Heterogeneity in Macro-Finance:

The Role of Disaggregate Dynamics in Aggregate Fluctuations

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Declaration of Authorship

This dissertation consists of two working papers and one published paper. All three papers are single authored:

- Jobless and Wageless Growth: The Composition Effects of Credit Easing.
- Contribution: 100 percent.

- The balance sheet effects of oil market shocks: An industry level analysis.
- Contribution: 100 percent.

- The Role of Labor Market Frictions in Structural Transformation.
- Contribution: 100 percent.

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Contents

List of Tables

List of Figures

Introduction

Recent macroeconomic developments since 2008 have revealed the limits of macroeconomic models that abstract from the essential role of financial markets and the dynamics of disaggregate heterogeneity in shaping the aggregate economy. In response, a growing body of research in macroeconomics incorporates credit markets and the frictions they impose on the economy and emphasizes the links between the macro and micro literature in explaining causes and effects of observed aggregate time series fluctuations and cross-sectional variation. Accompanying this shift in perspective, a new set of methodological tools that could enable the analysis and estimation of this novel class of macroeconomic models have been gaining importance. Motivated by the research program of this heterogeneity agenda, this thesis studies some of the key linkages between aggregate and disaggregate dynamics in labor and oil markets, with a focus on the role of financial factors.

Each of the three chapters of the dissertation belongs to one of the main class of questions that occupy this larger research agenda. The first paper, entitled "Jobless and Wageless Growth: The Composition Effects of Credit Easing", supports the notion that the state of the micro-level distribution matters for the transmission of aggregate fluctuations to the aggregate economy.[1] It brings empirics and theory together to explore the role of credit supply in explaining the jobless and wageless growth patterns observed over the business cycle in the United States, thereby reflecting on the effectiveness of credit easing policies as a means to support jobs and real wages growth in post crisis regimes. The paper therefore targets the policy debate on the expected benefits of continuing to use aggressive credit expansion in economies where labor markets still show signs of stagnation.

The main takeaway of the paper is that the main thrust of credit easing policies targets firms that face higher borrowing costs. Such firms are more inclined to use capital instead of labor in production, because of its collateral value, and pay lower wages because of

[1] Other examples include work that shows the dependency of monetary policy transmission to aggregate investment and the transmission of credit market disruptions to aggregate TFP on credit worthiness across the firm distribution (Ottonello and Winberry (2018), Khan and Thomas (2013)).

the negative impact of higher financing costs on the expected returns on labor. Hence, by increasing the share of firms with high financing costs in aggregate production, the *composition* effects that follow mean that the aggregate labor intensity and the aggregate real wage fall under negative pressure. The analysis advances the argument that economic policy aiming at increasing the aggregate labor share may be more effective if measures that support more equal growth in the full distribution of firms, such as aggregate demand and productivity stimulants, are adopted.

The second paper, entitled "The balance sheet effects of oil market shocks: an industry level analysis"[2] contributes to the argument that aggregate effects of macroeconomic shocks can indeed conceal a wider heterogeneity in the pass-through at disaggregated level. The analysis is motivated by the rapid decline of oil prices in 2015 that was followed, unexpectedly, by lackluster growth in economic activity and firm profitability. To investigate this point, the paper studies the pass-through of changes in the oil price to the balance sheet of US firms, using industry level data covering manufacturing, trade and mining sectors. It attempts to answer two questions: Are low oil prices good for firm profits? And through what channels do oil price fluctuations affect firm finances?

Its main conclusion is that the sign and magnitude of the effect of oil prices on the corporate sector depends on two levels of heterogeneity: first, different structural drivers of oil price changes such as oil demand and supply shocks have different effects; second, different industries respond differently to the different types of shocks. In addition, it introduces the novel insight that the real effects of an exogenous disruption in the oil market does not only depend on its effect on the price of oil; depending on their structural causes, limited oil prices changes could be associated with large effects on firms. Furthermore, it argues against the classic notion that the cost share of oil in an industry determines its level of exposure to oil market shocks.

The last category of questions under the heterogeneity agenda studies the effects of distributional changes on the aggregate economy. Different from the other two categories, micro-level distributional changes are taken as a source of aggregate shocks.[3] However, less structural efforts in this area play a large role in shaping contemporary understanding of the observed gaps in productivity and income across countries and economic sectors.[4]

[2]Published in the Journal of Banking and Finance in 2018.

[3]Being the most difficult to identify and analyze, structural work in this direction is more limited, focusing so far on the effects on aggregate economic performance of changes in income and wealth distributions across households and credit risk across firms (Chang, Chen, and Schorfheide (2018), Christiano, Motto, and Rostagno (2014)).

[4]*Misallocation* of resources across firms within the sector can for instance explain why agriculture in China and manufacturing in Mexico are less productive than agriculture and manufacturing in the United States. We also see that the disproportional allocation of the labor force towards less productive sectors, such as agriculture, explains the lower aggregate income levels of developing countries.

To this area belongs the third paper of this dissertation, entitled "The Role of Labor Market Frictions in Structural Transformation". It studies the large labor productivity gaps that persist across sectors in many developing economies as a result of stagnant structural transformation. Against what neo-classical growth models predict, this wedge between observed and optimal labor allocations suggests the presence of institutional and market frictions in the reallocation of labor from low to high productivity sectors, which lead to losses in aggregate labor productivity. The paper quantifies the size of these frictions and the role of structural reforms in stimulating the process of structural transformation.

The analysis answers these two points by estimating a dynamic panel error correction model using a panel of cross-country sector-level data. The model captures the dynamic adjustment of labor flows across sectors, and provides estimates of the size of the frictions impeding labor movement, as well as the success of structural reforms in alleviating them. I argue that policy reforms need to maneuver between the goal of easing job creation and destruction, while supporting labor incentives to reallocate through stronger social nets, labor protection and risk sharing.

In addition to its focus on the role of financial factors and micro-level dynamics in macroeconomic questions, the second main characteristic of my PhD work has been its reliance on *dynamic structural* models. These models aim to identify the effects of exogenous changes in the variable in question, while pinning down the economic agent's problem directly to allow for counter-factual scenarios and predictions. In other words, they model the *unchanging* structure and the deep parameters of the agent decision making process, and the mechanism by which specific surprise events (i.e. innovations) are transmitted to her optimal decisions. In the papers presented here, I make use of two main types of models: Heterogeneous agents dynamic equilibrium models and structural vector autoregression models.

Dynamic stochastic equilibrium models presuppose the economic environment and constraints surrounding agents and their optimization problem. Being quite elaborate on the dynamics and interaction of economic agents, this class of models provides a large degree of interpretability and allows for a wide range of policy simulations. However, as the modeled dynamics get richer, these models lose analytical tractability and require intensive computational efforts. Another shortcoming with typical dynamic equilibrium models is their struggle when met with the actual data they try to explain; that is, their more explicit modelling approach comes at the expense of well identified empirical estimation.

In this respect, structural vector autoregression (SVAR) models maintain an advantage, as they allow for tighter empirical estimation of the structural dynamic relations governing aggregate variables. Moreover, since they estimate the deep structure of the economy, not only simple correlations, SVAR models preserve the role of expectations in agents' decisions and are able to produce counter-factual simulations of macroeconomic scenarios. However, their more agnostic approach, i.e. their reliance on a simpler set of assumptions, comes at the cost of lesser interpretability and a narrower space for structuring of the data based on economic theory.

My work on the composition effects of credit easing is one showcase for the use of the two frameworks in answering a macroeconomic question. The paper analyzes the effects of aggregate credit easing policies on aggregate labor share. Ex-ante, neither the direction nor the magnitude nor the specific channels are known. Therefore, the analysis starts with an empirical assessment of these three unknowns, using an SVAR framework of the aggregate US economy, with a minimal set of inequality assumptions. The second part of the paper rationalizes the results and suggests specific channels that can explain the empirical results, using a dynamic equilibrium model of heterogeneous and financially constrained firms that uses a full set of assumptions on the economic behaviour of agents. The SVAR alone does not help us understand why the empirical relation between credit supply and the labor share are the way they are, and the equilibrium model alone lacks empirical, i.e. realistic, relevance.

The last element in the composition of my research is data. The papers presented here use aggregate, sectoral and cross-country variables within both dynamic time series and panel settings. This variance in data sources is typical of the research agenda this dissertation attempts to contribute to. While the individual papers discuss in details the data used in their respective empirical and descriptive analyses, one main and common point stands out and is worth mentioning here; that is, the methodological literature in econometrics on merging aggregate and disaggregate data, which are typically available at different frequencies, still lags behind the advancement in the solution and development of theoretical models.

As a result, there is a gap between the sophisticated predictions of state-of-the-art macroeconomic models on the one hand, and the extent to which these predictions can be supported by empirical evidence on the other. In two of my papers, I circumvent this challenge by carrying out estimation over multiple stages and aggregation techniques in order to identify aggregate innovations and match them to the disaggregated data. Nonetheless, in an ideal world, this type of questions need to be carried out within one larger system of equations, which is an area of ongoing intensive research.

The work presented here constitutes first steps into the important literature on heterogeneity in macroeconomics and finance, and the methodological technologies developed to analyze the challenges this literature posits. Moving forward, my research agenda aims at exploring other questions where micro-level dynamics can shed light on the evolution of the aggregate macroeconomy, while contributing to the methodological literature that can make this set of questions more accessible. In what follows, I present the three main papers of my dissertation, ordered in terms of the size of their contribution.

Summary

First Chapter The period of jobless and wageless growth that followed the great recession in the United States raises the question why expansionary credit policies were less effective for the recovery in employment and real wages in comparison to output. Using a structural time series analysis of the US credit and labor markets since 1965, I find that, indeed, credit supply expansions have been associated with a negative impact on the aggregate labor share. This paper offers one explanation that relies on the composition effects of credit expansion. I provide evidence that the pass-through of aggregate credit supply fluctuations to employment growth is stronger for industries that face higher borrowing costs. Firms in these industries prefer collateralizable capital to labor, and pay lower wages. Consequently, by increasing their share in total output and employment, the change in composition following an expansion in credit supply exerts negative pressure on the aggregate labor share. I build a dynamic model of heterogeneous firms and an aggregate financial sector, which accounts for the interaction between financial and labor market frictions. The model reproduces the negative composition effects of an aggregate credit supply expansion, and reconciles them with the positive within-firm effects predicted by models that abstract from the role of financial heterogeneity across firms. The paper, therefore, raises the concern that credit easing may not target firms that have strong potential to hire or pay high wages.

Second Chapter The paper estimates the dynamic impact of structural oil market shocks on the balance sheet of US firms, using industry level data covering manufacturing, trade and mining sectors. For manufacturing firms, findings indicate that an unexpected disruption in oil supply that raises oil prices by 1% lowers firm profits by 1.3% on impact. On the other hand, profits rise by 0.39% in response to the same increase in the price of oil, when it is driven by a positive movement in the global demand for oil, and by 0.79% after an unexpected surge in speculative oil demand. The positive balance sheet effect of speculative oil shocks on the manufacturing sector contrasts their negative effect on global economic activity. An explanation follows from the industry level analysis, which suggests that speculation in the oil market creates a ripple effect in downstream

industries and raises inventory demand for petroleum and chemical products. In contrast to its secondary role in explaining historical variations in the price of oil and profits in trade and mining sectors, oil supply shocks are found to have been the dominant oil market innovations in driving fluctuations in manufacturing firms' profits. The analysis also finds a limited response of production costs to exogenous changes in the oil price, disputing the classic notion that the cost share of oil in an industry determines its level of exposure to oil market shocks.

Third Chapter Large productivity gaps across sectors persist and the process of structural transformation is stagnant in many developing economies. This wedge between observed and optimal labor allocations reflects the presence of institutional and market frictions, which impose costs on the optimal reallocation of labor from low to high productivity sectors. Using a panel of cross-country sector-level data, I estimate a dynamic panel error correction model that captures the dynamics of sectoral labor flows. The model estimates provide a new set of stylized facts on the dynamics of the structural transformation process, and a measure of the magnitude of frictions facing labor flows. In addition, I analyze the contribution of labor regulations and reforms to the pace at which labor flows across economic sectors. Results suggest that policy reforms need to steer between the goal of easing job creation and destruction, while supporting labor supply incentives to reallocate through strong social nets, labor protection, and risk sharing.

Chapter 1

Jobless and Wageless Growth: The Composition Effects of Credit Easing

1.1 Introduction

The sharp decline in employment in the US and Europe during the great recession was followed by a period of near jobless growth as output growth recovered at a faster rate than growth in employment while growth in real wages stagnated (Calvo, Coricelli, and Ottonello (2012) and Schmitt-Grohé and Uribe (2017)). This pattern of recovery was associated with post crisis policies that relied mainly on easing the distress in the financial sector's balance sheet as means to restore growth in the real economy. Yet, their slower success with respect to employment and real wages relative to output growth raises the question: Could expansionary credit policies be partly responsible for the observed jobless and wageless recovery pattern?

Indeed, using structural time series analysis of credit and labor markets in the United States, I find that expanding credit supply negatively affects both aggregate labor intensity and the aggregate real wage. Since, these negative effects are the opposite of what firm-level theory predicts (Petrosky-Nadeau (2014)), this paper suggests an explanation that reconciles the firm level positive labor share effect of credit expansion with the aggregate negative response I find.

The intuition relies on the composition effects of aggregate credit supply fluctuations across the firm distribution. I find that the pass-through of aggregate credit supply fluctuations to investment and hiring decisions is stronger for industries that face higher borrowing costs, which coincides with lower levels of productivity and tangible assets.[1]

[1]Ottonello and Winberry (2018) find the opposite pattern for the transmission of monetary policy

Given their higher financing costs, firms in these industries prefer investment in collateralizable physical capital to labor (Jermann and Quadrini (2012)). In addition, they pay a lower wage per worker as their lower productivity and higher cost of financing diminish the surplus a filled job is expected to create (Michaels, Page, and Whited (2018)).

Therefore, expanding credit supply exerts negative pressure on the aggregate labor share by increasing the share in total output of firms that have lower labor intensity and pay lower wages. This novel *composition* or *between* channel takes place in parallel to the *within* or firm level channel that has typically been explored. I show that this mechanism is consistent with the empirical findings, as well as a dynamic model of heterogeneous firms and an aggregate financial sector, where the degree of financing costs vary across firms, while labor and financial markets frictions give rise to heterogeneous wages across the firm distribution.[2]

This argument rests on three complementary steps. I start by constructing an instrument of exogenous fluctuations in aggregate credit supply (i.e. structural credit supply shocks), estimated within a structural vector autoregression model (SVAR) of the joint dynamics of US output, labor, and credit markets. I introduce a novel *narrative* approach to the identification of credit supply shocks, implemented within a Bayesian sign restrictions framework (Kilian and Murphy (2014), Antolin-Diaz and Rubio Ramírez (2018)).[3] This identification approach ensures that the constructed instrument moves in the tightening direction during the key historical financial distress events that caused a balance sheet damage to the financial sector, limiting its risk appetite and ability to extend credit.

I find that credit expansion has positive persistent effects on aggregate output and employment levels, in contrast to its negative effect on aggregate labor intensity and the average real wage.[4] Decomposing the changes in aggregate labor intensity and the aggregate wage into *within* and *between* (i.e. composition) components, the negative aggregate responses could be a result of either: 1) a decline in labor intensity and compensations for all individual firms (i.e. the *within* channel), or 2) an increase in the share of firms that have lower labor intensity and pay lower wages (i.e. the *composition* channel).[5]

shocks. The reason is that monetary policy shocks affect the risk free rate in the economy, while our shock affects only the borrowing spread. The model I present in the second half of the paper makes this point clearer.

[2]The analysis focuses on the relation between credit supply and firm borrowing constraints. Credit supply can also affect firms through its effects on aggregate consumption, especially household spending, see Mian and Sufi (2014). Accounting for these effects affects neither the empirical results nor the main intuition of the paper.

[3]Kilian and Murphy (2014) and Antolin-Diaz and Rubio Ramírez (2018) use the narrative approach to identify oil market and monetary policy structural shocks, respectively.

[4]The negative effects on labor intensity are in the short run in contrast to the effect on the aggregate real wage which is persistent.

[5]The response of inflation under nominal wage rigidity could be another reason that lies outside the

However, the first channel goes against the documented empirical evidence, which points out that a healthier credit supply is associated with strong firm level employment effects (e.g. Chodorow-Reich (2014)), and lower borrowing costs are associated with higher firm level labor compensation (e.g. Klasa, Maxwell, and Ortiz-Molina (2009), Matsa (2010), Benmelech, Bergman, and Enriquez (2012), Michaels, Page, and Whited (2018)).

In the second part of the paper, I examine the second channel, exploring the dimensions over which the composition of the firm/industry cross-section changes in reaction to exogenous shifts in credit supply. Specifically, I look at whether the exposure of a firm to credit market fluctuations correlates positively with the effective relative price of labor that it faces (i.e. its propensity to prefer capital investment over hiring), and negatively with the labor wage it pays (i.e. expected labor productivity). If these two correlations are supported by the data, then we could expect expansionary movements in credit markets to result in output growth that is supported more by capital investment and less by hiring, and that creates jobs that pay lower wages than the aggregate wage.

To answer this point, I use the SVAR implied time series of exogenous movements in aggregate credit supply along with a long quarterly panel that matches US industry level data for employment, wages, job flows (openings, expansions, closings and contractions), and balance sheet variables. For the relative price of labor, I use financing costs as proxy; since firms rely on liquidity (i.e. cash holdings or working capital) to finance their labor stock before production is complete (Calvo, Coricelli, and Ottonello (2012), Jermann and Quadrini (2012), Bacchetta, Benhima, and Poilly (2015)), higher financing costs make labor relatively more expensive compared to capital; capital is its own collateral while labor carries no collateral value.

I find that in reaction to credit supply expansion, industries that face higher borrowing costs, and pay lower wages will hire and retain more workers; furthermore, the decline in aggregate real wage is even stronger in industries that hire and retain more workers. Across job flows, the positive employment effect appears to be driven more by the decline in job contractions and closings, in contrast to a weaker and less statistically significant response of job creation.[6] Putting them together, these results suggest that the composition effects could explain how credit expansion may give rise to a pattern of jobless and wageless growth, when the negative effects of the between channel dampen aggregate labor market growth.[7] They also confirm a significant role of borrowing and liquidity

scope of this paper; see Schmitt-Grohé and Uribe (2017).

[6]This result argues against propositions that restricting credit supply reduces employment mainly by constraining the number of new jobs (Mehrotra and Sergeyev (2016)). It also raises concerns on approaches that model financial shocks as shocks to continuation or entry costs (e.g. Khan and Thomas (2013))

[7]The result with regards to job flows is also in line with this conclusion; given that contracting and

constraints in the propagation of financial sector disruptions.[8]

The third and last part of the paper connects the empirical results in a theoretical framework that rationalizes and reproduces both the *within* and *between* effects. Specifically, it explains why credit expansion could contribute to a wider gap between *aggregate*(i.e. average) investment and hiring rates, while exerting negative pressure on the aggregate real wage. I build a dynamic equilibrium model of heterogeneous firms and a banking sector with endogenous default, where both types of agents are financially constrained and subject to balance sheet shocks that affect their borrowing costs (Bernanke, Gertler, and Gilchrist (1999), Gertler and Kiyotaki (2010), Gertler and Kiyotaki (2015), Hirakata, Sudo, and Ueda (2017)).

The second ingredient to the model is that labor wages must be paid before returns from production are realized. This payment schedule creates dependency between wages and today's available funds, thus implying that the expected return on an extra worker correlates with the cost of external financing used to hire her; that is, financing costs change the relative prices of labor and capital, making the latter cheaper for firms facing higher borrowing costs (Jermann and Quadrini (2012) and Calvo, Coricelli, and Ottonello (2012)). In addition, I introduce labor market frictions and make wage setting endogenous at the firm level, which gives rise to a distribution of heterogeneous wages across firms. Over this distribution, firms with higher financing costs and credit risk pay lower wages to their labor stock (Quadrini (2011), Petrosky-Nadeau (2014) and Michaels, Page, and Whited (2018)). These three ingredients could explain how a positive shock that arises in the financial sector balance sheet could bring about jobless and wageless growth as a result of composition effects.

Related literature The paper contributes to both the empirical and theoretical literature on the interaction between labor and credit markets. In addition to being the first to highlight the negative effects of credit expansion on aggregate labor share, it is to my knowledge the first detailed aggregate time series study of the effects of financial sector fluctuations on the labor market. Hristov, Hülsewig, and Wollmershäuser (2012), Eickmeier and Ng (2015), and Gambetti and Musso (2017) estimate the time series effects of financial shocks within an SVAR framework as well; yet, their focus is not on labor market responses and they do not explore the transmission and disaggregate dynamics.

With respect to identification, the analysis is the first to bring the *narrative* approach to

exiting firms are typically more financially constrained, less liquid and less productive, the jobs they retain, as they survive on credit supply expansion, are low productivity jobs.

[8]The result complements Mian and Sufi (2014) who find no significant evidence that borrowing constraints played a role in the 2008 decline in employment.

the study of the causal effects of aggregate financial sector fluctuations; see Kilian and Murphy (2014) and Antolin-Diaz and Rubio Ramírez (2018) for applications in identifying structural oil market and monetary policy shocks.

Moreover, by incorporating the information available over the time dimension, the paper complements studies that rely on single events to study the causal link between credit supply and labor markets (e.g. Chodorow-Reich (2014), Mian and Sufi (2014)). Estimates from the SVAR model also provide a more agnostic benchmark (Canova and Sala (2009)) for DSGE models that fit aggregate data to study similar questions, (e.g. Jermann and Quadrini (2012), Zanetti (2015), and Mehrotra and Sergeyev (2016)).

On the other hand, the novel contribution of the theoretical framework presented here versus Michelacci and Quadrini (2005), Quadrini (2011), Petrosky-Nadeau (2014) Quadrini and Sun (2015) and Michaels, Page, and Whited (2018) is to show the *aggregate* labor market implications of the interaction between labor and financial frictions across the firms distribution, when a turbulent financial sector is introduced; more specifically, the analysis here is the first to analyze the *composition* effects that are brought about by the heterogeneous impact of credit supply disruptions across the firm distribution.

More generally, the paper also contributes to the evolving literature on heterogeneity in firm growth and response to aggregate fluctuations (e.g. Davis and Haltiwanger (2001), Mitra (2018), Haltiwanger, Jarmin, and Miranda (2013), Ottonello and Winberry (2018)).

Outline The paper proceeds as follows. Section two discusses the empirical framework and results for the aggregate and disaggregate estimations. Section three presents the theoretical framework and discusses its dynamics and simulations. Section four concludes.

1.2 Empirical Framework

The first goal of the paper is to construct a measure of exogenous credit supply fluctuations and quantify the magnitude of their causal effects on the labor market. However, because aggregate variables such as loan volume, interest rates and bond spreads are jointly driven by shifts in credit supply and demand factors, these variables share both simultaneous and dynamic dependencies; thus, an instrument is needed in order to identify *exogenous* fluctuations in credit supply.

An SVAR model can account for such common dependencies over a long number of lags to distinguish between expected and unexpected components in the time series of aggregate variables. Moreover, by incorporating elements from economic theory to impose plausible economic assumptions on the effects of an exogenous change in credit supply, the model can break down the unexpected component to the *independent* time series of credit supply and demand shifters. That is, the SVAR implied series of *exogenous* fluctuations in credit supply is *orthogonal* to other structural drivers in the economy that affect demand for credit, including consumption, technology and monetary policy fluctuations.[9]

In addition, examining causal relations within an SVAR model has an advantage over other empirical strategies as it uses all available time series information without imposing restrictions on the dynamic dependency of the endogenous variables. It is also relatively simpler with respect to the assumptions it imposes on the structure of the data generating process and parameters priors compared to large equilibrium macro models (Canova and Sala (2009)).

Nonetheless, despite the advantages of the SVAR models, its ability to explain the transmission dynamics is limited. I overcome this concern, in the second part of the empirical analysis, by feeding the SVAR implied time series of credit supply shocks into a series of panel estimations (Kilian (2009), see also Buetzer, Habib, and Stracca (2012) and Herrera and Rangaraju (2018)). These second stage estimations explore the interaction between aggregate shocks and the cross-section of industry level wages and job flows.

1.2.1 An SVAR model of US credit, output and labor markets

Variables description and specification

The structural process governing US credit, output and labor markets dynamic interaction is assumed to follow a linear structural vector autoregression model. $\mathbf{Y_t}$ is a vector of ten *quarterly* endogenous variables that describe the three markets: 1) real business and commercial loans volume (log-level); 2) the BAA spread over the 10 years treasury bond (level); 3) long term interest rate, proxied by the 10-Year treasury constant maturity rate (level); 4) real GDP (log-level); 5) quarterly inflation (level); 6) fixed private investment, net of depreciation (log-level); 7) capacity utilization (level); 8) total US non-farm employees (log-level); 9) private average weekly hours of production and non-supervisory employees (log-level); 10) private average hourly earnings of production and non-supervisory jobs (log-level). The sample period is 1965:Q1 - 2019:Q1.[10]

The choice of credit market variables is motivated by the sign restrictions identification strategy to distinguish between demand and supply shocks. Therefore, I include a quantity variable (credit volume) and a price variable (bond spread). In addition, I include

[9] In that sense, the measure I use here is different from other financial distress indices (e.g. Gilchrist and Zakrajšek (2012))

[10] The results remain robust to using the sub-sample 1984:Q1 - 2008:Q2.

the interest rate to distinguish between credit supply and other interest rate shocks (e.g. shocks to monetary policy and the exchange rate); expansionary credit supply and interest rate shocks shift the credit supply curve in the same direction, but have opposite effects on the interest rate. The second block of variables constitutes an aggregate production function, whereby output is a function of labor and capital, over their intensive and extensive margins (capacity utilization and average hours).

