.

Based on structural assumptions developed in section (2.3), assume A_0 is lower triangular such that:

$$A_0^{-1} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{pmatrix}^{-1}$$

Now there are 10 equations with 10 unknowns as 10 elements of A_0 are set to precise values, either 0 or 1. The system is just identified.

C SVAR models specifications

Table 5: SVAR lag order selection by selection criteria for the United-States

Maximum lag length	LR	FPE	AIC	SBIC	HQ
2	2	2	2	2	2
4	4	4	4	2	2
6	6	6	6	2	2
10	10	6	6	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 6: SVAR lag order selection by selection criteria for Germany

Maximum lag length	LR	FPE	AIC	SBIC	HQ
2	2	2	2	2	2
4	2	2	2	2	2
6	5	2	2	2	2
10	10	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.

Table 7: Augmented Dickey-Fuller (ADF) tests for the United-Sates

	Level		First difference	
	Model specification	Test statistic	Model specification	Test statistic
Credit	t, c, p= 3	-2.967	c, p = 2	-4.473***
Output	t, c, p = 3	-2.218	c, p = 2	-8.563***
Unemployment	c, p = 3	-3.893***		
Vacancies	c, p = 3	-4.038***		
Consumption	t, c, p = 3	-2.067	c, p = 2	-8.234***
Investment	t, c, p = 3	-2.316	c, p = 2	-8.157***

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 8: Augmented Dickey-Fuller (ADF) tests for Germany

	Level		First difference	
	Model specification	Test statistic	Model specification	Test statistic
Credit	t, c, p = 2	-1.252	c, p = 2	-5.521***
Output	t, c, p = 2	-2.807	c, p = 2	-4.704***
Unemployment	c, p = 2	-3.211**		
Vacancies	t, c, p = 2	-3.393**		
Consumption	t, c, p = 2	-0.358	c, p = 2	-5.338***
Investment	t, c, p = 3	-0.569	c, p = 2	-5.203***

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.

D Cumulative impulse responses

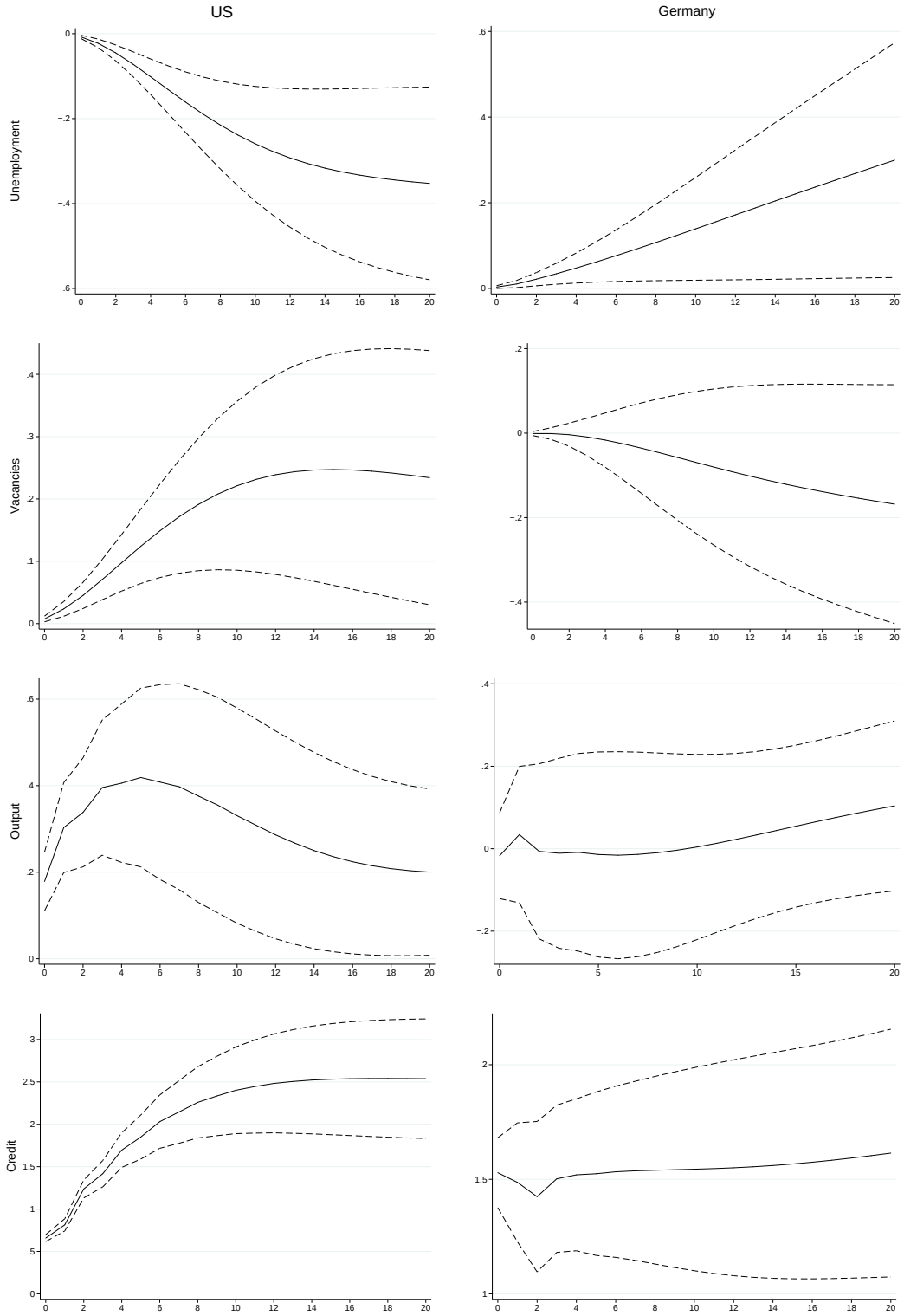


Figure 22: Cumulative impulse responses to credit shock

Notes: The figure reports cumulative impulse responses to an unanticipated permanent credit shock. The column report the CIRFs for the United-Sates and Germany. The solid lines denote the median CIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

