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Abstract

The Great Moderation in the U.S. economy was accompanied by a widespread increase in the volatility of financial variables. We explore the sources of the divergent patterns in volatilities by estimating a model with time-varying financial rigidities subject to structural breaks in the size of the exogenous processes and two institutional characteristics: the coefficients in the monetary policy rule and the severity of the financial rigidity at the steady state. To do so, we generalize the estimation methodology developed by Cúrdia and Finocchiaro (2013). Institutional changes are key in accounting for the volatility slowdown in real and nominal variables and in shaping the transmission mechanism of financial shocks. Our model accounts for the increase in the volatility of financial variables through larger financial shocks, but the vulnerability of the economy to these shocks is significantly alleviated by the estimated changes in institutions.

JEL Classification: E32, E44, C11, C13

Keywords: Changes in cyclical volatilities, financial frictions, financial shocks, structural breaks, Bayesian methods

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1 Introduction

Since the mid-1980s, the U.S. economy has been characterized by a decline in the volatility of aggregate economic activity, often referred to as the Great Moderation. We document that, contemporaneous to the Great Moderation, there was a widespread increase in the volatility of financial variables. Moreover, during this period, there were substantial changes in financial factors in the U.S., including regulatory changes, the development of new financial products and techniques, and periods of heightened financial stress. We argue that a comprehensive analysis of the drivers of the divergent patterns in volatilities should incorporate financial factors, in addition to the traditional drivers of the Great Moderation: good luck and good monetary policy. In this paper, we evaluate the role of each of these drivers in accounting for the empirical evidence by means of an estimated dynamic stochastic general equilibrium (DSGE) model with financial frictions and financial shocks.

The model integrates the financial accelerator framework of Bernanke, Gertler and Gilchrist (1999) into a standard model with nominal and real rigidities as in Justiniano, Primiceri and Tambalotti (2010). In our model, loans are extended at a premium over the risk-free rate because there is asymmetric information between borrowers and lenders. This external finance premium depends upon the balance sheet position of firms and the size of the financial rigidity, which is summarized by the marginal bankruptcy cost parameter. We introduce financial shocks affecting the firms' net worth and marginal bankruptcy costs. In this environment, the institutional framework defining the debtor-creditor relationship and product innovation is captured by the size of the financial rigidity at the steady state, while financial shocks capture changes in financial factors at business cycle frequencies. To test the role of institutional change and changes in the size of exogenous shocks in accounting for the divergent patterns in cyclical volatilities, we estimate the model subject to structural breaks in the monetary policy coefficients, the size of the financial rigidity at the steady state, and the size of shocks. Our econometric approach generalizes the work of Cúrdia and Finocchiaro (2013) by incorporating steady-state parameters in the set of parameters subject to structural breaks.

Unlike many articles in the literature, we conclude that there was no unique driver of the Great Moderation. In particular, in our model, the slowdown in real and nominal volatilities was driven by a combination of good luck, in the form of smaller economic shocks, and better institutions, in the form of a more proactive monetary authority and an easier access to credit for firms. The increase in the volatility of financial variables was driven by larger financial shocks hitting the U.S. economy. However, despite the increase in the size of financial shocks, we show that, thanks to the institutional changes in the mid 1980s, the relative role of financial shocks in driving nonfinancial variables has not increased and the transmission mechanism of financial shocks is significantly more muted. Therefore, we conclude that the tighter monetary policy regime and the improvements in the financial intermediation process have safeguarded the U.S from financial disturbances.

A vast literature has examined the sources of the Great Moderation. Most of the contributions using structural vector autoregressive (VAR) models, such as Stock and Watson (2002) and Primiceri (2006), attribute the slowdown in aggregate volatility to good luck in the form of smaller innovations. However, using simulated data from a DSGE model with a change from passive to active monetary policy, Benati and Surico (2009) estimate a structural VAR model and show that the good luck and good policy hypotheses are close to observationally equivalent in the context of a VAR model.

Researchers using DSGE models, such as Clarida, Galí and Gertler (2000), Lubik and Schorfheide (2004), and Boivin and Giannoni (2006), conclude that the main driver of the Great Moderation is good policy in the form of a stronger response to inflation by the monetary authority. However, Smets and Wouters (2007) and Justiniano and Primiceri (2008) conclude that good luck is the source of the Great Moderation. While the former constrained the parameter set at the boundary of the determinacy region, the latter allows for indeterminacy of equilibria but introduces time-varying volatilities in the structural innovations. Jermann and Quadrini (2006), focusing on corporate debt and equity financing, and deBlas (2009), using a neoclassical model with limited participation and rigidities in the supply of capital, conclude that a reduction in the level of financial rigidities combined with smaller shocks can slowdown the volatility of real variables.

This paper contributes to the debate about the sources of the Great Moderation by analyzing jointly the role of shocks, the conduct of monetary policy, and financial rigidities in the demand of capital. This paper also contributes to the literature by documenting the increase in financial volatilities in the U.S. corporate sector and extending the novel estimation methodology of Cúrdia and Finocchiaro (2013) .

The paper is structured as follows. We present the empirical evidence that motivates the paper in Section 2. We provide an overview of regulatory changes, innovations in technology and financial engineering, and episodes of heightened financial uncertainty or financial shocks beginning in the mid-1980s in Section 3. We describe the model in Section 4. We explain the estimation procedure and model evaluation in Section 5. We analyze the role of institutional change in accounting for the empirical evidence and in the transmission of financial shocks in Section 6. We conclude in Section 7.

2 Empirical Evidence

The stylized fact motivating this paper is that there is a divergent pattern in the evolution of cyclical volatilities of macroeconomic and financial variables during the Great Moderation. In this section, we revisit the dating of structural breaks in macroeconomic volatilities and provide evidence of the slowdown in macroeconomic volatility contemporaneous with the increase in financial volatility.

To identify the existence of and to date the structural breaks, we first run univariate Bai and Perron (1998) tests, which allow for multiple breakpoints at unknown dates, on unbiased estimators for the residual standard deviation of the cyclical component of real and nominal variables[1] over

[1]We run an autoregressive model of order 1 (AR(1)) on the cyclical component of a variable, assuming that the error of the AR(1) model, ε_t, follows a normal distribution. Then, we can ensure that $|\widehat{\varepsilon}_t|\sqrt{\pi/2}$ is an unbiased estimator for the residual standard deviation of the cyclical variable. Given that the cyclical component of a series has zero mean by construction, testing only for breaks in volatility using Bai and Perron (1998) is not subject to the

the 1954-2006 period .[2] Table 1 shows that we can reject the null of parameter constancy for real variables around 1984. For nominal variables, the null is rejected for two different periods: the early 1970s and the early 1980s.

Table 1: STRUCTURAL BREAK TESTS IN CYCLICAL VOLATILITY

Output	1984:Q2	
Investment	1984:Q1	
Consumption	1984:Q2	
Inflation	1970:Q1	1981:Q2
Federal funds rate	1972:Q4	1983:Q1

NOTE: The series are defined in Appendix A The data range covers 1954 to 2006. The cyclical component is extracted using the Hodrick-Prescott filter for the quarterly frequency ($\lambda = 1600$).

We use a multivariate approach to decide whether to consider one or two structural breaks. In particular, we test for multiple structural breaks as in Qu and Perron (2007) in the covariance matrix of a VAR model for the cyclical component of output, consumption, investment, hours worked, wages, inflation, the federal funds rate, spreads, and corporate net worth and we identify two breaks: one in 1969:Q4 and one in 1985:Q1. Therefore, we conclude that the period under analysis is best described by two structural breakpoints: one occurring in the late 1960s to early 1970s and another one in the mid-1980s. Following the literature, the first structural break marks the beginning of the Great Inflation (which is characterized by highly volatile macroeconomic variables) and the second break establishes the start of the Great Moderation[3].

Finally, in order to establish the exact dating for the two structural breaks, we use Bayesian techniques to estimate the DSGE model in Section 4 subject to structural breaks considering the range of dates for the Great Inflation from 1968:Q2 to 1970:Q4 and from 1984:Q1 to 1985:Q4 for the Great Moderation. The marginal data density is maximized when the Great Inflation is set to start in 1970:Q3 and the Great Moderation is set to start in 1985:Q1.[4]. This paper focuses on the drivers of the Great Moderation, hence, we refer the reader to Appendix E for the analysis of the Great Inflation.

Table 2 reports cyclical volatilities during the 1970:Q3-1984:Q4 period and the 1985:Q1-2006:Q4 period in the first and second columns, respectively. The last column summarizes the magnitude

size distortions put forward by Gadea-Rivas, Gómez-Loscos and Pérez-Quirós (2014).