The SVAR takes the following structural form,

$$\mathbf{A_0}\mathbf{Y}_t = \sum_{i=1}^{4} \mathbf{A}_i \mathbf{Y}_{t-i} + \epsilon_t \tag{1.1}$$

where all variables are allowed to have dynamic interdependency up to 1 years (4 quarters lags) and a constant term is included but suppressed for notational convenience. The number of lags is chosen to make the model specification compatible to standard aggregate SVAR models.[11]. $\mathbf{A}_0$ and $\mathbf{A}_i$ describe the contemporaneous and dynamic relations, respectively, between the system variables. ϵ_t is a vector of structural shocks with a *diagonal* covariance matrix $\mathbf{\Omega}$. I estimate this quarterly 10-D SVAR(4) model within a Bayesian framework, with diffuse Normal-inverse Wishart priors.[12]

Identification by sign restrictions

Sign restrictions are a natural candidate for the identification of supply shocks; by imposing simple prior *inequality* constraints on the impulse responses of quantities (i.e. loan volume in our application) and prices (i.e. bond spreads), we can differentiate between the effects of exogenous supply and demand shifters in the credit market: a tightening credit supply is expected *a priori* to lower credit volume and raise bond spreads, while a contraction in credit demand lowers both spread and quantity.

The model is partially identified, meaning that, in addition to credit supply shocks, I identify a single generic credit demand shock. Although we are only interested in the role of the credit supply shocks, as Canova and Paustian (2011) and Kilian and Murphy (2012) discuss, it is still important to impose all available prior economic knowledge, even on the other structural shocks. Adding this extra structure shrinks the uncertainty around the estimates; see Kilian and Lütkepohl (2017) for a detailed discussion of the

[11]Statistical information criteria suggest a lower number of lags. The main results remain unchanged when using 2 or 8 lags

[12]This choice of priors minimizes the effect of the inclusion of subjective information on the posterior estimates. In addition, since output, labor, and credit markets are highly entangled with potentially sticky dynamics, I opt not to use a Minnesota (Litterman) prior, which imposes prior assumptions on the dynamic and cross relations between the variables that may not be well founded in this context.

sign restrictions approach.

With respect to the form of sign restrictions I apply, in addition to imposing impact inequality restrictions, similar to Hristov, Hülsewig, and Wollmershäuser (2012), Eickmeier and Ng (2015), and Gambetti and Musso (2017), I introduce novel *narrative* restrictions. These restrictions ensure that the constructed series for credit supply and demand shocks moves in the tightening direction during the key historical financial distress events that caused a balance sheet damage to lenders and borrowers, limiting their risk appetite and risk bearing capacity. The narrative approach plays a large role in the monetary and fiscal policy literature (e.g. Romer and Romer (1989), Romer and Romer (2004), Ramey (2011)), and was introduced into the sign restrictions framework by Kilian and Murphy (2014) and by Antolin-Diaz and Rubio Ramírez (2018) for an application in the oil market and Zeev (2018) in the identification of news shocks. This paper is the first to use it in the context of identifying credit market shocks.

Impact restrictions

Table 1.1 summarizes the sign restrictions imposed on impact. An expansionary credit supply shock is defined as aggregate exogenous change that lowers bond spreads and stimulates both loan volume and economic activity, triggering an increase in both inflation and the real interest rate.[13] The response of real wages is ambiguous because of two competing forces: on the one hand, the rise in labor demand exerts upward pressure on labor compensations and, on the other hand, the higher inflation after the shock pushes real wages down.

The second column refers to the impact restrictions of positive credit demand shocks. Demand shocks in the credit market are any exogenous aggregate fluctuations that drive an increase in demand for credit. These aggregate innovations include aggregate demand and investment opportunities shocks as well as transitory aggregate supply shocks that may opt producers to smooth their returns by borrowing. Therefore, we only impose the prior knowledge with regards to the impact of these shocks as demand shifters in the credit market.

Narrative restrictions

Large financial losses, which follow unexpected bankruptcy events or market valuation disturbances, cause balance sheet (i.e. net worth) distress at both the firm as well as the financial sector sides. As a result, credit markets experience a deterioration of the risk-bearing capacity and risk appetite of both lenders and borrowers, which discourages

[13]see Gambetti and Musso (2017) for a summary of the responses predicted by a set of standard macro-finance DSGE models.

Table 1.1: SVAR impact sign restrictions

	Pos. credit supply shock	Pos. credit demand shock
Real loan volume	+	+
Bond spread	−	+
Real long-term interest rate	+	Unrestricted
Real GDP	+	Unrestricted
Inflation	+	Unrestricted
Real fixed investment	+	Unrestricted
Utilization	+	Unrestricted
N. Employees	+	Unrestricted
Average weekly hours	+	Unrestricted
Real average wage	Unrestricted	Unrestricted

both demand and supply of credit (Bernanke, Gertler, and Gilchrist (1999), Gertler and Kiyotaki (2010), Gilchrist and Zakrajšek (2012)). Over the time period of the sample, such unexpected events could be interpreted as exogenous credit supply and demand shifters and, therefore, should map to the shock series we aim to identify. In other words, these historical events provide additional prior information that takes the form of negative restrictions on the identified time series of credit supply and demand shocks at the points in time the events took place.

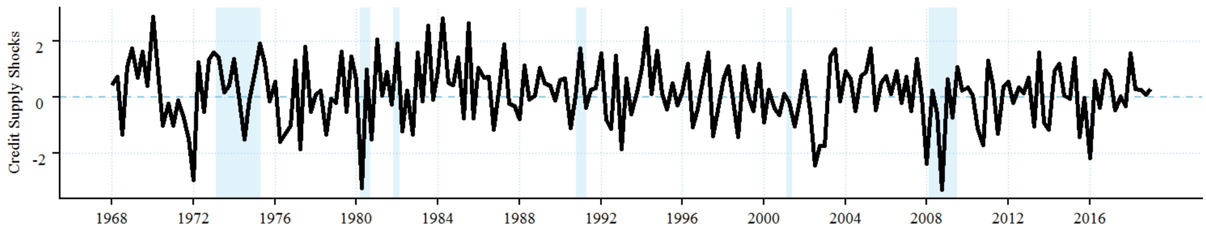
The identifying events need to have had an unexpected component, caused balance sheet damage to the aggregate financial and non-financial sector in the US, and not been accompanied by other unexpected events that had stronger and opposite effects. I apply this intuition to a total of five unexpected stock and credit market crashes, during which the balance sheet of the financial and corporate sectors must have incurred some damage due to actual losses in assets, losses in market valuation of asset holdings, decline in returns (due to weaker demand), or simply confidence losses.

1. August 2015: the global stock market sell-off (Chinese Black Monday) caused major losses in Western and Asian financial markets. The Dow Jones index fell by 7.6% between August 18^{th} and 21^{st}, while the Shanghai composite loss was over 15 %. In addition, oil prices fell by 16% during this month and many Asian currencies had to significantly depreciate.

2. September 2008: Lehman Brothers collapsed with asset holdings over 600 billion USD; it was the largest bankruptcy in US history, triggering the financial crisis and the great recession.

3. September 2001: the US experienced its most violent terrorist attacks, which caused widespread turbulence in financial markets and 40 billion USD in insurance losses.

Figure 1.1: Quarterly time series of aggregate credit supply shocks



The plots present the identified quarterly aggregate credit supply shocks, using the *modal* model estimates, see Inoue and Kilian (2013). The *modal* model estimate of the time series of credit supply shocks is highly correlated with the rest of the models in the admissible set: For a total of 305 admissible models, the distribution of correlation values has the following characteristics: 1^{st} quartile: 0.73; median:0.78; mean: 0.75; 3^{rd} quartile: 0.82.

In addition, the Dow Jones index fell by 7.13 % in reaction once trading resumed.

4. April 2000: the Dot Com bubble imploded, causing around 1.755 trillion USD losses in market value.

5. October 1987: the Black Monday crash caused Dow Jones to fall by 22.6%.

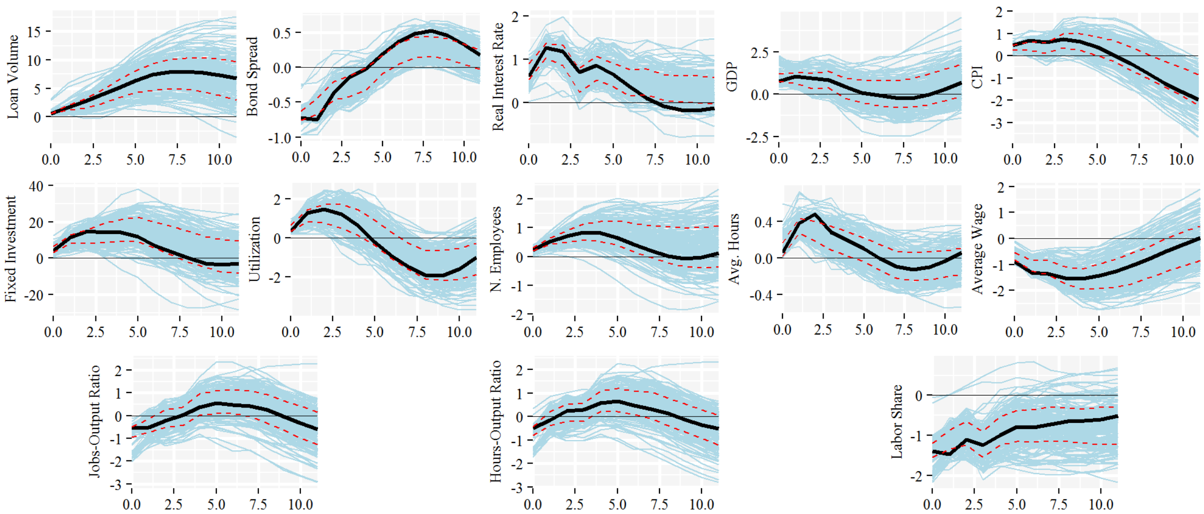
These dates specify an additional set of filters that I impose on the set of admissible models identified by impact sign restrictions. For each of these models (i.e. for every admissible set of $\mathbf{A}_i$ and $\mathbf{\Sigma}$ matrices), the narrative restrictions algorithm works by computing the implied time series of the credit supply shocks associated with it, and filtering out models that do not yield negative shocks on these specific dates.[14]

1.2.2 Discussion: Aggregate effects

Figure 1.1 plots the time series of the identified quarterly credit supply shock (using the modal model estimates, see Inoue and Kilian (2013)) and figure 1.2 reports the impulse response functions to an unexpected easing in credit supply. The responses reflect an expansionary effect, where a shock of the magnitude that lowers bond spreads by one standard deviation (0.72%) on impact, leads to an increase in real GDP and number of employees, peak at about 1% above their pre-shock levels. However, the average real wage declines to a trough of -1.6%. Fixed investment shows the highest sensitivity to credit supply fluctuations with a peak effect reaching 17%. The response to the shock takes place at the intensive margin as well. Both capacity utilization and the average weekly hours rise, peaking at around 1.5% and 0.45%, respectively.

[14]The narrative restrictions help shrink the uncertainty of the estimates; as a robustness test, I estimate the model with only the events of 2008 Lehman crash and 2001 attacks; the estimates are more uncertain but are qualitatively the same.

Figure 1.2: Structural impulse responses to an expansionary credit supply shock



The plots present the *modal model* (thick black line) and models in the 68% joint regions of highest posterior density (blue hairlines), see Inoue and Kilian (2013). The red dashed lines are estimates of the 68% *point-wise* posterior credible sets. The shock is scaled to produce one standard deviation decline in the bond spread on impact. Responses of bond spread and utilization represent differences in levels, where the levels of the two variables are in percent. The remaining responses of the first two rows are differences in log-levels (i.e percentage differences). Jobs-output ratio response is the difference between the responses of n. employees and GDP. Hours-output ratio is the difference between the response of *total* hours, defined as the sum of n. employees and avg. hours responses, and the response of GDP. The response of the labor share is the sum of total hours and average wage responses minus the response of GDP.

More interestingly, comparing the responses of employment, average hours and the average wage to output reveals a negative impact on the aggregate labor share, which is more intensified in the short-run. This decline in the labor share is driven primarily by a decline in the average wage as well as a short-run decline in labor intensity in production (labor to output ratio). Hence, the results are consistent with the initial hypothesis laid out: credit supply expansion contributes to the jobless and wageless growth pattern observed over the business cycle in aggregate output and labor markets.

These results are particularly interesting because they go against the firm level empirical and theoretical reasoning, which predicts that lowering financing costs should result in 1) higher demand for labor, as the effective relative price of labor declines (Jermann and Quadrini (2012), Calvo, Coricelli, and Ottonello (2012)), and 2) an increase in wages, as the expected surplus workers create increases (Michelacci and Quadrini (2005), Michaels, Page, and Whited (2018)). On the other hand, since it is not clear why the indirect aggregate demand effects of expanding aggregate credit supply could affect the relative price of factors of production, these demand effects cannot explain the negative response of the labor share.

The next section explores the composition effects over the cross section of firms, in order to reconcile the result of negative aggregate labor share effect with the evidence on positive firm-level effect. That is, it tries to answer the question: even though credit supply stimulates employment and wages at the firm level, could the composition of the firm distribution change such that aggregate employment and wage growth is subdued?

1.2.3 Inspecting the mechanism: Disaggregate effects

The composition effects of aggregate credit supply fluctuations

This part of the analysis aims to explore the dimensions over which the composition of the firm distribution changes in reaction to exogenous shifts in credit supply. Since the aggregate labor intensity and aggregate wage are simply the weighted averages of their respective values at individual firms or industries i, composition effects can be important if heterogeneity in the cross sectional effects is not random. Formally,

$$\text{Aggregate Labor Intensity} = \sum_i w_i \times LI_i \tag{1.2}$$

$$\text{Aggregate Wage} = \sum_i w_i \times Wage_i \tag{1.3}$$

$$w_i \equiv \frac{Output_i}{\sum_i Output_i} \tag{1.4}$$

$$LI_i \equiv \frac{Employment_i}{Output_i} \tag{1.5}$$

and the change in aggregate labor intensity in reaction to an aggregate credit supply shock can be decomposed into,

$$\Delta\text{Aggregate Labor Intensity} = \overbrace{\sum_i w_i^0 \times \Delta LI_i}^{\text{within effect } (+)} + \overbrace{\sum_i \Delta w_i \times LI_i^0}^{\text{composition effect } (-)} + \overbrace{\sum_i \Delta w_i \times \Delta LI_i}^{\text{interaction } (+)} \tag{1.6}$$

$$\Delta\text{Aggregate Wage} = \overbrace{\sum_i w_i^0 \times \Delta Wage_i}^{\text{within effect } (+)} + \overbrace{\sum_i \Delta w_i \times Wage_i^0}^{\text{composition effect } (-)} + \overbrace{\sum_i \Delta w_i \times \Delta Wage_i}^{\text{interaction } (+)} \tag{1.7}$$

where w_i^0 and LI_i^0 are the shares and firm labor intensity *prior* to an exogenous increase in credit supply, respectively. The decomposition breaks the change in aggregate labor intensity to *within*, and *cross* firms (or industries) changes as well as an *interaction* term. Corollary 1 in section 1.3.3 below discusses this decomposition in details and explains the motivation behind the suggested signs in light of the theoretical model. For our purposes at this empirical stage of the analysis, it suffices to point out that our interest in the rest of the empirical part of the paper lies in analyzing the *composition* effects embodied in the second term.

That is, we are interested in examining whether the effect of movements in credit supply, on a firm or an industry share in total output, Δw_i, correlates negatively with its individual labor intensity,LI_i^0, and wage, $Wage_i^0$. More specifically, in what follows I explore the correlation between a firm's propensity to grow in reaction to credit supply expansion, on the one hand, and the effective relative price of labor it faces and the labor wage it pays, on the other hand. If these two correlations are supported by the data, then we could expect the effect of expansionary movements in credit markets on output growth to be stronger than their effects on growth in the aggregate labor intensity and wage, due to the negative influence of the composition term.

A panel of industry level employment, job flows, wages, and balance sheet variables

To explore the composition effects and the transmission mechanisms of credit supply shocks to labor markets, I construct a panel of US *quarterly* job flows, employment, wages, and balance sheet variables at the 3-digit NAIC industry level. For employment and wages, I use the Quarterly Census of Employment and Wages (QCEW) database. QCEW is reported by employers and covers more than 95 percent of US jobs. For job flows, I use the Business Employment Dynamics (BED) database from the Bureau of Labor and Statistics. The data is generated from the Quarterly Census of Employment and Wages program and provides estimates of job flows by type (openings, expansion, closings and contractions).

Finally, for the balance sheet variables, I use the Quarterly Financial Report (QFR) from the US Census Bureau. It is a quarterly survey that covers around 10,000 US firms and presents estimated statements of earnings, balance sheets, and related financial and operating variables for manufacturing, services, and trade firms.

The purpose of the panel is to explore the disaggregate effects of the financial sector shocks across industries and job flows, while using industry level interaction terms to find out the determinants of the heterogeneity observed across these disaggregate effects. I run the estimations that do not require balance sheet variables on the larger QCEW and BED samples, which extends over the 1992:Q3-2017:Q3 period with 98 time observations for 86 industries. Due to the narrower coverage of the QFR, when balance sheet data enters the econometric specification, the sample becomes unbalanced and shrinks to the period 2000:Q4-2017:Q3, covering 25 industries. Table 1.2 reports summary statistics for the panel variables used in the analysis.

Heterogeneity across sectors

Before testing the dynamics that determine the composition effects suggested by the paper, I start by exploring the degree of dispersion across economic sectors with respect to their responses to aggregate credit supply shocks. I estimate the following simple regressions, where the LHS are net job flows and average real wages for industry i within sector j at time t. Sectors are determined based on the first 2-digit of an industry NAIC classification. Net job flows are the difference between gross job gains and losses, while average wages are computed as the total wage bill divided by total number of employees each quarter.

On the RHS, $\epsilon_t^{CreditSupply}$ is the time series of SVAR implied credit supply shocks (using the modal model estimates, see Inoue and Kilian (2013)), normalized by its standard

Table 1.2: Summary statistics of the disaggregate industry-level panel

Variable	Min.	1st Quart.	Median	Mean	3rd Quart.	Max.	Std.
Net job flows (thous.)	-343.292	-2.051	0.975	3.739	7.470	261.957	21.820
Gross job losses (thous.)	0.622	16.397	44.548	84.233	97.986	945.617	128.353
Gross job gains (thous.)	0.802	16.332	45.212	87.971	101.638	937.036	136.870
Closings (thous.)	0.060	2.442	7.328	16.502	18.034	224.562	28.213
Contraction (thous.)	0.146	13.798	35.725	67.731	78.029	803.090	101.458
Expansions (thous.)	0.147	13.736	36.944	70.244	81.008	776.692	105.473
Openings (thous.)	0.089	2.248	7.236	17.727	18.657	264.859	33.084
Avg. wage	716.7	2223.2	3222.9	3753.6	4594	30030.3	2357.21
Fixed assets	0.119	0.293	0.504	0.489	0.646	1.011	0.217
Total liabilities	0.330	0.509	0.587	0.579	0.646	0.811	0.091
Current liabilities	0.063	0.167	0.209	0.207	0.246	0.337	0.051
Sales	0.075	0.153	0.242	0.262	0.328	0.761	0.136
Operational income	-0.013	0.013	0.019	0.019	0.023	0.044	0.008

The table reports summary statistics of industry level data used in the disaggregate analysis, as described in section (1.2.3). Non-balance sheet data are based on QCEW and BLS panels and cover 86 3-digit NAICs industries and 98 quarterly time observations over 1992:Q3-2017:Q3. The series for gross job flows are plotted in figure 1.3. Balance sheet data are based on the QFR unbalanced panel and covers 25 industries over the 2000:Q4-2017:Q3. Average real wage is in levels (wage bill/employment). All balance sheet variables are ratios over total assets.

deviation; figure 1.1 plots the series prior to normalization. SIC sector$_j$ is a dummy for the respective sector; η_i is the industry fixed effect,

$$\begin{aligned}&\text{Net Job Flows}_{i,j,t} = \\ &\quad \beta_1 \text{Net Job Flows}_{i,j,t-1} + \beta_2 \epsilon_t^{CreditSupply} + \beta_3 \{\text{SIC sector}_j \times \epsilon_t^{CreditSupply}\} + u_{i,j,t}\end{aligned} \tag{1.8}$$

$$\begin{aligned}&\text{Avg. real wages}_{i,j,t} = \\ &\quad \beta_1 \text{Avg. real wages}_{i,j,t-1} + \beta_2 \epsilon_t^{CreditSupply} + \beta_3 \{\text{SIC sector}_j \times \epsilon_t^{CreditSupply}\} + u_{i,j,t}\end{aligned} \tag{1.9}$$

The findings in table 1.3 reveal a wide dispersion in the magnitude of sectors reaction to credit supply shocks, with respect to both net job flows and average real wages. The job flows result falls in line with our hypothesized intuition and indicates that credit easing policies alter the relative shares of employment *across* sectors by supporting job creation/retention in different sectors with different degrees.

Similarly, table 1.3 reveals that the negative response of average wages also takes place at the disaggregate level. Within the composition hypothesis, these negative signs imply that the composition effects do not only take place across industries, but also within industries at the firm level. In this respect, the significant sector dummies with regards to the average wage responses indicate that credit market conditions affect the distribution of jobs *within* sectors by varying degrees. This distinction between cross and within effects based on job flows and wage responses will prove to be useful for the subsequent discussion. Next, I move to test the empirical relevance of the two correlation patterns, discussed earlier, which are required to explain the potential causal link between credit expansion and jobless/wageless growth.

Financial heterogeneity and the transmission of the aggregate shock

Borrowing costs are one proxy of the relative price of labor, which we could also expect to be a determinant of the pass-through of credit supply movements across firms; since firms rely on liquidity (i.e. cash holdings or working capital) to finance their labor stock before production is complete (Calvo, Coricelli, and Ottonello (2012), Jermann and Quadrini (2012), Bacchetta, Benhima, and Poilly (2015)), higher financing costs make labor relatively more expensive compared to capital; this is because the latter is its own collateral while labor carries no collateral value.

To proxy for the level of financing costs an industry faces, I use the ratio of total current liabilities to total assets, which captures the interest expenses and other short term obligations (with maturity less than one year) firms have to pay within an industry. Therefore, between two industries that are similar in their degree of long term solvency, revenues, proftitability and size, the level of current liabilities provides a measure of how financially risky an industry is from the lenders' perspective and how dependent it is on liquidity in the financial sector. I estimate the following specification for industry i at time t.

$$\begin{aligned}\text{Net job flows}_{i,t} = \\ &\beta_1 \text{Net job flows}_{i,t-s-1} + \beta_2 \epsilon_{t-s}^{CreditSupply} \times \log\{\text{Current liabilities}\}_{i,t-s-1} + \\ &\beta_3 \log\{\text{Current liabilities}\}_{i,t-s-1} + \beta_4 \epsilon_{t-s}^{CreditSupply} + \\ &\beta \mathbf{Z_{i,t-s-1}} + \mathbf{u_{i,t}} \qquad (1.10)\end{aligned}$$

$Z_{i,t} \equiv \{$ log{Avg. real wages}; log{Sales}; log{Operational income}; log{Total liabilities}; log{Fixed assets}; log{Total assets }; log{N. employees } $\}$

Importantly, $\epsilon_t^{CreditSupply}$ is exogenous to net job flows (LHS), not serially correlated, and orthogonal to other aggregate shocks, which saves us the need to control for other dynamics, aggregate variables, or time fixed effects. Table 1.4 reports the results for the estimation of equation (1.10) for different lag values s, using industry fixed effects and both industry and time fixed effects.

I find an important role for the degree of borrowing constraints in the transmission of aggregate credit supply disruptions, $\epsilon_{t-s}^{CreditSupply} \times log(CurrLiab)_{i,t-s-1}$; the higher is the value of current liabilities assets of an industry, the larger is employment growth in response to credit supply shocks: between two similar industries that differ by 1% in their current liabilities, net job flows of the more liable industry are 4165.65 jobs higher in reaction to one standard deviation positive expansion in credit supply. These findings, which supplement Mian and Sufi (2014) findings, suggest that output growth in periods of credit expansion is more likely to be jobless since it is disproportionately more driven by firms that face higher financing costs; these firms value physical capital more than labor and are more likely to have a lower labor intensity in production.

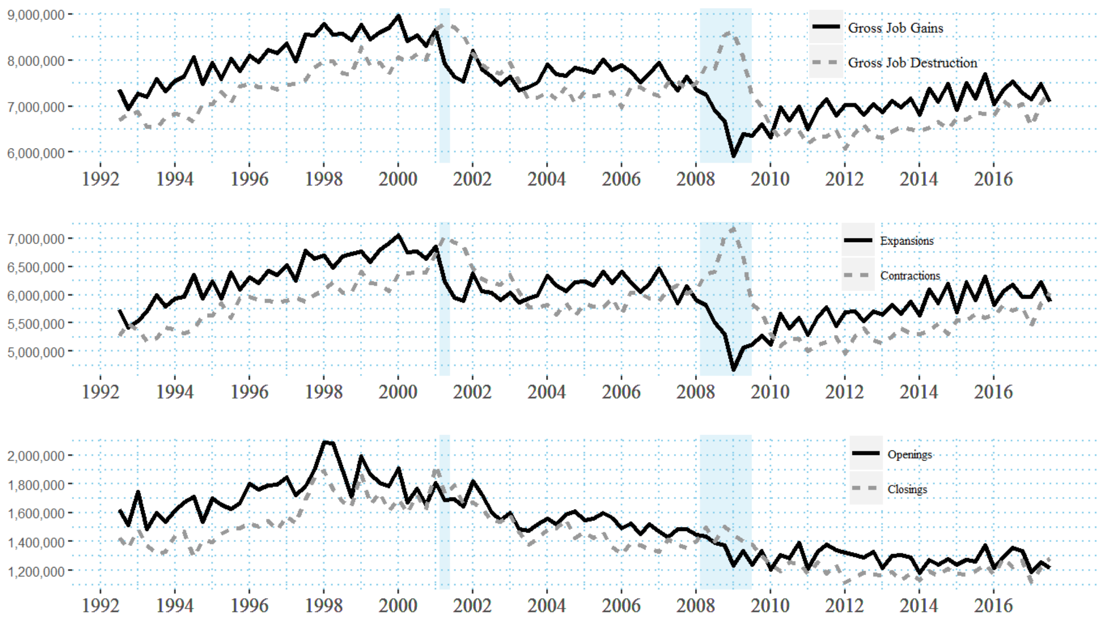
Does heterogeneity in labor productivity matter? The second correlation we need to examine in order to verify the composition mechanism suggested by the paper is between the level of labor productivity within an industry and its propensity to hire or retain workers in response to credit expansion. I estimate the following specification,

$$\begin{aligned}\text{Net job flows}_{i,t} = \beta_1 \text{Net job flows}_{i,t-s-1} + \\ \beta_2 \epsilon_{t-s}^{CreditSupply} \times \log\{\text{Avg. real wages}\}_{i,t-s-1} + \\ \beta_3 \log\{\text{Avg. real wages}\}_{i,t-s-1} + \beta_4 \epsilon_{t-s}^{CreditSupply} + u_{i,t} \quad (1.11)\end{aligned}$$

The average real wage is the deflated total quarterly wage bill divided by the total number of employees for industry i at time t. Table 1.5 reports the estimation results; our interest is in β_2 of the interaction term between exogenous aggregate credit supply movements and average labor productivity at the industry level. The figures indicate that industries paying higher average real wages, hire considerably less in response to an exogenous easing in credit supply: between two industries that differ in their average real wage by 1%, the net job flows of the higher pay industry is 976.53 jobs less in response to one standard deviation positive shock to aggregate credit supply. Thus, by increasing the number of workers employed in industries or firms that pay lower than the mean wage, credit expansion could exert a negative pressure on the aggregate average wage, despite the rise in output (i.e. wageless growth).

