



# **Fluctuations in Uncertainty, Efficient Borrowing Constraints and Firm Dynamics**

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## **Abstract**

In main essay of my dissertation I quantify the importance of microeconomic uncertainty shocks for the firm dynamics over the business cycle in economy with frictional financial markets. To begin, I document novel facts on asymmetric, cyclical behavior across age and size groups of firms in the US. Then I lay down a theory in which differences between firms originate from the presence of asymmetric information in the financial market and long-term efficient contracts with financial intermediaries. Fluctuations in microeconomic uncertainty drive movements of the endogenous borrowing constraint affecting real allocations and imply asymmetric response of firms to the shocks.

Disruptions in the financial markets have been viewed to play an important role in shaping aggregate fluctuations and firm dynamics over the business cycle. In particular, a conventional belief is that small firms are more sensitive to the business cycle due to a limited access to credit markets<sup>1</sup>. In this essay I challenge this belief. I begin with documenting a key observation that age of the firm rather than its size is a determinant of the cyclical employment volatility. I look at this observation through the lens of endogenously frictional financial markets theory and propose a model of firm dynamics reflecting two ubiquitous features of the credit market: relevance of past performance and long-term nature of financial arrangements. I apply this theory to study, in a quantitative macroeconomic model, an impact of the aggregate shocks to microeconomic uncertainty on macroeconomic aggregates and on employment dynamics across various groups of firms. The motivation for such approach comes from the US postwar data. Starting from the 70's recessions in the United States have been associated in the data with two phenomena: (1) an increase of microeconomic uncertainty faced by firms measured in terms of the cross-sectional dispersion of firm level total factor productivity or sales (2) a reduction in the availability of credit in the economy, reflected for instance by a fall in the ratio of private lending to firms and GDP. These two regularities have been extensively studied in the macroeconomic literature. However, the existing studies dismiss an important feature of the economic downturns: heterogeneity across firms in response to the changes in the aggregate conditions. The main essay in my dissertation is an attempt to fill this gap. It consists of three parts: empirical, theoretical and quantitative.

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<sup>1</sup> One of the numerous examples of such belief is the speech of Ben Bernanke at the Federal Reserve Meeting Series: "Addressing the Financing Needs of Small Businesses".

In the empirical section of the essay I document novel facts on differences in volatility of the employment stocks between certain groups of firms at the business cycle frequency. Table 1 illustrates the main empirical finding: age rather than size of a firm is a determinant of the employment volatility. To illustrate this finding I look at three divisions of the population of firms from the Business Dynamics Statistics (BDS) data set. Young firms, which are five or less years old, account for 16.1% of the aggregate employment in the US economy and hire on average 8.1 employees. Old firms, which are six and more years old, account for 83.9% of the aggregate employment and hire on average 31.6 employees. The first group of small firms, with less than 20 employees, accounts for 20.0% of total employment, a number comparable to the share of the young firms, and the average number of employees is 4.9 in this group. The second group, firms with less than 100 employees, accounts for 38.0% of total employment and the average number of employees is 8.4 in this group, which is a similar figure to the average for young firms.

Table 1: Employment volatility for different groups of firms in the US

	Share of total employment	Average number of employees	Standard deviation of employment
All firms	100	21.6	1.47
Young (0-5)	16.1	8.1	3.20
Old (6+)	83.9	31.6	1.25
Young, no entry (1-5)	13.2	8.8	3.07
Small (0-19)	20.0	4.9	1.04
Large (20+)	80.0	148.0	1.64
Small (0-99)	38.0	8.4	1.21
Large (100+)	62.0	692.3	1.61

Notes: Employment series are logged and HP filtered. Share of total employment and average number of employees are average values. Annual data, 1982-2012. Source: Business Dynamics Statistics (BDS).

The third column of Table 1 reports the standard deviation of the logged, filtered (to extract business cycle component) time series of employment for all three divisions of the BDS sample. It illustrates the main point of the empirical section, i.e. age rather than size is a determinant of the asymmetric response of firms to the cyclical changes in the aggregate economic conditions. The standard deviation of employment of young firms is 2.6 times larger relative to the standard deviation of the old firms. It is also 3.2 times larger relative to the small firms with less than 20 employees (2.5 times larger for the second definition of the small firms). The groups of firms that are similar along certain dimension (share in total employment, average number of employees) exhibit entirely different employment dynamics at the business cycle frequency. These differences are not driven by the entry of new firms to the group of young ones. Relative standard deviations remain almost unchanged after I restrict the definition of young firms to those at age between 1 and 5 years.

Table 2: Standard deviation of employment over age and size distribution.

	Young (0-5)	Old (6+)	All ages
Small	2.37	1.02	1.31
Large	7.66	1.50	1.67
All sizes	3.25	1.25	1.47

Notes: Employment series are logged and HP filtered. Annual data, 1982-2012. Source: BDS.