[2]We use pre-Great Recession data to avoid distortions caused by nonlinearities induced by the zero lower bound on the federal funds rate, binding downward rigidities, and upward pressures on financial volatilities during recent years.

[3]Figure 5 in Appendix A reports the evolution of 5-year rolling-window cyclical volatilities for output, inflation, credit spreads, and net worth. The rolling cyclical volatilities for inflation and credit spreads increases significantly during the Great Inflation. The rolling volatility for these nominal variables and output decreases during the Great Moderation, while the rolling cyclical volatility for net worth increases during that period.

[4]We consider 300,000 posterior draws to compute the marginal data density for each model. There are two pairs of dates, 1970:Q2–1985:Q1 and 1970:Q3–1984:Q3, with marginal data densities close to the maximum. The prior odds in favor of these alternative dates should be, respectively, three and four times larger than the prior odds for 1970:Q3–1985:Q1 in order to be selected over the baseline dating.

Table 2: Standard deviation of the cyclical component

	1970 − 1985	1985 − 2006	Ratio: $\frac{1985-2006}{1970-1985}$
Output	3.16	1.65	0.53
Investment	8.65	3.91	0.46
Consumption	1.99	1.38	0.70
Inflation	2.48	0.86	0.35
Nominal interest rate	2.36	1.16	0.50
Net worth 1: total assets - total liabilities	1.66	2.95	1.78
Net worth 2: tangible assets - credit market liabilities	1.52	3.10	2.03
Net increase in liabilities: credit market liabilities	107.7	139.3	1.29
Net increase in liabilities: corporate bonds	33.3	97.3	2.92
Equity payout	47.2	123.8	2.62
Tobin's q: (equities+total liabilities)/total assets	4.74	5.54	1.17
Equity q: equities/net worth 1	7.06	10.58	1.50
Total liabilities/net worth 1	2.19	2.65	1.21
Credit market liabilities/net worth 2	1.32	2.25	1.70

Note: The first two columns report cyclical volatilities and the last column reports the ratio of late period volatility to early period volatility. The cyclical component is extracted using the Hodrick-Prescott filter for the quarterly frequency ($\lambda = 1600$) from log-levels for output, investment, consumption, net worth 1 and net worth 2 and from levels for inflation, the nominal interest rate, the two measures of net increase in liabilities, equity payout, Tobin q, equity q, and the two leverage ratios. The volatilities for output, investment, consumption, and the two net worth measures are multiplied by 100. Business wealth measured by net worth 1 is defined as total assets minus total liabilities, and business wealth measured by net worth 2 is defined as tangible assets minus liabilities related to credit market instruments. The latter definition of business wealth is consistent with the model-implied concept of net worth in Section 4. We consider two measures of corporate debt flows: the net increase in credit market liabilities and the net increase in corporate bonds. Following Jermann and Quadrini (2006), equity payout is defined as net dividends minus net equity issues. Tobin's q is defined as the ratio of the sum of the market value of equities and liabilities to total assets. Equity q is defined as the ratio of the market value of corporate equities to corporate net worth 1. The last two rows in the table are indicators of indebtedness in the nonfinancial corporate business sector.

of the change in volatilities using the ratio of late period volatility to early period volatility. As shown in the upper panel of Table 2, the cyclical volatility of real and nominal variables declined significantly in the mid-1980s. The lower panel of Table 2 reports a comprehensive set of balance sheet and financial flow variables for the corporate sector from the flow of funds accounts of the Federal Reserve Board. Although the relative size of the increase in volatilities is not uniform, there is clear evidence that the increase in financial volatility was a widespread phenomenon in the U.S. corporate sector since the mid-1980s.

3 Changes in Financial Factors

Financial factors encompass the institutional framework defining the debtor-creditor relationship, the development of new financial products, and financial shocks. In the model, the institutional framework and product innovation are captured by the average size of the financial rigidity, while financial shocks are modelled as shocks to corporate net worth or to marginal bankruptcy costs.

Financial shocks affecting the conditions of access to credit will be reflected as time variation in the level of financial rigidities, that is, as shocks to marginal bankruptcy costs, while financial shocks affecting the balance sheet position of firms will be reflected as net worth shocks.

The 1980s-2000s saw regulatory changes, development of new financial products, improvements in the assessment of risk, and some periods of heightened financial stress. In this section, we first discuss changes in corporate bankruptcy laws and in banking regulation in the U.S. Next, we provide an overview of innovations in technology and financial engineering since the 1980s, and, finally , we provide an accounting of some well-known financial shocks during the period of analysis.

3.1 Regulatory changes

3.1.1 Corporate bankruptcy law

The Bankruptcy Reform Act of 1978, commonly referred to as the Bankruptcy Code, replaced the Bankruptcy Act of 1938. The Bankruptcy Code emerged in response to the large number of business failures during the 1970s and focused on promoting reorganization and rehabilitation under Chapter 11, rather than liquidation under Chapter 7.

Regarding Chapter 11, the Bankruptcy Code reintroduced the self-administration model for corporate bankruptcies (which changed the voting rules of a reorganization plan and increased the bargaining power of shareholders), introduced "cramdown" reorganization,[5] and changed the conditions for voluntary filing so that insolvency was no longer a requirement for an indebted firm to file for reorganization. As a result, Chapter 11 filings emerged as a method to conduct financial restructuring for corporations that were highly indebted but had relatively healthy assets. The proportion of Chapter 11 filings in total filings increased after the bankruptcy reform, as shown in Hackbarth, Haselmann and Schoenherr (2015) and in Corbae and D'Erasmo (2017). As documented by Bris, Welch and Zhu (2006) and Acharya, Bharath and Srinivasan (2007),[6] bankruptcies resulting in reorganization produce higher recovery rates than those resulting in liquidation of the firm's assets. Given that the share of Chapter 11 filings is larger after the bankruptcy reform and that the recovery rates for these filings are higher, the average recovery rate for the corporate sector is higher. In our model, this improvement in recovery rates is captured by a reduction in the average size of the financial rigidity.

3.1.2 Banking sector regulation

As highlighted by Berger, Kashyap and Scalise (1995), regulatory changes affecting the banking sector can be summarized as deregulation of deposit accounts, a reduction in reserve requirements, formalization and tightening of capital requirements, and liberalization of the geographic rules.

[5] Chapter 11 grants "cramdown" powers to bankruptcy courts so that a court can confirm the reorganization plan proposed by the debtor despite the objections of creditors. Under Chapter 11, the debtor keeps possession and control of its assets during reorganization.

[6] Bris, Welch and Zhu (2006) consider defaulted firms in New York and Arizona from 1995 to 2001. Acharya, Bharath and Srinivasan (2007) use data on defaulted firms over the 1982-1999 period. Both papers document that the average recovery rate for Chapter 7 and Chapter 11 filings is around 27% and 70% – 80%, respectively.

In 1980, Congress passed the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) allowing banks to expand their practices and lending capabilities[7] along with a schedule to phase out Regulation Q on interest rate ceilings on deposits. The Garn-St. Germain Depository Institutions Act of 1982 accelerated the phase out of Regulation Q, completely deregulating price competition between brokerage money market funds and depository institutions, provided new business opportunities to savings and loans institutions (S&Ls), and eased the restrictions on the ability of S&Ls to invest in assets other than residential mortgages.[8]

The DIDMCA introduced mandatory Federal Reserve requirements for all depositary institutions while lowering the reserve requirements on nontransaction accounts. In 1981, regulators defined a new set of standards requiring banks to hold as capital a fixed percentage of their balance sheet assets. However, there were no capital requirements for off-balance-sheet activities, providing incentives to focus on these activities until the Basel Accord of 1988 challenged the differential treatment of balance sheet and off-balance-sheet assets.[9] In 1987, the Federal Reserve allowed large banks to underwrite securities, and the Gramm-Leach-Bliley Act of 1999 widened further the range of activities banks and their holding companies could engage in. Finally, the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994 dismantled the long-standing geographic restrictions on banking in the U.S.

This deregulation and increase in competition in the banking industry expanded the access to credit and borrowing for firms through both traditional loans and alternative credit market instruments. This larger access to borrowing in our model is accounted for by a reduction in the average size of the financial rigidity.

3.2 Financial innovations

Frame and White (2012) define financial innovations as "something new that reduces costs, reduces risks, or provides an improved product/service/instrument that better satisfies financial system participants' demands." Since the 1980s, technological innovations in telecommunications and information processing have facilitated the development and widespread use of innovations in financial engineering.