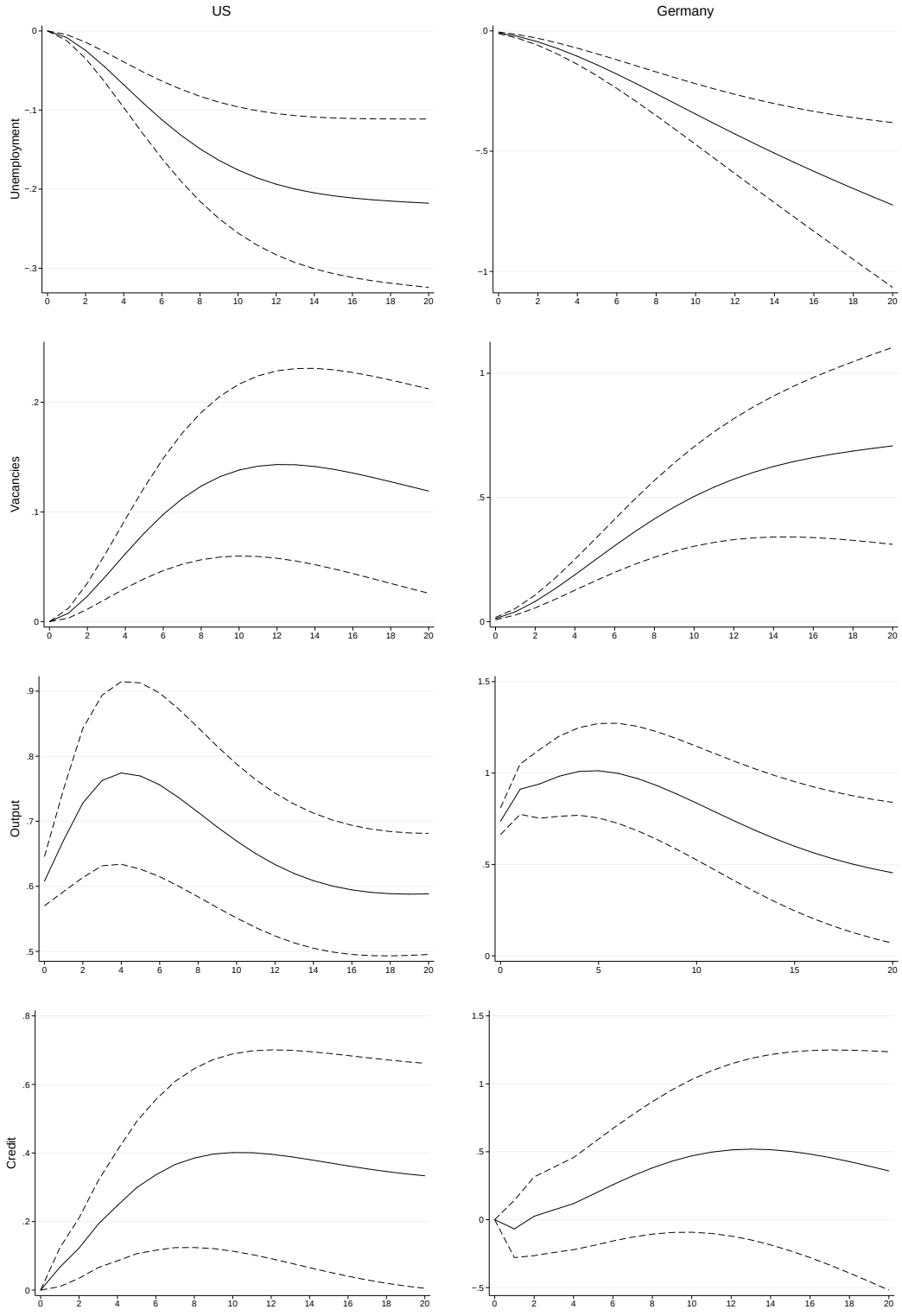
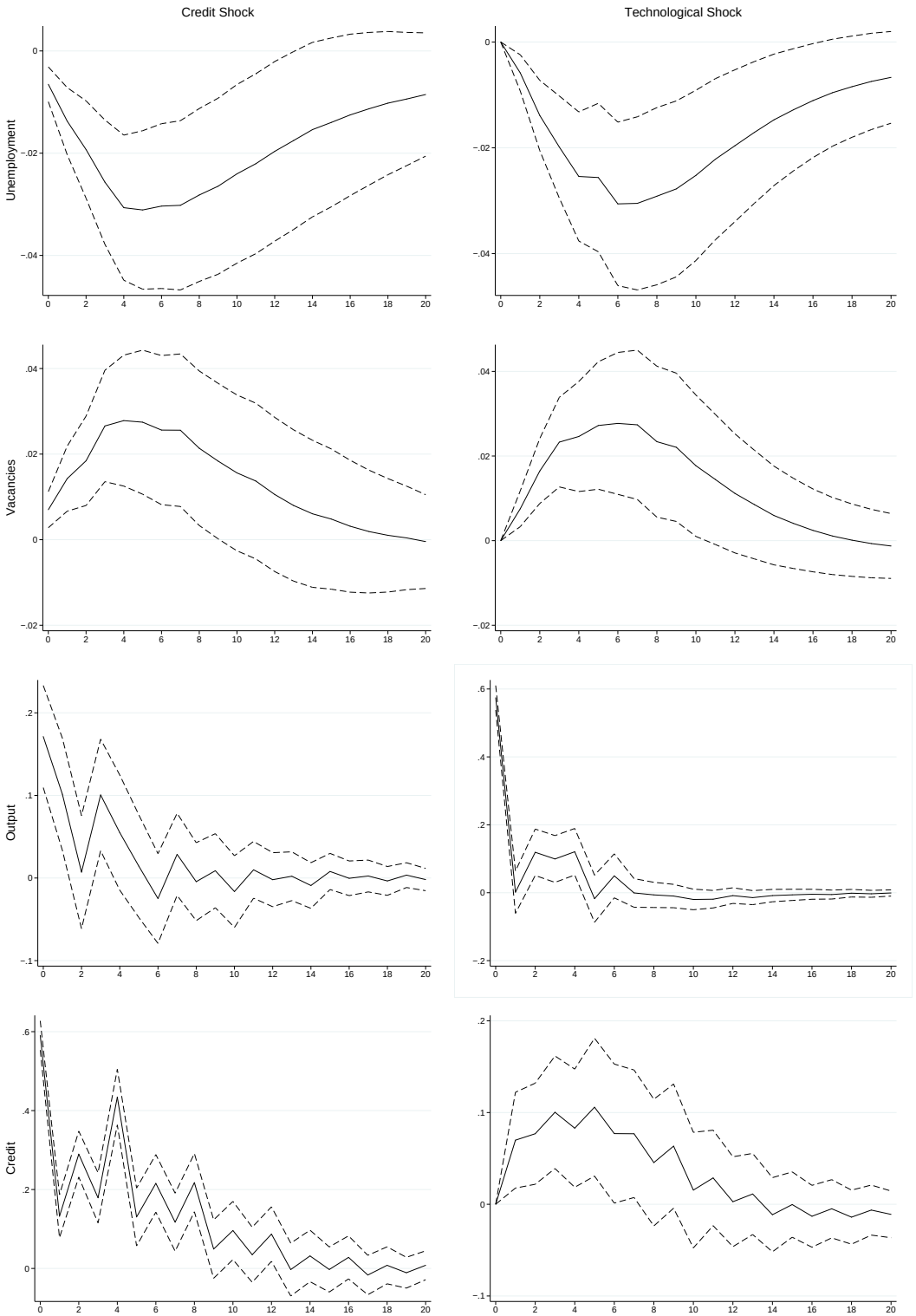


Figure 23: Cumulative impulse responses to technological shock

Notes: The figure reports cumulative impulse responses to an unanticipated permanent technological shock. The column report the CIRFs for the United-Sates and Germany. The solid lines denote the median CIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