Heterogeneity across job flows Next, I examine whether there is an asymmetry in the respective roles of job creation and destruction in accounting for the dynamic adjustment of employment to credit supply disruptions. The purpose of the exercise is to see whether the rise in net job flows is a result of new jobs being created or old jobs being retained, which could shed light on the type of firms that are most affected. Job creating firms are typically in a growth state, meaning that they are less likely to be facing high financing costs, compared to firms that retain old jobs, but do not necessarily

Figure 1.3: Job flows in levels by type, from the Business Employment Dynamics dataset.



create new ones. In addition, created jobs have more competitive wages that reflect in part the aggregate economic outlook of the labor market. The mechanism suggested by the paper would predict the magnitude of credit expansion effect on job creating firms to be smaller than its effect on job destroying firms, because the latter is more likely to be facing higher financing costs. If that is indeed the case, then it also follows that we should expect credit expansion not to be very effective in raising aggregate wages.

Figure 1.3 plots US job flows by type over the intensive and extensive margins of firm distribution (expansion, contraction, openings and closings). Two relevant observations stand out: First, the extensive margin of job flows matters: out of the 8.613 million jobs destroyed in the first quarter of 2009, 1.5 million jobs (17.4 %) were lost by exiting firms. Second, between 2009 and 2010, the number of jobs lost due to firm contractions declined at a faster rate than the number of job expansions. By the third quarter of 2009, gross job destruction rebounded to a lower level than 2007 and continued to decline to reach its lowest level over the 1992-2017 period in the first quarter of 2012. This fast rebound is in contrast to the slow recovery of job gains that did not reach its pre-crisis level until 2015. That is, the slow recovery of employment after the crisis was driven primarily by the slow growth of the number of expanding firms.

Given that quantitative easing has been the main policy tool in most of the post crisis regime, the figures suggest that credit expansion may actually be more effective at lowering job destruction in comparison to its ability to encourage job creation. To formalize this point, I regress the seven time series of aggregate job flows (net flows, gross gains, gross losses, closings, contractions, openings and expansions) on the time series of aggregate credit supply shocks in seven individual regressions,

$$log\{\text{Agg job flows}\}_t = \sum_{s=0}^{s=3} \beta_s \epsilon_{t-s}^{CreditSupply} + u_t \tag{1.12}$$

The left hand side variable is the log of job flows. For *net* job flows, I do not use the logged variable since the time series crosses the zero line over a few episodes in the sample. Since the SVAR estimation delivers an instrument that is exogenous and orthogonal to other types of aggregate shocks, no other controls are needed to establish causality or account for potential omitted variables. On the RHS, I use contemporaneous and 3 lagged values of credit supply shocks to account for the dynamic response of job flows to the shocks. Beyond the forth quarter, I do not find a significant effect for the shock series on the disaggregate flows series.

Table 1.6 reports the estimates of equations (1.12). A single standard deviation expansionary credit supply shock creates a net increase in employment of 144702.34 jobs on impact. Net job flows continue to rise over the three quarters following the shock. The effect on job destruction (1.6% decline in job losses) is immediate, driving the short term effects of the shock on net job flows. On the other hand, the rise in gross job gains is sluggish, occurring after one and three quarters since the shock took place. With respect to the roles of the intensive versus extensive margins, table 1.6 indicates that the intensive margin plays the main role in the propagation of aggregate credit fluctuations to aggregate employment; the estimated effects for openings and closings are insignificant.

Table 1.3: Response of job flows and average wages to credit supply shocks by SIC sector

LHS variable	Net job flows (1)	Net job flows (2)	Avg. real wage (1)	Avg. real wage (2)
Net job flows$_{t-1}$	0.48***	0.43***		
Avg. quarterly real wage$_{t-1}$			0.45***	0.38***
	(0.12)	(0.12)		
$\epsilon_t^{CreditSupply}$	-793.81^{*}		-0.07	
	(392.25)		(0.10)	
Construction	6896.69***	7018.62**	-0.19^{*}	-0.19^{*}
	(2052.43)	(2142.26)	(0.08)	(0.08)
Finance, Insurance, and Real Estate	903.88	915.75	-0.42	-0.39
	(578.59)	(573.39)	(0.59)	(0.59)
Management of Companies and Enterprises	901.92	917.18	-0.33	-0.31
	(809.23)	(813.63)	(0.52)	(0.52)
Manufacturing	1735.40**	1746.70**	-0.08	-0.08
	(544.26)	(543.84)	(0.08)	(0.08)
Mining	972.35$^{\cdot}$	956.55$^{\cdot}$	-0.46	-0.45
	(519.35)	(517.27)	(0.34)	(0.35)
Retail Trade	2216.85*	2248.89*	0.03	0.03
	(979.62)	(985.68)	(0.07)	(0.07)
Services	2223.76**	2227.03**	$-0.18^{\cdot}$	$-0.18^{\cdot}$
	(846.25)	(835.81)	(0.09)	(0.09)
Trans., Comm. and Public Util.	1382.70**	1373.44**	-0.12	-0.11
	(525.94)	(512.75)	(0.12)	(0.12)
Wholesale Trade	2146.39*	2181.84*	-0.25^{*}	-0.25^{*}
	(928.56)	(937.27)	(0.12)	(0.12)
			(0.06)	(0.06)
Industry fixed effects	yes	yes	yes	yes
Time fixed effects	no	yes	no	yes
R^2	0.24	0.19	0.21	0.15
Adj. R^2	0.23	0.17	0.20	0.13
Num. obs.	8600	8600	8600	8600

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\cdot}p < 0.1$

The table reports the effect of exogenous credit supply fluctuations on net job flows and average wages by SIC sector, using OLS fixed effects estimation of equations (1.8) and (1.9). Inference is based on Driscoll and Kraay (1998)'s SCC estimator (spatial correlation consistent) which relies on T asymptotics and accounts for serial correlation between residuals from the same industry in different time periods, cross-serial correlation between different industries in different times and, within the same period, cross-sectional correlation.

Table 1.4: Financial heterogeneity in the transmission of credit supply shocks to industry-level net job flows

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	s=0	s=1	s=2	s=3	s=0	s=1	s=2	s=3
Net job flows$_{t-s-1}$	0.58^{***}	0.41^{***}	0.22^{***}	0.21^{*}	0.51^{***}	0.37^{***}	0.20^{**}	0.23^{*}
	(0.08)	(0.08)	(0.07)	(0.10)	(0.07)	(0.08)	(0.08)	(0.10)
$\epsilon_{t-s}^{CreditSupply}$	2713.63	8567.23^{**}	6267.83^{**}	5726.87^{**}				
	(1956.05)	(3029.06)	(2252.84)	(2163.35)				
log(Avg. real wages$_{t-s-1}$)	2780.98	3203.74	5368.13	1487.19	2730.81	9663.10^{***}	8596.77^{*}	$6143.15^{\cdot}$
	(3219.04)	(3149.84)	(4748.36)	(2871.55)	(2788.53)	(2438.82)	(3375.81)	(3303.89)
log(Sales$_{t-s-1}$)	-5978.64	$-9204.25^{\cdot}$	-9893.42^{*}	-8278.35^{*}	-4921.42	-7340.68	-4917.60	-3975.09
	(4472.24)	(4952.12)	(4556.08)	(4018.58)	(3148.19)	(5209.30)	(4941.56)	(4217.81)
log(Operational income$_{t-s-1}$)	$135331.38^{\cdot}$	120434.43	$91007.72^{\cdot}$	82072.56	78709.69	36293.34	-18123.98	14189.70
	(69559.32)	(77485.40)	(53269.67)	(60332.97)	(56481.76)	(71371.37)	(66914.79)	(66835.46)
log(Current liabilities$_{t-s-1}$)	2551.62	-1622.06	-1189.18	-5218.54	4610.85^{*}	2845.71	5114.26^{*}	2011.38
	(2164.57)	(2903.10)	(3312.97)	(3529.46)	(1954.24)	(2456.09)	(2291.73)	(2814.53)
log(Total liabilities$_{t-s-1}$)	-1656.17	-340.60	-599.32	1285.63	-598.65	-269.17	-2422.98	-3483.13
	(2403.12)	(2640.34)	(3190.89)	(3159.35)	(2405.30)	(2903.53)	(3023.73)	(2891.19)
log(Fixed assets$_{t-s-1}$)	4115.49	$9997.93^{\cdot}$	$9368.23^{\cdot}$	10327.35^{*}	-138.46	2406.86	-266.94	1298.93
	(3931.64)	(5659.91)	(5594.27)	(4997.91)	(2180.33)	(3218.27)	(3155.08)	(2899.40)
log(Total assets$_{t-s-1}$)	1958.62	1497.40	552.31	-407.17	520.36	-1334.11	-533.38	-208.58
	(2912.94)	(3822.69)	(3815.64)	(3210.13)	(884.27)	(1090.57)	(1059.05)	(1203.57)
log(Total employment$_{t-s-1}$)	-9359.87^{**}	-12380.01^{**}	-13987.89^{***}	-12790.41^{***}	-5023.81^{***}	-4832.97^{**}	-7104.05^{***}	-6417.86^{**}
	(3288.63)	(4621.29)	(3880.93)	(3745.55)	(1440.71)	(1866.96)	(2119.97)	(2229.75)
$\epsilon_{t-s}^{CreditSupply} \times log$(CurrLiab.$_{t-s-1}$)	1131.38	4165.65^{**}	3047.77^{**}	2838.87^{*}	-163.25	$2568.55^{\cdot}$	614.89	1453.08
	(1000.71)	(1529.83)	(1107.84)	(1116.96)	(1124.01)	(1320.33)	(1112.69)	(1109.97)
Industry fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Time fixed effects	no	no	no	no	yes	yes	yes	yes
R^2	0.44	0.33	0.19	0.17	0.27	0.16	0.07	0.08
Adj. R^2	0.43	0.31	0.17	0.15	0.22	0.10	0.00	0.02
Num. obs.	1495	1470	1445	1420	1495	1470	1445	1420

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\cdot}p < 0.1$

The table reports the OLS fixed effects estimation of equation (1.10) for the relation between an industry's propensity to hire or fire workers in reaction to exogenous credit supply movements, and the level of its current liabilities. Inference is based on Driscoll and Kraay (1998)'s SCC estimator (spatial correlation consistent), which relies on T asymptotics and accounts for serial correlation between residuals from the same industry in different time periods, and cross-serial correlation between different industries in different times and, within the same period, cross-sectional correlation.

Table 1.5: Heterogeneous productivity in the transmission of credit supply shocks to industry-level net job flows

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	s=0	s=1	s=2	s=3	s=0	s=1	s=2	s=3
Net job flows$_{t-s-1}$	0.48***	0.44***	0.31***	0.41***	0.43***	0.40***	0.28***	0.41***
	(0.12)	(0.09)	(0.09)	(0.10)	(0.12)	(0.09)	(0.08)	(0.10)
$\epsilon_{t-s}^{CreditSupply}$	1607.47	5114.35*	144.73	3375.00*				
	(2124.62)	(2058.17)	(1632.29)	(1324.73)				
$log\{$Avg. real wages$\}_{t-s-1}$	-2463.90	-4615.01^{*}	-4833.01^{*}	-6837.12^{*}	3675.96*	2225.03	1664.89	228.32
	(2054.84)	(1943.55)	(2364.75)	(2914.92)	(1619.40)	(1763.31)	(1682.97)	(1797.20)
$\epsilon_{t-s}^{CreditSupply} \times log\{$Avg. real wages$_{t-s-1}\}$	-187.23	$-976.53^{\cdot}$	418.27	-611.47	-422.54	-1021.40^{*}	272.28	$-764.68^{\cdot}$
	(615.94)	(549.05)	(550.29)	(427.48)	(551.70)	(517.23)	(585.80)	(442.24)
Industry fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Time fixed effects	no	no	no	no	yes	yes	yes	yes
R^2	0.23	0.21	0.10	0.18	0.19	0.16	0.08	0.17
Adj. R^2	0.23	0.20	0.09	0.17	0.17	0.14	0.06	0.15
Num. obs.	8600	8514	8428	8342	8600	8514	8428	8342

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\cdot}p < 0.1$

The table reports the OLS fixed effects estimation of equation (1.11) for the relation between an industry's propensity to hire or fire workers in reaction to exogenous credit supply movements, and the level of its labor productivity, as proxied by its average real wage. Inference is based on Driscoll and Kraay (1998)'s SCC estimator (spatial correlation consistent), which relies on T asymptotics and accounts for serial correlation between residuals from the same industry in different time periods, and cross-serial correlation between different industries in different times and, within the same period, cross-sectional correlation.

Table 1.6: Heterogeneity across job flows in response to aggregate credit supply shocks (Aggregate time series specification)

LHS variable	Net job flows	Gross job gains	Openings	Expansions	Gross job losses	Closings	Contractions
(Intercept)	284306.2722***	15.8351***	14.2231***	15.6116***	15.7963***	14.1575***	15.5795***
	(54520.0014)	(0.0083)	(0.0149)	(0.0073)	(0.0087)	(0.0142)	(0.0079)
$\epsilon_t^{CreditSupply}$	144702.3419**	0.0033	0.0044	0.0029	$-0.0159^{\cdot}$	-0.0100	-0.0173^{*}
	(54724.0103)	(0.0083)	(0.0149)	(0.0073)	(0.0087)	(0.0143)	(0.0080)
$\epsilon_{t-1}^{CreditSupply}$	255047.2712***	0.0161$^{\cdot}$	0.0132	0.0168*	-0.0184^{*}	-0.0153	-0.0190^{*}
	(53815.9498)	(0.0082)	(0.0147)	(0.0072)	(0.0086)	(0.0140)	(0.0078)
$\epsilon_{t-2}^{CreditSupply}$	169071.3992**	0.0102	0.0040	0.0118	-0.0124	-0.0068	$-0.0137^{\cdot}$
	(53486.4106)	(0.0081)	(0.0146)	(0.0071)	(0.0085)	(0.0140)	(0.0078)
$\epsilon_{t-3}^{CreditSupply}$	173967.7333**	0.0165*	0.0137	0.0171*	-0.0068	-0.0009	-0.0083
	(53229.3250)	(0.0081)	(0.0145)	(0.0071)	(0.0085)	(0.0139)	(0.0077)
R^2	0.3333	0.0890	0.0190	0.1242	0.0960	0.0188	0.1290
Adj. R^2	0.3047	0.0498	-0.0231	0.0865	0.0571	-0.0234	0.0915
Num. obs.	98	98	98	98	98	98	98

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\cdot}p < 0.1$

The table reports the effect of exogenous credit supply fluctuations on job flows by type, using a simple OLS estimation of equation 1.12. Other than net flows, all other flows are in log levels.

1.3 Theoretical Framework

This part of the paper connects the empirical results within a theoretical framework and rationalizes the mechanism and composition effects suggested by the paper. Specifically, it formally explains why credit expansion could contribute to a decline in aggregate labor share, including the aggregate labor intensity and wage. I show within this framework that an expansionary shift in credit supply affects firms with varying degrees depending on the level of their financing costs. In reaction to this exogenous movement, each firm responds by increasing its labor intensity and wage paid per worker. However, at the aggregate level, across the firm distribution, the average results could be the opposite. The model shows that credit expansion can stimulate growth disproportionately across firms, where firms facing higher borrowing costs and have preferences for capital investment over hiring grow at a higher rate.

In the following theoretical exposition, I adopt small letters to indicate individual firm level variables and capital letters for aggregate variables.

1.3.1 Economic environment

Two types of agents inhabit the model: A single representative bank and heterogeneous firms that differ with respect to their idiosyncratic productivity, asset size, liabilities employment level, and wages. Both agents are financially constrained and face balance sheet shocks. Default is endogenous for the two types of agents, giving rise to three distinct interest rates: risk free r^f, base rate r^b, and firm loan rate $\tilde{r}_i$. The first is the risk free rate and is set exogenously to the model dynamics. The aggregate base rate includes a premium that compensates lenders in the interbank lending market and is determined based on the aggregate level of the sector's net worth. The third loan rate includes an additional premium, derived based on the idiosyncratic risk of each firm.

Thus, the model distinguishes between the two types of risk (i.e. firms and banks') that drive borrowing spreads (Townsend (1979), Bernanke, Gertler, and Gilchrist (1999), Gertler and Kiyotaki (2010) and Gilchrist and Zakrajšek (2012)). In addition, aggregate labor supply is homogeneous and unlimited, while hiring and firing has convex costs, reflecting expenses on vacancy posting, search, and training required for hiring, as well as severance payments and job restructuring following firing. Lastly, employers and workers share the surplus their match is expected to create, with labor wage is determined through a bargaining process at each firm; a distribution of wages arises across firms that depend on the firm growth outlook, size of labor stock, and default probability.

Firms

The world is populated by a large number of *heterogeneous* risk neutral firms, producing homogeneous output at the beginning of every period, using predetermined capital, k^i, and labor, n^i, stocks via *Cobb-Douglas* technology. Output is subject to uncertainty that depends on a stochastic idiosyncratic productivity process. z follows an autoregressive log-normal specification, subject to exogenous i.i.d shocks $\epsilon^z \sim N(0, \sigma^z)$. There is a common capital depreciation rate, δ, with firms paying taxes on their cash flow and receiving deductions for their depreciation and debt services (Hennessy and Whited (2007)). Thus, debt financing is desirable for its tax shield benefits.

In addition, firms are also subject to an idiosyncratic net worth shock, ω_i, (i.e balance sheet or capital quality shock, similar to Gertler and Kiyotaki (2010)), which follows a stochastic i.i.d process $\sim LogNormal(\mu^\omega, \sigma_i^\omega)$. Since the capital used in production is homogeneous, we introduce net worth shocks, ω, to capture all idiosyncrasies in the ability of entrepreneurs and firms that lead to different valuation of firms in the cross section. For lenders, this is a source of risk that is independent of investment opportunities risks, z. Q^k is the price of both capital and finished goods, which is normalized to 1,

$$\pi = \omega_i Q^K z k^\alpha n^\beta \tag{1.13}$$

$$k' = \Delta k + \omega_i(1-\delta)k \tag{1.14}$$

$$n' = \Delta n + n \tag{1.15}$$

$$z' = (1-\rho^Z)\bar{z} + \rho^z z + \epsilon'^z \tag{1.16}$$

Following standard notation, the future value of any variable x is x'. Every firm starts with an individual state vector, $s^i \equiv \{a, l, n, z\}$, that includes its assets, liabilities, labor stock, and productivity. Assets are the sum of cash flow and depreciated capital stock. Liabilities summarize the total liabilities due to creditors, which were determined the period before, in addition to losses due to ω. After realizing their net worth values at the beginning of each period, assets net liabilities, a firm continues if its net worth is positive, or exits if it is below zero.[15]

In addition to its individual state vector, firms also observe the aggregate state, $S^{agg} \equiv \{\xi\}$, which includes the value of the aggregate financial sector net worth shock. The aggregate state vector allows market participants to extract the aggregate base interest

[15] I assume a continuation value of zero. Using other values as a default cut off does not affect the model dynamics.

rate r^b.

$$NetWorth' = Q^K a' - l' \tag{1.17}$$

$$a' = \pi' + \omega' Q^K (1-\delta)k' - t^c \tag{1.18}$$

$$l' = (1 + (1-\tau^c)\tilde{r})b' \tag{1.19}$$

$$t^c = \tau^c \times (\pi' - \delta\omega_i' Q^K k' - \tilde{r}b') \tag{1.20}$$

Continuing firms invest in their capital stock by purchasing or selling capital, incurring quadratic capital adjustment cost that depends on the gap between the desirable capital level and their current assets; that is, capital is partially irreversible. The cost is scaled by the size of the firm to make sure that the bite of the adjustment costs stays binding as the firm grows. The formulation of capital adjustment costs here follows the typical formulation in the literature (Cooper and Haltiwanger (2006)),

$$investment^k = Q^K(k' - \omega_i(1-\delta)k) + c^{\Delta K} \tag{1.21}$$

$$c^{\Delta K} = \gamma^{\Delta K}\left(\frac{k'-k}{k}\right)^2 k \tag{1.22}$$

Given firm expectations with respect to future returns, default probability, and its current stock of labor, it determines the number of workers to hire or fire, subject to quadratic hiring and firing costs (Bentolila and Bertola (1990), Cooper and Willis (2009)) in the same fashion of capital adjustment costs.

$$c^{\Delta N} = \gamma^{\Delta N}\left(\frac{n'-n}{n}\right)^2 n \tag{1.23}$$

Firms live infinitely and maximize the discounted sum of their infinite dividend stream, d, by choosing the optimal amount of tomorrow's capital and labor stocks. They start with equal amount of equity and fund their financing gap through borrowing b or issuing equity when $d < 0$. Equity issuance is subject to a quadratic cost function, making debt the more favorable means of financing, in addition to its tax shield advantage.

$$\max_{k',b',n'} \quad E_t\left\{\sum_{s=0}^{\infty}\left(\frac{1}{1+r^f}\right)^s d_{t+s}\right\} \tag{1.24}$$

$$d = NetWorth + b' - Q^K k' - w \times n' - c^{\Delta K} - c^{\Delta N} - c^{Eq} \tag{1.25}$$

$$c^{Eq} = \gamma^{Eq} d^2 \text{ if } d < 0 \tag{1.26}$$

The loan contract

The loan contract is subject to an incentive compatibility constraint following the structure of Townsend (1979) and Bernanke, Gertler, and Gilchrist (1999). The banking sector charges $\tilde{r}$, which depends on the credit worthiness of the firm. It compensates the lender for the bankruptcy losses in collateral value the bank would incur in case of firm default.

$$(1+r^b)b' = E_\xi \Big\{ E_z \Big\{ (1+\tilde{r})b' \int_{\bar{\omega}}^{\infty} d\omega + \\ \int_0^{\bar{\omega}} \omega'(1-\mu)Q'^K \Big\{ (1-\tau^c)z'k'^\alpha n'^\beta + (1-(1-\tau^c)\delta)k_i' \Big\} Q(\omega, d\omega') \tag{1.27}$$

where success and default probabilities depend on $\bar{\omega}$, which is the value at which the firm has to endogenously choose default,

$$\bar{\omega} \equiv \omega_{|netW=0} = \frac{(1+(1-\tau^c)\tilde{r}_i)b'}{Q'^K \Big((1-\tau^c)Z'k'^\alpha n'^\beta + (1-(1-\tau^c)\delta)k' \Big)} \tag{1.28}$$

Labor demand and wage setting In a standard frictionless economy with no heterogeneity, the representative firm hires labor until the marginal return of an extra worker is exactly equal to her marginal cost, i.e. her wage. The aggregate wage level there is determined based on the marginal dis-utility of workers in the representative household and perfectly equates labor demand and supply. In addition, in that classical framework, workers are paid after production is complete, allowing the firm to use the cash flow generated by the labor force to cover its labor expenses. However, the model presented here departs from this simple environment with respect to three elements.

First, I allow for labor market frictions by introducing hiring and firing costs, which is a reduced form formulation of the effect on firm job flow decisions of expenses related to vacancy posting, search, matching, and training in case of hiring, or severance payments and job restructuring following firing decisions. These adjustment frictions introduce a wedge between the long run and tomorrow's optimal labor stock, implying that an employment contract is particularly valuable for both employees and employers who would have to incur additional costs (e.g. search costs) if they were to break their agreement and look for another opportunity. Within such environment, both employees and employers decide to share the surplus created by their match according to their relative bargaining powers.[16]

[16]The key difference between this formulation and the typical search and matching framework is that hiring costs here are constant over the cycle, not dependent on market tightness, and do not react to aggregate fluctuations.

The second point of departure is with respect to the timing of wage payments. In this model, the firm has to pay workers upon hiring them and before production is complete, which creates pressure on today's liquidity. This does not need to be a problem in a complete market where the firm could costlessly borrow today against expected future gains. However, by introducing financial frictions, external financing becomes costly; hence, borrowing to cover hiring costs affects the marginal return of the new worker, which is discounted by how much it would add to the firm financing burden. This combination of wage bill timing and financial frictions is what affects the relative price of labor compared to capital. While capital is its own collateral, labor is not, making labor less attractive for constrained firms (Jermann and Quadrini (2012), Calvo, Coricelli, and Ottonello (2012)).

Finally, the economy we model here is one where firms are heterogeneous and the marginal return to labor varies across the firm distribution depending on a firm's net worth, size, productivity, and aggregate financing conditions. This deviation from the representative agent framework gives rise to a distribution of wages whose dynamics depend on variations in both the cross section of firms and aggregate credit supply fluctuations over time.