Regarding cost reduction, advances in computing power and telecommunications have made electronic payments significantly more efficient. Automated clearing house (ACH) networks expanded in the 1980s reducing processing costs. For example, the direct cost of an automated clearinghouse payment was 85% lower in 1994 than in 1979 (see Berger, Kashyap and Scalise (1995)).

[7]The DIDMCA allowed financial institutions to offer interest-bearing checking accounts (the so-called negotiable order of withdrawal (NOW) accounts) increased the Federal Deposit Insurance Corporation deposit insurance coverage, and allowed S&Ls to offer checking-type accounts and to issue credit cards. All depositary institutions were subject to the Federal Reserve reserve requirements but they were given access to the Federal Reserve discount window

[8]The Garn-St. Germain Depository Institutions Act allowed S&Ls to have up to 50% of assets in commercial real estate, up to 30% of assets in consumer loans, commercial paper, and corporate debt; and to use land and other non-cash assets as capital.

[9]In the U.S., the Basel Accord capital standards were phased in from 1900 to 1992.

The way consumers and firms conduct banking has changed significantly in the recent decades from the rapid diffusion of automated teller machines (ATMs) in the 1980s to the replacement of ATM cards by debit cards in the 1990s to online banking in the 2000s.

Several financial innovations affected risk-taking behavior, including the application of credit-scoring software standardizing credit evaluation, the development of financial futures and option markets, the increasing importance of off-balance-sheet financing and asset securitization, and the development of markets for high-yield "junk" bonds. Financial innovations facilitated an increase in risk taking by S&Ls, deteriorating the quality of their loan portfolios, which led to bank failures at the end of the 1980s and a bank credit crunch in the 1990s. In the 1990s, automated underwriting techniques, that is credit-scoring, were introduced for small business loans, which led to an increase in the quantity of lending to small businesses (See Frame, Srinivasan and Woosley (2001) and Berger, Frame and Miller (2005)). More recently, the use of statistics to measure risk and to design risk-based pricing led to a rise in subprime lending.

Since the 1980s, there has been a constant development of financial products and markets, which have expanded the borrowing capabilities of firms and households. In the early 1980s, adjustable rate mortgages (ARMs) were introduced and by the late 1980s, the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac) began securitizing mortgages, while asset-backed securities were introduced in 1985. Interest-rate swap agreements were introduced in the early 1980s and credit default swaps in the 1990s. In the 1980s, the contracting conventions of repurchase agreement, or repos, changed to accommodate market expansion and the growing use of repos to borrow securities.

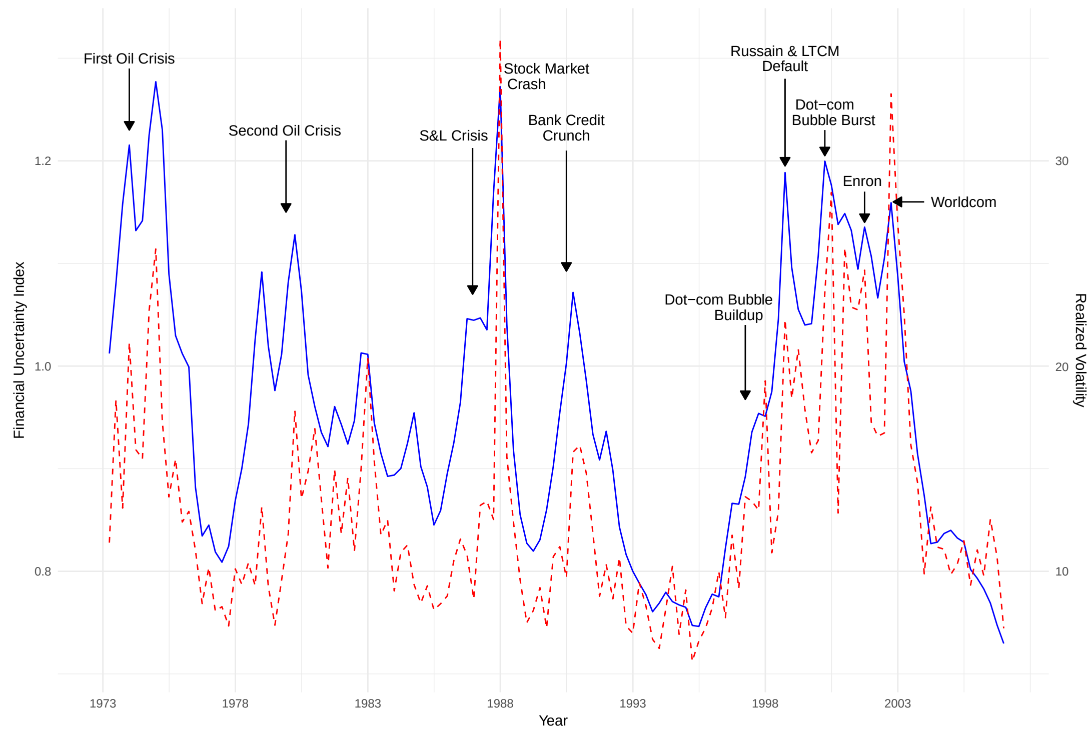
All of these financial innovations translated into improvements in access to credit during the Great Moderation, which in our model implies a reduction in the size of the average level of financial rigidities.

3.3 Financial shocks

In this section, we provide an overview of some well-known financial shocks and periods of heightened financial uncertainty during the Great Moderation using proxies for financial stress. Figure 1 shows the financial uncertainty index by Ludvigson, Ma and Ng (2017) – the blue line– and the realized stock market volatility as in Caldara et al. (2016) – the dashed red line. In Ludvigson, Ma and Ng (2017), the financial uncertainty index summarizes how difficult it is to forecast the near-term path of 148 separate financial variables. In Caldara et al. (2016), realized equity volatility, computed as the annualized standard deviation of the daily value-weighted total market (log) return from the Center for Research in Security Prices data base, summarizes macroeconomic uncertainty.

As indicated in Figure 1, the periods of heightened financial uncertainty during the 1970s were linked to the oil crises of 1973 and 1979. During the 1980s, almost one-third of S&L institutions failed, posing a challenge to the stability of the banking industry and leading to the increase in financial uncertainty and the S&L crisis in 1986. The spike in the last quarter of 1987 reflects the aftermath of the October 1987 stock market crash, while the run-up in financial uncertainty

Figure 1: Financial uncertainty index by Ludvigson, Ma and Ng (2017) and realized volatility by Caldara et al. (2016)



Note: The blue line is the quarterly average of the three-month-ahead financial uncertainty index by Ludvigson, Ma and Ng (2017) and is represented in the left axis. The red dashed line is the quarterly average of the realized stock market volatility in Caldara et al. (2016) and is represented in the right axis.

from1989 to mid-1991 is related to the bank credit crunch during the recession in the early 1990s. Beginning in 1995, there was a steady increase in financial uncertainty linked to the buildup of the dot-com bubble and events such as the Asian financial crisis in 1997 and the Russian and Long-Term Capital Management hedge fund defaults in 1998. The dot-com bubble burst in 2000 driving the economy into a moderate and short-lived recession in 2001. The spikes in 2001 and 2002 correspond to the Enron and WorldCom bankruptcies respectively.

In our model, we consider two types of financial shocks: shocks to corporate net worth and shocks to the size of the financial rigidity. Temporary changes in the conditions of access to credit are captured by time variation in the size of the financial rigidity. Shocks affecting the balance sheet position of firms are captured by net worth shocks.

4 The Model

The core of the theoretical framework features real and nominal rigidities as in Justiniano, Primiceri and Tambalotti (2010). To study the role of financial factors in the Great Moderation and the increase of financial volatility, we incorporate financial rigidities à la Bernanke, Gertler and Gilchrist (1999), allowing for exogenous shocks to the firm's net worth and to the parameter summarizing the level of financial rigidities in the model economy – the so-called marginal bankruptcy cost or agency cost parameter. These two types of financial shocks affect the two channels determining the cost of external financing for firms in the model.

Regulatory changes and innovations in technology and in financial engineering described in Section 3.1 and Section 3.2, respectively, will be reflected in a reduction of the average level of financial rigidities in the model economy, which implies a reduction in the steady state value for the marginal bankruptcy cost. Transitory changes in financial factors affecting the conditions of access to credit will be accounted for in the model by shocks to marginal bankruptcy costs. Shocks affecting the balance sheet position of firms are represented by net worth shocks that summarize the sensitivity of the economy to asset price movements.