The fact that age is a major determinant of employment volatility can be further validated by looking at the employment dynamics inside the size groups of firms. Table 2 presents volatility of employment across subgroups in the age/size distribution of the population of firms. Employment volatility declines with age and increases, but only mildly with size. Put differently even inside size groups young firms are more volatile

than old ones in terms of employment. This robust finding strengthens the main message of the empirical section of this essay: age of the firm is the relevant margin if one seeks for the volatility differences. Table 2 also documents an existence of a group of small old firms that are the least volatile of all groups. For the size threshold of 20 employees this groups accounts for 49.9% of all firms (for 100 employees threshold the number is 56%) and for 11.9% of the total employment (25.1% for 100 employees threshold). The existence of such groups of firms challenges the conventional view that small firms are those who reduce their employment the most in recessions and highlights the key role of firm's age for response to changes in the aggregate economic conditions.

The empirical part of this essay contributes to the empirical literature on firm dynamics over the business cycle. Thus far due to the data limitation, most of this literature has focused on the role of firm size and the cycle, see Gertler and Gilshrist (1994), Christiano, Chari and Kehoe (2008), Moscarini and Postel-Vinay (2012). The main conclusion from the existing studies is that large firms are more responsive to the NBER recessions, whereas small firms tend to respond more to credit market tightening. Recently, Fort et. al. (2013) explores the role of local housing market and aggregate financial conditions for the dynamics of the growth rates in the business cycle context. They find variation in housing prices during the last decade is especially pertinent for job creation of startups and young firms. Rather than focusing on the growth rates and the role of housing prices this project studies the dynamics of the employment stocks of different size and age groups of firms and focuses on their contribution to volatility of the aggregate employment.

Motivated by the facts documented in the empirical section I develop a theory of economic downturns and asymmetric cyclical employment dynamics across firms. I propose a macroeconomic model of firm dynamics with endogenously frictional financial markets. Key ingredients of my theory are existence of private information in the financial market on the side of the firm and an efficient, long-term, lending arrangement between an individual firm and financial intermediary. Financial friction originates from these two ingredients and manifests itself as an endogenous borrowing constraint. A key contribution of my theory is endogenously generated link between firm's age and size and its ability to obtain financing. Each firm is run by an entrepreneur who seeks to maximize the stream of profits from the investment project. Every period a return on a project is subject to privately observed individual risk, which I interpret as demand risk as it occurs after the production takes place. Moreover, firms differ in terms of average demand and therefore in the expected return on the project. The firm's operation, i.e. paying for the wage bill and renting capital stock is financed through the loan from the financial intermediaries. The combination of the history of demand shocks, which can be interpreted in the model as proxy for firm's performance, together with the differences in the mean returns on projects lead to rich age/size distribution of firms in the model. In the theory part I show that, for any given expected return, financial contract imposes an endogenous borrowing constraint on a new firm, i.e. it is unable to obtain a level of financing it would achieve under perfect information. I provide sufficient conditions under which as firm ages the information problem vanishes and firm moves towards unconstrained level of financing. Then, I characterize the structure of consumptions and payments over the firm's life cycle. Further, I show that an increasing relationship

between firm average demand and access to financing which holds in the full information economy is preserved in the environment with private information. As a result firms with larger optimal scale of operation (size) are able to borrow more relative to firms with lower average demand even though they still may be constrained relative to their own efficient financing level. Finally, I show the existence of a stationary distribution of firms in my environment and further the existence of an equilibrium.

In the quantitative part of the essay I exploit the dependence of the access to financing of firm's size and age to investigate the effects of the aggregate fluctuations in microeconomic uncertainty observed in the US macroeconomic data for individual financial arrangements, distribution of firms and hence macroeconomic aggregates. My findings in this part are twofold: (i) an increase of microeconomic uncertainty triggers recession even though contracts are efficient and cannot be improved upon (ii) a recession is characterized by an asymmetric response of employment across different groups of firms. I find that for a realistically calibrated economy an unanticipated increase in microeconomic uncertainty, disciplined by the data, reduces aggregate output by 1.53 percent and aggregate employment by 1.35 percent, causing a significant recession. Moreover, an economic downturn in my model, in line with the data, is characterized by a fall of credit to GDP ratio, drop of investment and labor productivity. Furthermore, employment stock of young firms falls 6.4 times more relative to the employment of the old accounting for 71.5 percent of the average difference. At the same time small firms reduce employment by 11 percent less relative to the large ones accounting for 60.2 percent of the average difference in the data. These results are in a stark contrast with two natural benchmarks considered in the existing literature:



aggregate shock to microeconomic uncertainty operating in the economy with the full information and aggregate productivity shock as a source of fluctuations. In the first case an aggregate shock has absolutely no effects, i.e. an economy remains in the initial state. The reason is that with full information only the expected return on the firm's project matters for the lending, consumptions and payments and there are no informational considerations. Therefore efficient level of financing can be sustained every period, no matter of the existing risk. If instead productivity shock drives the fluctuations the economy falls into recession regardless of the presence of the informational friction. However, the economic downturn in this case is characterized by a symmetric fall of employment, investment and output across all firms and constant credit to GDP ratio, counter to the data. Aggregate productivity shock implies a symmetric reduction of the expected return and if affects all firms the same way regardless of age and size. Therefore my quantitative results indicate that a combination of fluctuations in microeconomic uncertainty and private information in the financial market is crucial to account jointly for a decline of main macroeconomic aggregates and asymmetric response of employment across various groups of firms observed in the US recessions.