To set their wages, firms engage with workers in standard Nash bargaining over the expected returns of their match and they solve the following optimization problem,

$$max_w(J^{Employed} - J^{Unemployed})^{\psi}(J^{Filled})^{1-\psi} \tag{1.29}$$

where J^{Filled} stands for the firm's net present value of the filled job, $J^{Employed}$ is the worker's net present value of holding the job, and $J^{Unemployed}$ is his net present value if he is unemployed instead. I show in the appendix building on Elsby and Michaels (2013) and Michaels, Page, and Whited (2018), that labor wage per worker w is,

$$\text{w} = \frac{\psi}{(1-\psi)}\Big\{\frac{\partial c^{\Delta N}}{\partial n'} + \frac{1}{1+r^f}\int_{\xi}\int_{Z}\int_{\bar{\omega}}^{\infty}\Big\{\frac{\partial c'^{\Delta N}}{\partial n''}\Big\}\phi^{\omega}(\omega', d\omega)\phi^{Z}(Z', dZ)\phi^{\xi}(\xi', d\xi)\Big\} + \Psi^{\Delta}$$

The first term on the left hand side is the cost of hiring or firing an extra worker. In case of hiring, $\frac{\partial c^{\Delta N}}{\partial n'}$ is positive referring to the positive value the worker adds to the shared surplus by saving the firm the need to hire another worker (e.g. vacancy cost in typical search and matching). If the firm is firing, $\frac{\partial c^{\Delta N}}{\partial n'}$ is negative and the firm surplus is less than what it could be if it were not for firing frictions. The second term is the discounted value of expected future returns to staying employed, which depends on whether the firm expects to be growing or shrinking in the future, as well as its default probability. The third term is the difference between today's and tomorrow's net present value of unemployment benefits and leisure utility.

The financial sector I assume a single representative and risk neutral intermediary whose role is to grant one period loans to the aggregate economy, B'. These loans are borrowed by firms and constitute the assets side of the bank balance sheet. *Expected* returns to these loans are $(1 + r^b)B'$ based on the lending contracts to producing firms. However, *realized* returns depend on the repayments it collects from borrowing firms, where the total size of these repayments fluctuate as the number of defaulting firms change over the cycle. Firm bankruptcy is costly to the bank, which has to incur the losses associated with monitoring efforts and sale of the obsolete assets of defaulting firm. These losses open a channel through which shocks in the real economy could gain further persistence by hurting the asset side of the financial sector, which affects the volume of future credit supply and the liquidity the financial sector could provide without having to borrow, similar to Gertler and Kiyotaki (2010).

$$E\{R'^{Bank}\} = (1 + r^b)B' \tag{1.30}$$

$$R^{Bank} = \sum_{Survivals} (1 + \tilde{r_i})b_i - \sum_{Defaults} (1 - \mu)liqValue_i \tag{1.31}$$

The bank starts the initial period with a predetermined endowment of cash deposits; then, it finances its lending activities primarily by borrowing from the interbank market if its own cash on hand is not sufficient to cover requested firm loans B'. Lenders in the interbank market realize that the borrowing capacity (i.e. balance sheet) of the banking sector is subject to unexpected exogenous shocks, ξ, that are independent of the idiosyncratic firm shocks ω, z.

ξ encompasses all sources of risk that have their origin within the financial sector, such as prudential regulatory changes, fluctuations in market confidence and sentiments, contagious international financial events, or arrival of news with new information about the true risk of bank assets. Consequently, lenders associate a positive probability to a default event of the banking sector if $\xi \leq \bar{\xi}$, and require a premium over the risk free rate, whereby the banking sectors pays an interest rate $r^b \geq r^f$ depending on the aggregate risk of financial sector disturbances.

The banking sector net worth evolves accordingly, where every period it collects debt plus interest repayments (net defaults) and pays back its liabilities to lenders in the interbank market. Moreover, the bank has to pay a dividend to its shareholders equal to the risk free rate, r^f, and I also allow for a constant reserve ratio that has to be set aside for regulatory purposes,

$$netW'^{Bank} = \xi \times (1 - r^f - ReserveRatio)\Big\{R'^{Bank} - (1 + r^b)B^{InterBank}\Big\} \tag{1.32}$$

$$B'^{InterBank} = B' - netW^{Bank} \tag{1.33}$$

Since such a default event would have extreme consequences, I assume that lenders to the bank believe that the liquidation value of the banking sector under such circumstances would be zero (i.e. $\mu^{Bank} = 1$),[17]

$$(1 + r^f)B'^{InterBank} = (1 + r^b)B'^{InterBank} \int_{\bar{\xi}}^{\infty} Q(\xi, d\xi) \tag{1.34}$$

$$\ln\{\xi'\} = (1 - \rho^{\xi})\ln\{\xi_0\} + \rho^{\xi}\ln\{\xi'\} + \epsilon'^{\xi} \tag{1.35}$$

$$\epsilon^{\xi} \sim N(0, 1) \tag{1.36}$$

where success and default probabilities depend on $\bar{\xi}$, which is the value at which the bank has to endogenously default.

$$\bar{\xi} \equiv \xi_{|netW'^{Bank}=0} = \frac{(1 + r^b)B^{InterBank}}{R'^{Bank}} \tag{1.37}$$

The bank maximizes profits subject to the borrowing constraint (1.34) and the return function (1.30), which yields a corner solution where the bank lends all the demanded loans. If $B' < netW^{Bank}$, the bank does not access the interbank market and the base rate charged to firms in this case reduces to the risk free rate, $r^b = r^f$.

This intuition here is essentially similar to Kiyotaki and Moore (2012) and Gertler and Kiyotaki (2015); however, while they use the limited enforcement constraint with no default risk of Kiyotaki and Moore (1997) to model the financial contracts in the interbank market, I implement the financial contract of Townsend (1979) and Bernanke, Gertler, and Gilchrist (1999), in the same fashion used above for the firm borrowing contract. This allows for default risk on the bank side and makes borrowing costly in the interbank market when the balance sheet of the bank sector is weak. The premium the bank has to pay is a function of the state of its balance sheet (i.e. net worth).

This is an additional amplifying channel to the transmission of economic shocks; an event that hurts bank valuation and net worth, lowers its borrowing capacity and raises its default risk, resulting in higher premiums over borrowing between the bank and its lenders. Consequently, firms that borrow from the bank have to pay extra on their premiums to

[17] This assumption is only a matter of calibration and does not affect the mechanisms and intuition of the model.

cover for the increased lending costs in the interbank market. This mechanism could lead unexpected economic events to take the form of a financial shock that lowers aggregate credit supply volume and raises the premium on loans to the real economy; this description matches the kind of credit supply shocks we identified in the SVAR exercise in the first part of the paper.

1.3.2 Model solution and calibration

The firm problem is solved globally using nonlinear methods, where I iterate over the Euler equation using time iterations and linear interpolation (Rendahl (2015)). Expectations are approximated using Tauchen and Hussey (1991) discritization approach over the three sources of idiosyncratic and aggregate uncertainty (z, ω, Ξ). Aggregation follows Krusell and Smith (2006) where agents use linear forecasting rules to construct their estimates of base rate depending on the aggregate state of the financial sector.

With respect to parameterization, table 1.8 summarizes the values assigned to the model parameters. A set of the model parameters are calibrated following standard values in the literature, while the rest is fitted to match the empirical moments reported in Michaels, Page, and Whited (2018) and Covas and Den Haan (2012), conditioning on the fixed parameters. Specifically, the matching exercise focuses on the parameters that govern the financial sector (σ^{ξ}) and firm investment and financing decisions, in addition to the dynamics of wages and the effective relative price of labor.

The firm net worth risk parameter σ^{ω} drives the price of firm loan spread and therefore affects firm demand for debt financing. I calibrate it to match the model simulated mean leverage to the mean leverage value reported in Michaels, Page, and Whited (2018) sample. Equity issuance cost γ^{Eq} determines firm demand and access for equity financing. There are possibly two ways to set the parameter value depending on the type of firms we emulate with the model: First, it could be set to match the reported standard deviation of SEOs issuing costs, reported in Covas and Den Haan (2012) of 0.6%. However, the majority of firms do not have access to equity markets in the standard sense, and these reported costs are not representative of the costs they incur to attract private shareholders funds.

Therefore, I fix the equity cost parameter to match the default probability of simulated and empirical value. The idea is that a firm access to equity determines how much it is willing to accept high borrowing costs from the banking sector. If equity is costless, then a firm will not borrow more than the level where the marginal tax shield advantage of debt equals its marginal cost. Hence, the cost of borrowing is indicative of the cost of access to private equity funds. This only holds because σ^{ω} is already anchored based on the leverage moment. Hull, Predescu, and White (2005) reports a value of 1.86% spread on BAA bonds and 2.4% expected default probability, which are similar values to the figures Covas and Den Haan (2012) and Bernanke, Gertler, and Gilchrist (1999) use.

Adjustment cost parameters for capital $\gamma^{\Delta K}$ and labor $\gamma^{\Delta N}$ are set to match the standard deviation of capital investment and hiring rates in Michaels, Page, and Whited (2018) sample, respectively. The standard deviation of firm productivity σ^{z} matches the simulated and empirical firm cash flow volatility reported in Michaels, Page, and Whited (2018).

Finally, the bank net worth risk σ^{ξ} drives the credit supply relevant margin of the risk premium paid by firms $r^b - r^f$. Given that firms with AAA credit rating are very rare, with very low expected default probabilities (their default rate per year is 0.0004 according to Hull, Predescu, and White (2005)), I use the premium they pay on their debt as a proxy for the basis premium $r^b - r^f$ that banks pay in the interbank market. In other words, I assume that AAA firms do not have idiosyncratic default risk. Hull, Predescu, and White (2005) reports a value of 0.83% AAA premium over the risk free rate.

1.3.3 Discussion

The goal of the theoretical heterogeneous firms framework that we laid down so far is to rationalize the labor market responses to credit supply shocks, as observed in the empirical part of the analysis, and reproduce the distinction between the *within* and *composition* effects. Since the role ϵ^{ξ} plays in the theoretical framework comes very close to the role implied by our identification of credit supply shocks in the aggregate SVAR model, the dynamics implied by the model in response to a balance sheet shock in the financial sector can help us understand the observed responses to the SVAR credit supply shocks. Specifically, the model is constructed to show how the composition effects of credit expansion lower the aggregate labor share. In supporting the following propositions, I rely on the numerical solution of the model policy functions, since the model has no closed form solution.

A key characteristic of the economic environment implied by the model is that introducing financing costs augment the relative price of labor to capital, making the latter *effectively* cheaper (Petrosky-Nadeau (2014)). This is because, unlike labor, capital has a collateral value that lowers its financing costs, in addition to its marginal contribution to future production. Figure 1.4 plots the marginal effect of capital, labor and borrowing on the firm risk premium, $\tilde{r}$, over different values of leverage decisions, while keeping other state

Table 1.7: Calibrated Parameters

Parameter		Value	
Risk free rate	r^f	0.025	Michaels, Page, and Whited (2018)
Capital share in production	α	0.3	
Labor share in production	β	0.57	
Labor bargaining power	ψ	0.3	Michaels, Page, and Whited (2018)
Unemployment benefits	Ψ	1	
Corporate tax rate	τ^c	0.257	
Default cost	μ	0.2	Bernanke, Gertler, and Gilchrist (1999)
Firm productivity persistence	ρ^z	0.5	Michaels, Page, and Whited (2018)
Bank net worth shock persistence	ρ^ξ	0	

Table 1.8: Matched Parameters

Parameter		Value	Target moment	Empirical value	Simulated value
Firm net worth shock standard deviation	σ^ω	0.42	Leverage ratio	0.35	0.32
Capital adjustment cost	$\gamma^{\Delta K}$	0.385	Std. dev. investment	0.017	0.019
Labor adjustment cost	$\gamma^{\Delta N}$	0.095	Std. dev. employment growth	0.060	0.058
Equity issuance cost	γ^{Eq}	0.19	BAA spread	1.86	1.85
Firm productivity shock standard deviation	σ^z	0.01	Std. dev. of operating income	0.019	0.04
Bank net worth shock standard deviation	σ^ξ	0.19	AAA spread	0.0086	0.0087

and policy variables constant. Despite the larger share of labor in production, i.e. $\alpha < \beta$, capital plays a larger role in influencing firm default probability and financing costs; this role could also be directly observed in figure 1.5, which shows the marginal effects on the cut off default threshold $\bar{\omega}$. The two curves for k' and n' diverge as leverage increases, implying that the wedge created between the relative prices of labor and capital rises with the rise in firm financing needs and default probability. The following proposition summarizes this point.

Proposition 1. *Financing costs raise the effective prices of both labor and capital, thus augmenting the effective relative price of labor to capital. Therefore, values of optimal labor and capital decisions and the ratio between them (i.e. labor intensity) are smaller for firms with higher financing needs and default risk (i.e. higher borrowing costs and lower net worth), keeping other state variables constant;*

i.e. $\frac{n'_i}{\pi'_i} < \frac{n'_j}{\pi'_j}$ *if* $netWorth_i < netWorth_j$, *and* $\{k,n,z\}_i = \{k,n,z\}_j \forall$ *firms* i, j.

Proof. The optimal labor and capital decisions that maximize the firm value must satisfy the following Euler equations,

$$\frac{\partial V}{\partial n'} = 0 = -n' \frac{\partial w}{\partial n'} - w - \frac{\partial c^{\Delta N}}{\partial n'} - \frac{\partial c^{Eq}}{\partial n'} +$$
$$\frac{1}{1+r^f} \int_\xi \int_Z \int_{\bar{\omega}}^{\infty} \left\{ Q'^K \frac{\partial a'}{\partial n'} - \frac{\partial l'}{\partial n'} - n'' \frac{\partial w'}{\partial n'} - \frac{\partial c'^{\Delta N}}{\partial n'} - \frac{\partial c'^{Eq}}{\partial n'} \right\} \phi^\omega(\omega', d\omega) \phi^Z(Z', dZ) \phi^\xi(\xi', d\xi)$$

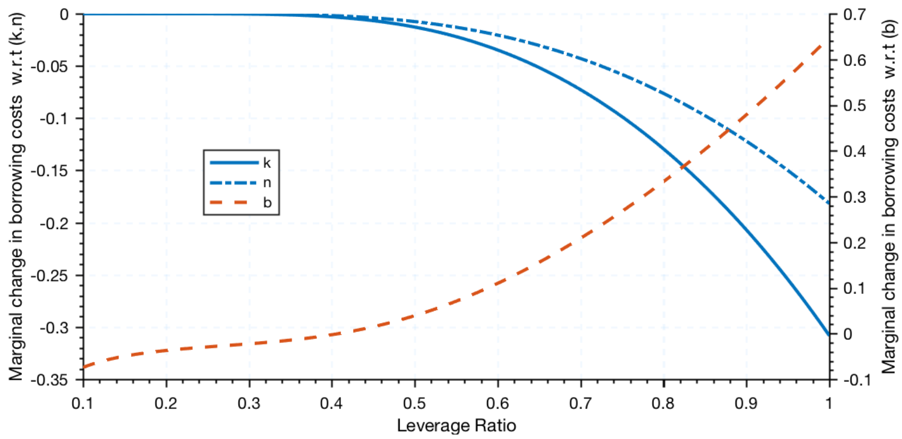
$$\frac{\partial V}{\partial k'} = 0 = -Q^K - n' \frac{\partial w}{\partial k'} - \frac{\partial c^{\Delta K}}{\partial k'} - \frac{\partial c^{Eq}}{\partial k'} +$$
$$\frac{1}{1+r^f} \int_\xi \int_Z \int_{\bar{\omega}}^{\infty} \left\{ Q'^K \frac{\partial a'}{\partial k'} - \frac{\partial l'}{\partial k'} - \frac{\partial c_i'^{\Delta K}}{\partial k'} - \frac{\partial c'^{Eq}}{\partial k'} \right\} \phi^\omega(\omega', d\omega) \phi^Z(Z', dZ) \phi^\xi(\xi', d\xi)$$

The need to access external financing to buy capital and pay wages, when borrowing is costly, lowers the expected marginal value of both capital and labor. The decline in marginal value depends on the marginal increase in firm liabilities,

$$\frac{\partial l'}{\partial n'} = (1-\tau^c) b' \frac{\partial \tilde{r}}{\partial n'}$$
$$\frac{\partial l'}{\partial k'} = (1-\tau^c) b' \frac{\partial \tilde{r}}{\partial k'}$$

since $\frac{\partial \tilde{r}}{\partial n'} > \frac{\partial \tilde{r}}{\partial k'}$ (see equations (71 and 80) and figure 1.4) because of the capital collateral

Figure 1.4: Marginal effects of capital, labor and borrowing on the firm risk premium



value, the decline in labor marginal value is larger than the decline in the marginal value of capital. The size of the wedge that financing costs introduces, scaled by the expected default probability, is

$$\int_{\xi}\int_{Z}\int_{\bar{\omega}}^{\infty}\left\{\frac{\partial l'}{\partial n'}-\frac{\partial l'}{\partial k'}\right\}\phi^{\omega}(\omega',d\omega)\phi^{Z}(Z',dZ)\phi^{\xi}(\xi',d\xi) \qquad >0$$

according to equations (71 and 80)) in the appendix, the size of the wedge grows in proportion to loan size, leverage and $\tilde{r}$. These three variables correlate negatively with the availability of internal funds (i.e. net worth).

The proposition is validated by the numerical solution of the model: Figure 1.6 plots the cost of debt as well as the labor intensity of output based on the optimal capital, labor, and leverage policies, over different values of net worth, for the same values of assets, labor stock, and productivity. Because financing costs lower the relative price of capital to labor, the optimal capital investment to hiring ratio increases as financing cost rises and net worth falls (in the right direction). □

The model also implies the following propositions.

Proposition 2. *For any two firms, where one is hiring and the other is firing, the firing firm must be in a state of higher financing needs and default risk (i.e. higher borrowing costs and lower net worth), if they share the same values of capital and labor stocks and productivity levels;*

i.e. $NetWorth_i < NetWorth_j$ *if* $\dfrac{\Delta n_i'}{n_i} < \dfrac{\Delta n_j'}{n_j}$ *and* $\{k,n,z\}_i = \{k,n,z\}_j, \forall i,j.$

Proof. The proposition follows from the positive association between current net worth and future optimal labor stock, implied by proposition 1, and the fact that the state

Figure 1.5: Marginal effects of capital, labor, and borrowing on the default threshold

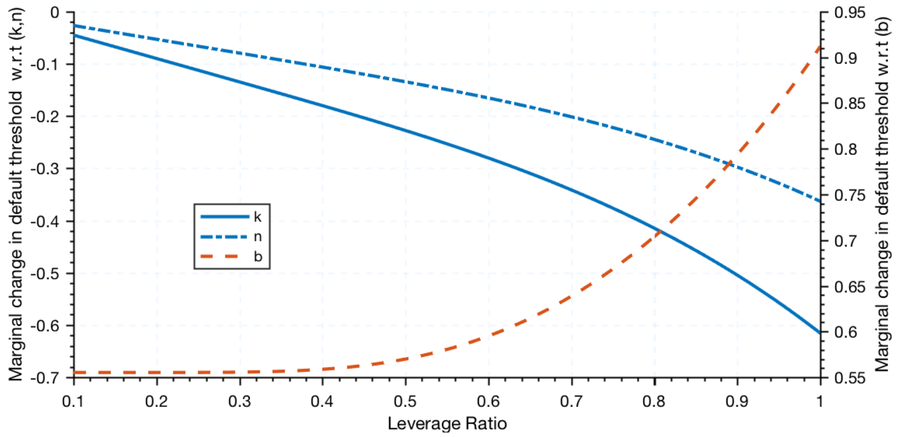
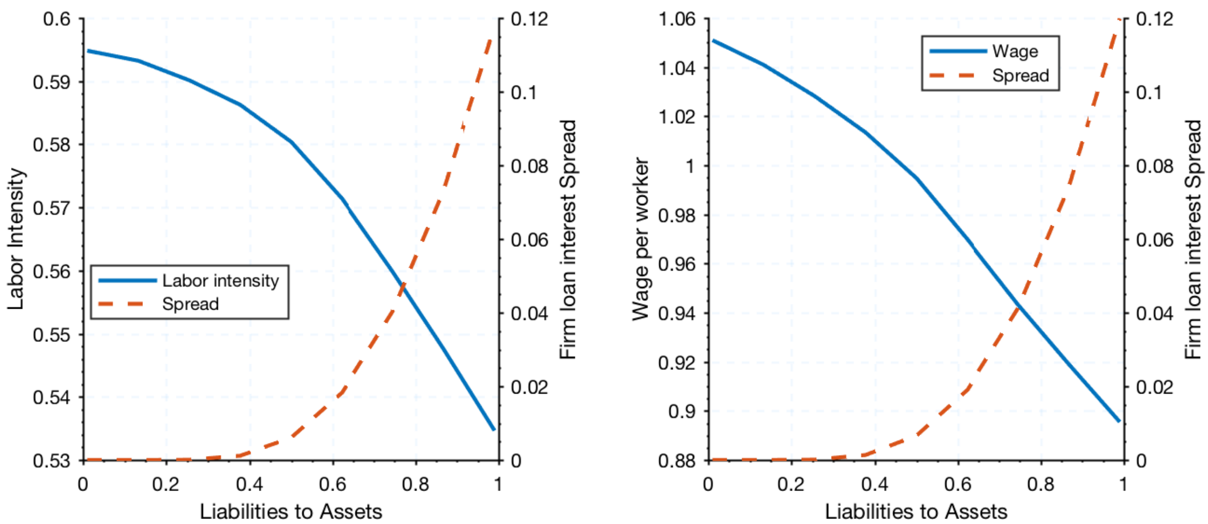


Figure 1.6: Labor intensity and average wage policies



The solid line on the left panel is the labor intensity of production implied by optimal capital and labor policies over different values of liabilities to net worth, where the value of capital and labor stocks as well as productivity are fixed at the center of their grid. The solid line on the right panel is the wage a firm pays per worker as an outcome of the bargaining process. The dashed line is the borrowing premium the firm pays on its debt. Lower net worth (moving right) is associated with higher cost of borrowing and a decline in labor intensity and wages.

space that determines a firm decision is fully covered by {k,l,n,z}. □

The other dimension where the interaction between borrowing costs and labor demand plays a role is with respect to the wage setting problem between a firm and its employees. As equation (1.3.1) points out, the marginal wage depends, in part, on the future surplus the firm-employee match is expected to create. Since the discounted expected value of this surplus depends on the default probability of the firm, changes in $\bar{\omega}$ result in a change in labor compensations. This point is summarized by the following proposition.

Proposition 3. *The optimal wage a firm pays per worker is lower for firms with higher financing needs and default risk (i.e. higher borrowing costs and lower net worth, keeping other state variables constant);*

i.e. $w_i < w_j$ *if* $netWorth_i < netWorth_j$*, and* $\{k, n, z\}_i = \{k, n, z\}_j \forall$ *firms* i, j*.*

Proof. The optimal wage that solves the firm and workers bargaining problem is,

$$w = \frac{\psi}{(1-\psi)}\Big\{\frac{\partial c^{\Delta N}}{\partial n'} + \frac{1}{1+r^f}\int_\xi \int_Z \int_{\bar{\omega}}^{\infty} \big\{\frac{\partial c'^{\Delta N}}{\partial n''}\big\}\phi^{\omega}(\omega', d\omega)\phi^Z(Z', dZ)\phi^{\xi}(\xi', d\xi)\Big\} + \delta$$

An increase in the expected default probability, lowers the discounted value of expected future surplus $\frac{1}{1+r^f}\int_Z \int_{\bar{\omega}}^{\infty} \big\{\frac{\partial c'^{\Delta N}}{\partial n''}\big\}\phi^{\omega}(\omega', d\omega)\phi^Z(Z', dZ)$, which lowers the wage value. $\bar{\omega}$ determines the default states and depends on the availability of internal funds (i.e. net worth), see equation (1.28).

The proposition is validated by the numerical solution of the model: Figure 1.6 presents the wage a firm pays per worker as an outcome of the bargaining process over different values of liabilities to net worth for the same values of assets, labor stock, and productivity. Because financing costs and default probabilities factor into labor costs and its expected surplus, the optimal wage declines as financing cost rises and net worth falls. □

The propositions introduced above illustrate the association between a firm's cost of financing, on the one hand, with its labor demand and the wage it agrees to pay, on the other. Next, I show that firm decisions to invest in reaction to an expansion in credit supply depend on its default probability and the borrowing costs it faces.

Proposition 4. *Expanding credit supply has a positive effect on optimal firm decisions with respect to capital and labor stocks. Furthermore, the magnitude of the effect is larger for firms with higher financing needs and default risk (i.e. higher borrowing costs and lower net worth, keeping other state variables constant);*

i.e. $\frac{\partial x'}{\partial \xi} = f(netW)$ *and* $\frac{\partial x'}{\partial netW \partial \xi} < 0$, *where* $x \in \{k', b', n'\}$ *and {k,n,z} are fixed.*

Proof. According to the Euler equations (56, 58, and 57) of the firm problem, changes in credit supply affect the firm optimization problem through its effect on the base rate r^b. The decline in r^b that follows credit supply expansion implies that firms face lower liabilities and, therefore, are less likely to default. Because of the convexity of the relation between the price of risk and firm net worth, see figure 1.6, the decline in r^b also translates to a decline in the firm risk spread $\tilde{r} - r^b$. Moreover, the decline in $\tilde{r} - r^b$ is stronger for firms that used to face a higher $\tilde{r}$ and default probability, where the slope is steeper.

□

Putting these propositions together brings about the main argument of the paper: Expanding credit supply raises output, labor intensity, and wages at each firm; moreover, output growth at firms with higher financing needs and default risk is disproportionally higher. Nonetheless, the optimal levels of labor intensity and wages for this group of firms remain low relative to the mean firm, despite their marginal increase in reaction to the shock. Hence, larger shares of total output and employment in the economy are driven by lower level of labor intensity and wages, while the mean (i.e. aggregate) values of labor intensity and wages fall. The following corollary summarizes this point.