The economy is populated by households, labor packers, capital producers, intermediate good producers, retailers, financial intermediaries, entrepreneurs, and a policymaker. The core of the model without financial rigidities follows Justiniano, Primiceri and Tambalotti (2010) closely, so we refer the reader to this paper for details.[10] We proceed here to discuss in detail the modeling of financial rigidities only.

Entrepreneurs are finitely lived risk-neutral agents who borrow funds captured by financial intermediaries from households to purchase physical capital. In this environment, financial frictions arise because there is asymmetric information between borrowers and lenders as in Townsend (1979); in other words, while borrowers freely observe the realization of their idiosyncratic risk, lenders must pay monitoring costs to observe an individual borrower's realized return. At the beginning of the period, an entrepreneur is hit by an idiosyncratic shock, $\omega_t^j \sim \mathcal{LN}\left(-\sigma_\omega^2, \sigma_\omega\right)$, that affects the productivity of the entrepreneur's capital holdings. This idiosyncratic shock is at the center of the informational asymmetry, as it is only freely observed by the entrepreneur. After observing the realization of the idiosyncratic shock, entrepreneurs choose the capital utilization rate, u_t^j, so that the capital services rented to intermediate good producers are given by $k_t^j = u_t^j \omega_t^j K_t^j$. The capital demand for entrepreneur j is given by the gross nominal return on holding one unit of capital from t to $t+1$, that is,

$$R_{t+1}^{k,j} = \left[\frac{r_{t+1}^{k,j} u_{t+1}^j + \omega_{t+1}^j (1-\delta) Q_{t+1}}{Q_t} \right] \frac{P_{t+1}}{P_t}, \tag{1}$$

where $\omega_{t+1}^j(1-\delta)Q_{t+1}$ is the return to selling the undepreciated capital stock back to capital producers.

Entrepreneurs can finance the purchase of new physical capital by investing their own net worth, N_{t+1}^j, and using external financing (in nominal terms), B_{t+1}^j, to leverage a project. Given that the entrepreneurs are risk neutral, they offer debt contracts that ensure lenders a return free of aggregate risk. Lenders can diversify idiosyncratic risks by holding a perfectly diversified portfolio,

[10] In Appendix B, we summarize the log-linearized equilibrium conditions for the core of the model in Table 9 and the stochastic processes in Table 10.

which allow them to offer a risk-free rate on deposits to households. Financial intermediaries cannot observe the realized return of a borrower unless they pay an auditing cost, μ_t. This auditing cost, also called the marginal bankruptcy cost, summarizes the level of financial rigidities in the model economy.

A debt contract is characterized by the amount of the loan, B^j_{t+1}, the contractual rate, Z^j_{t+1}, and a schedule of state-contingent threshold values of the idiosyncratic shock, $\bar{\omega}^j_{n,t+1}$, where n refers to the state of nature. For values of the idiosyncratic productivity shock above the threshold, the entrepreneur is able to repay the lender at the contractual rate. For values below the threshold, the borrower defaults, and the lender steps in and seizes the firm's assets. A fraction of the realized entrepreneurial revenue, μ_t, is lost in the process of liquidating the firm. In this case, the financial intermediary obtains $(1-\mu_{t+1})P_t\omega^j_{n,t+1}R^k_{n,t+1}Q_tK^j_{t+1}$, where μ_{t+1} stands for the marginal bankruptcy cost.

In the literature, the marginal bankruptcy cost is assumed to be a constant parameter. In this paper, we assume the marginal bankruptcy cost parameter is drifting so that exogenous changes in the level of financial rigidities affect the business cycle properties of the model. In particular, we assume $\mu_t = \frac{1}{1+e^{\varphi_t}}$ with $\ln\varphi_t = (1-\rho_\varphi)\ln\varphi_\star + \rho_\varphi \ln\varphi_{t-1} + \varepsilon_{\varphi,t}$ and $\varepsilon_{\varphi,t} \sim \mathcal{N}\left(0,\sigma_\varphi\right)$.[11] The unconditional mean of the process governing the agency problem between borrowers and lenders, $\mu^\star = 1/\left(1+e^{\varphi_\star}\right)$, that is, the steady-state level of the marginal bankruptcy cost, determines the average level of financial rigidity in the model economy. In the estimation, we allow for structural breaks in $\mu^\star$.

The terms of the debt contract are chosen to maximize expected entrepreneurial profits conditional on the return of the lender for each possible state of nature being equal to the riskless rate. From the zero profit condition for the financial intermediary, we obtain the supply for loans in the model as follows:

$$\mathbb{E}_t \frac{R^k_{t+1}}{R_t}\left[\Gamma(\bar{\omega}_{t+1}) - \mu_{t+1}G(\bar{\omega}_{t+1})\right] = \left(\frac{Q_tK_{t+1} - N_{t+1}}{Q_tK_{t+1}}\right), \tag{2}$$

where $\Gamma(\bar{\omega}^j_{t+1})$ is the expected share of gross entrepreneurial earnings going to the lender and $\mu_{t+1}G(\bar{\omega}^j_{t+1})$ is the expected monitoring costs.[12]. The above equation states that financial intermediaries are only willing to provide funds to entrepreneurs if they are compensated by the default risk. That is, lenders charge a premium over the risk-free rate, the so-called external finance premium, $\mathbb{E}\left[R^k_{t+1}/R_t\right]$. The external finance premium in equation (2) determines the efficiency of the contractual relationship between borrowers and lenders because it provides a linkage between the entrepreneur's financial position and the cost of external funds.

[11] This specification ensures that the realization of the marginal bankruptcy cost, μ_t, lies between 0 and 1 every period. Alternatively, time variation in the marginal bankruptcy cost can be modeled as $\ln\mu_t = (1-\rho_\mu)\ln\mu_\star + \rho_\mu\ln\mu_{t-1} + \sigma_\mu\epsilon_\mu$, which does not restrict the realization of the marginal bankruptcy cost to the unit interval. However, the posterior odds favor the restricted specification over the unrestricted one.

[12] $\Gamma(\bar{\omega}^j_{t+1}) = \int_0^{\bar{\omega}^j_{t+1}} \omega f(\omega)d\omega + \bar{\omega}_t\int_{\bar{\omega}^j_{t+1}}^{\infty} f(\omega)d\omega$ and $\mu_{t+1}G(\bar{\omega}^j_{t+1}) = \mu_{t+1}\int_0^{\bar{\omega}^j_{t+1}} \omega f(\omega)d\omega$

Let us rewrite the supply for loans as follows

$$\mathbb{E}_t \frac{R_{t+1}^k}{R_t} = \mathcal{S}\left(\bar{\omega}_{t+1}, \mu, \sigma_\omega\right) \left(\frac{Q_t K_{t+1} - N_{t+1}}{Q_t K_{t+1}}\right), \tag{3}$$

where $\mathcal{S}\left(\bar{\omega}_{t+1}, \mu, \sigma_\omega\right)$ is the elasticity of the external finance premium with respect to the leverage ratio. Therefore, in the model, the external finance premium is determined by two channels: the *balance sheet channel*, through the debt-to-assets ratio, $\left(\frac{Q_t K_{t+1} - N_{t+1}}{Q_t K_{t+1}}\right)$, and the *elasticity channel*. In this paper, we explore the role played by financial shocks affecting both of these channels.

The *balance sheet channel* highlights the negative dependence of the premium on the amount of collateralized net worth, N_{t+1}. The higher the stake of a borrower in the project, the lower the premium over the risk-free rate required by the intermediary. The assumption of finitely-lived entrepreneurs ensures that entrepreneurs do not accumulate enough wealth to be self-sufficient in terms of funding. Each period t, entrepreneurs die with probability $(1-\gamma)$ transferring their wealth holdings, W_t^e, to the pool of active entrepreneurs. Aggregate entrepreneurial net worth (average net worth across surviving entrepreneurs) is given by the sum of entrepreneurial equity, V_t, and the wealth transfers made by exiting firms.

$$P_t N_{t+1} \quad = \quad x_t \gamma V_t + P_t W_t^e \tag{4}$$

Entrepreneurial equity is equal to the nominal gross return on capital net of repayment of loans in the nondefault case, $\left[R_t^k P_{t-1} Q_{t-1} K_t^j - R_{t-1} B_t\right]$, minus the gross return lost in case of bankruptcy, $\mu_t G\left(\bar{\omega}_t\right) R_t^k Q_{t-1} K_t$. In equation (4), x_t is an entrepreneurial equity shifter or net worth shock, which is assumed to follow the process $\ln(x_t) = \rho_x \ln(x_{t-1}) + \varepsilon_{x,t}, \varepsilon_{x,t} \sim \mathcal{N}(0, \sigma_x)$. Exogenously driven changes in the valuation of entrepreneurial equity need to be financed by another sector of the model economy. We assume that the household sector receives (provides) wealth transfers from (to) the entrepreneurial sector. This type of wealth shock was first introduced by Gilchrist and Leahy (2002) and recently explored by Gilchrist, Ortiz and Zakrajšek (2009), Nolan and Thoenissen (2009), Christiano, Motto and Rostagno (2014), Smets and Villa (2016), and Mumtaz and Zanetti (2016).