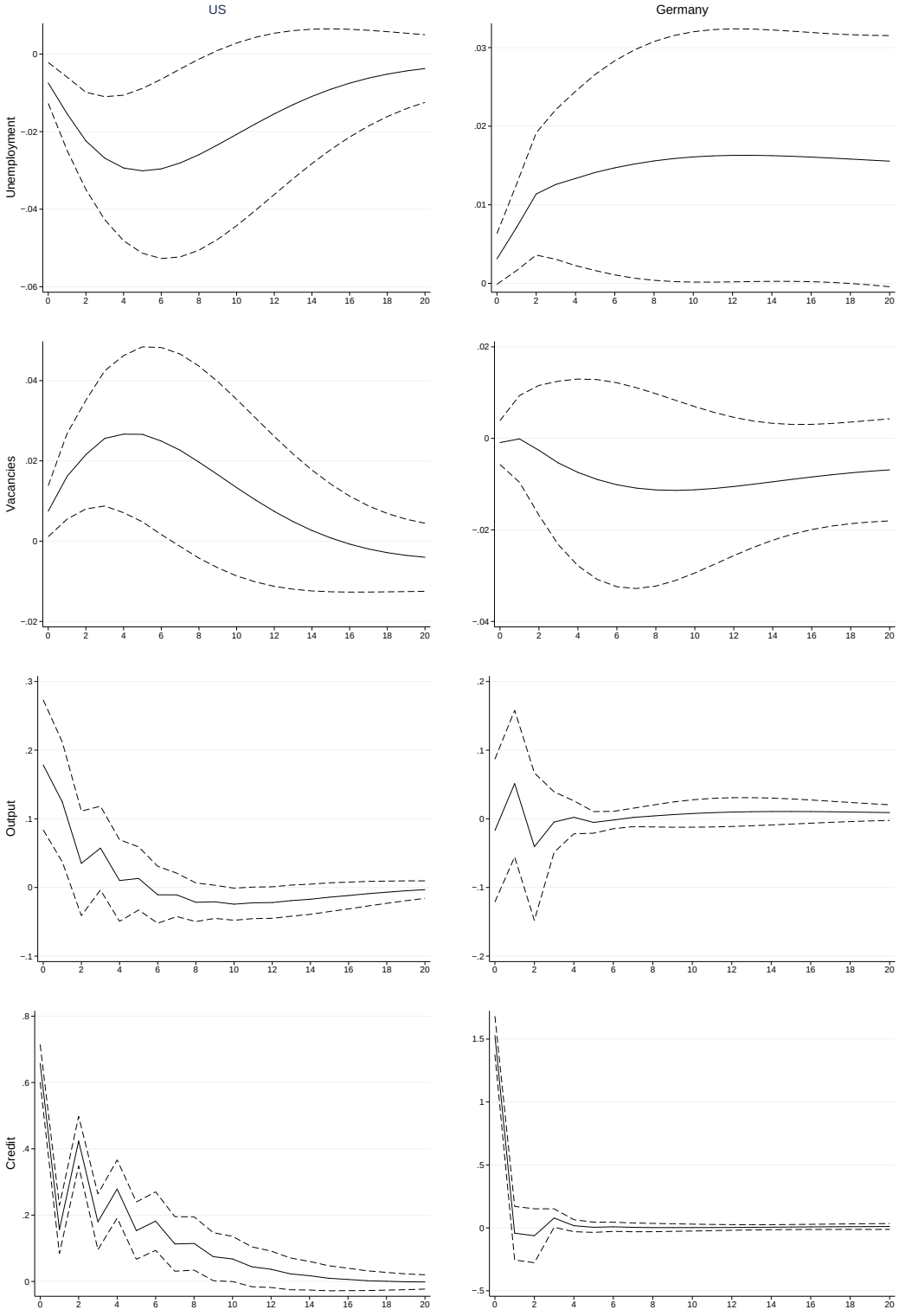
E Robustness analysis - Impulse responses

Figure 24: Structural impulse responses to credit and technological shocks for the United-States. Lag = 6.



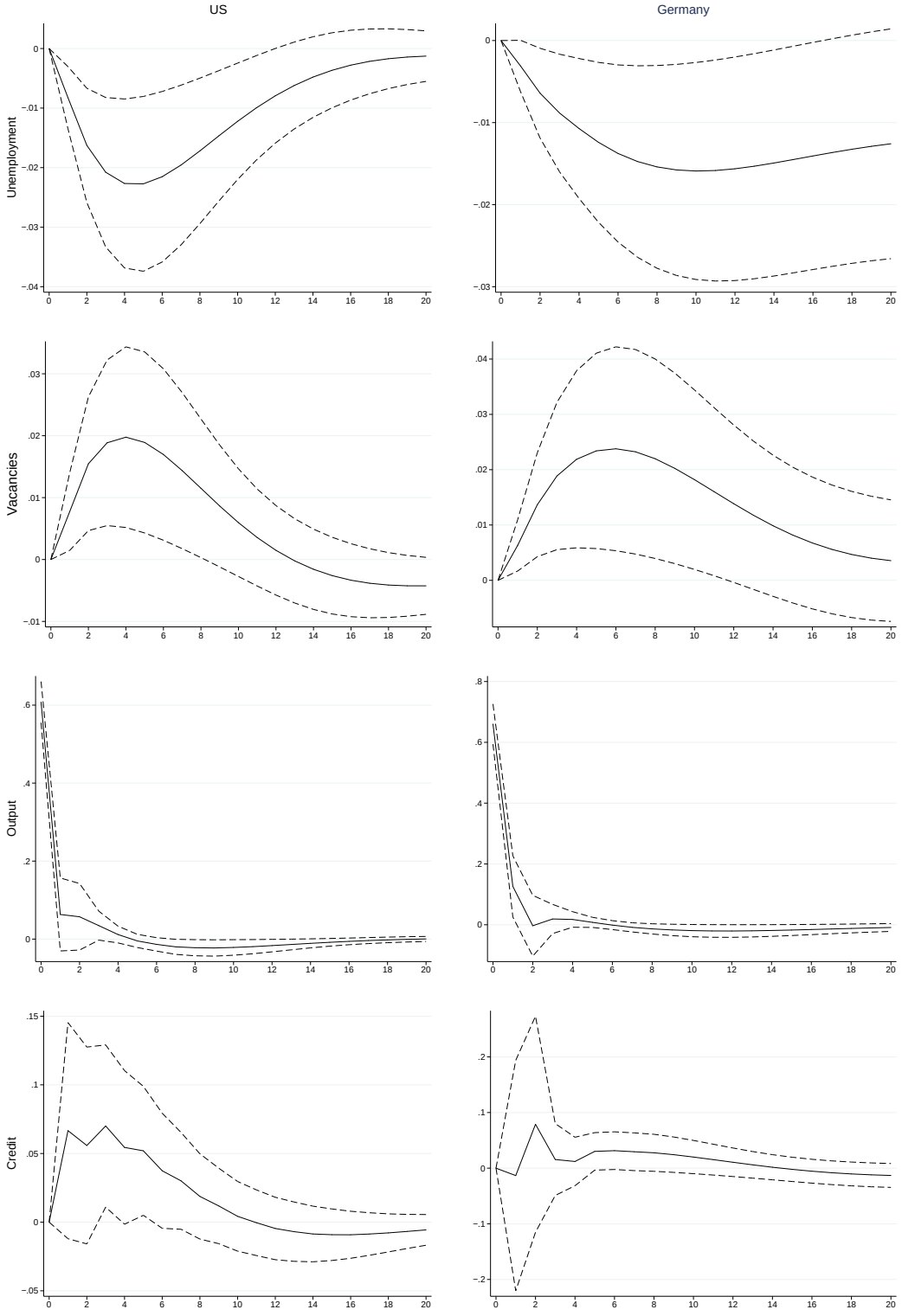
Notes: The figure reports structural impulse responses to unanticipated credit and technological shocks. The column report the IRFs for the United-Sates. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

Figure 25: Structural impulse responses to credit shock. Unemployment ordered second.