Corollary 1. *Expanding credit supply stimulates aggregate output growth, labor intensity, and wages at the firm level; yet, composition effects exert negative pressure and weaken its effect on aggregate labor intensity and the aggregate wage.*

Proof. Recall the decomposition of the change in aggregate labor intensity and real wage, equation (1.6),

$$\Delta \text{Aggregate Labor Intensity} = \overbrace{\sum_i w_i^0 \times \Delta LI_i}^{\text{within effect }(+)} + \overbrace{\sum_i \Delta w_i \times LI_i^0}^{\text{composition effect }(-)} + \overbrace{\sum_i \Delta w_i \times \Delta LI_i}^{\text{interaction }(+)}$$

w_i^0 and LI_i^0 are the shares and firm labor intensity before a positive ξ shock, respectively.

The first term on the right hand side corresponds to *within* firm changes in labor intensity, which takes a *positive* value in response to credit expansion, as implied by proposition 4. The magnitude of the *within* term is expected to be limited due to the convexity of the debt contract, proposition 4. Large firms that have large output shares w_i^0 are less likely to be facing high financing costs. Therefore, in reaction to the credit supply expansion, their ΔLI_i will be of lower magnitude compared to smaller, less liquid firms, which hold smaller shares w_i^0. That is, the potential of within effects to contribute to the growth of aggregate labor intensity depends on the share of output that is carried out by firms under tight borrowing costs.

The second term, which is the focus of this corollary, reflects the change in aggregate labor intensity due to *cross* firms reallocation of output shares. Propositions (1) and (4) conject that this term takes a *negative* value in response to credit expansion as firms that face higher financing costs and maintain low levels of labor intensity grow by a faster rate and occupy larger share of the total output. The potential of this channel to exert negative pressure depends on the distance between labor intensity at firms facing high versus low financing costs. The larger is the effect of borrowing costs on the effective relative price of labor, the larger is the *loss* in aggregate labor intensity when credit supply expands. Hence, an expansion in credit supply that follows extreme events is expected to be particularly associated with low labor intensity.

The third term is an interaction of the two effects. By the same two propositions, this term is also expected to take a *positive* value since the same firms that increase their share, also grow their labor intensity more, when aggregate borrowing costs fall,

$$\delta_i^w > \delta_j^w \text{ and } \delta_i^{LI_i} > \delta_j^{LI_j} \text{ if } NetWorth_i^0 < NetWorth_j^0 \text{ and } \{k, l, n, z\}_i = \{k, l, n, z\}_j \quad (1.38)$$

Hence, the corollary reference to the negative effects of credit expansion points at the cross reallocation effect. Whether the aggregate effect is positive or negative depends on the state of the economy at the time the expansion in credit supply takes place. A positive aggregate effect is more likely if the state of the economy is one where the larger share of firms struggle with high financing costs and there is not wide heterogeneity among them with respect to these costs. As heterogeneity increases and the gap between firms' access to credit market widens, the aggregate effect is more likely to turn negative.

Similarly, the change in the aggregate wage can be decomposed in an analogous manner that follows the same intuition. □

The empirical analysis also documents the finding that credit easing lowers job losses more than it raises job gains. The dynamics of the model and the composition effects put forward by the paper provide an explanation, which is summarized in the following corollary.

Corollary 2. *Expanding credit supply decreases job losses more than it increases job gains.*

Proof. The corollary relies on two elements. First, as proposition 2 suggests, firing firms face higher financing costs than hiring firms. Second, from proposition 4, the effect of an expansion in credit supply is stronger for firms that face higher financing costs. Putting them together, it follows that job retention would rise more than job creation in response to the shock. □

Heterogeneous impulse responses across the firm distribution I summarize the dynamics of the model through an impulse response analysis. The analysis shows how the effects of an aggregate financial sector shock on firms vary across the net worth distribution of firms, along the lines suggested by corollaries (1 and 2).

Figure 1.7 plots the baseline scenario of firms that belong to the $10^{th}, 20^{th}, 30^{th}, 50^{th}$ and 90^{th} quantiles of the firm net worth distribution. In this scenario, simulation starts with a large number of firms that are left to reach their stochastic steady state over a long period of time, while all shocks are shut off at $t \neq t_0$ (i.e. before and after t_0). At time t_0, every firm receives an idiosyncratic net worth shock ω_i, generating a distribution of firms that vary with respect to their net worth and, consequently, optimal policy decisions $\{k_i', n_i', LR_i\}$. The presented firms have the highest net worth among their corresponding quantiles, based on the net worth distribution at $t = t_0$. I include more quantiles for the lower end of the distribution because this where firms are most sensitive to fluctuations in credit supply. At the upper end, the response of firms that belong to the 75^{th} quantile is hardly distinguishable from a firm that belongs to the 90^{th} quantile.

In line with the propositions discussed above, the figure shows that lower net worth firms are exposed to higher default probabilities and pay a higher financing premium. Firms in the 90^{th} hardly face any premium since their default probability is almost zero. More importantly, the hiring rates of lower net worth firms are lower, the labor intensity of their production is lower, they pay lower wages, and their shares of total output and total employment are smaller.

Figure 1.8 plots how these different firms react when they are exposed to an expansionary credit supply shock at $t = t_0$. The shock leads to a decline in the aggregate base rate in response to the exogenous increase in the financial sector net worth. The key observation here is that the decline in default probabilities and financing premium is stronger for lower net worth firms. That is, their borrowing constraint relaxes by a larger magnitude compared to higher net worth firms. This differential response is an outcome of the convexity of the loan contract, as discussed in proposition 4; a feature that is typically lost in linearized models (Brunnermeier and Sannikov (2014)).

This heterogeneity in the effects of the shock on the borrowing constraints of the three firms leads to faster growth in output, labor intensity, and wages for lower net worth firms. As a result, the output share of lower net worth firms rises, and the *within* component of aggregate labor intensity ($\sum_i w_i^0 \Delta LI_i$) and aggregate wage ($\sum_i w_i^0 \Delta W_i$) take positive values.

Nevertheless, as could be seen in figure 1.9, despite their larger expansion in response to the aggregate shock, they still remain riskier than the median and higher net worth firms; the higher risk implies that the low net worth firm maintains lower labor intensity and wage levels while growing to occupy a larger output share of the aggregate economy. In other words, the *cross* component of aggregate labor intensity ($\sum_i \Delta w_i LI_i$) and aggregate wage ($\sum_i \Delta w_i W_i$) take negative values, exerting downward pressure on the aggregate labor intensity and wage.

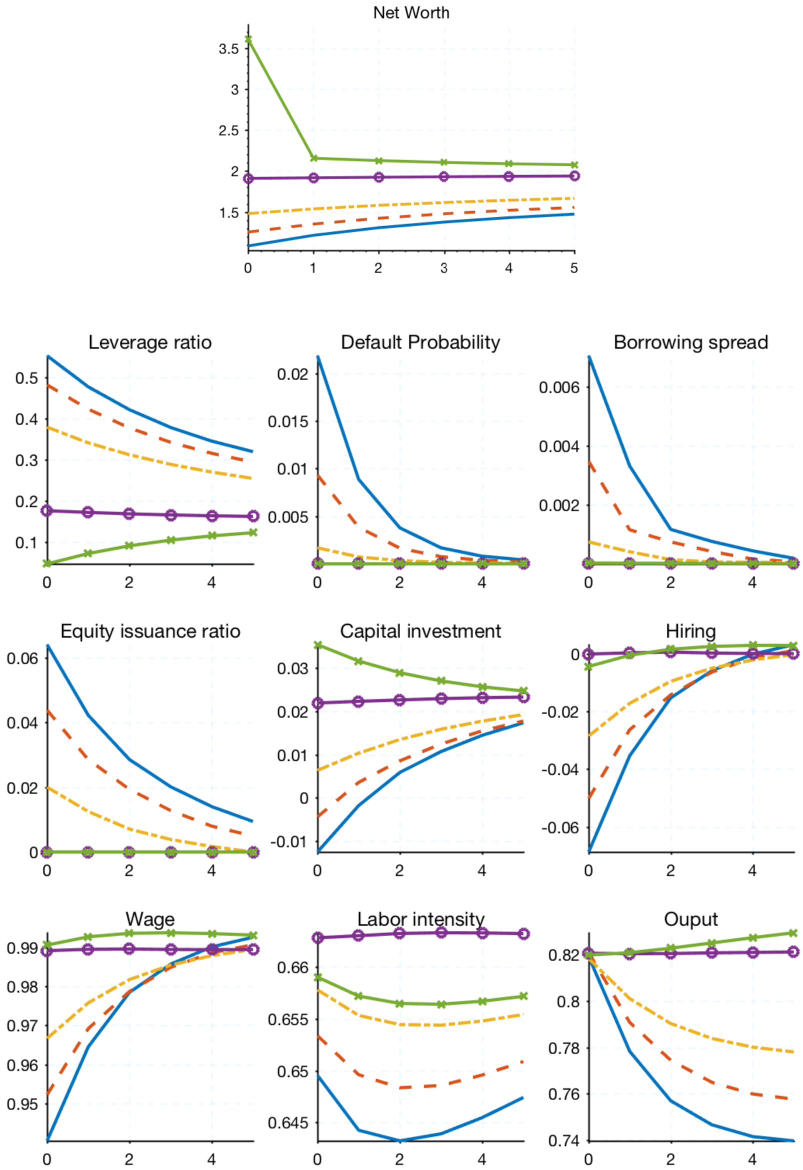
As discussed in corollary (1), whether the within or composition effects dominate depends on the level of dispersion in financing costs or net worth across firms, and the share of output produced by firms subject to tight borrowing constraint (i.e. under the steeper part of the loan contract curve, figure 1.6). The wider the dispersion and the smaller the share of tightly constrained firms, the more likely the negative effects dominate the aggregate labor intensity and wage response to credit expansion. The negative empirical responses of the two variables, documented in the time series analysis section of the paper, suggest that, on average, fluctuations in credit supply are associated with dominating compositional effects.

1.4 Conclusion

The analysis proposes an explanation why expanding credit supply can bring about a jobless and wageless growth pattern. I start by exploring the causal relationship between aggregate credit market fluctuations and the aggregate labor share in the United States, using a novel *narrative* approach to identify aggregate exogenous variations in aggregate credit supply within an aggregate structural VAR model. Against what theory predicts at the firm level, I find a negative effect of credit expansion on both the aggregate labor intensity (employment/output) and the aggregate real wage.

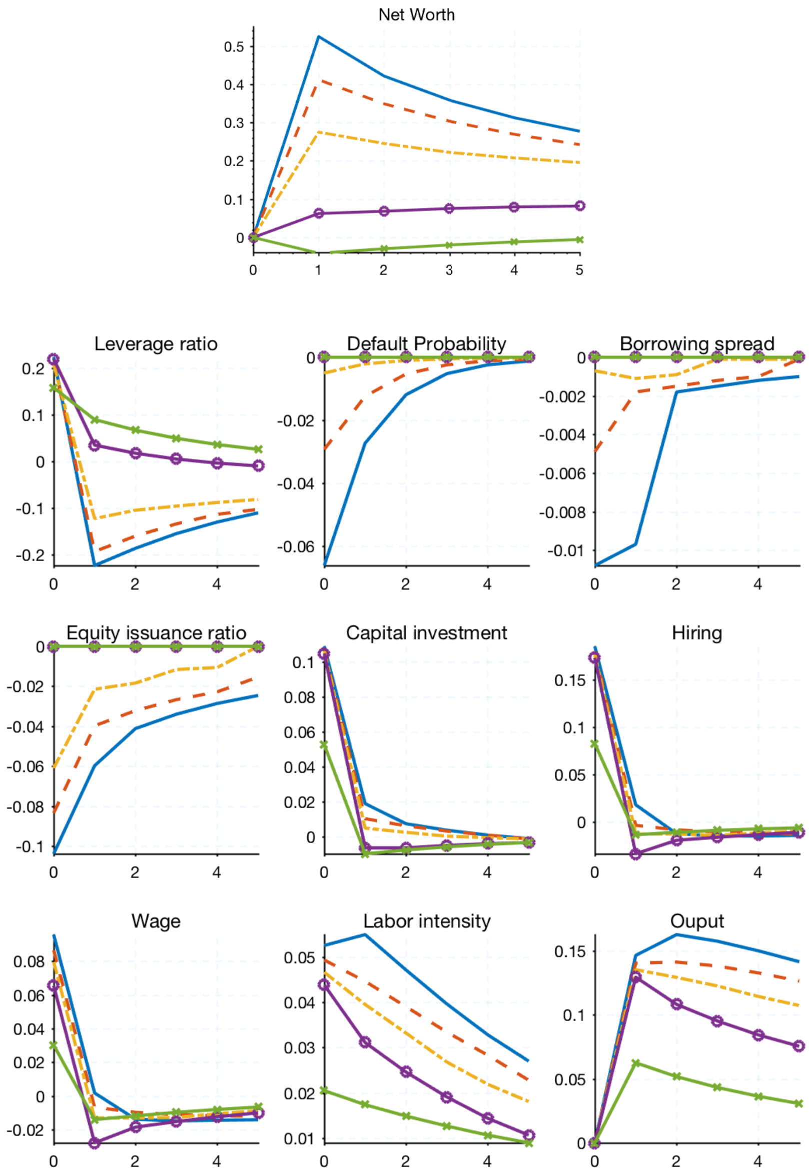
The explanation the paper proposes reconciles the firm level positive labor share effect with the aggregate negative effect. I argue that credit supply expansion has heterogeneous effects across firms depending on their borrowing costs. Therefore, in response to credit supply easing, aggregate output grows primarily through the expansion of firms at the lower end of the firm net worth and productivity distributions. Firms that belong to this part of the distribution prefer investing in collateralizable capital over hiring and pay

Figure 1.7: Baseline scenario



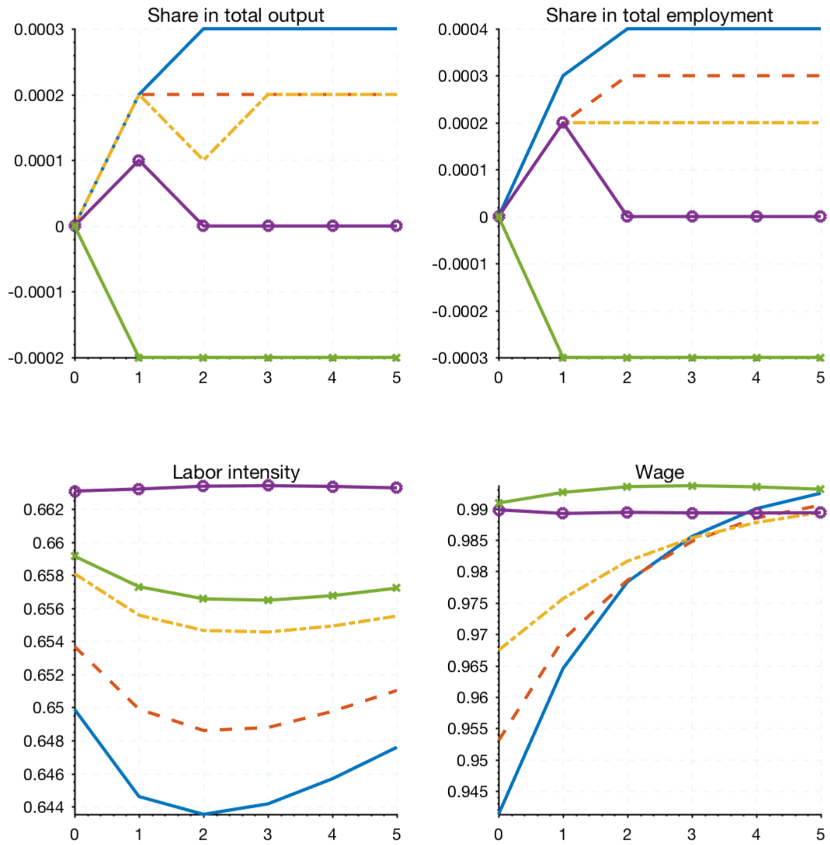
Stochastic steady state of firms that belong to 10^{th} (blue solid), 20^{th} (red dashed), 30^{th} (orange dot dashed), 50^{th} (purple circles) and 90^{th} (green crosses) quantiles of the firm net worth distribution. In this scenario, simulation starts with a large number of firms that are left to reach their stochastic steady state over a long period of time, while all shocks are shut off at $t \neq t_0$. At time t_0, every firm receives an idiosyncratic net worth shock ω_i, generating a distribution of firms that vary with respect to their net worth and, consequently, optimal policy decisions $\{k_i', n_i', LR_i\}$. The presented firms have the highest net worth among their corresponding quantiles, based on the net worth distribution at $t = t_0$.

Figure 1.8: Impulse responses



Impulse responses of the firms that belong to the 10^{th} (blue solid), 20^{th} (red dashed), 30^{th} (orange dot dashed), 50^{th} (purple circles) and 90^{th} (green crosses) quantiles of the firm net worth distribution to one standard deviation bank net worth shock (i.e. credit supply shock) which brings the base rate down to the risk free rate such that $r^b = r^f$. The shock takes place at time t_0, which is the time at which the horizon of figure 1.7 begins. Capital investment rate, output weight, labor weight, hiring rate, labor intensity, leverage ratio, borrowing spread and Equity issuance ratio are presented as the difference between the benchmark scenario and the shock scenario $\times 100$. On the other hand, output, net worth, wage and default probability are presented as the *log* difference between the benchmark scenario and the shock scenario $\times 100$.

Figure 1.9: Composition effects



The curves correspond to firms that belong to the 10^{th} (blue solid), 20^{th} (red dashed), 30^{th} (orange dot dashed), 50^{th} (purple circles) and 90^{th} (green crosses) quantiles of the firm net worth distribution after one standard deviation bank net worth shock (i.e. credit supply shock) which brings the base rate down to the risk free rate such that $r^b = r^f$. The shock takes place at time t_0, which is the time at which the horizon of figure 1.7 begins. The upper two plots are the impulse responses of the firms share in total output and total employment, respectively. The lower two plots are the values of the labor intensity and wages at the firms under the shock scenario. The plot shows that the credit supply shock drives the share in total output and employment of firms that have lower labor intensity and pay lower wages.

lower wages. It follows that by increasing the output share of these firms, the composition channel of credit expansion exerts negative pressure over the aggregate labor share.

I report empirical evidence that, based on a long quarterly panel of industry level employment, wage, job flows, and balance sheet data for the US, supports this composition mechanism. In addition, I construct a dynamic equilibrium model of heterogeneous firms and an aggregate financial sector that accounts for the interaction between financial and labor market frictions. Within this economic environment, I reproduce this heterogeneity in the responses of firms across the distribution to a balance sheet shock that hits the aggregate financial sector.

The paper therefore provides a novel insight that stresses the role of heterogeneity in understanding the aggregate effects of credit market fluctuations with respect to the labor market. It also raises the concern that the main thrust of expansionary credit policies may not be targeting firms that have strong potential to create high labor productivity jobs as their investment levels grow. Policies designed to boost growth in employment and wages may find it more effective to prioritize demand and productivity-related channels over the firm-borrowing channel.

Appendices

.1 Wage setting

This section derives the wage equation (1.3.1) based on a bargaining problem between firms and employees (Michaels, Page, and Whited (2018)). The main distinction of this approach from standard models of search and matching frictions is that wages are set at the firm level, allowing them to vary across the cross-section of firms; in other words, there is no single wage level for the whole economy.

The bargaining problem solves the following maximization,

$$max_w(J^{Employed} - J^{Unemployed})^{\psi}(J^{Filled})^{1-\psi} \tag{39}$$

and the answer is the simple sharing rule,

$$(1-\psi)(J^{Employed} - J^{Unemployed}) = \psi J^{Filled} \tag{40}$$

where J^{Filled} is the employer's surplus from the rents generated by the joint efforts of the worker and the firm, $\frac{\partial V}{\partial n'}$. At the point of negotiating wages, employment adjustment costs (i.e. hiring or firing) are sunk,

$$\begin{aligned} J^{Filled} = \frac{\partial V}{\partial n'}\Big|_{Sunk \Delta c^N} = -n'\frac{\partial w}{\partial n'} - w - \frac{\partial c^{Eq}}{\partial n'} + \\ \frac{1}{1+r^f}\int_{\xi}\int_{Z}\int_{\bar{\omega}}^{\infty}\left\{Q'^K\frac{\partial a'}{\partial n'} - \frac{\partial l'}{\partial n'} - n''\frac{\partial w'}{\partial n'} - \frac{\partial c'^{\Delta N}}{\partial n'} - \frac{\partial c'^{Eq}}{\partial n'}\right\}\phi^{\omega}(\omega', d\omega)\phi^{Z}(Z', dZ)\phi^{\xi}(\xi', d\xi) - \\ \frac{1}{1+r^f}\int_{\xi}\int_{Z} d'(\bar{\omega})\frac{\partial \bar{\omega}}{\partial n'}\phi^{Z}(Z', dZ)\phi^{\xi}(\xi', d\xi) = -\frac{\partial c^{\Delta N}}{\partial n'} \end{aligned} \tag{41}$$

where the last equality uses the firm first order condition, i.e. $\frac{\partial V}{\partial n'} = 0$. $J^{Employed}$ is the worker's surplus which equals the wage it receives today, w, minus the unemployment benefits she forgoes, δ, in addition to discounted value staying employed in the future,

$$\begin{aligned} J^{Employed} = w + \frac{1}{1+r^f}\int_{\xi}\int_{Z}\Big\{\int_{\bar{\omega}}^{\infty}\left(J'^{Employed}\right)\phi^{\omega}(\omega', d\omega) + \\ \int_0^{\bar{\omega}} J'^{Unemployed}\phi^{\omega}(\omega', d\omega)\Big\}\phi^{Z}(Z', dZ)\phi^{\xi}(\xi', d\xi) \end{aligned} \tag{42}$$

Since the analysis is concerned with labor demand, I abstract from unemployment dynamics; once unemployed, a worker cannot access the labor market again. Nonetheless, introducing unemployment dynamics will not change the predictions of the channel discussed in the model.

$$J^{Unemployed} = \sum_{\tau=0}^{\infty}\left(\frac{1}{1+r^f}\right)^{\tau}\Psi = \frac{1+r^f}{r^f}\Psi \tag{43}$$

and using the sharing rule of equation (40) to replace $J'^{Employed}$,

$$\begin{aligned} J^{Employed} = w + \frac{1}{1+r^f}\int_{\xi}\int_{Z}\Big\{\int_{\bar{\omega}}^{\infty}\left(\frac{\psi}{1-\psi}J'^{Filled} + J'^{Unemployed}\right)\phi^{\omega}(\omega', d\omega) + \\ \int_{0}^{\bar{\omega}} J'^{Unemployed}\phi^{\omega}(\omega', d\omega)\Big\}\phi^{Z}(Z', dZ)\phi^{\xi}(\xi', d\xi) \end{aligned} \tag{44}$$

substituting equations (41, 42 and 43) into the sharing rule,

$$\begin{aligned} (1-\psi)\Big\{w - \delta + \frac{\psi}{1-\psi}\frac{1}{1+r^f}\int_{\xi}\int_{Z}\int_{\bar{\omega}}^{\infty}\{\frac{\partial c'^{\Delta N}}{\partial n''}\}\phi^{\omega}(\omega', d\omega)\phi^{Z}(Z', dZ)\phi^{\xi}(\xi', d\xi)\Big\} = \\ \psi\frac{\partial c^{\Delta N}}{\partial n'} \end{aligned} \tag{45}$$

Since wage setting takes place after hiring or firing by the firm is determined, contemporary labor adjustment costs are sunk at this point and do not appear in the wage equation. This is similar to the typical search and matching framework where vacancy posting and its associated costs take place prior to wage negotiations. Then using the firm's Euler equation with respect to n',

$$\begin{aligned} w = \\ \frac{\psi}{(1-\psi)}\Big\{\frac{\partial c^{\Delta N}}{\partial n'} + \frac{1}{1+r^f}\int_{\xi}\int_{Z}\int_{\bar{\omega}}^{\infty}\{\frac{\partial c'^{\Delta N}}{\partial n''}\}\phi^{\omega}(\omega', d\omega)\phi^{Z}(Z', dZ)\phi^{\xi}(\xi', d\xi)\Big\} + \Psi^{\Delta} \end{aligned} \tag{46}$$

.2 Firm Problem

This section derives the first order conditions of the firm maximization problem. Under the problem description in section 1.3.1, the firm value function has the following Bellman function representation,

$$\begin{aligned} V(a, l, n, z, K, \xi) = max_{k',b',n'}\Big\{Q^{K}a - l + b'_i - Q^{K}k' - wn' - c^{\Delta K} - c^{\Delta N} - c^{Eq} + \\ \frac{1}{1+r^f}\int_{\xi}\int_{Z}\int_{\bar{\omega}}^{\infty} V'(k', b', n', z', \tilde{r}, \xi')\phi^{\omega}(\omega', d\omega)\phi^{Z}(Z', dZ)\phi^{\xi}(\xi', d\xi)\Big\} \end{aligned} \tag{47}$$

subject to,

$$a' = \omega_i' \Big\{ (1-\tau^c) z' k'^{\alpha} n'^{\beta} + (1-(1-\tau^c)\delta) k' \Big\} \tag{48}$$

$$l' = (1 + (1-\tau^c)\tilde{r}) b' \tag{49}$$

$$c^{\Delta K} = \gamma^{\Delta K} \left(\frac{k' - a}{a} \right)^2 a \tag{50}$$

$$c^{\Delta N} = \gamma^{\Delta N} \Big(\frac{n' - n}{n} \Big)^2 n \tag{51}$$

$$c^{Eq} = \gamma^{Eq} Eq^2 \tag{52}$$

Firm loan contract:

$$(1+r^b)b' = E_\xi \left\{ E_z \left\{ (1+\tilde{r}) b' \int_{\bar{\omega}}^{\infty} d\omega + \right.\right. \\ \int_0^{\bar{\omega}} \omega' (1-\mu) Q'^K \Big\{ (1-\tau^c) z' k'^{\alpha} n'^{\beta} + (1-(1-\tau^c)\delta) k_i' \Big\} Q(\omega, d\omega') \tag{53}$$