This essay contributes to the large literature on financial frictions. They are viewed to play central role in a propagation of aggregate fluctuations and they have been extensively explored in the economic literature see Brunnermeier et. al. (2012) for a recent survey. A common assumption in this literature is that markets are exogenously incomplete and firms utilize one period debt contracts to overcome the incompleteness.

When borrowers and lenders form long-term lending relationship, which are contingent on all public information (complete contracts), the macroeconomic consequences of that might be quite different. Though, the role of long-term financial contracts in shaping aggregate dynamics remains largely unexplored<sup>2</sup> and this project delivers some new insights to this issue. The literature also imposes that credit frictions are subject to exogenous shocks. I develop a model in which credit frictions endogenously fluctuate over the business cycle and I link these fluctuations to changes in microeconomic uncertainty. The latter links this proposal to the strand of the literature on the fluctuations in idiosyncratic uncertainty. The major conclusion from this literature is that at the micro level, the recessions have been accompanied by large increases in the cross-section dispersion of firm growth rates, TFP and sales (Bloom (2014)). The role of heightened uncertainty was particularly large in the recent recession as documented by Stock and Watson (2012). Arellano, Bai and Kehoe (2012), Bloom et. al (2014) or Gilchrist et.al. (2014) build general equilibrium models with heterogeneous firms where fluctuations of micro uncertainty are the source of the aggregate shocks. The results in these papers though hinge on incomplete markets assumption. Moreover, the nexus between micro uncertainty and real economic activity operates through irreversibility of firm's actions and so called "wait and see" policy. In my essay I explore a novel mechanism where uncertainty shocks are endogenously translated into movements in the available credit and further cause real effects. Moreover, my model generates asymmetric response to aggregate shocks across firms of different size and age. Finally this study contributes to the dynamic contracting literature with informational frictions.

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<sup>2</sup> Notable exceptions are Cooley, Marimon and Quadrini (2004) and Verani (2014) who study the aggregate consequences of limited commitment and private information respectively. They are silent about the role of fluctuations in idiosyncratic uncertainty though.

Existing studies assume either risk neutrality of entrepreneurs or a constant size of investment in a firm (Clementi and Hopenhayn (2006), DeMarzo and Fishman (2007), Smith and Wang (2006)). I characterize an optimal contracting problem with private information where entrepreneurs are risk averse and scale of investment in a firm is time varying.

## BIBLIOGRAPHY

1. Smith, Anthony Jr. & Wang, Cheng, 2006. "Dynamic credit relationships in general equilibrium," *Journal of Monetary Economics*, Elsevier, vol. 53(4), pages 847-877, May.
2. Gina Luca Clementi & Hugo A Hopenhayn, 2006. "A Theory of Financing Constraints and Firm Dynamics," *The Quarterly Journal of Economics*, MIT Press, vol. 121(1), pages 229-265, 02.
3. Peter M. DeMarzo & Michael J. Fishman, 2007. "Agency and Optimal Investment Dynamics," *Review of Financial Studies*, Society for Financial Studies, vol. 20(1), pages 151-188, January.
4. Simon Gilchrist & Jae W. Sim & Egon Zakrajšek, 2014. "Uncertainty, Financial Frictions, and Investment Dynamics," NBER Working Papers 20038, National Bureau of Economic Research, Inc.
5. Nicholas Bloom & Max Floetotto & Nir Jaimovich & Itay Saporta-Eksten & Stephen J. Terry, 2014. "Really Uncertain Business Cycles," Working Papers 14-18, Center for Economic Studies, U.S. Census Bureau.
6. Nicholas Bloom, 2014. "Fluctuations in Uncertainty," *Journal of Economic Perspectives*, American Economic Association, vol. 28(2), pages 153-76, Spring.
7. James H. Stock & Mark W. Watson, 2012. "Disentangling the Channels of the 2007-2009 Recession," NBER Working Papers 18094, NBER, Inc.
8. Cristina Arellano & Yan Bai & Patrick J. Kehoe, 2012. "Financial frictions and fluctuations in volatility," Staff Report 466, Federal Reserve Bank of Minneapolis.
9. Markus K. Brunnermeier & Thomas M. Eisenbach & Yuliy Sannikov, 2012. "Macroeconomics with Financial Frictions: A Survey," NBER Working Papers 18102, National Bureau of Economic Research, Inc.
10. Giuseppe Moscarini & Fabien Postel-Vinay, 2012. "The Contribution of Large and Small Employers to Job Creation in Times of High and Low Unemployment," *American Economic Review*, American Economic Association, vol. 102(6), pages 2509-39, October.
11. Teresa C Fort & John Haltiwanger & Ron S Jarmin & Javier Miranda, 2013. "How Firms Respond to Business Cycles: The Role of Firm Age and Firm Size," *IMF Economic Review*, Palgrave Macmillan, vol. 61(3), pages 520-559, August.
12. Gertler, Mark & Gilchrist, Simon, 1994. "Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms," *The Quarterly Journal of Economics*, MIT Press, vol. 109(2), pages 309-40, May.