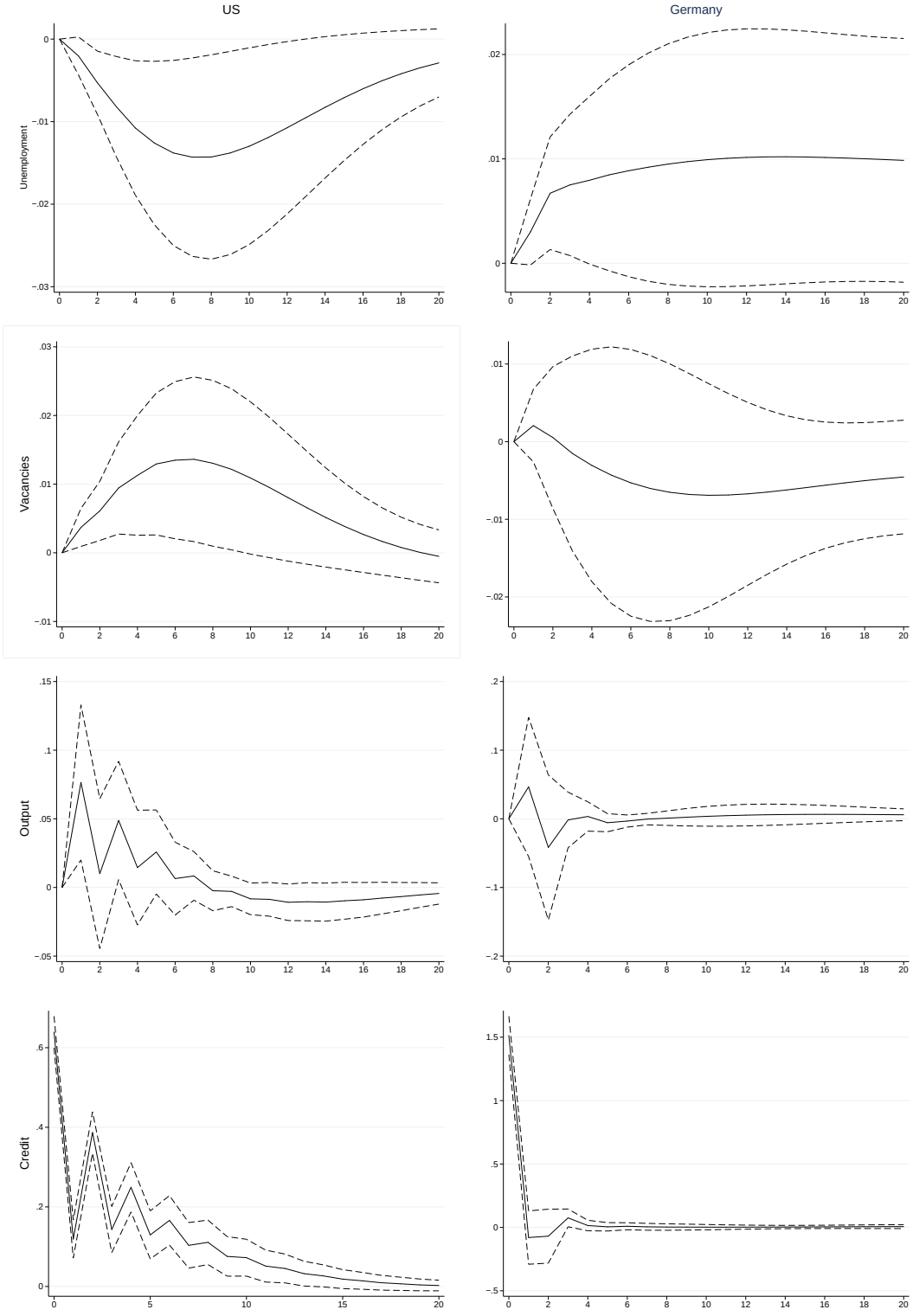
Notes: The figure reports structural impulse responses to unanticipated credit shock. I rank unemployment second. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

Figure 26: Structural impulse responses to technological shock. Unemployment ordered second.



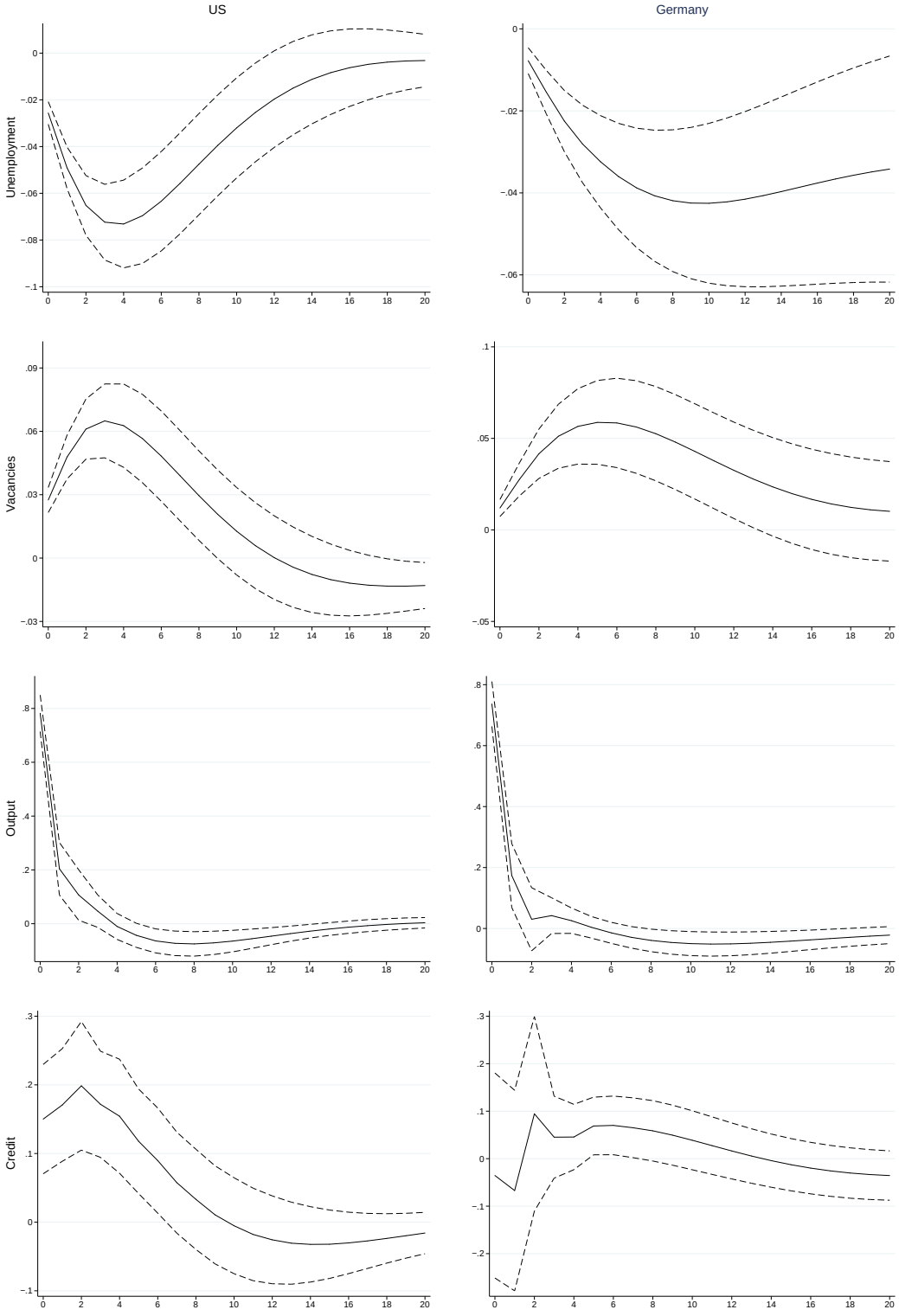
Notes: The figure reports structural impulse responses to unanticipated technological shock. I rank unemployment second. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

Figure 27: Structural impulse responses to credit shock. Output ordered first.