Wage contract:

$$w(n') = \\ \frac{\psi}{(1-\psi)} \Big\{ \frac{\partial c^{\Delta N}}{\partial n'} + \frac{1}{1+r^f} \int_\xi \int_Z \int_{\bar{\omega}}^{\infty} \Big\{ \frac{\partial c'^{\Delta N}}{\partial n''} \Big\} \phi^{\omega}(\omega', d\omega) \phi^Z(Z', dZ) \phi^{\xi}(\xi', d\xi) \Big\} + \delta \tag{54}$$

where,

$$\bar{\omega} \equiv \omega_{|netW=0} = \frac{(1 + (1-\tau^c)\tilde{r}) b'}{Q'^K \Big((1-\tau^c) Z' k'^{\alpha} n'^{\beta} + (1-(1-\tau^c)\delta) k' \Big)} \tag{55}$$

The problem yields three Euler equations:

$$\frac{\partial V}{\partial k'} = 0 = -Q^K - n' \frac{\partial w}{\partial k'} - \frac{\partial c^{\Delta K}}{\partial k'} - \frac{\partial c^{Eq}}{\partial k'} + \\ \frac{1}{1+r^f} \int_\xi \int_Z \int_{\bar{\omega}}^{\infty} \Big\{ Q'^K \frac{\partial a'}{\partial k'} - \frac{\partial l'}{\partial k'} - \frac{\partial c_i'^{\Delta K}}{\partial k'} - \frac{\partial c'^{Eq}}{\partial k'} \Big\} \phi^{\omega}(\omega', d\omega) \phi^Z(Z', dZ) \phi^{\xi}(\xi', d\xi) \tag{56}$$

$$\frac{\partial V}{\partial b'} = 0 = \\ 1 - n' \frac{\partial w}{\partial b'} - \frac{\partial c^{Eq}}{\partial b'} - \frac{1}{1+r^f} \int_\xi \int_Z \int_{\bar{\omega}}^{\infty} \Big\{ \frac{\partial l_i'}{\partial b'} + \frac{\partial c'^{Eq}}{\partial b'} \Big\} \phi^{\omega}(\omega', d\omega) \phi^Z(Z', dZ) \phi^{\xi}(\xi', d\xi) \tag{57}$$

$$\frac{\partial V}{\partial n'} = 0 = -n'\frac{\partial w}{\partial n'} - w - \frac{\partial c^{\Delta N}}{\partial n'} - \frac{\partial c^{Eq}}{\partial n'} +$$
$$\frac{1}{1+r^f}\int_{\xi}\int_{Z}\int_{\bar{\omega}}^{\infty}\Big\{Q'^{K}\frac{\partial a'}{\partial n'} - \frac{\partial l'}{\partial n'} - n''\frac{\partial w'}{\partial n'} - \frac{\partial c'^{\Delta N}}{\partial n'} - \frac{\partial c'^{Eq}}{\partial n'}\Big\}\phi^{\omega}(\omega', d\omega)\phi^{Z}(Z', dZ)\phi^{\xi}(\xi', d\xi) \tag{58}$$

Future assets and liabilities derivatives

$$\frac{\partial a'}{\partial k'} = \omega'\Big\{(1-\tau^c)Z'\alpha k'^{\alpha-1}n'^{\beta} + 1 - (1-\tau^c)\delta\Big\} = \omega_i'\Big\{(1-\tau^c)(Z'\alpha k'^{\alpha-1}n'^{\beta} - \delta) + 1\Big\} \tag{59}$$

$$\frac{\partial a'}{\partial n'} = \omega'\Big\{(1-\tau^c)Z'\beta k'^{\alpha}n'^{\beta-1}\Big\} \tag{60}$$

$$\frac{\partial l'}{\partial k'} = (1-\tau^c)b'\frac{\partial \tilde{r}}{\partial k'} \tag{61}$$

$$\frac{\partial l'}{\partial b'} = 1 + (1-\tau^c)\tilde{r} + (1-\tau^c)b'\frac{\partial \tilde{r}}{\partial b'} \tag{62}$$

$$\frac{\partial l'}{\partial n'} = (1-\tau^c)b'\frac{\partial \tilde{r}}{\partial n'} \tag{63}$$

Wage derivatives

$$\frac{\partial w}{\partial k'} = -\frac{\psi}{1-\psi}\frac{1}{1+r^f}E_Z\Big\{\phi(\bar{\omega})\frac{\partial \bar{\omega}}{\partial k'}\Big\} \tag{64}$$

$$\frac{\partial w}{\partial b'} = -\frac{\psi}{1-\psi}\frac{1}{1+r^f}E_Z\Big\{\phi(\bar{\omega})\frac{\partial \bar{\omega}}{\partial b'}\Big\} \tag{65}$$

$$\frac{\partial w}{\partial n'} = \frac{\psi}{1-\psi}\Big(\frac{\partial c^{\Delta N}}{\partial^2 n'} + \frac{1}{1+r^f}E_Z\Big\{\frac{\partial c'^{\Delta N}_i}{\partial n'\partial n''}P(\omega' > \bar{\omega}) - \phi(\bar{\omega})\frac{\partial c'^{\Delta N}_i}{\partial n''}\frac{\partial \bar{\omega}}{\partial n'}\Big\}\Big) \tag{66}$$

$$\frac{\partial w}{\partial n} = \frac{\psi}{1-\psi}\frac{\partial c^{\Delta N}}{\partial n \partial n'} \tag{67}$$

Loan rate derivatives

Use implicit differentiation over the loan contract equation: **with respect to k'**

$$\frac{\partial Y}{\partial k'} = E_z\Bigg\{(1+\tilde{r})b'(-\phi(\bar{\omega}))\frac{\partial \bar{\omega}}{\partial k'} + b'P(\omega > \bar{\omega})\frac{\partial \tilde{r}}{\partial k'} +$$
$$(1-\mu)\Big\{Q'^{K}\frac{\partial a_0'}{\partial k'}\int_0^{\bar{\omega}}\omega\phi(\omega', d\omega) + Q'^{k}a_0'\bar{\omega}\phi(\bar{\omega})\frac{\partial \bar{\omega}}{\partial k'}\Big\}\Bigg\} = 0 \tag{68}$$

where $l' = (1 + (1-\tau^C)\tilde{r})b$ $a_0' \equiv \{(1-\tau^c)Z'k'^{\alpha}n'^{\beta} + (1-(1-\tau^c)\delta)k_i'\}$ and $\frac{\partial a_0'}{\partial k'} =$

$\{Z'\alpha k'^{\alpha-1}n'^{\beta} + (1-(1-\tau^c)\delta)\}$, and

$$\frac{\partial\bar{\omega}}{\partial k'} = \frac{(1-\tau^c)b'}{Q'^K a_0'}\frac{\partial\tilde{r}}{\partial k'} - \frac{l'}{Q'^K a'_0}\frac{\partial a_0'}{\partial k'} \tag{69}$$

$$\begin{aligned} E_z\Big\{\frac{\partial\tilde{r}}{\partial k'}\Big((1+\tilde{r})b'(-\phi(\bar{\omega}))\frac{(1-\tau^c)b'}{Q'^K a_0'} + b'P(\omega>\bar{\omega}) + (1-\mu)Q'^k a_0'\bar{\omega}\phi(\bar{\omega})\frac{(1-\tau^c)b'}{Q'^K a_0'}\Big)\Big\} = \\ -1\times E_z\Big\{(1+\tilde{r})b'(-\phi(\bar{\omega}))\big[-\frac{l'}{Q'^K a'_0}\frac{\partial a_0'}{\partial k'}\big]+ \\ (1-\mu)\big\{Q'^K\frac{\partial a_0'}{\partial k'}\int_0^{\bar{\omega}}\omega\phi(\omega',d\omega) + Q'^k a_0'\bar{\omega}\phi(\bar{\omega})\big[-\frac{l'}{Q'^K a'_0}\frac{\partial a_0'}{\partial k'}\big\}\Big\} \end{aligned} \tag{70}$$

$$\begin{aligned} E_z\Big\{\frac{\partial\tilde{r}}{\partial k'}\Big((1+\tilde{r})b'(-\phi(\bar{\omega}))\frac{(1-\tau^c)b'}{Q'^K a_0'} + b'P(\omega>\bar{\omega}) + (1-\mu)\bar{\omega}\phi(\bar{\omega})(1-\tau^c)b'\Big)\Big\} = \\ -1\times E_z\Big\{(1+\tilde{r})b'(-\phi(\bar{\omega}))\big[-\frac{l'}{Q'^K a'_0}\frac{\partial a_0'}{\partial k'}\big]+ \\ (1-\mu)\big\{Q'^K\frac{\partial a_0'}{\partial k'}\int_0^{\bar{\omega}}\omega\phi(\omega',d\omega) + \bar{\omega}\phi(\bar{\omega})\big[-\frac{l'}{a_0'}\frac{\partial a_0'}{\partial k'}\big\}\Big\} \end{aligned} \tag{71}$$

with respect to b'

$$\begin{aligned} \frac{\partial Y}{\partial b'} = (1+r^b) = \\ E_z\Bigg\{(1+\tilde{r})b'(-\phi(\bar{\omega}))\frac{\partial\bar{\omega}}{\partial b'} + b'P(\omega>\bar{\omega})\frac{\partial\tilde{r}}{\partial b'} + (1+\tilde{r})P(\omega>\bar{\omega})+ \\ (1-\mu)Q'^K a_0'\bar{\omega}\phi(\bar{\omega})\frac{\partial\bar{\omega}}{\partial b'}\Bigg\} \end{aligned} \tag{72}$$

$$\frac{\partial\bar{\omega}}{\partial b'} = \frac{1}{Q'^K a_0'}\Big((1-\tau^c)b'\frac{\partial\tilde{r}}{\partial b'} + (1+(1-\tau^c)\tilde{r})\Big) \tag{73}$$

$$\frac{\partial Y}{\partial b'} = (1+r^b) =$$

$$E_z\Bigg\{(1+\tilde{r})b'(-\phi(\bar{\omega}))\Big[\frac{1}{Q'^K a_0'}\Big((1-\tau^c)b'\frac{\partial \tilde{r}}{\partial b'} + (1+(1-\tau^c)\tilde{r})\Big)\Big]+$$
$$b'P(\omega > \bar{\omega})\frac{\partial \tilde{r}}{\partial b'} + (1+\tilde{r})P(\omega > \bar{\omega})+$$
$$(1-\mu)Q^K a_0'\bar{\omega}\phi(\bar{\omega})\Big[\frac{1}{Q'^K a_0'}\Big((1-\tau^c)b'\frac{\partial \tilde{r}}{\partial b'} + (1+(1-\tau^c)\tilde{r})\Big)\Big]\Bigg\} \tag{74}$$

$$\frac{\partial Y}{\partial b'} = (1+r^b) =$$

$$E_z\Bigg\{\frac{\partial \tilde{r}}{\partial b'}\Bigg((1+\tilde{r})b'(-\phi(\bar{\omega}))\frac{1}{Q'^K a_0'}(1-\tau^c)b' + b'P(\omega > \bar{\omega}) + (1-\mu)\bar{\omega}\phi(\bar{\omega})(1-\tau^c)b'\Bigg)+$$
$$(1+\tilde{r})b'(-\phi(\bar{\omega}))\Big[(1+(1-\tau^c)\tilde{r})\Big)\Big] + (1+\tilde{r})P(\omega > \bar{\omega})+$$
$$(1-\mu)Q'^K a_0'\bar{\omega}\phi(\bar{\omega})\Big[(1+(1-\tau^c)\tilde{r})\Big)\Big]\Bigg\} \tag{75}$$

with respect to n'

$$0 = E_Z\Big\{(1+\tilde{r})b'(-\phi(\bar{\omega}))\frac{\partial \bar{\omega}}{\partial n'} + b'P(\omega > \bar{\omega})\frac{\partial \tilde{r}}{\partial n'}+ \tag{76}$$
$$(1-\mu)\Big\{Q'^K\frac{\partial a_0'}{\partial n'}\int_0^{\bar{\omega}}\omega\phi(\omega', d\omega) + Q'^K a_0'\bar{\omega}\phi(\bar{\omega})\frac{\partial \bar{\omega}}{\partial n'}\Big\}\Big\} \tag{77}$$

$$\frac{\partial \bar{\omega}}{\partial n'} = \frac{(1-\tau^c)b'}{Q'^K a_0'}\frac{\partial \tilde{r}}{\partial n'} - \frac{l'}{Q'^K a'_0}\frac{\partial a_0'}{\partial n'} \tag{78}$$

$$0 = E_Z\Big\{(1+\tilde{r})b'(-\phi(\bar{\omega}))\Big[\frac{(1-\tau^c)b'}{Q'^K a_0'}\frac{\partial \tilde{r}}{\partial n'} - \frac{l'}{Q'^K a'_0}\frac{\partial a_0'}{\partial n'}\Big] + b'P(\omega > \bar{\omega})\frac{\partial \tilde{r}}{\partial n'}+$$
$$(1-\mu)\Big\{Q'^K\frac{\partial a_0'}{\partial n'}\int_0^{\bar{\omega}}\omega\phi(\omega', d\omega) + Q'^K a_0'\bar{\omega}\phi(\bar{\omega})\Big[\frac{(1-\tau^c)b'}{Q'^K a_0'}\frac{\partial \tilde{r}}{\partial n'} - \frac{l'}{Q'^K a'_0}\frac{\partial a_0'}{\partial n'}\Big]\Big\}\Big\} \tag{79}$$

$$0 = E_Z\Big\{\frac{\partial \tilde{r}}{\partial n'}\Bigg((1+\tilde{r})b'(-\phi(\bar{\omega})\frac{(1-\tau^c)b'}{Q'^K a_0'} + b'P(\omega > \bar{\omega}) +$$
$$(1-\mu)Q'^K a_0'\bar{\omega}\phi(\bar{\omega})\frac{(1-\tau^c)b'}{Q'^K a_0'}\Bigg) +$$
$$(1+\tilde{r})b'\phi(\bar{\omega})\frac{l'}{Q'^K a_0'^2}\frac{\partial a_0'}{\partial n'} + (1-\mu)\Big\{Q'^K\frac{\partial a_0'}{\partial n'}\int_0^{\bar{\omega}}\omega\phi(\omega', d\omega) - \bar{\omega}\phi(\bar{\omega})\frac{l'}{a_0'}\frac{\partial a_0'}{\partial n'}\Big\}\Big\} \tag{80}$$

Capital adjustment cost derivatives

$$\frac{\partial c^{\Delta K}}{\partial k'} = 2\gamma^{\Delta K}\left(\frac{k' - k_0}{k_0}\right) \tag{81}$$
$$\frac{\partial {c'}_i^{\Delta K}}{\partial k'} = \gamma^{\Delta K_{div}}\frac{k_0'^2 - k''^2}{k_0'^2}\frac{\partial k_0'}{\partial k'} \tag{82}$$

where $k_0 \equiv (1-(1-\tau^C)\delta)k$

Labor adjustment cost derivatives

$$\frac{\partial c^{\Delta N}}{\partial n'} = 2\gamma^{\Delta N}\left(\frac{n' - n}{n}\right) \tag{83}$$
$$\frac{\partial c^{\Delta N}}{\partial^2 n'} = \frac{2\gamma^{\Delta N}}{n} \tag{84}$$
$$\frac{\partial c^{\Delta N}}{\partial n \partial n'} = -2\frac{\gamma^{\Delta N} n'}{n^2} \tag{85}$$
$$\frac{\partial {c'}_i^{\Delta N}}{\partial n'} = \gamma^{\Delta N}\frac{n'^2 - n''^2}{n'^2} \tag{86}$$

Dividend tax and equity cost derivatives

$$\frac{\partial \Gamma^{Eq}}{\partial k'} = 2\gamma^{Eq} d_i^{pre\Gamma}\frac{\partial d^{pre\Gamma}}{\partial k'} = 2\gamma^{Eq} d(-Q^K - n'\frac{\partial w}{\partial k'} - \frac{\partial C_i^{\Delta K}}{\partial k'})\text{if } d \leq 0 \tag{87}$$

$$\frac{\partial \Gamma'^{Eq}}{\partial k'} = 2\gamma^{Eq} d'^{pre\Gamma}(Q'^K \frac{\partial a'}{\partial k'} - \frac{\partial l'}{\partial k'} - \frac{\partial C'^{\Delta K}}{\partial k'}) \tag{88}$$

$$\frac{\partial \Gamma^{Eq}}{\partial b'} = \gamma^{Eq} d^{pre\Gamma}(1 - \frac{\partial w}{\partial b'}) \tag{89}$$

$$\frac{\partial \Gamma'^{Eq}}{\partial b'} = 2\gamma^{Eq} d'^{pre\Gamma}\Big(\frac{\partial l'}{\partial b'}\Big) \tag{90}$$

$$\frac{\partial \Gamma^{Eq}}{\partial n'} = 2\tau^{div} d^{pre\Gamma}(-n' \frac{\partial w}{\partial n'} - w - \frac{\partial C^{\Delta N}}{\partial n'}) \tag{91}$$

$$\frac{\partial \Gamma'^{Eq}}{\partial n'} = 2\tau^{div} d'^{pre\Gamma}_i(Q'^K \frac{\partial a'}{\partial n'} - \frac{\partial l'}{\partial n'} - n'' \frac{\partial w'}{\partial n'} - \frac{\partial c'^{\Delta N}}{\partial n'}) \tag{92}$$

$$\text{where } d_i^{pre\Gamma} = Q^K a_i - l_i + b'_i - Q^K k'_i - C_i^{\Delta K} \tag{93}$$

.3 Bank Problem

This section derives the first order conditions of the bank maximization problem,

$$\max_{B'} \quad E\left\{\sum_{s=0}^{\infty} \left(\frac{1}{1+r^f}\right)^s d^b_{t+s}\right\} \tag{94}$$

subject to,

$$d^b = \xi N^b - B' - C^{lending}(B') \tag{95}$$

$$N'^b = \xi' \times \{(1+r^b)B - (\text{Bankruptcy Losses})\} \tag{96}$$

$$C^{lending}(B', N^b) = \gamma^{C_{lending}} \frac{B'}{N^b} \tag{97}$$

$$d^b > 0 \tag{98}$$

The problem yields one Euler equation,

$$\begin{aligned} & -1 - \frac{\partial C^{lending}}{\partial B'} + \frac{1}{1+r^f} E\Big\{\frac{\partial N'^b}{\partial B'} - \frac{\partial C'^{lending}}{\partial B'}\Big\} = \\ & -1 - \frac{\partial C^{lending}}{\partial (B'/N^b)} \times \frac{\partial (B'/N^b)}{\partial B'} + \frac{1}{1+r^f} E\Big\{\frac{\partial N'^b}{\partial B'} - \frac{\partial C'^{lending}}{\partial (B''/N'^b)} \times \frac{\partial (B''/N'^b)}{\partial B'}\Big\} = 0 \end{aligned} \tag{99}$$

where,

$$\frac{\partial C^{lending}}{\partial (B'/N^b)} = \gamma^{C_{lending}} e^{\frac{B'}{N^b}} \tag{100}$$

$$\frac{\partial (B'/N^b)}{\partial B'} = \frac{1}{N^b} \tag{101}$$

$$E\Big\{\frac{\partial N'^b}{\partial B'}\Big\} = E\{\xi'\}(1+r^b) \tag{102}$$

$$\frac{\partial C'^{lending}}{\partial (B''/N'^b)} = 2\gamma^{C_{lending}} \times e^{\frac{B''}{N'^b}} \tag{103}$$

$$\frac{\partial (B''/N'^b)}{\partial B'} = -\frac{B''}{E\{\xi'\}(1+r^b)B'^2} \tag{104}$$

$$-1-\gamma^{C_{lending}} e^{\frac{B'}{N^b}} \times \frac{1}{N^b} + \frac{1}{1+r^f}\Big\{E\{\xi'\}(1+r^b) - E\Big\{\gamma^{C_{lending}} e^{\frac{B''}{N'^b}} \times \frac{-B''}{\xi'(1+r^b)B'^2}\Big\}\Big\} = 0 \tag{105}$$

$$-1-\gamma^{C_{lending}} \frac{e^{\frac{B'}{N^b}}}{N^b} + \frac{1}{1+r^f}\Big\{E\{\xi'\}(1+r^b) + \gamma^{C_{lending}} E\Big\{\frac{B'' e^{\frac{B''}{N'^b}}}{\xi'(1+r^b)B'^2}\Big\}\Big\} = 0 \tag{106}$$

$$(1+r^b)^2 - (1+\gamma^{C_{lending}} \frac{e^{\frac{B'}{N^b}}}{N^b})\frac{(1+r^f)}{E\{\xi'\}}(1+r^b) + \gamma^{C_{lending}} E\Big\{\frac{B'' e^{\frac{B''}{(1+r^b)B'}}}{E\{\xi'\}^2 B'^2}\Big\} = 0 \tag{107}$$

Chapter 2

The Balance Sheet Effects of Oil Market Shocks: An Industry-Level Analysis

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Chapter 3

The Role of Labor Market Frictions in Structural Transformation

3.1 Introduction

Cross-country studies reveal a large gap in aggregate labor productivity levels between countries at the opposite ends of the income distribution (Caselli (2005) and Erosa, Koreshkova, and Restuccia (2010)). In a multi-sector economy, two factors determine aggregate labor productivity: within sector productivity and the allocation efficiency of resources across these sectors. Empirical work shows that countries struggling with low aggregate productivity levels lag in both respects; first, levels of sectoral labor productivity differ widely across countries in favor of developed economies, with the differences being largest in the agriculture and services sectors, but smaller in manufacturing (Duarte and Restuccia (2010), Gollin, Lagakos, and Waugh (2014)); second, there are larger discrepancies in labor productivity levels across sectors within less developed countries (McMillan and Rodrik (2011)).[1]

In this paper, I focus on the *across*-sector allocation efficiency as a determinant of aggregate labor productivity.[2] Theory postulates that the process of structural transformation within a country, whereby labor moves from low to high labor productivity sectors, should be immediate and continue until productivity gaps across sectors cease to exist (e.g. Laitner (2000), Ngai and Pissarides (2007)). However, against this prediction, large

[1] Taking Egypt as an example, the value added per employee (a measure of labor productivity) in the agriculture sector in 2005 was 14.1 (constant USD), compared to 39.34 in France. In addition, the ratio between labor productivity in manufacturing to agriculture was 2.74 in Egypt compared to 1.57 in France.

[2] The observed difference in labor productivity of the same sectors across different countries has received ample attention (Hsieh and Klenow (2009)).

productivity gaps across sectors persist in most economies, suggesting the presence of frictions that impede the immediate flow of labor toward its efficient allocation. In this context, job flows across sectors are only partial and incomplete. The first goal of this paper is to quantify the magnitude of these frictions as implied by the pace by which jobs flow toward their optimal allocations.

The second goal is to evaluate the contribution of labor market regulations to these frictions. That is, I explore whether variations across countries with respect to the tightness of their labor market regulations could explain the heterogeneity observed among them with respect to the persistence of across-sector productivity gaps. Economies facing lower frictions enjoy more dynamic labor mobility and react faster to shifts in the drivers of the structural transformation process, making productivity gaps less persistent. On the other hand, excessive labor regulations make hiring and firing costly for firms, discouraging, in return, both job destruction in lower productivity occupations and job creation in higher productivity ones. These rigidities inhibit the efficient flow of jobs across sectors and result in inefficient allocations of employment shares and lost opportunities for productivity growth.

Understanding the obstacles to an efficient structural transformation is particularly valuable for developing economies, which have set in place ambitious sectoral policies designed to boost potential growth, but where productivity and employment outcomes continue to lag. McMillan and Harttgen (2014) show that between 2000 and 2010, structural transformation toward high productivity sectors accounted for roughly half of Africa's growth in output per worker.

To meet these goals, I estimate a dynamic panel error correction model (P-ECM) of sectoral labor allocation using sector level data for a panel of 44 countries covering developed, emerging, and frontier economies. The choice of the model is motivated by the observation that the process of structural transformation is non-stationary, where value added and employment shares are *cointegrated*, being driven by the same underlying process of technical change (i.e. changes in sector level TFP) or income growth (Herrendorf, Rogerson, and Valentinyi (2013), Ngai and Pissarides (2007), Laitner (2000)). The P-ECM model is able to capture these key empirical patterns, while providing a measure of the level of policy distortions or institutional costs that restrict the fluidity of labor reallocation (i.e. speed of adjustment, Pagan (1985), Alogoskoufis and Smith (1991)). These distortions cause short term gaps (i.e. errors) in labor productivity across sectors by slowing down the efficient adjustment of employment shares in reaction to changes in aggregate income growth or sector level TFP.

The paper's contribution to the literature is twofold. First, it documents a new set of stylized facts with regards to the structural transformation process; I find empirical evidence that labor allocation (i.e. employment shares) across sectors follows an adjustment process, converging toward equilibrium allocations and closing around 15.4 % of labor productivity gaps each year over the full sample, on average. The rate of labor flow varies across country income groups and regions, with higher income countries enjoying more fluid structural transformation processes than lower income countries. In addition to income, I also find heterogeneity with respect to geographical regions, where Asia appears to have been the fastest transforming region, followed by Latin America, Europe-USA, and, finally, Africa. This is consistent with the large structural transformation wave that took place in these faster regions in the second half of the twentieth century, compared to the western countries that experienced their main wave in the 19^{th} and 18^{th} centuries, and African countries that are yet to undergo a major transformation. Moreover, I find that the rate of labor flows varies across sectors, implying different degrees of frictions among them and indicating a role for sectoral policies.

With regard to labor market regulations, I find a significant positive association between the pace of labor reallocation across sectors and the freedom level of labor market institutions. However, in contrast to the classical intuition, I find that lowering firing costs slows down the structural transformation process. This result suggests that the discouraging effect of having lower job security on the labor supply side is stronger than the benefits that firms gain from more flexible labor market conditions. Looking at the heterogeneity at the country income level, I find that for low income countries, higher levels of average labor costs, average employee payroll taxes, and minimum to mean wage ratios are associated with a slower flow of labor across sectors. For high income countries, the effect is insignificant, which implies that the effect of labor regulations on the process of structural transformation is more binding for less developed economies.