The *elasticity channel* depends upon *(i)* the idiosyncratic productivity threshold, $\bar{\omega}_{t+1}$, *(ii)* the marginal bankruptcy cost, μ, and *(iii)* the distribution of the idiosyncratic productivity shocks. Given our assumptions, the latter is fully characterized by the cross-sectional dispersion of productivity across entrepreneurs, σ_ω. Time variation in the elasticity of the premium with respect to leverage is endogenously driven by fluctuations in the idiosyncratic threshold. The *elasticity channel* establishes that the external finance premium is a positive function of the severity of the agency problem measured by the marginal bankruptcy cost, which we assume is time-varying because time variation in this parameter captures changes in access to credit at business cycles frequencies.

Using a partial equilibrium version of the financial accelerator model and firm-level data over the 1997-2003 period, Levin, Natalucci and Zakrajšek (2004) assess the relative role of exogenous variation in the marginal bankruptcy cost parameter and the standard deviation of the idiosyncratic productivity shock in accounting for the observed wedge between the cost of external and internal finance. They conclude that, in the data, there is little variation in idiosyncratic volatility across the distribution of firms and that most of the variation in the external finance premium is driven by the variation in the bankruptcy cost parameter. Christiano, Motto and Rostagno (2003) and Christiano, Motto and Rostagno (2014) challenge the small role of the variation in idiosyncratic volatility in a general equilibrium framework by exploring mean-preserving changes in the cross-sectional dispersion of productivity across entrepreneurs, the so-called risk shocks. They conclude that these risk shocks play a relevant role in driving business cycle fluctuations. In this paper, we test the role of time variation in the bankruptcy cost parameter in the context of a general equilibrium framework.[13]

5 Bayesian Inference and Model Fit

5.1 Estimation methodology

We want to assess the relative role played by luck versus institutional change in accounting for the observed evolution in the magnitude of business cycle fluctuations. To do so, we allow for breaks in three subsets of parameters: the size of shocks, the monetary policy coefficients, and the unconditional mean of the marginal bankruptcy cost, which summarizes the average level of financial rigidities present in the economy.[14] Structural breaks in any of these parameters affect model dynamics, but the unconditional mean of marginal bankruptcy costs also affects the steady state of the economy. Cúrdia and Finocchiaro (2013) developed a Bayesian estimation methodology for models with structural breaks in parameters that affect only model dynamics. They applied their estimation approach to an open economy model with breaks only in the monetary policy coefficients. In this paper, we generalize the Cúrdia and Finocchiaro (2013) methodology to models with breaks in parameters governing the steady state of the economy.

Following Cúrdia and Finocchiaro (2013), we impose the dating of the structural breaks, but we do not allow economic agents to form expectations about these breaks. These two assumptions allow us to proceed within the log-linear framework using small departures in generating the posterior. Separate rational expectations equilibria for the same model with only a subset of regime-dependent equations changed are computed and reconnected via the likelihood function. In

[13] The aggregate data clearly favors the model with time-varying marginal bankruptcy costs over the model with time-varying idiosyncratic risk à la Christiano, Motto and Rostagno (2003). In particular, the marginal data density of the former is 37 log points larger than that of the latter. Recently, Zeke (2016) showed that the relative role of idiosyncratic volatility shocks in driving business cycle fluctuations is very sensitive to the cost of default. In particular, for default costs along the lines of the micro empirical evidence, idiosyncratic volatility shocks cannot generate enough aggregate variation.

[14] Allowing for breaks in only one of the parameters characterizing the financial accelerator may seem too simplistic despite being the parameter that conceptually measures the size of the financial rigidity. Table 11 in Appendix C reports the fit of alternative model specifications that allow for breaks in the steady state default probability, $F(\bar{\omega})^{\star}$, the entrepreneurial survival rate, γ, and the volatility of the distribution of idiosyncratic productivity, σ_{ω}. The log posterior odds are clearly in favor of the baseline model in which the only parameter linked to the structure of the financial accelerator subject to structural breaks is the steady state value of the marginal bankruptcy cost.

this way, a computational bridge is established between subsamples so that the entire sample can be used to estimate parameters that are constant across regimes and we can proceed with the joint estimation of the regimes.

We first describe our estimation methodology by means of a simple example; in particular, let us consider the following autoregressive process of order 1 (AR(1)) with time-varying mean:

$$x_t = \rho x_{t-1} + (1-\rho)\,\bar{x}_t + u_t, \tag{5}$$

where $|\rho| < 1$, $\bar{x}_t$ is the time-varying mean, and u_t is a zero-mean iid process. Let us define $\widetilde{x}_t = x_t - \bar{x}_t$; that is, the deviation of x_t with respect to the time-t mean of the process. Note that expression (5) cannot be written as $\widetilde{x}_t = \rho\widetilde{x}_{t-1} + u_t$ given that $\widetilde{x}_{t-1} \neq x_{t-1} - \bar{x}_t$ but $\widetilde{x}_{t-1} = x_{t-1} - \bar{x}_{t-1}$. Instead, the model can be expressed as

$$\begin{aligned} x_t - \bar{x}_t &= \rho\,(x_{t-1} - \bar{x}_{t-1}) + \rho\,(\bar{x}_{t-1} - \bar{x}_t) + u_t \\ \widetilde{x}_t &= \rho\widetilde{x}_{t-1} + \rho\,(\bar{x}_{t-1} - \bar{x}_t) + u_t \end{aligned}$$

where $\widetilde{x}_t = x_t - \bar{x}_t$ and $\widetilde{x}_{t-1} = x_{t-1} - \bar{x}_{t-1}$.

To illustrate the relevant case for this paper, let us assume that the time-varying mean process is given by

$$\bar{x}_t = \begin{cases} \bar{x}_1 & \text{for } t < t^\star \\ \bar{x}_2 & \text{for } t \geq t^\star \end{cases} \tag{6}$$

Thus, we can represent (5) as follows:

$$\begin{array}{llll} \text{For} \quad t < t_\star, & \widetilde{x}_t = \rho\widetilde{x}_{t-1} + u_t & \text{where} \quad \widetilde{x}_t = x_t - \bar{x}_1 & \text{and} \quad \widetilde{x}_{t-1} = x_{t-1} - \bar{x}_1 \\ \text{For} \quad t = t_\star, & \widetilde{x}_t = \rho\widetilde{x}_{t-1} + \rho\,(\bar{x}_1 - \bar{x}_2) + u_t & \text{where} \quad \widetilde{x}_t = x_t - \bar{x}_2 & \text{and} \quad \widetilde{x}_{t-1} = x_{t-1} - \bar{x}_1 \\ \text{For} \quad t > t_\star, & \widetilde{x}_t = \rho\widetilde{x}_{t-1} + u_t & \text{where} \quad \widetilde{x}_t = x_t - \bar{x}_2 & \text{and} \quad \widetilde{x}_{t-1} = x_{t-1} - \bar{x}_2 \end{array}$$

That is,

$$\begin{aligned} (x_t - \bar{x}_1) &= \rho\,(x_{t-1} - \bar{x}_1) + u_t, && \text{if } t < t_\star, \\ (x_t - \bar{x}_2) &= \rho\,(x_{t-1} - \bar{x}_1) + \rho\,(\bar{x}_1 - \bar{x}_2) + u_t, && \text{if } t = t_\star, \\ (x_t - \bar{x}_2) &= \rho\,(x_{t-1} - \bar{x}_2) + u_t, && \text{if } t > t_\star. \end{aligned}$$

The generalization of the above example is straightforward. Let ϱ be the subvector of structural parameters in the DSGE model that is constant across subsamples, and let τ_t be the subvector subject to structural breaks. The system of log-linearized equilibrium conditions can be represented as

$$\Gamma_0\,(\varrho, \tau_t)\,\widetilde{s}_t = \Gamma_1\,(\varrho, \tau_t)\,\widetilde{s}_{t-1} + \Psi\,(\varrho, \tau_t)\,\varepsilon_t + \Pi\,(\varrho, \tau_t)\,\eta_t, \tag{7}$$

where $\widetilde{s}_t$ is a vector of model variables expressed in deviations from the steady state, ε_t is a vector of exogenous shocks, and η_t is a vector of rational expectations errors with elements $\eta_t^x = \widetilde{x}_t - \mathbb{E}_{t-1}\,[\widetilde{x}_t]$.