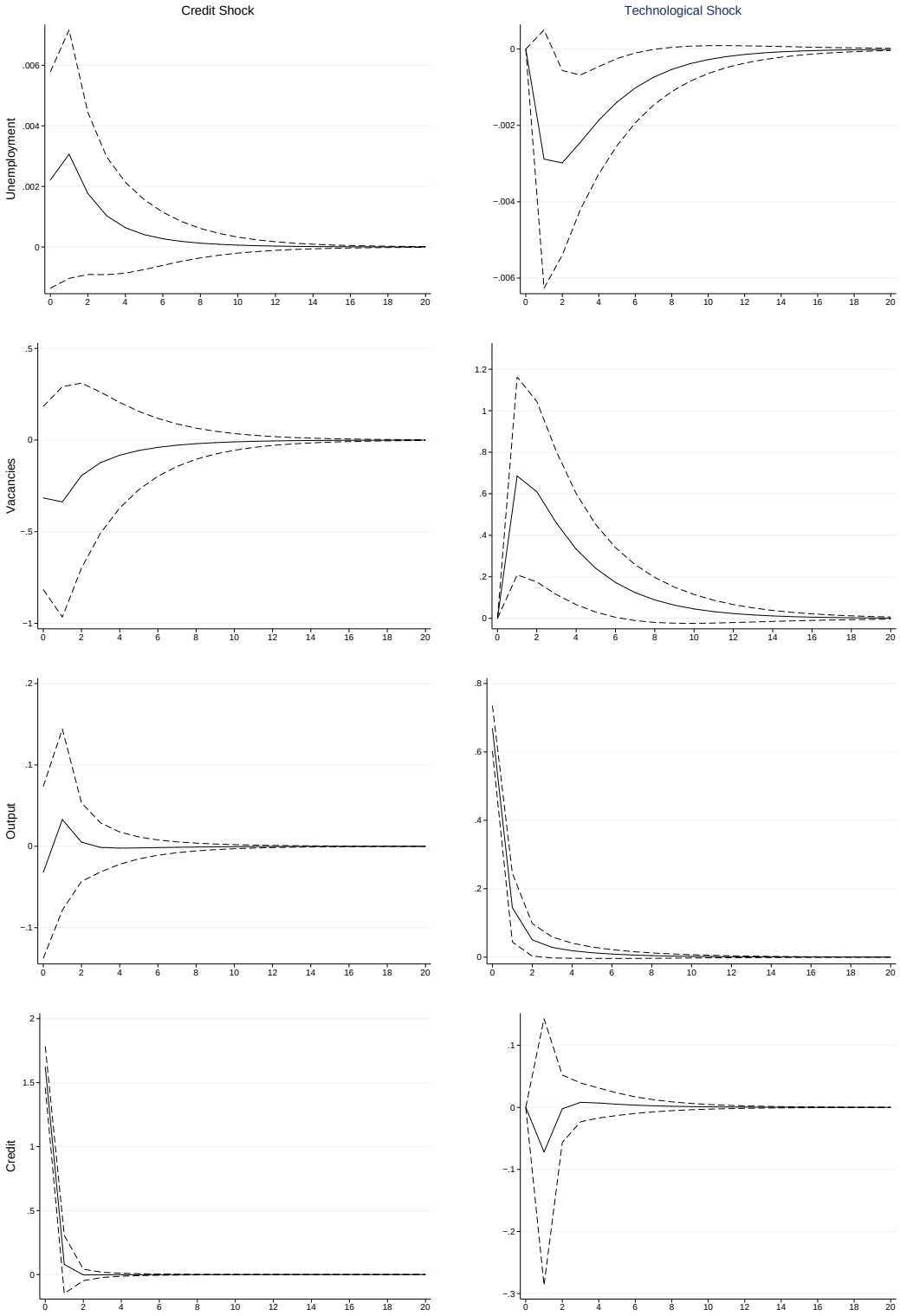
Notes: The figure reports structural impulse responses to unanticipated credit shock. I order the output first and the credit last. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

Figure 28: Structural impulse responses to technological shock. Output ordered first.



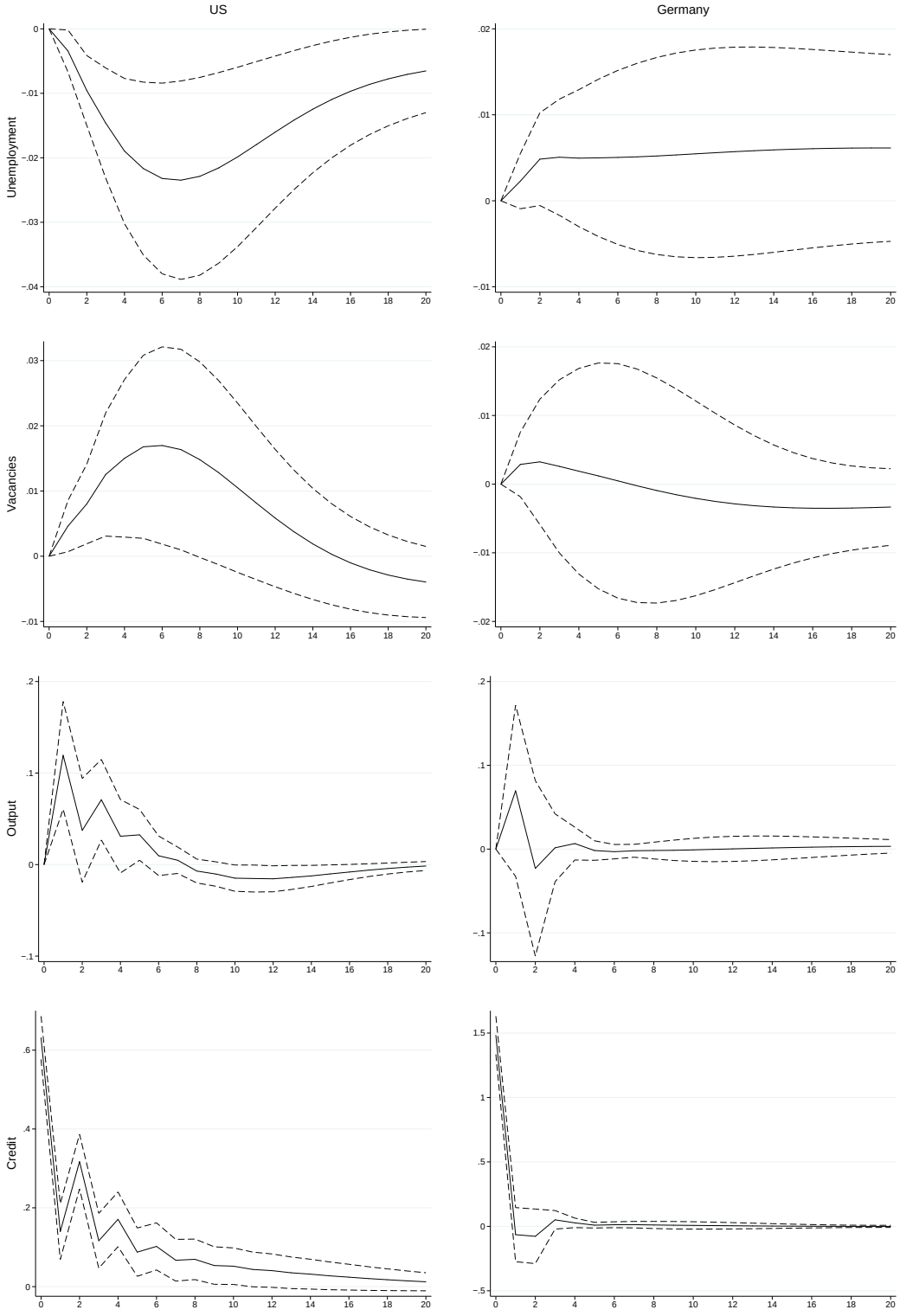
Notes: The figure reports structural impulse responses to unanticipated technological shock. I order the output first and the credit last. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

Figure 29: Structural impulse responses to credit and technological shocks for Germany. Unemployment and vacancies expressed in first-difference.