Given this set of results, I argue that there is space for policy reforms in labor markets to provide higher levels of aggregate labor productivity growth. However, policy reforms aiming at improving the fluidity of structural transformation need to maneuver between the goal of easing job creation and destruction, while supporting labor supply incentives to reallocate and shift industries through strong social nets, labor protection, and risk sharing. The remainder of the paper proceeds as follows: Section 2 reviews existing literature related to structural transformation and constraints to labor reallocation; section 3 describes the data; section 4 carries out a decomposition analysis to quantify the role of across-sector labor reallocation in aggregate productivity growth. Section 5 discusses our data and empirical strategy; Section 6 discusses our results; finally, section 7 concludes.

3.2 Literature Review

A large literature discusses the employment and participation rates effects of labor market regulations, including labor cost, employee payroll taxes, and other welfare measures such minimum wages and unemployment benefits (Siebert (1997)). The general agreement that comes out of the literature is that higher employment costs and less flexible regulations contribute to higher unemployment rates, where this line of argument is typically taken to justify the differences in employment levels between the United States and European economies. In this paper, I am more concerned with allocation efficiency; that is, I want to understand to the effect of labor market regulations on job flows across sectors. The answer to this question is less salient in the literature.

The efficient allocation of resources within a country can help close the gap between sectoral labor productivity levels within a country and raise aggregate productivity levels. Krugman (1994) provides a less formal presentation of this intuition for the case of China and the Soviet Union, where he argues that the significant rise in their productivity levels stem from massive reallocation of factor inputs toward higher productivity sectors, without necessarily raising sectoral TFP and efficiency levels. Restuccia and Rogerson (2008) analyze the relationship between allocative efficiency among firms and aggregate TFP. Their theoretical framework shows how frictions lead to a misallocation of resources and a decline in aggregate TFP; that is, frictions lead markets to allocate firms a disproportionate share of resources relative to their labor productivity. Hsieh and Klenow (2009), applying this intuition to Chinese and Indian industrial firms, find large hypothetical gains in productivity stemming from redistributing capital and labor resources such that marginal returns among firms are matched to levels observed in the US. The key contribution of these papers is to analyze the role frictions play in misallocation of resources and its impact on sectoral productivity.

Against this background, several papers try to identify the key frictions that drive labor and capital misallocations. Most of this work focuses on the firm-level. Haltiwanger, Scarpetta, and Schweiger (2014), using a large sample of Eastern European firms, find a statistically significant role for distortionary labor market regulations in hindering efficient labor allocations. Bai, Carvalho, and Phillips (2015), assessing the role of credit frictions across the US, find a positive significant effect of banking deregulation on the efficiency of labor reallocation across firms. Trade costs are another source of distortions that allow less productive firms to survive, while high productivity firms suffer costly access to local markets. Costinot and Donaldson (2012) examine the empirical relevance of this intuition within the agricultural sector to test Ricardo's theory on comparative advantage.

In addition to capital and labor adjustment costs and financial and trade frictions, another set of frictions are more likely found in countries with less-developed institutions. For one, the presence of large state-owned enterprises (SOEs) can be a source of distortion. Subsidizing large and inefficient firms can drive resources away from more productive entities, as argued in Hsieh and Klenow (2009) for the case of India. The spread of an informal sector can also give rise to another source of distortions: in a study on Indian and Mexican firms, Hsieh and Klenow (2014) observe that manufacturing firms do not grow at the same speed observed in the US; Mexican and Indian firms tend to prefer to operate in the informal sector to avoid rigidities in the regulatory framework, but suffer lower productivity in return. At the sectoral level, McMillan and Rodrik (2011) highlight several sector-level frictions: (1) customs on imported goods protect less efficient firms from international competition, preventing labor force from shifting toward more productive sectors of the economy; (2) currency devaluation practices can serve as a subsidy to less productive firms; and (3) revealed comparative advantage in natural resources or extractive sector.

Ciccone and Papaioannou (2008) analyses the flow of labor between sectors subject to barriers to entry, documenting a significant role for this kind of friction among manufacturing industries. Cheremukhin et al. (2017) finds that barriers to entry and monopoly powers in the non-agricultural sector largely explain the failure to industrialize the Russian economy over the Tsarist and Soviet periods. There are no empirical studies that attempt to estimate the frictions at the sectoral level and to quantify the impact of structural reforms on sectoral labor reallocation. To this end, this paper proposes an empirical methodology to measure frictions and the role of labor market reforms in supporting structural transformation.

As suggested by the aforementioned studies, a specific set of structural reforms are expected to have an impact on structural transformation in this respect, of which labor reforms are usually ranked high. A reform that has the potential to create jobs in higher productivity sectors and allow more fluid mobility of labor could potentially do so through the following channels, *with respect to labor demand*: 1) easing regulations around the destruction of jobs in activities of low productivity; 2) lowering the costs of hiring in sectors of higher productivity; 3) removing regulatory and market biases that would channel more capital or financial resources to a sector than is justified by its relative value added; 4) allowing market access to competitive sectors; 5) boosting confidence and lowering uncertainty about growth prospects in productive sectors, *with respect to labor supply*; 6) protecting labor rights; 7) providing a social safety net that could encourage risk taking in job transition; and 8) providing easier access and more exposure to opportunities for training and skill development.

3.3 Data

The dataset is taken from several sources. The Groningen Growth and Development Center 10 sectors (GGDC) database provides data on annual series of value added, output deflators, and persons employed for 10 broad sectors for 44 countries in the US, Europe, Africa, Asia, and Latin America. The sample period is unbalanced and runs between 1950 and 2013; see tables (.1.1 and.1.2).

The labor market regulations indicators are part of recent indices compiled by the IMF of *de jure* reforms and liberalization in the real and financial sectors (IMF (2008)). While these annual indicators span enacted reforms in other areas like international trade, FDI, and the financial sector (banking system and capital market), in this study I only use the labor market indices (Schindler and Aleksynska (2011)). I examine four indicators: Average labor costs, average employee payroll taxes, ratio of minimum wage to mean wage, and unemployment coverage. The first two measure the regulatory financial burden associated with creating or holding a job, which increases proportionally with its productivity, while the last two indicators reflect the welfare aspects of labor market institutions; both areas are the subject of continuing debate on the optimal economic policies for inclusive growth. The time interval is between 1980 and 2005.

In addition, I also use the labor market measures from the Economic Freedom indicators, which are available on an annual basis from 2000 through 2013. These include measures of hiring and firing regulations, centralized collective bargaining, mandated cost of worker dismissal, and a labor market regulations summary index.

3.4 Structural transformation in aggregate productivity

I start the analysis by showing the magnitude of the role played by the process of structural transformation in the growth of aggregate labor productivity. To measure the contribution to labor productivity growth from the reallocation of labor across sectors of the economy, I use a variant of the canonical decomposition originating from Fabricant (1942):

$$\Delta P = \sum_i (P_i^T - P_i^0)S_i^0 + \sum_i (S_i^T - S_i^0)P_i^0 + \sum_i (P_i^T - P_i^0)(S_i^T - S_i^0) \tag{3.1}$$

where S_i is the share of sector i in overall employment, P_i the labor productivity level of sector i, and superscripts 0 and T refer to initial and final period. In the equation, the change in aggregate productivity is decomposed into within-sector productivity changes (the first term on the right-hand side that I call the "within-effect," also known as "intra-effect") and two other effects. The within-effect is positive when the weighted change in labor productivity levels in sectors is positive. The second term measures the contribution of labor reallocation across sectors, being positive when labor moves from less to more productive sectors (structural change), our term of interest. The third term in the equation is known as the cross term or interaction term. It represents the joint effect of changes in employment shares and sectoral productivity growth.

Table 3.1 reports the computed results for all countries in our sample, and table 3.2 summarizes its statistics. Over the full sample, I find that the median contribution of labor flows across sectors to aggregate labor productivity growth is 6.6%; however the distribution is skewed to the left, with the left 14^{th} quantile as low as 295.2 %. The low magnitude of the median value and the very negative left tail reflect the difficulty economies face in utilizing the structural transformation potential for productivity growth as well as the high level of misallocation and failure of many economies to reallocate labor toward higher productivity sectors over time.

On the other hand, breaking the sample by income group reveals that gains in the labor productivity growth of high-income countries over the same time period appears to have been far higher than that of low income countries. The median for the latter is negative amounting to -53.9 %, pointing at lost opportunities in countries at the lower end of the income distribution. High-income countries have a distribution of results with relatively more symmetric tails and a median of 9.88% .

Table 3.3 reports the potential gains that countries could attain by merely mobilizing labor across sectors such that labor productivity across sectors were equated, and table 3.4 reports its summary. The large magnitude of the figures especially for low income countries, which ranges between 92.8 and 617.08 % give a profound motivation for policy reforms that aim at removing institutional and regulatory impediments to labor flows from low to high productivity sectors.[3]

[3]It is important to keep in mind that these numbers are only suggestive, given that the analysis abstracts from possible non-linearities and changes in agents' optimization decisions.

Table 3.1: Aggregate productivity decomposition

Country	Within sectors	Cross sectors	Interaction	Country	Within sectors	Cross sectors	Interaction
ARG	106	9	-15	KEN	228	-409	281
BOL	76	442	-419	KOR	98	10	-7
BRA	102	24	-26	MAR	111	10	-20
BWA	194	-17	-78	MEX	55	122	-77
CHL	196	-27	-70	MUS	95	20	-16
CHN	82	5	14	MWI	-34	406	-272
COL	1209	-2189	1080	MYS	115	-10	-4
CRI	127	80	-107	NGA	433	-134	-199
DNK	141	-19	-22	NLD	72	33	-5
EGY	211	-46	-65	PER	132	-3	-29
ESP	51	55	-6	SEN	103	155	-158
ETH	23	150	-59	SGP	143	-22	-21
FRA	86	22	-8	SWE	122	-8	-13
GBR	137	-1	-36	THA	50	63	-13
GHA	85	19	-4	TWN	108	-6	-2
HKG	135	-5	-30	TZA	7	130	-37
IDN	85	10	5	USA	124	-3	-21
IND	76	32	-9	VEN	122	-109	87
ITA	99	11	-10	ZAF	151	58	-110
JPN	96	15	-11	ZMB	64	123	-86

Table reports the decomposition of aggregate labor productivity gains between 1990 and 2005 for all countries in our sample, following equation (3.1). Numbers are in percentages.

Table 3.2: Summary statistics of table (3.1)

	Median	84th Quantile	14th Quantile
Full Sample	6.60	67.50	-295.20
High-income countries	9.88	22.09	-6.19
Low-income countries	-53.88	76.02	-573.99

The results are in percentage with respect to aggregate labor productivity growth between 1990 and 2005. Low-income countries include countries classified by the world bank as low or lower middle income. High-income countries include those classified as high or higher middle income countries.

Table 3.3: Potential gains in aggregate labor productivity labor.

Country	Potential Gains	Country	Potential Gains	Country	Potential Gains	Country	Potential Gains
ARG	58.67	EGY	1737.81	KOR	56.35	SEN	314.65
BOL	371.06	ETH	170.62	MAR	66.4	SGP	76.65
BRA	88.64	GHA	93.03	MEX	169.92	THA	251.23
BWA	301.45	HKG	135.89	MUS	32.69	TWN	58.07
CHL	147.45	IDN	166.67	MWI	176.38	TZA	166.1
CHN	70.15	IND	91.69	MYS	294.15	USA	29.11
COL	151.91	JPN	19.16	NGA	3682.85	VEN	219.2
CRI	41.88	KEN	102.51	PER	114.05	ZAF	49.41

The table reports the potential gains in aggregate labor productivity from reallocating labor across sectors such that there is no labor productivity gaps across them. Computation is based on the observed productivity and labor shares per sector in 2010. Computed numbers are in percentage as a ratio aggregate productivity in 2010.

Table 3.4: Summary statistics of table (3.3)

	Median	84th Quantile	14th Quantile
Full Sample	124.97	305.31	53.71
High-income countries	58.07	137.74	27.52
Low-income countries	168.65	617.08	92.79

The figures are the summary statistics of the expected gains in aggregate labor productivity from labor reallocation across sectors in percentage terms with respect to aggregate labor productivity in 2010. Low-income countries include countries classified by the world bank as low or lower middle income. High-income countries include those classified as high or higher middle income countries.

3.5 The ECM framework

3.5.1 Theoretical motivation

There are two main theoretical approaches attempting to explain the process of structural transformation across economic sectors in a growing economy. The first approach relies on the demand-side effects generated by growing income when preferences are non-*homothetic* (e.g. Laitner (2000), Gollin, Parente, and Rogerson (2002)). As income levels grow, consumption saturates for one sector after another, and the increase in wealth flows into different sectors, i.e. after a certain level of income, consumption of manufactured goods rises with higher income levels while spending on agricultural products saturates; the same mechanism also works between manufacturing and services. According to this mechanism, a structural transformation is a necessary feature that accompanies income growth and an ever-continuing process, whereby the relative value added and prices of saturating sectors decline perpetually.

The second approach is the supply-side approach, discussed by Ngai and Pissarides (2007), where employment shares are driven by the relative magnitude of productivity growth across sectors. Relative prices play a key role here; higher productivity growth sectors experience lower relative prices since demand is unable to catch up with the increasing supply of output. The lower prices put downward pressure on labor compensation and prompts an outflow of labor from sectors with higher productivity growth rates, such as agriculture, thus helping to restore the balance in labor productivity across sectors. According to this channel, employment shares across sectors are set such that labor productivity (i.e. wages) are equal across sectors, and structural transformation is triggered when the growth rate of a sector's TFP exogenously changes.

No matter which of the two mechanisms drives the transformation dynamics, labor moves across sectors with the goal to restore the balance in labor productivity; otherwise, agents have no incentive to reallocate. In a frictionless economy, this flow of labor ensures equal labor productivity across any two sectors i and j at any point in time t in country c,

$$LaborProductivity_{i,t} = LaborProductivity_{j,t} \tag{3.2}$$

$$\frac{VA_{i,c,t} \times P_{i,c,t}}{N_{i,c,t}} = \frac{VA_{j,c,t} \times P_{j,c,t}}{N_{j,c,t}} \tag{3.3}$$

where VA_i is the value added per sector i, P_i is the relative price of sector i output, and

N_i is the size of labor force it employs. This relation implies that sectoral employment shares maintain the following *optimal* expression,

$$\frac{N^*_{i,c,t}}{N^*_{j,c,t}} \equiv \frac{VA_{i,c,t} \times P_{i,c,t}}{VA_{j,c,t} \times P_{j,c,t}} \tag{3.4}$$

under either *homothetic* or non-*homothetic* preferences, and irrespective of how different TFP growth rates are across sectors, theory predicts no gaps in labor productivity across sectors.

Multi-sector growth models, like Gollin, Parente, and Rogerson (2002)) and Ngai and Pissarides (2007), assume a *friction-less* world, where labor allocations and prices can fully adjust to restore optimality in response to changes in aggregate income or relative sector level productivity, respectively. Nonetheless, in reality, structural market and institutional frictions slow down this adjustment process, allowing labor to only partially reallocate; as a result, a wedge grows between the observed sector level allocation of labor and the optimal plan where labor productivity across sectors are equalized. It is important to note that the rate of this partial adjustment and the size of this wedge are both functions of the structural frictions impeding the efficient flow of labor force. I use this intuition to quantify the magnitude of the frictions facing labor reallocation in the economy by estimating the rate of adjustment within a Co-integrated Error Correction Model (ECM).

Modelling structural transformation The ECM model can be interpreted as the optimal adjustment rule in an economy where workers in lower productivity sectors for-goes potential earnings by not reallocating toward higher productivity sectors and, at the same time, they also face costs if they carry out rapid adjustments, i.e. reallocation. Under a simple quadratic specification of these adjustment costs,

$$C(\frac{N_{i,c,t}}{N_{j,c,t}}, \frac{N^*_{i,t}}{N^*_{j,t}}) = \frac{1}{2}(\frac{N_{i,c,t}}{N_{j,c,t}} - \frac{N^*_{i,c,t}}{N^*_{j,c,t}})^2 + \frac{\kappa}{2}\Delta\left(\frac{N_{i,c,t}}{N_{j,c,t}}\right)^2 \tag{3.5}$$

where $N_{i,t}$ is the employment level in sector i at time t, which tracks, but may deviate from, the optimal level $N^*_{i,t}$, as described in equation (3.4). κ is the ratio of the marginal cost of adjustment relative to the marginal cost of being away from the optimal allocation $N^*_{i,t}$.

Labor in lower productivity sectors reallocate, to minimize C in equation (3.5), such that at any point in time t, the following Error Correction model exactly describes employment shares allocations for an efficient economy,

$$\Delta\left(\frac{N_{i,c,t}}{N_{j,c,t}}\right) = \lambda\left(\frac{N^*_{i,c,t}}{N^*_{j,c,t}} - \frac{N_{i,c,t-1}}{N_{j,c,t-1}}\right) = \lambda\Delta\left(\frac{N^*_{i,c,t}}{N^*_{j,c,t}}\right) - \lambda\left(\frac{N_{i,c,t-1}}{N_{j,c,t-1}} - \frac{N^*_{i,c,t-1}}{N^*_{j,c,t-1}}\right) \tag{3.6}$$

where $\lambda \equiv \dfrac{1}{1+\kappa}$ is the speed of labor reallocation and $0 < |\lambda| < 1$; if it is negative (positive), the closer it is to 1, the faster the rate at which job flows are able to narrow (widen) productivity gaps.

See Pagan (1985), Nichell (1985) and Alogoskoufis and Smith (1991) for a discussion of the ECM model as an equilibrium condition within a rational framework of optimizing agents facing adjustment costs.

The observation that the ECM model shows up as an analytical solution for the optimal structural transformation process in a model where labor reallocation is costly is only one part of our motivation behind the use of this framework. Another large part stems from the fact that the ECM environment captures the main empirical patterns of structural transformation and, therefore, allows for a direct estimation of its key structural parameters: First, the underlying process of structural transformation is non-stationary, meaning that sectoral labor shares and productivity maintain a secular trend over time, as observed in the data and documented in Herrendorf, Rogerson, and Valentinyi (2013).

Second, since these trends are driven by the same underlying process of TFP or income growth, they are co-integrated. Third, in the short run, sector output and employment are subject to disturbances that move them away from their co-integration equilibrium values. Fourth, there are frictions in the adjustment process of labor, output, and prices that prevent an instantaneous reversion to the trend. By preserving the co-integration relation between the variables, the ECM model allows for estimating both long and short-term elasticities as well as the speed of the adjustment. While the model has a long history in time series analysis, its application to panel dynamics is relatively limited (e.g. Malpezzi (1999), Maddala et al. (1997), Yasar, Nelson, and Rejesus (2006)).

3.5.2 The role of human capital

One leading explanation that could be put forward to explain part of the persistence in productivity gaps refers to the heterogeneity in human capital across sectors and countries (Herrendorf and Schoellman (2017), Alvarez et al. (2018)). According to this channel, workers do not reallocate from lower to higher productivity sectors not because of institutional and market frictions, but because they lack the knowledge and necessary skills to perform different tasks. Under this view, the flow of jobs from lower to higher productivity sectors stops when the skill barrier is reached, which occurs before labor productivities are equated,

$$LaborProductivity_{i,t} > LaborProductivity_{j,t} \tag{3.7}$$

let $\gamma_{i,j,c,t}$ be the magnitude of the productivity differential between workers in two different sectors i, j at country c at time t, then,

$$(1 - \gamma_{i,j,c,t})\left(\frac{VA_{i,c,t} \times P_{i,c,t}}{N^*_{i,c,t}}\right) = \frac{VA_{j,c,t} \times P_{j,c,t}}{N^*_{j,c,t}} \tag{3.8}$$

This specification implies that the human capital induced wedge in labor productivity across sectors is a share of the labor productivity of the higher productivity sector; that is, the higher the productivity of sector i, the larger the absolute value of its gap with respect to sector j. For instance, assuming no market or institutional frictions in a country like Egypt, labor should ideally be able to flow from the agriculture sector to manufacturing, up to the point where the skill barrier binds; at this point, the gap between average labor productivity of a worker in manufacturing and agriculture is $\gamma_{m,a,Egy,t}$ times the average labor productivity of a worker in manufacturing, which increases as manufacturing productivity increases.

Hence, in a frictionless economy, the flow of jobs across sectors takes place such that the sector level employment shares are described according to the following expression,

$$\frac{N^*_{i,c,t}}{N^*_{j,c,t}} \equiv (1 - \gamma_{i,j,c,t})\frac{VA_{i,c,t} \times P_{i,c,t}}{VA_{j,c,t} \times P_{j,c,t}} \tag{3.9}$$

that is, the feasible optimal employment share of sectors with lower productivity and lower skill levels becomes larger in comparison to equation (3.4) due to the introduction of the human capital term $\gamma_{i,j,c,t}$.

This human capital channel raises a challenge for empirical work given the lack of a good measure for human capital, in general, and at the sector level in particular. I overcome this problem by making the assumption that $\gamma_{i,j,c,t}$ is constant across countries such that $\gamma_{i,j,c,t} \equiv \gamma_{i,j,t}$; in other words, I assume that the productivity differentials are sector-specific irrespective of the country; for example, the difference in the skills required for a job in services compared to manufacturing at year t does not depend on whether these jobs are in France or Morocco. Continuing with this example, this implies that the difference in human capital between any services and manufacturing is the same in France and Morocco, even though there is a difference between the two countries in terms of the levels of human capital in manufacturing or services.

3.5.3 Econometric specification

The goal of the econometric analysis is to estimate the magnitude of the frictions facing sector level flows in labor markets across countries. Using the ECM model, I estimate the speed of adjustment parameter λ for the whole sample, and for different sectors and country groups. This parameter is the rate at which jobs flow from one sector to another, which is an implied measure of the magnitude of adjustment costs (i.e. frictions). A negative estimate of λ would imply converging productivity gaps across sectors, while a positive one would imply a diverging pattern whereby gaps grow even wider.

In the baselines specification, I estimate λ for the full sample first and then attempt to explore the heterogeneity across country groups and sectors by estimating it for the corresponding subsamples. Substituting equation (3.4) into (3.6), after log transforming the variables yields an ECM of labor reallocation dynamics:[4]

$$\begin{aligned}\Delta log\left(\frac{N_{i,c,t}}{N_{j,c,t}}\right) &= \overbrace{\beta_1 \Delta log\left(\frac{VA_{i,c,t}}{VA_{j,c,t}}\right) + \beta_2 \Delta log\left(\frac{P_{i,c,t}}{P_{j,c,t}}\right) + \beta_3 \Delta X_{i,c,t}}^{\text{Short Term Dynamics}} \\ &+ \underbrace{\lambda\left(log\left(\frac{N_{i,c,t-1}}{N_{j,c,t-1}}\right) - \left[\delta_1 log\left(\frac{VA_{i,c,t-1}}{VA_{j,c,t-1}}\right) + \delta_2 log\left(\frac{P_{i,c,t-1}}{P_{j,c,t-1}}\right) + \delta_3 X_{i,c,t-1}\right]\right)}_{\text{Long Term Dynamics}} + u_{i,c,t}\end{aligned} \tag{3.10}$$

where X_t includes controls for factors that may justify persistent deviation (i.e. error) in observed employment shares from the efficient allocation described by equation (3.4), such as differences in human capital and the skill level of workers. I control for the human capital effects by including a (sector $\times$time) fixed effect, given the assumption discussed above of a constant γ across countries. The fixed effects also control for essential differences across sectors and countries (e.g. capital intensity). As mentioned earlier, both $\frac{N_{i,c,t-1}}{N_{j,c,t-1}}$ and $\frac{VA_{i,c,t-1}}{VA_{j,c,t-1}}$ exhibit similar trends that reflect the process of structural transformation as the shares of labor and value added grow in manufacturing and services at the expense of agriculture and other lower labor productivity sectors (Herrendorf,

[4]This econometric specification is motivated above as an equilibrium condition of the structural problem facing labor force, and it is consistent with general specification of the ECM model discussed in Sargan (1964) and Alogoskoufis and Smith (1991): $\Delta y_t = \lambda \Delta y_t^* - \lambda(y_{t-1} - y_{t-1}^*)$

Rogerson, and Valentinyi (2013)).

Specifically, X_t includes world real GDP growth rate, growth rate of countries real GNP per capita, population growth rate, a global linear trend, as well as constant and linear trend fixed effects: (sector × country) and (linear trend × sector × country); these additional controls make sure that the estimated rate of adjustment captures only country level market and institutional factors, and is not contaminated by the effects of demographic and other global and sector specific trends or global fluctuations. β_1, β_2 and β_3 are the short term elasticities, λ is the adjustment speed, and δ_1, δ_2 and δ_3 are the long term elasticities.

Equation (3.10) implies that labor moves every period to correct past deviations from the optimal values of employment shares (i.e. long term target), and to accommodate contemporaneous changes in these optimal allocations (short term dynamics). In all estimations, I always use the agriculture sector as sector j; such that employment and value added shares as well as sector price levels are normalized by the corresponding values for the agriculture sector.