As in the AR(1) example, $\widetilde{s}_t$ is in log-deviations from the steady state at time t, $\bar{s}_t$, and $\widetilde{s}_{t-1}$ is in log-deviations from the steady state at time $t-1$, $\bar{s}_{t-1}$. The state-space representation of the solution to the linear rational expectations model can be written as follows:

$$\begin{array}{lc} \text{Transition equations} & [s_t - \bar{s}_t] = \Phi(\varrho, \tau_t)\,[s_{t-1} - \bar{s}_{t-1}] + \Phi_\varepsilon(\varrho, \tau_t)\varepsilon_t \\ \text{Measurement equations} & y_t = B s_t, \end{array}$$

where s_t is the state vector in log-levels. Note that while breaks in the size of shocks shift only $\Phi_\varepsilon(\varrho, \tau_t)$ and breaks in monetary policy coefficients affect $\Phi(\varrho, \tau_t)$, breaks in parameters defining the steady state of the economy translate into changes in $\Phi(\varrho, \tau_t)$ and $\bar{s}$. To evaluate the likelihood function, we only need to modify the forecasting step of the Kalman filter to accommodate for structural breaks as follows:

$$\begin{array}{rcll} \left[\widehat{s}_{t|t-1} - \bar{s}_1\right] & = & \Phi\left(\varrho, \tau_1\right)\left[\widehat{s}_{t-1|t-1} - \bar{s}_1\right] & \text{if } t < t_\star \\ \left[\widehat{s}_{t|t-1} - \bar{s}_2\right] & = & \Phi\left(\varrho, \tau_2\right)\left[\bar{s}_1 - \bar{s}_2\right] + \Phi\left(\varrho, \tau_2\right)\left[\widehat{s}_{t-1|t-1} - \bar{s}_1\right] & \text{if } t = t_\star \\ \left[\widehat{s}_{t|t-1} - \bar{s}_2\right] & = & \Phi\left(\varrho, \tau_2\right)\left[\widehat{s}_{t-1|t-1} - \bar{s}_2\right] & \text{if } t > t_\star. \end{array}$$

5.2 Prior and posterior distributions

We use quarterly observations on 9ninevariables covering the period from 1954:Q4 to 2006:Q4. Seven of these variables are standard in empirical analyses with macroeconomic data: output, consumption, investment, the real wage, hours worked, inflation, and the federal funds rate. We consider first differences of real-per capita output, consumption, investment, and wages. The description of all data transformations is available in Appendix A. We use two financial variables in our analysis: corporate net worth and the credit spread. We define corporate net worth as tangible assets minus credit market liabilities in the flow of funds accounts provided by the Federal Reserve Board. We consider the growth rate of the real per-capita measure of corporate net worth. We measure the credit spread by the difference between the interest rate on BAA-rate corporate bonds and the 10-year U.S. government bond rate.

The parameter space can be partitioned into three sets: *(i)* parameters with degenerate priors, *(ii)* parameters estimated using the full sample information, and *(iii)* parameters subject to structural breaks. The first set contains parameters that are usually calibrated such as the capital depreciation rate as well as the steady-state price, wage markups, and the steady-state share of government spending. Moreover, we use degenerate priors for the steady-state value of log-hours, $ln(H_\star)$, and the quarterly growth rate in the model economy, Υ, to overcome the well-known difficulty of DSGE models to match sample averages of observable variables. The values for these parameters and the prior and posterior distributions for the parameters estimated using the full sample are available in Table 12 and Table 13 of Appendix C, respectively. We choose priors similar to those in the literature and the posterior estimates we obtain are in line with standard values. Because the solution of the linear rational expectations model may have multiple equilibria, the joint prior distribution is truncated at the boundary of the determinacy region.

Among the parameters estimated using the entire sample, we review here the prior and posterior distributions of the parameters linked to the financial rigidity only, which are reported in the first three columns and the last two columns of Table 3, respectively. As reported in Table 3, the Beta distribution for the entrepreneurial default probability at the steady state, $F(\bar{\omega})$, is centered at the average of the historical default rates for U.S. bonds over the 1971–2005 period reported by Altman and Pasternack (2006). The steady-state default probability is estimated to be 0.36%, which is a bit lower than the estimate in Christiano, Motto and Rostagno (2014) for the post-1985 period as well as the median default probability in the firm-level data set explored by Levin, Natalucci and Zakrajšek (2004) for the 1997–2003 period. For the survival probability, γ, we assume a Beta prior with location parameter implying a steady state value for the debt-to-wealth ratio equal to its historical average. The survival probability of entrepreneurs is estimated to be about 98% per quarter, which implies a median life for entrepreneurs of about 12 years. The tenure implied by the posterior median is close to the median tenure of 14 years reported by Levin, Natalucci and Zakrajšek (2004) and the values used in Bernanke, Gertler and Gilchrist (1999), Christiano, Motto and Rostagno (2010), and Christiano, Motto and Rostagno (2014). We impose a truncated Gaussian distribution as the prior for the standard deviation of the distribution of idiosyncratic productivities, σ_ω. The posterior median estimate for this parameter is similar to the value imposed for the U.S. by Christiano, Motto and Rostagno (2010).

Table 3: Parameters estimated using the full sample linked to the financial rigidity

		Prior		*Posterior*	
	Density	*Para 1*	*Para 2*	*Median*	*95% CI*
Steady-state default probability: $100\,[F(\bar{\omega})]^\star$	Beta	0.70	0.37	0.36	[0.10, 0.62]
Survival probability: $100\,[1/\gamma - 1]$	Gamma	1.48	0.50	1.87	[0.81, 3.38]
St deviation of idiosyncratic productivity: σ_ω	Normal	0.28	0.10	0.55	[0.47, 0.64]

Note: Para 1 and Para 2 list the mean and the standard deviation, respectively, for Beta, Gamma, and Normal distributions.

Table 4 reports the prior and posterior distributions for the parameters subject to structural breaks. We choose priors that are agnostic about the magnitude and sign of the changes by using identical priors across subsamples. We choose a Beta distribution with location parameter equal to 0.28 and diffusion parameter equal to 0.05 for the unconditional mean of the marginal bankruptcy cost, $\mu^\star$, so that the 95% credible set encompasses most of the values provided in the literature. For example, Altman (1984), using data from 26 firms, concludes that bankruptcy costs are about 20% of the firm's value prior to bankruptcy and Alderson and Betker (1995), using data from 201 firms that completed Chapter 11 bankruptcies between 1982 and 1993, conclude that the mean liquidation costs are 36.5%. Using panel data from 1997 to 2003 and a partial equilibrium version of the Bernanke, Gertler and Gilchrist (1999) model, Levin, Natalucci and Zakrajšek (2004) provide a time series for the marginal bankruptcy cost ranging between 7% and 47%.

The right panel of Table 4 shows that $\mu^\star$ declines from 13% to 1%.[15] The estimate for the Great Moderation period is along the lines of the direct costs of bankruptcy estimated by Weiss (1990), which are, on average, 3.1% of the book value of debt plus the market value of equity and show that the range for a set of corporations filing for bankruptcy after the enactment of the Bankruptcy Reform Act of 1978 is 1% to 6.6%. Our estimates for the average marginal bankruptcy cost parameter imply that the recovery rate for creditors increases from 87% in the 1970s to 99% in the mid-1980s. The estimated model-implied increase in recovery rates lines up with the discussion on the effects of the Bankruptcy Code in recovery rates in Section 3. As stated earlier, Hackbarth, Haselmann and Schoenherr (2015) provide evidence on the shift from bankruptcy filings under Chapter 7 to filings under Chapter 11 since the inception of the Bankruptcy Code, while Bris, Welch and Zhu (2006) and Acharya, Bharath and Srinivasan (2007) show that the recovery rate for creditors in Chapter 11 bankruptcies is significantly larger than for those in Chapter 7 bankruptcies. The estimated reduction in the average level of financial rigidities accounts not only for the decrease in bankruptcy costs and the increase in recovery rates linked to the Bankruptcy Code, but also for other changes in the US financial system such as the information technology revolution, waves of deregulation, development of new products, and improvements in the assessment of risk, all of which translated into improvements in the conditions of access to credit as discussed in Section 3.1 and Section 3.2.