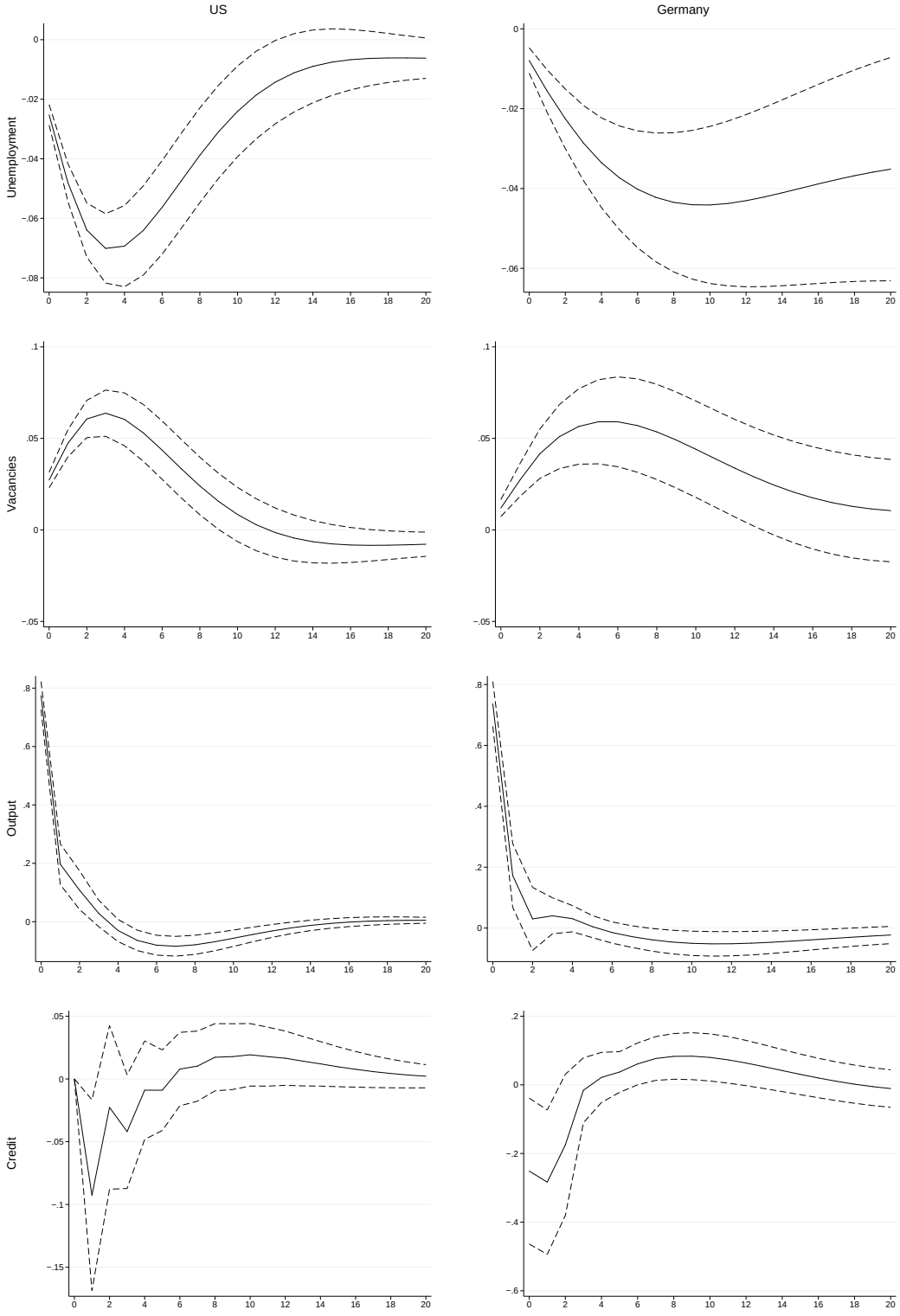
Notes: The figure reports structural impulse responses to unanticipated credit and technological shocks for Germany. Vacancies and unemployment are expressed in first-difference. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

Figure 30: Structural impulse responses to credit shock. Credit to output ratio.



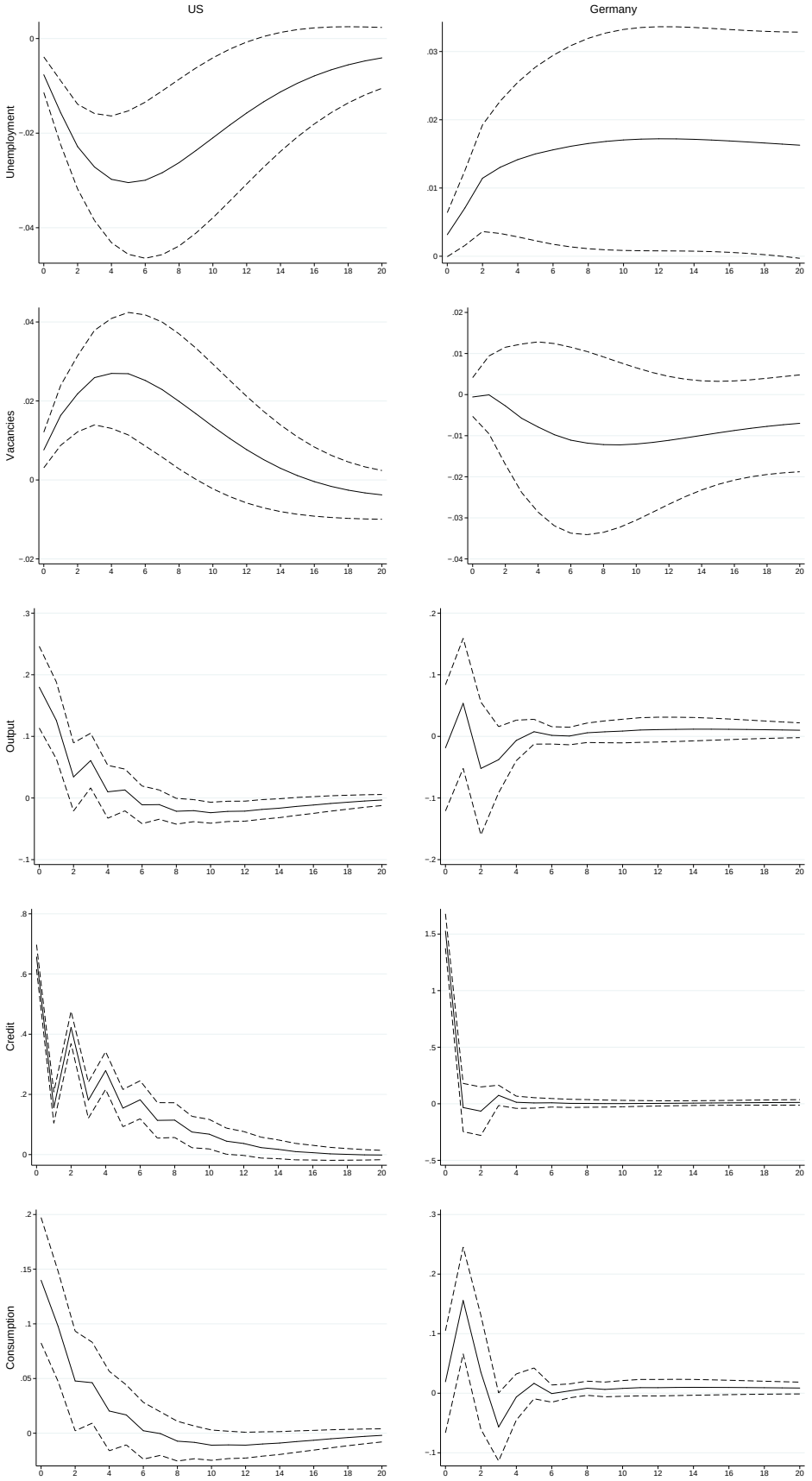
Notes: The figure reports structural impulse responses to unanticipated credit shock. Credit is expressed as the credit to output ratio. I order output first and credit last. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

Figure 31: Structural impulse responses to technological shock. Credit to output ratio.