The role of labor market frictions in labor reallocation

Next, I explore the answer to the second main question of the paper on the magnitude of the part played by labor market regulations in the process of structural transformation. I carry out this task by augmenting the baseline equation (3.10) to introduce a country level labor market indicator R_t via an interaction term with the rate of adjustment.

$$\Delta log\left(\frac{N_{i,c,t}}{N_{j,c,t}}\right) = \beta_1 \Delta log\left(\frac{VA_{i,c,t}}{VA_{j,c,t}}\right) + \beta_2 \Delta log\left(\frac{P_{i,c,t}}{P_{j,c,t}}\right) + \beta_3 \Delta X_{i,c,t} + \lambda_1 Gap_{i,j,c,t-1} + \overbrace{\lambda_2\{R_{t-1} \times Gap_{i,j,c,t-1}\}}^{\text{Labor market Interaction}} + \beta Z_{t-1} + u_{i,c,t} \quad (3.11)$$

where,

$$Gap_{i,j,c,t} \equiv \left(log\left(\frac{N_{i,c,t-1}}{N_{j,c,t-1}}\right) - \left[\delta_1 log\left(\frac{VA_{i,c,t-1}}{VA_{j,c,t-1}}\right) + \delta_2 log\left(\frac{P_{i,c,t-1}}{P_{j,c,t-1}}\right) + \delta_3 X_{i,c,t-1}\right]\right) \quad (3.12)$$

Z_t is a vector of controls for other areas of regulations that could be correlated with the state of labor market institutions. For that, I use the IMF structural reform indices for four key areas: capital flows, banking, domestic finance, and trade. In addition, I also include the other components of the labor market regulations when examining their interaction individually,

$$Z_t \equiv \{R_t^{CapitalFlows}, R_t^{Banking}, R_t^{DomesticFinance}, R_t^{Trade}, R_t^{Avg.LaborCost}, R_t^{Avg.payrolltax}, R_t^{MinimumWageMeanWageRatio}\} \quad (3.13)$$

λ_2 is a measure of the contribution of R_{t-1} in explaining the differences across high-income countries in the average pace of job flows across sectors. I also add another interaction term for low- and high-income country groups, to analyze whether the role labor market regulations plays changes for economies that are at different stages of development,

$$\Delta log\left(\frac{N_{i,c,t}}{N_{j,c,t}}\right) = \beta_1 \Delta log\left(\frac{VA_{i,c,t}}{VA_{j,c,t}}\right) + \beta_2 \Delta log\left(\frac{P_{i,c,t}}{P_{j,c,t}}\right) + \beta_3 \Delta X_{i,c,t} + \lambda_1 Gap_{i,j,c,t-1} + \overbrace{\lambda_2\{R_{t-1} \times Gap_{i,j,c,t-1}\} + \lambda_3\{D_{Income}^{Low} \times R_{t-1} \times Gap_{i,j,c,t-1}\}}^{\text{Labor market Interaction}} + \beta Z_{t-1} + u_{i,c,t} \quad (3.14)$$

D_{Income}^{Low} is a dummy for countries that belong to lower middle income and low income classification of the World Bank. λ_3 measures how much λ_2 changes for low-income countries compared to high-income countries.

3.5.4 Estimation

I estimate equations (3.10) and (3.11) in two stages. In the first stage, I extract the *stationary* error term (i.e. the 'Gap' term) using the co-integration relation (i.e. Long run dynamics) in equation (3.10) by a Pooled OLS estimation. Panel unit root tests confirm the presence of stochastic trends in the labor and value added shares, as expected. Similarly, I also run another round of unit root and (non-)stationarity tests on the error term to verify its stationarity; see Gengenbach, Palm, and Urbain (2009) for a survey of unit root tests in the presence of cross-sectional dependencies.

In the second stage, I substitute this error term and estimate the short term elasticities as well as the adjustment speed parameter λ using Fixed Effect OLS estimation. The endogeneity between employment shares, on the one hand, and sectoral value added and price levels, on the other hand, do not concern us because obtaining a consistent estimator of short term elasticities is not the objective of the analysis; these two endogenous terms work as conditioning information (i.e. controls) that allows the identification of the adjustment rate parameter. In addition, the endogeneity induced by the inclusion of the fixed effect in our dynamic setting (Nickell (1981)) is also not a concern given that the time dimension of the panel is fairly large.

3.6 Results and discussion

3.6.1 Baseline estimation

The results of the baseline regression for the labor reallocation process, equation (3.10), are reported in Table 3.5. Our main interest is the estimated value of the adjustment rate λ, which is the coefficient on the deviation or gap term. Its estimated value is -0.154. The negative sign confirms a convergence pattern; that is, it verifies that, on average, employment shares move toward closing the labor productivity gap across sectors. The magnitude of the speed implies that the average economy in our sample reallocates its labor across different sectors to close 15.4% of the distance between its current and desired long run allocation within one year. It is important to note that by controlling for human capital, country income growth rate and other fixed effects, I make the assumption that the economy's desired plan of labor allocation across sectors does not necessarily eliminate productivity gaps completely. While this assumption deviates from our theoretical motivation to some extent, it reflects the structural and technological barriers in the economy that may not be easily surpassed overtime; for instance, sectors that rely on natural resources like mining cannot fully expand enough to absorb all willing labor force.

Table 3.5: Labor Reallocation Baseline Results

Dependent Variable: $\Delta log\left(\frac{N_{i,c,t}}{N_{j,c,t}}\right)$

Explanatory Variables		Est.	Std. Error	t-statistic	p-value
Value Added	$\Delta log\{VA_{i,c,t}/VA_{j,c,t}\}$	$\beta_1 = 0.323$	0.011	0.297	0.000
Sectoral Prices	$\Delta log\{P_{i,c,t}/P_{j,c,t}\}$	$\beta_2 = 0.048$	0.010	5.029	0.000
Gap	LT Dynamics	$\lambda =$**-0.154**	0.008	-18.731	0.000

R^2: 0.211
adj R^2: 0.155
Unbalanced Panel: N. sector$\times$country = 277, T = 4-50, N. Observations = 10748.
Time and Individual fixed effects OLS estimation.

The table reports the estimation results for equation (3.10). Estimation uses both individual (*sector* $\times$ *country*) and time fixed effects, and robust inference, where clustering is on the *sector* $\times$ *country* level, which accounts for both potential heteroscedasticity and serial correlations in the residuals.

3.6.2 Baseline estimation across sub-groups

I repeat the estimation over sub-samples split according to income groups, regions, and economic sectors, reporting the results for the adjustment rate in tables 3.6, 3.7 and 3.8, respectively. I find that the persistence of productivity gaps correlates with country income; that is, high-income countries enjoy the most dynamic labor force, allowing them to close productivity gaps across sectors with a faster speed (25.2 % a year). This speed drops to 19.7 % for upper middle income countries, 12.5 % for lower middle income countries, and 9.4 % for low income countries. Interestingly, these numbers reflect a nonlinear relationship between country income and the flexibility with which it is able to reallocate its labor force across sectors. I see that labor force mobility across sectors in high-income countries is 5.5 % faster than that of upper middle income countries, but the latter is 7.2 % faster than lower middle income countries. This difference shrinks again between lower middle income and low-income countries to 3.1 %, pointing at a significant institutional gap between low and high income groups.

Different channels could potentially explain this association between higher income levels and higher sectoral labor mobility. The first channel, addressed by our analysis, is the labor market regulation channel; higher income countries enjoy better institutional frameworks that allows more fluid creation and destruction of jobs in reaction to changes in sector level TFP or the aggregate income level. Another potential channel is linked to the magnitude of geographical frictions, which limit mobility across regions and cities. Since different regions may adopt different specialization patterns, the efficiency of the structural transformation process depends on the capacity of workers to physically move. Hnatkovska and Lahiri (2018) discusses the contribution of this channel in explaining differences in the Chinese and Indian transformation experience.

Differences in human capital across income groups could also explain the disparity I observe in the fluidity of their structural transformation processes. For workers to efficiently change sectors, they need to maintain adequate levels of transferable skills and education. In both respects, I expect high-income countries to be in a better position given the accessibility and universality of their education systems.

The results of reallocation speed across regions reveals another dimension of heterogeneity. I find the fastest labor share dynamics in Asia, followed by Latin America, Europe-USA, and, finally, Africa. This is consistent with the evidence on the significant structural transformation that took place in these faster regions in the second half of the twentieth century, compared to the western countries that experienced their main wave in the 19th and 18th centuries, and African countries that are yet to undergo major transformations.

What this tells us is that structural transformation is most dynamic in countries with not just better institutions, as proxied by income, but also higher transformation potential.

Looking at the reallocation speed across sectors, we see that mining and manufacturing are the fastest in attracting labor out of agriculture, followed by construction, utilities, government services, and, finally, services sectors, such as trade, restaurants and hotels, and transport, storage, and communication. The results reflect government efforts around the world to move labor toward mining and manufacturing, especially mining which still maintains the widest productivity gap in developing countries with respect to other sectors. The estimates also point at the higher rigidity that faces the economy in reallocating its employment shares toward services industries such as trade and communication.

Table 3.6: Rate of adjustment across income groups

Income Group	N. Obs.	λ Estimate	Std. Error	t-statistic	p-value
High income	3233	-0.252	0.025	-10.087	0.000
Upper middle income	3684	-0.197	0.015	-13.542	0.000
Lower middle income	2913	-0.125	0.014	-8.650	0.000
Low income	918	-0.094	0.026	-3.587	0.000

The table reports the estimation results for the adjustment rate λ in equation (3.10) by income group. Estimation uses both individual (*sector* $\times$ *country*) and time fixed effects, and robust inference, where clustering is on the *sector* $\times$ *country* level, which accounts for both potential heteroscedasticity and serial correlations in the residuals.

Table 3.7: Rate of adjustment across regions

Region	N. Obs.	λ Estimate	Std. Error	t-statistic	p-value
Asia	2800	-0.261	0.022	-11.903	0.000
Latin America	2412	-0.220	0.019	-11.524	0.000
Europe-USA	1911	-0.178	0.022	-8.136	0.000
Africa	3625	-0.102	0.011	-9.098	0.000

The table reports the estimation results for the adjustment rate λ in equation (3.10) by region. Estimation uses both individual (*sector* $\times$ *country*) and time fixed effects, and robust inference, where clustering is on the *sector* $\times$ *country* level, which accounts for both potential heteroscedasticity and serial correlations in the residuals.

3.6.3 The Role of labor regulations

In this part of the analysis, I assess the extent to which structural reforms and regulations in the labor market are associated with less persistent productivity gaps across sectors. Table (3.9) reports the estimation results for equation (3.11) for the full sample, where λ_2 reflects the contribution of the respective indicator to the pace by which labor reallocates across sectors. A negative estimate implies an accelerating effect, and vice versa. In table (3.10), I repeat the same estimations while accounting for the heterogeneity between high and low income countries. Overall, the data reflects a relatively large role for the area

Table 3.8: Rate of adjustment across sectors

Sector	N. Obs.	λ Estimate	Std. Error	t-statistic	Pr(>|t|)
Mining	1569	-0.186	0.019	-9.909	0.000
Manufacturing	1579	-0.155	0.018	-8.614	0.000
Construction	1579	-0.147	0.018	-8.151	0.000
Utilities	1569	-0.143	0.017	-8.545	0.000
Government services	1196	-0.140	0.017	-8.427	0.000
Trade, restaurants and hotels	1579	-0.119	0.017	-7.152	0.000
Transport, storage and communication	1579	-0.115	0.016	-7.011	0.000

The table reports the estimation results for the adjustment rate λ in equation (3.10) by sector. Estimation uses both individual (*sector* $\times$ *country*) and time fixed effects, and robust inference, where clustering is on the *sector* $\times$ *country* level, which accounts for both potential heteroscedasticity and serial correlations in the residuals.

of labor market regulations as indicated by their corresponding λ_2, λ_3. Policy reforms aiming at achieving efficient structural transformation need to maneuver between the goal of raising labor productivity, while maintaining strong social nets, labor protection and risk sharing.

For the full sample, I find that only two indicators are significant. The mandated cost of worker dismissal and the general labor market regulations indices. Both indicators come from the Economic Freedom indices and are constructed such that higher values indicate more open and less regulated markets. The negative result of λ_2 for the general labor market regulation index is consistent with Haltiwanger, Scarpetta, and Schweiger (2014) and implies that an increase in the freedom of labor market regulations by 10 on a scale of 100 is associated with 7 % increase in the pace of job flows across sectors. Hence, fewer regulations correspond to more dynamic labor force and more efficient employment shares allocations.

Interestingly, the result for mandated cost of worker dismissal indicator is not necessarily what one would expect to see in the typical discussions on labor market reforms. I find that lowering the cost of worker dismissal dampens the pace of job flows. This result suggests that reforms that undermine job security, while allowing firms to be more dynamic and agile in reacting to market fluctuations, could have a strong discouraging effect on labor transitions. This is particularly relevant for the structural transformation process where job transition across sectors, which may also require migration, entails higher risk and social costs than transition within sectors. Hence, the policy agenda on labor market reforms needs to be advised on the effect of these reforms on labor incentives to shift careers and reallocate.

Controlling for the country income level when estimating the effect of labor market mea-

Table 3.9: The role of labor regulations

Indicator	Source	No. Obs.	λ_2	Std. Errors	Pr(>|t|)
Hiring and firing regulations	EF	974	-0.0035	0.0030	0.2396
Centralized collective bargaining	EF	1050	-0.0020	0.0031	0.5300
Mandated cost of worker dismissal	EF	432	0.0112	0.0033	0.0007
Labor market regulations	EF	1024	-0.0078	0.0045	0.0875
Average labor cost	IMF SR	3720	0.0014	0.0012	0.2436
Average employee payroll taxes	IMF SR	3720	0.0023	0.0027	0.3878
Ratio of minimum wage to mean wage	IMF SR	3720	0.0004	0.0011	0.6924
Unemployment benefits coverage	IMF SR	3176	0.0019	0.0025	0.4382
Time and Individual(*sector* $\times$ *country*) fixed effects OLS estimation.					

I scaled all indicators to a scale of 100

sures on the pace of structural transformation across sectors reveals some heterogeneity aspects and allows a stronger identification of the effects of some of the measures (table (3.10); in addition to the earlier results with respect to mandated dismissal costs and the aggregate labor market regulation indices, the effects of both hiring, firing and bargaining regulations are negative and significant. This result is consistent with the common intuition, which suggests that lower regulations and more flexible wage setting can ease the labor market dynamics. For these measures, there does not seem to be a significant difference between high and low income countries.

More interesting, however, are the results for λ_2 and λ_3 for average labor costs, employee payroll taxes, and minimum wages. While they remain insignificant for the high-income group (i.e. λ_2), they are positive and significant for low-income countries. An increase by 10 on a scale of 100 of labor costs is associated with 1.8 % decline in the pace of job flows for low income countries, but has an insignificant effect for high income countries. This number is 1.2 % and 4 % for 10 points increase in average payroll taxes and minimum wages ratio to mean wages, respectively, in low income countries. What this implies is that policy agendas need to be different for high- and low-income countries; for the latter, there seems to be a larger gain potential from targeting the costly and overly generous labor regulations.

Table 3.10: The role of labor regulations

Indicator	Source	No. Obs.	λ_2	Std. Errors	Pr(>|t|)	λ_3	Std. Errors	Pr(>|t|)
Hiring and firing regulations	EF	606	-0.0089	0.0035	0.0119	-0.0042	0.0026	0.1149
Centralized collective bargaining	EF	681	-0.0053	0.0035	0.1318	0.0003	0.0014	0.8344
Mandated cost of worker dismissal	EF	250	0.0113	0.0035	0.0016	0.0032	0.0048	0.5013
Labor market regulations	EF	662	-0.0096	0.0065	0.1363	0.0004	0.0024	0.8760
Average labor cost	IMF SR	2593	-0.0003	0.0014	0.8575	0.0021	0.0006	0.0005
Average employee payroll taxes	IMF SR	2593	-0.0006	0.0026	0.8105	0.0018	0.0005	0.0005
Ratio of minimum wage to mean wage	IMF SR	2593	0.0008	0.0012	0.4990	0.0032	0.0006	0.0000
Time and Individual(*sector* $\times$ *country*) fixed effects OLS estimation.								

I scaled all indicators to a scale of 100

3.7 Conclusion

This paper documents the role of labor markets regulations in the misallocation of labor across sectors within the economy. The rigidities caused by these regulations inhibit the efficient flow of jobs across sectors and result in inefficient allocations of employment shares and lost opportunities for productivity growth. Excessive labor regulations make hiring and firing costly for firms, discouraging, in return, both job destruction in lower productivity occupations and job creation in higher productivity ones. While these frictions are also binding for many developed economies, understanding the obstacles to efficient structural transformation is particularly valuable for developing economies, which have set in place ambitious sectoral policies to boost potential growth, but where productivity and employment outcomes continue to lag behind expectations.

Our analysis argues that addressing these labor market frictions could help promote more fluid reallocation toward higher productivity sectors, raising growth and employment. However, these policy reforms need to maneuver between the goal of easing job creation and destruction, while supporting the labor supply incentives to reallocate and shift industries through strong social nets, labor protection, and risk sharing. In addition, there is no one-size-fits-all policy prescription for all countries, given individual circumstances and growth experiences. Reform priorities depend on country-specific settings, including the scale of particular policy distortions.

Appendices

.1 Data Appendix

Table .1.1: Sectoral Coverage

Sector name	ISIC Rev. 3.1 description
Agriculture	Agriculture, Hunting and Forestry, Fishing
Mining	Mining and Quarrying
Manufacturing	Manufacturing
Utilities	Electricity, Gas and Water supply
Construction	Construction
Trade services	Wholesale and Retail trade; repair of motor vehicles, motorcycles and personal and household goods, Hotels and Restaurants
Transport services	Transport, Storage and Communications
Business services	Financial Intermediation, Renting and Business Activities (excluding owner occupied rents)
Government services	Public Administration and Defense, Education, Health and Social work
Personal services	Other Community, Social and Personal service activities, Activities of Private Households
Total Economy	Total Economy

Table .1.2: Baseline Regression Country and Time Coverage

Acronym	Country	Nominal Value Added	Sectoral Prices	Sectoral Employment
Sub-Saharan Africa				
BWA	Botswana	1964-2010	1964-2010	1964-2010
ETH	Ethiopia	1961-2010	1961-2010	1961-2010
GHA	Ghana	1960-2010	1960-2010	1960-2010
KEN	Kenya	1960-2010	1964-2010	1969-2010
MWI	Malawi	1960-2010	1966-2010	1966-2010
MUS	Mauritius	1960-2010	1970-2010	1970-2010
NGA	Nigeria	1960-2010	1960-2010	1960-2011
SEN	Senegal	1960-2010	1970-2010	1970-2010
ZAF	South Africa	1960-2010	1960-2010	1960-2010
TZA	Tanzania	1960-2010	1960-2010	1960-2010
ZMB	Zambia	1960-2010	1965-2010	1965-2010
North Africa				
EGY	Egypt	1960-2013	1960-2012	1960-2012
MOR	Morocco	1970-2012	1960-2012	1960-2012
Asia				
CHN	China	1952-2011	1952-2010	1952-2011
HKG	Hong Kong	1970-2011	1974-2011	1974-2011
IND	India	1950-2012	1950-2012	1960-2010
IDN	Indonesia	1966-2012	1960-2012	1961-2012
JPN	Japan	1953-2011	1953-2011	1953-2012
KOR	South Korea	1953-2011	1953-2011	1963-2011
MYS	Malaysia	1970-2011	1970-2011	1975-2011
PHL	Philippines	1971-2012	1971-2012	1971-2012
SGP	Singapore	1970-2012	1960-2012	1970-2011
TWN	Taiwan	1951-2012	1961-2012	1963-2012
THA	Thailand	1951-2011	1951-2011	1960-2011
Latin America				
ARG	Argentina	1950-2011	1950-2011	1950-2011
BOL	Bolivia	1958-2011	1950-2011	1950-2010
BRA	Brazil	1990-2011	1950-2011	1950-2011
CHL	Chile	1950-2011	1950-2011	1950-2012
COL	Colombia	1950-2011	1950-2011	1950-2010
CRI	Costa Rica	1950-2011	1950-2011	1950-2011
MEX	Mexico	1950-2011	1950-2011	1950-2012
PER	Peru	1950-2011	1950-2011	1960-2011
VEN	Venezuela	1960-2012	1950-2012	1950-2011
North America				
USA	United States	1947-2010	1947-2010	1950-2010
Europe				
DEW	West Germany	1968-1991	1950-1991	1950-1991
DNK	Denmark	1970-2011	1947-2009	1948-2011
ESP	Spain	1970-2011	1947-2009	1950-2011
FRA	France	1970-2011	1950-2009	1950-2011
GBR	United Kingdom	1960-2011	1949-2009	1948-2011
ITA	Italy	1970-2011	1951-2009	1951-2011
NLD	The Netherlands	1970-2011	1949-2009	1950-2011
SWE	Sweden	1970-2011	1950-2009	1950-2011

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German Summary

Erstes Kapitel Die Phase der wirtschaftlichen Erholung in den USA nach der "Great Recession" ist charakterisiert durch Produktionswachstum bei gleichzeitiger Stagnation von Beschäftigung und Löhnen. Dies führt zur Frage, warum Maßnahmen zur Förderung der Kreditvergabe vergleichsweise stärker auf die Produktion wirken als auf Reallöhne und Beschäftigung. Mit Hilfe einer strukturellen Zeitreihenanalyse von US Daten zum Kredit- und Arbeitsmarkt ab 1965 kann ich zeigen, dass eine Ausweitung der Kreditvergabe zu einem Absinken der Lohnquote führt. In diesem Artikel präsentiere ich eine Erklärung für diesen Zusammenhang die auf dem Kompositionseffekt von Kreditwachstum basiert. Dabei zeige ich, dass die Transmission von gesamtwirtschaftlichen Schwankungen des Kreditangebotes auf das Beschäftigungswachstum in jenen Industriezweigen am stärksten ausgeprägt ist, welche im Vergleich hohe Finanzierungskosten aufweisen. Diese Firmen bevorzugen besicherungsfähige Kapitalgüter gegenüber Arbeitskräften und zahlen in weiterer Folge geringere Löhne. Wenn nun diese Firmen in Folge eines steigenden Kreditangebots ihren Anteil an der gesamtwirtschaftlichen Produktion und Beschäftigung erhöhen, führt diese Kompositionsänderung zu einem Abwärtsdruck auf die aggregierte Lohnquote. Des Weiteren entwickle ich ein dynamisches Modell welches heterogene Firmen und einen aggregierten Finanzsektor beinhaltet, und die Interaktion zwischen Finanzmarkt- und Arbeitsmarktfriktionen abbilden kann. Dieses Modell kann die negativen Kompositions-, Beschäftigungs- und Lohneffekte bei steigendem gesamtwirtschaftlichen Kreditangebot erklären. Darüber hinaus bringt es diese negativen Effekte in Einklang mit den gegenläufigen, positiven Einzeleffekten auf Firmenebene. Letztere werden in Modellen ohne Berücksichtigung heterogener Firmencharakteristika erklärt/vorhergesagt. Dieser Artikel zeigt daher auf, dass eine erleichterte Kreditvergabe möglicherweise kein zielgerichtetes wirtschaftspolitisches Instrument ist, um Firmen mit hohem Potential zum Beschäftigungsaufbau oder für Lohnsteigerungen zu erreichen.

Zweites Kapitel In diesem Kapitel analysiere ich den dynamischen Einfluss von strukturellen Ölmarktschocks auf die Bilanzen von US Firmen anhand von Daten auf dem Industrielevel, die das verarbeitende Gewerbe, den Handel und den Bergbau umfassen.

Für Firmen des verarbeitenden Gewerbes zeigen meine Ergebnisse, dass unerwartete Turbulenzen des Ölangebots, die den Ölpreis um 1% erhöhen, die Gewinne dieser Firmen um 1,3% bei Eintreffen des Schocks senken. Die Gewinne steigen um 0,39% infolge eines Ölpreisanstiegs gleicher Höhe, wenn dieser durch positive Bewegungen der Weltnachfrage nach Öl getrieben wird, und um 0,89% nach einem unerwarteten Anstieg der spekulativen Ölnachfrage. Die positiven Effekte spekulativer Schocks auf die Firmenbilanzen im verarbeitenden Gewerbe stehen im Gegensatz zu deren negativen Effekte auf die weltweite ökonomische Aktivität. Eine Erklärung hierfür folgt aus der Analyse auf Firmenebene, die suggeriert, dass Spekulationen auf dem Ölmarkt einen nachgelagerten Effekt bei Zulieferfirmen verursachen und die Nachfrage nach Lagerhaltung für Petroleum und Chemieprodukte erhöhen. Im Gegensatz zur sekundären Rolle von Ölangebotsschocks, die darin besteht historische Variationen im Ölpreis sowie der Gewinne im Handels- und Bergbausektor zu erklären, finde ich Evidenz, dass sie die wichtigsten Ölmarktinnovationen für das Verhalten der Gewinne im verarbeitenden Gewerbe sind. Des Weiteren finde ich eine gedämpfte Reaktion der Produktionskosten auf exogene Variationen im Ölpreis. Dies steht im Gegensatz zu klassischen Annahme, dass der Kostenanteil von Öl im Industriesektor deren Anfälligkeit für Ölmarktschocks determiniert.

Drittes Kapitel In vielen Entwicklungsländern sind große Produktivitätslücken über verschiedene Sektoren hinweg persistent und der strukturelle Transformationsprozess stagniert. Diese Lücke zwischen beobachteter und optimaler Arbeitsallokation zeigt institutionelle- sowie Marktfriktionen auf, welche Kosten bei der optimale Allokation von Arbeit von Niedrig- zu Hochproduktivitätssektoren verursachen. In einem internationalen Datensatz aus Zeitreihen auf Sektorenlevel schätze ich ein dynamisches Panel-Fehlerkorrekturmodell, welches die Dynamiken von inter-sektoralen Arbeitsflüssen auffängt. Die Modellschätzung zeigt eine Anzahl neuer stilisierter Fakten zu den die Dynamiken des Strukturanpassungsprozesses auf. Es liefert außerdem ein Maß für die Ausprägung von Friktionen denen Arbeitsflüsse ausgesetzt sind. Dazu analysiere ich den Beitrag von Arbeitsmarkregulierung und -reform zur Flussgeschwindigkeit von Arbeit über Sektoren. Die Ergebnisse suggerieren, dass Politikreformen zwischen dem Ziel der leichteren Arbeitsplatzschaffung und -zerstörung für Firmen und dem Ziel der Unterstützung des inter-sektoralen Arbeitsangebots durch starke soziale Netze, Arbeitsschutz und Risikoteilung für Arbeitnehmer lenken muss.

Declaration

I hereby declare that I have independently written the submitted dissertation with only the help of the tools listed on the following page. All content from published or unpublished documents are identified as such. The submitted dissertation, in this form or any other form, has not been submitted to any other faculty or examination board at another university.

Berlin, May 2019

Khalid ElFayoumi

List of Tools Used

- For equilibrium macroeconomic dynamic modelling: Matlab
- For empirical econometric analysis: R on RStudio
- For faster implementations of both econometric and analytical algorithms: C++ on XCode
- For text editing: Latex