Time variation in marginal bankruptcy costs captures changes in the conditions of access to credit at business cycle frequencies. The estimated range of variation for μ_t is quite wide, with a minimum of 0% and a maximum of 50%. This range of variation encompasses the ranges estimated using micro evidence. For example, the range of variation for default costs in Andrade and Kaplan (1998), Levin, Natalucci and Zakrajšek (2004), and Davydenko, Strebulaev and Zhao (2012) is $10\% - 23\%$, $7\% - 47\%$, and $14.7\% - 30.5\%$, respectively. Davydenko, Strebulaev and Zhao (2012) estimate the cost of default for an average firm to be 21.7% of the market value of assets, while the average value of μ_t over the entire sample is 19%. Therefore, the estimated smoothed series for marginal bankruptcy costs seems to be consistent with the range of estimates in the empirical corporate finance literature.

As reported in Table 4, the Taylor rule during the Great Moderation is characterized by a tighter response to inflation and a stronger response to deviations of output growth from its target. As standard in the literature, our estimates characterize the Great Moderation as a period with a more proactive monetary authority.

Finally, we describe the estimated breaks for the size of the exogenous shocks. On the one hand, good luck in the form of smaller shocks is present in our estimation for the nonfinancial shocks. Their size decreases during the Great Moderation by a minimum of 15% for the wage markup shock and a maximum of 60% for the monetary policy shock. On the other hand, the size of financial shocks increases in the mid-1980s, which implies a higher exposure to financial risk in the model

[15] Using post-1980s data, Pinter, Theodoridis and Yates (2013) also estimate a low level of financial rigidities in the U.S. Their estimate of the marginal bankruptcy cost parameter is 0.05.

economy. Therefore, the internal dynamics of the model and the information in the likelihood function of the data drive the size of financial shocks and the strength of the financial rigidity in opposite directions to accommodate the existing tension in the data regarding the evolution of the volatility of net worth and credit spreads.

Table 4: Parameters subject to structural breaks

		Prior		*Posterior:* 1970 − 1984		*Posterior:* 1985 − 2006	
	Density	*Para 1*	*Para 2*	*Median*	*95% CI*	*Median*	*95% CI*
Marginal bankruptcy cost: $\mu^{\star}$	$\mathcal{N}$	0.28	0.05	0.13	[0.06, 0.20]	0.01	[0.01, 0.03]
Policy weight on inflation: ψ_{π}	$\mathcal{N}$	1.50	0.50	1.20	[1.11, 1.31]	1.85	[1.57, 2.18]
Policy weight on output growth: ψ_{y}	$\mathcal{N}$	0.50	0.30	0.22	[0.06, 0.37]	0.39	[0.28, 0.51]
Shock to marginal bankruptcy cost: σ_{φ}	$\mathcal{IG}$	0.001	4.00	0.38	[0.21, 0.85]	0.60	[0.30, 1.41]
Wealth shock: $100 \cdot \sigma_{x}$	$\mathcal{IG}$	0.10	4.00	0.83	[0.57, 1.21]	2.50	[2.07, 2.94]
Technology growth shock: $100 \cdot \sigma^{z}$	$\mathcal{IG}$	0.10	4.00	1.30	[1.08, 1.55]	0.99	[0.84, 1.15]
Investment-specific technology shock: $100 \cdot \sigma_{\zeta}$	$\mathcal{IG}$	0.10	4.00	1.41	[1.07, 1.84]	0.88	[0.68, 1.11]
Price markup shock: $100 \cdot \sigma_{\lambda^{p}}$	$\mathcal{IG}$	0.10	4.00	0.28	[0.22, 0.35]	0.18	[0.14, 0.22]
Wage markup shock: $100 \cdot \sigma_{\lambda^{w}}$	$\mathcal{IG}$	0.10	4.00	0.29	[0.22, 0.37]	0.25	[0.20, 0.30]
Intertemporal preference shock: $100 \cdot \sigma_{b}$	$\mathcal{IG}$	0.10	4.00	3.05	[1.83, 4.70]	2.30	[1.36, 3.71]
Government spending shock: $100 \cdot \sigma_{g}$	$\mathcal{IG}$	0.10	4.00	0.41	[0.35, 0.49]	0.29	[0.25, 0.34]
Monetary policy shock: $100 \cdot \sigma_{r}$	$\mathcal{IG}$	0.10	4.00	0.38	[0.31, 0.45]	0.15	[0.12, 0.18]

Notes: $\mathcal{N}$ stands for Normal distribution and $\mathcal{IG}$ stands for Inverse Gamma distribution. Para 1 and Para 2 list the mean and the standard deviation, respectively, for Normal distributions. Para 1 and Para 2 list s and ν, respectively, for the Inverse Gamma distribution, where $p_{IG}(\sigma|\nu, s) \propto \sigma^{-\nu-1}e^{-nus^{2}/2\sigma^{2}}$.

5.3 Model evaluation

We evaluate the model by assessing its ability to replicate the observed swings in cyclical volatility using posterior predictive checks and by analyzing the ability of the model-implied time series for the marginal bankruptcy cost to account for temporary changes in the conditions of access to credit using external instruments.

To perform posterior predictive checks, we generate 1,000 samples of 200 observations from the model using every 1,000th posterior draw. We filter the data in log levels obtained from the simulation using the Hodrick-Prescott filter and compute the standard deviation of the cyclical component. Table 5 reports the model-implied ratios of volatilities for the cyclical component. In particular, we report the median and 90% credible intervals, which are due to both parameter and small sample uncertainty. The likelihood function based estimation attempts to match the entire autocovariance function of the data making it difficult to match the standard deviations and other second moments of the data. Therefore, the researcher should not expect a perfect accounting of the observed cyclical volatilities. Moreover, in the estimation exercise, we use data in log-levels and first differences instead of cyclical data.

However, as shown in Table 5, the estimated model is successful at delivering a moderation in real and nominal variables at business cycle frequencies contemporaneous to an increase in the cyclical volatility of entrepreneurial net worth. Moreover, the model accounts for the differences in size of the slowdown in the volatility of real variables, nominal outcomes, and the credit spread in the mid-1980s. Therefore, given that the estimated model quite accurately delivers the observed divergent pattern in cyclical volatilities, we conclude that the estimated model is a good candidate to dissect the relative role of each of the potential drivers of the Great Moderation and the increase in financial volatility.

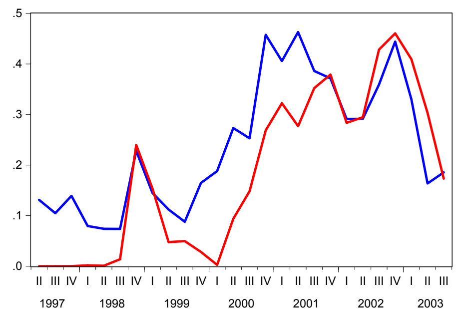
Table 5: Model fit: Ratio of standard deviations, cyclical component

	Data	Model	
		Median	90%
Output	0.53	0.56	[0.48, 0.65]
Investment	0.46	0.54	[0.45, 0.61]
Consumption	0.70	0.78	[0.68, 0.89]
Wage	0.66	0.70	[0.59, 0.79]
Hours	0.64	0.56	[0.48, 0.65]
Inflation	0.35	0.47	[0.38, 0.55]
Nominal interest rate	0.50	0.44	[0.36, 0.60]
Net worth	2.03	2.17	[1.57, 2.70]
Spread	0.51	0.43	[0.32, 0.53]

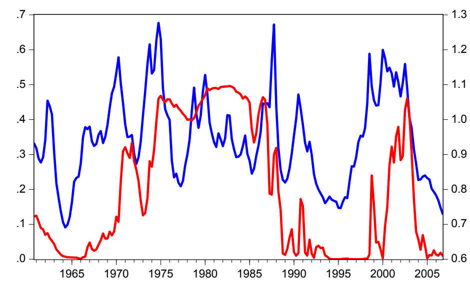
We now proceed to evaluate the model using external instruments. We have introduced time variation in the marginal bankruptcy cost parameter arguing that, in this way, we can capture variations in the conditions of access to credit at business cycle frequencies. We have also argued that the marginal bankruptcy cost in the model can be interpreted as the general equilibrium counterpart of the time-specific estimate of the bankruptcy cost parameter in Levin, Natalucci and Zakrajšek (2004), which is available for the rather short time span of 1997:Q2 to 2003:Q3. Figure 3(a) shows the estimate in Levin, Natalucci and Zakrajšek (2004) based on micro evidence, the blue line, and the general equilibrium model-implied series, the red line. Despite not using micro evidence in the estimation of the general equilibrium model, the two series similarly depict: *(i)* a spike in 1998:Q4, which most likely reflects the turbulence in financial markets after the Russian default and the collapse of the Long-Term Capital Management hedge fund, *(ii)* a run-up in bankruptcy costs linked to the burst of the stock market bubble in 2000, *(iii)* a moderate decline during the 2001 downturn until early 2002, *(iv)* an increase at the end of 2002 capturing the heightened uncertainty generated by the post-Enron scandals, and *(v)* a decline in 2003 reflecting the narrowing of credit spreads as the economy recovers.