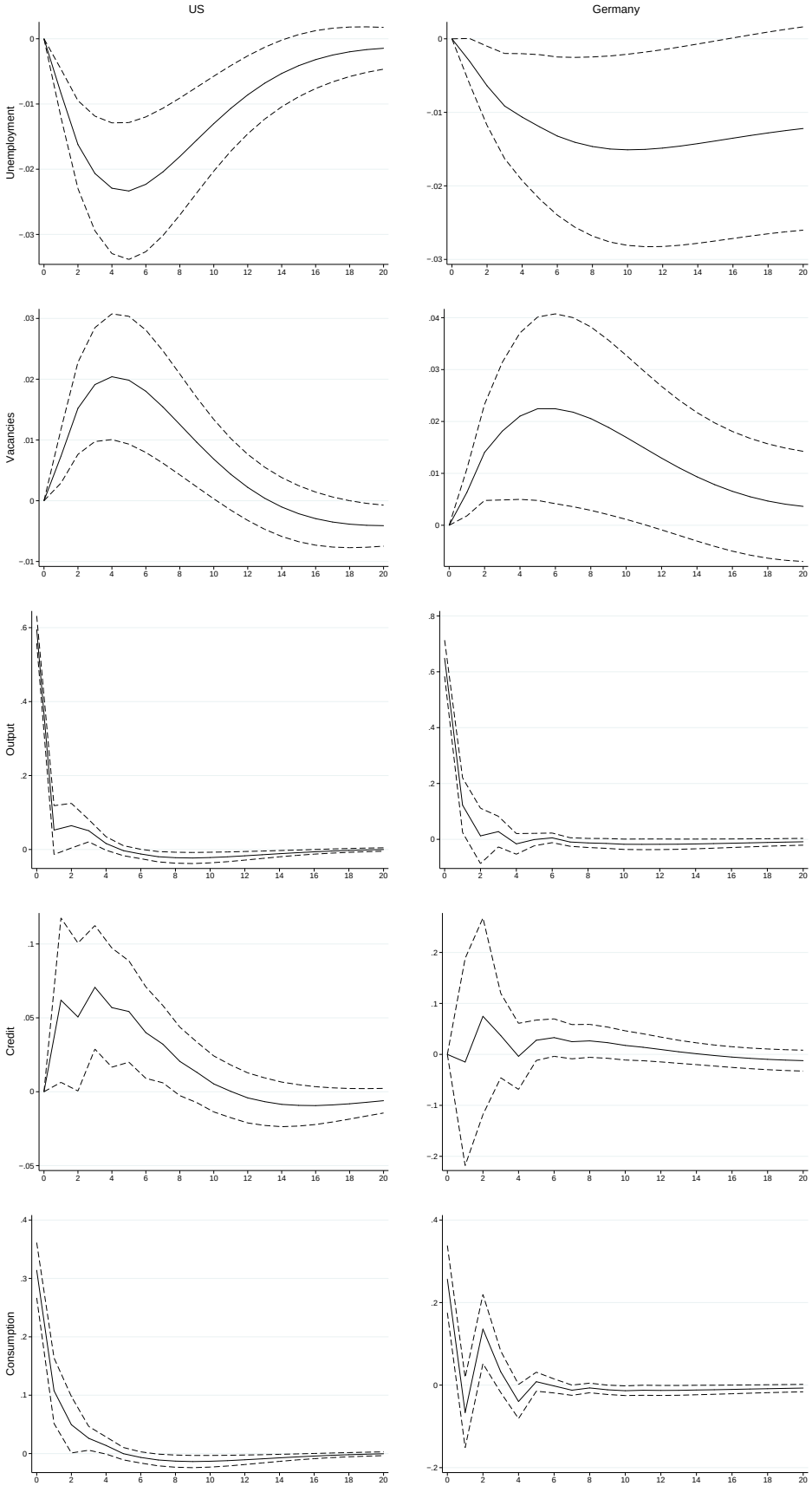
Notes: The figure reports structural impulse responses to unanticipated credit shock. Credit is expressed as the credit to output ratio. I order output first and credit last. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

Figure 32: Structural impulse responses to credit shock. Consumption added.



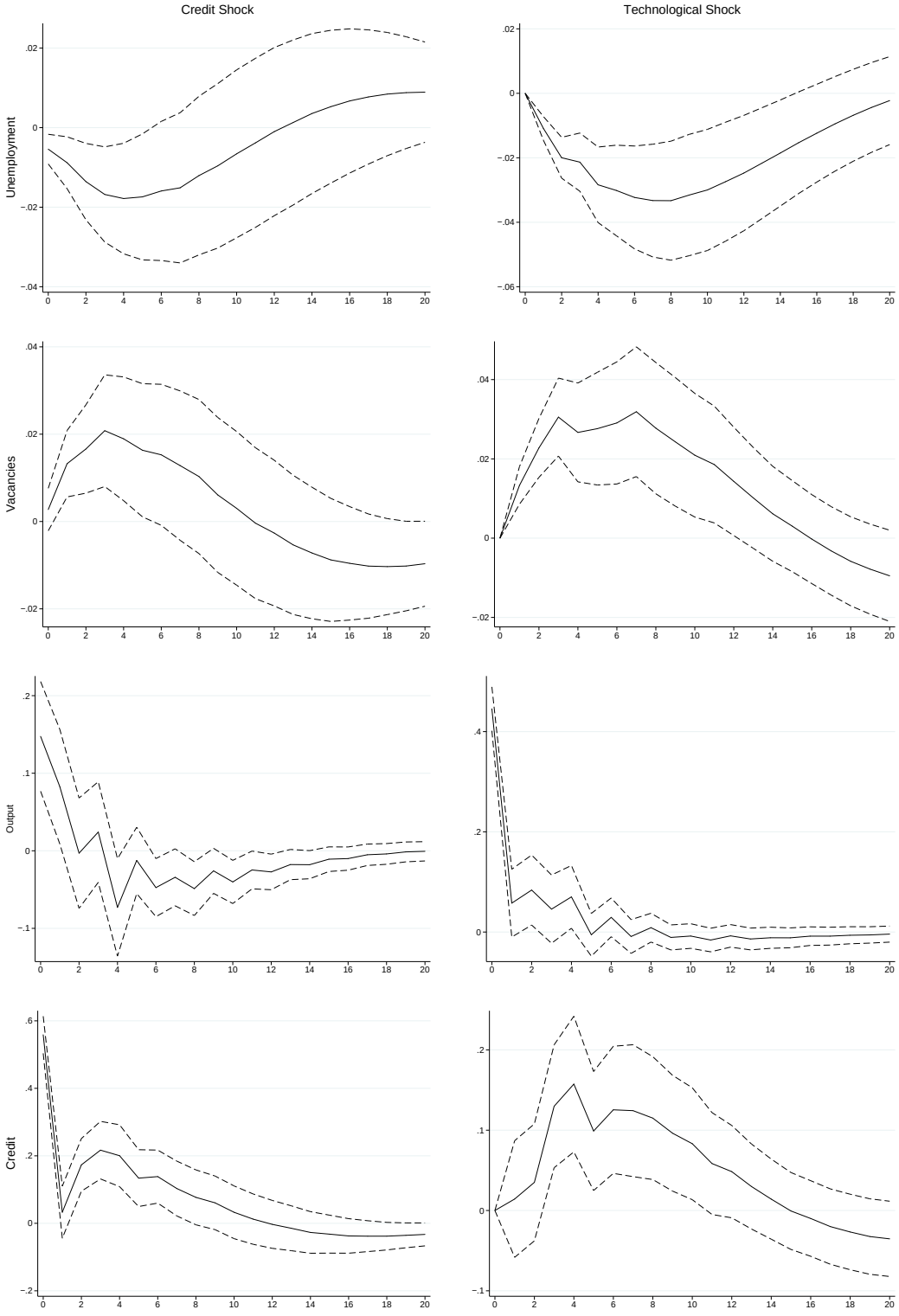
Notes: The figure reports SIRF to unanticipated credit shock. I add consumption ordered last. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

Figure 33: Structural impulse responses to technological shock. Consumption added.



Notes: The figure reports SIRF to unanticipated technological shock. I add consumption ordered last. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

Figure 34: Structural impulse responses to credit and technological shocks for the United-States. 1991.1 to 2016.2 data period.



Notes: The figure reports structural impulse responses to unanticipated credit and technological shocks for the United-States. I set the data time period from 1991.1 to 2016.2. The solid lines denote the median SIRFs. The dot lines identify confidence intervals at 90% level. The horizontal axis identifies quarters.

General conclusion

This dissertation addressed the interactions between labor and credit markets in an imperfect information framework, taking into account the institutional environment surrounding the labor markets.
Chapter I investigated the way financial frictions interact with frictional labor markets, through which transmission channels. It showed that financial frictions interact with labor markets through a marginal costs channel. Asymmetric information implied a financial mark-up charged by financial intermediaries to firms. It induces less posting vacancies by these firms, less employment in the economy and a higher level of prices. A calibration exercise is carried out to investigate the impact of a net worth shock, a monitoring cost shock and an idiosyncratic volatility shock on macroeconomic variables, such as vacancies, unemployment rate and real wages. Different channels of propagation from the financial sphere of the economy to the labor market are investigated and appear to be consistent with the theoretical model. However, there are some limitations to this empirical exercise. Each shock has not been clearly separately identified so as to determine their specific contributions to the real economy dynamics. Furthermore, a Bayesian estimation could be an empirical work worth to consider so as to improve the empirical analysis and to see if the model is able to replicate data behaviors in the United-States.

Chapter II compares two bargaining regimes between workers and firms, the efficient bargaining and the right-to-manage bargaining in a labor search model with credit constraints on the credit market. It showed that in an imperfect information framework, different wage bargaining regimes affect differently labor market outcomes. In an efficient bargaining regime, financial frictions reduce the relative bargaining power of the firm. An inefficiency gap appears, the so-called financial mark-up. In a right-to-manage bargaining regime, financial frictions reduce the relative bargaining power of firms but to a lesser extent as the firm has a higher degree of freedom in the bargaining process. Another source of inefficiency appears, the so-called wage mark-up, that will be influenced by financial frictions levels. Depending on the bargaining regime, firms are able to alleviate more or less easily the cost linked to the presence of financial frictions. A right-to-manage bargaining gives them a higher degree of freedom for their choices. However, the final allocation of resources in the economy is going even worse. This chapter is based on a partial equilibrium model. It may be relevant to develop in future research a stochastic general equilibrium model in order to be able to implement a calibration, or even an estimation of this enriched model.

Chapter III provided an empirical analysis taking into account two different countries, that are Germany

and the United-States. It studied potential differences on the way their credit markets interact with labor markets. It showed that higher levels of non-financial corporations credit have various impacts on labor markets depending on countries. In the 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. The impacts on vacancies and output are ambiguous: no evidence of a robust effect of credit shock on these variables is found. In Germany, a 'search for conciliation' mechanism seems to appear. German firms tend to keep their labor force when credit conditions are not good, because of the role played by labor unions in this country. This argument is reinforced by the fact that the German labor market reacts differently in normal periods compared to periods of crisis. The non-linear impact of credit shocks in Germany could be deeply investigated with non-linear models in futures researches.

Through this dissertation, I studied in an imperfect information environment, labor and credit markets interactions, depending on the institutional environment surrounding the labor market. Labor market institutions are often referred as a source of rigidity that impede the efficient adjustment of labor markets. This dissertation could also bring to think that institutions in the credit market can be a source of potential rigidity. Thus, it seems relevant to develop future theoretical models that allow to analyse market interactions based on different institutional framework across markets, and not on a one-to-one market as I have done in this dissertation. A more general comprehensive framework would be an interesting perspective to be able to propose structural reforms which would not have unwanted perverse effects due to the particular institutional characteristics on the different markets.

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Title: Financial frictions and labor market

Abstract: Unemployment rates in developed economies are now significantly different. Labor market institutions are also diverse and multifaceted. These institutions could be considered as allowing to increase or to reduce the levels of unemployment. However empirically, there is no direct and unambiguous link between unemployment rates and institutions in the labor market. By considering more precisely the way in which firms decide on their payroll, we realize that we omit, by making this simple correlation link, an essential variable that determines the hiring and firing behavior of firms, namely the funding variable. The external financing capacity of firms may determine the labor demand, conditional on the institutions in the labor market. Thus, the problem is not whether institutions in the labor market condition its relative performance but rather whether the couple of institutions in labor and credit markets determines this performance. A firm is certainly constrained by a greater or lesser flexibility in the labor market, but its computations are part of a broader perspective, which is whether or not it has access to the funding it needs. The importance of financial frictions in the credit market determines the level of the external financing constraint for firms. This could then have an impact on their hiring plans and job levels in economies depending on the prevailing labor market institutions. Financial frictions should therefore influence the main labor market macroeconomic variables, namely unemployment, wage level and the number of vacancies, conditional on existing labor market institutions.

Keywords: labor market, credit market, imperfection information, institutions, frictions, unemployment, wages.

Titre : Frictions financières et marché du travail

Résumé : Les niveaux des taux de chômage des économies développés sont aujourd'hui sensiblement différents. Les institutions du marché du travail sont elles aussi diverses et protéiformes selon les pays. Ces institutions pourraient être considérées comme permettant d'accroître ou de réduire les niveaux de chômage. Or empiriquement, on ne trouve pas de lien direct et univoque entre les taux de chômage et les institutions sur le marché du travail. Si nous considérons plus précisément la façon dont les firmes décident de leur masse salariale, on réalise que l'on omet en faisant ce simple lien de corrélation, une variable essentielle qui détermine les comportements d'embauche et de licenciement des entreprises, à savoir la variable du financement. La capacité de financement externe des firmes pourrait déterminer, ou non, la demande de travail, conditionnellement aux institutions sur le marché du travail. Ainsi, le problème ne serait pas de savoir si les institutions sur le marché du travail conditionnent sa performance relative mais plutôt de savoir si le couple d'institutions sur le marché du travail et le marché du crédit détermine ces performances. Une entreprise est certes contrainte par la plus ou moindre grande flexibilité existante sur le marché du travail, mais ses calculs s'inscrivent dans une perspective plus large, qui est de savoir si elle a accès ou non aux financements dont elle a besoin. L'importance des frictions financières sur le marché du crédit détermine le niveau de la contrainte de financement externe pour les firmes. Cela pourrait alors avoir un impact sur leurs projets d'embauche et sur les niveaux d'emplois dans les économies. Les niveaux de frictions financières devraient donc influencer le niveau des principales variables macroéconomiques relatives au marché du travail, que sont le chômage, le niveau du salaire et le nombre de postes vacants, conditionnellement aux institutions existantes sur le marché du travail.

Mots clés : marché du travail, marché du crédit, information imparfaite, institutions, frictions, chômage, salaires.