Despite the similarities between the model-implied series for marginal bankruptcy costs and the estimated series using micro data by Levin, Natalucci and Zakrajšek (2004), μ_t, in practice, represents much more than just direct default costs. In the context of the model, marginal bankruptcy costs are a summary statistic for the conditions of access to credit.

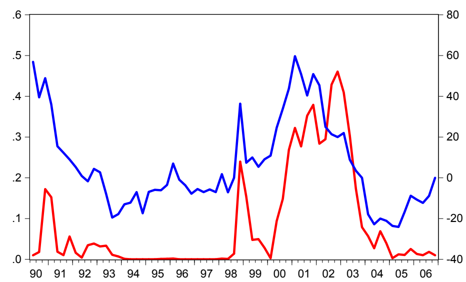
Figure 2: External Validation of the model-implied marginal bankruptcy cost



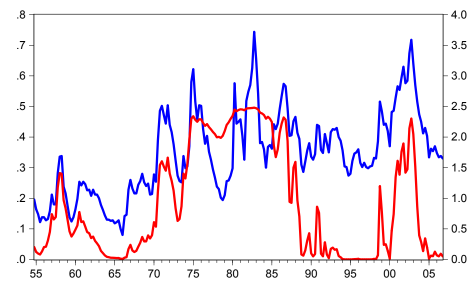
(a) Bankruptcy cost estimates by Levin, Natalucci and Zakrajšek (2004)



(b) Financial uncertainty index by Ludvigson, Ma and Ng (2017)



(c) Lending standards



(d) Credit Spread

Note: The red line, which represents the model implied measure of marginal bankruptcy costs, is measured on the left vertical axis in all panels, while the blue line is measured on the right axis unless otherwise noted. In the top-left panel, the blue line represents the time-specific estimate of the bankruptcy cost parameter in Levin, Natalucci and Zakrajšek (2004) and is measured on the left axis; in the top-right panel, the blue line represents the financial uncertainty index in Ludvigson, Ma and Ng (2017); in the bottom-left panel, the blue line represents the net percentage of domestic banks tightening standards for commercial and industrial loans to large and middle-market firms; and in the bottom-right panel, the blue line represents the credit spread.

There are several empirical proxies for conditions of access to credit, including lending standards and financial stress indexes. Figure 3(b) shows the financial uncertainty index by Ludvigson, Ma and Ng (2017), the blue line, that we analyzed in Section 3.3. The model-implied marginal bankruptcy cost and the financial uncertainty index show a decline until the mid-1960s followed by a run-up until the mid-1970s linked to the oil crises. In the decade from 1975 to 1985, the cost parameter remains relatively stable but high. In 1986, the marginal bankruptcy cost experiences a sharp decline, interrupted during the stock market crash in the fourth quarter of 1987, for which both the bankruptcy cost and the financial uncertainty index show a sharp spike. The following significant increase in both measures is related to the bank credit crunch of the early 1990s. The

1997-2003 period was described earlier. Finally, the model-implied measure of financial conditions also mimics the sharp decline in the financial uncertainty index starting at the end of 2002 and lasting until the end of the sample. Moreover, the volatility of the financial uncertainty index increased about 27% during the Great Moderation while the volatility of the smoothed marginal bankruptcy cost parameter increased 35% during the same period.

Figure 3(c) shows the smoothed series for μ_t (the red line) against the net percentage of domestic banks tightening standards for commercial and industrial loans to large and middle-market firms (the blue line), which has been available since 1990. The model-implied measure of financial rigidities mimics the sudden tightening in lending standards at the end of 1998 and from 2000 to 2001 as well as the loosening of business lending standards over the 2003-2004 period. Therefore, we conclude that, overall, the model-implied measure of marginal bankruptcy costs seems to be a good summary statistic of the underlying financial stress present in the U.S. economy.

Finally, Figure 3(d) reports the observed credit spread, the blue line, and the model-implied series for marginal bankruptcy costs, the red line. Similar to the results in Levin, Natalucci and Zakrajšek (2004), in our estimation, the shock to the marginal bankruptcy cost arises as the key driver of credit spreads in the model, as shown in Table 7 in Section 6.2. Therefore, it is not surprising that the marginal bankruptcy cost mirrors the observed dynamics for credit spreads.

6 Results

We first assess the drivers of the Great Moderation and the contemporaneous increase in the volatility of firms' balance sheet variables using counterfactual exercises. Appendix D provides a detailed description of the implementation of the counterfactuals. We conclude that the Great Moderation was the result of a combination of good luck in the form of smaller real and nominal shocks and better institutions. Larger financial shocks drove the increase in firms' balance sheet volatility. Our counterfactual analysis shows that the increase in the size of financial shocks contemporaneous with the decrease in the size of the remaining shocks imply an increase in the volatility of real and nominal variables. Institutional change arises as the only mechanism counteracting the large increase in cyclical volatilities linked to higher financial risk and, therefore, as the key channel to account for the Great Moderation in our model.

To further explore the interaction between institutional changes and financial shocks, we analyze the relative role played by financial shocks in driving business cycles fluctuations and then, we study the role of institutions in the transmission mechanism of financial shocks. From our analysis, we conclude that: *(i)* the regulatory changes and financial innovations described in Section 3, captured by the reduction in the average level of financial rigidities, are key in limiting the role of financial shocks in driving business cycle fluctuations in real and nominal variables during the Great Moderation, *(ii)* the estimated changes in the conduct of monetary policy also reduce significantly the role of financial shocks in driving nominal variables, *(iii)* the easier access to credit, which began in the mid-1980s, reduces the magnitude of the responses to financial shocks at all horizons, and *(iv)* the monetary policy stance during the Great Moderation dampens the real effects of financial shocks in the short and medium run, but has limited effects on long-run dynamics, even though it is key in shaping the transmission of financial shocks to nominal variables at all frequencies.

6.1 The sources of the Great Moderation and the increase in balance sheet volatility

Using counterfactual exercises, we analyze the contribution of changes in the size of shocks, changes in the conduct of monetary policy, and changes in the size of the financial rigidity to the model-impled changes in business cycle properties. Table 6 reports the percentage of the total increase or decrease in the cyclical standard deviation generated by the model that can be accounted for by the corresponding counterfactual. A dash indicates that the sign of the counterfactual change is at odds with the model-implied changes in volatilities.

First, we assess the sources of the Great Moderation through the counterfactuals reported in rows 1 to 6 of Table 6. Second, we analyze the sources of the increase in balance sheet volatility in rows 7 and 8. Finally, we analyze the interaction of each of these drivers in accounting for the slowdown in real and nominal variables contemporaneous with the increase in balance sheet volatility.

Table 6: Counterfactuals: Percentage of the model-implied change in cyclical standard deviations.

	Y	**I**	**C**	**H**	**W**	π	R	**N**	$\frac{\mathbb{E}\left(R^k_{t+1}\right)}{R_t}$
1. All institutions	**53**	**65**	**15**	**53**	**8**	**56**	**54**	–	**130**
2. All shocks	–	–	–	–	**56**	–	–	**117**	–
3. Monetary policy	43	37	–	44	3	51	33	–	–
4. Financial institutions	13	27	13	12	0	39	45	–	130
5. Nonfinancial shocks	49	37	92	48	97	36	32	–	1
6. All institutions and nonfinancial shocks	107	116	116	106	105	101	107	–	130
7. Financial shocks	–	–	–	–	–	–	–	121	–
8. All institutions and financial shocks	49	47	4	48	6	55	50	105	100

Notes: A dash (-) indicates that the direction of the counterfactual-implied change is at odds with the model-implied changes in volatilities. Y stands for real output, I for real investment, C for real consumption, H for hours, W for real wages, π for inflation, R for the policy interest rate, N for real net worth, and $\mathbb{E}\left(R^k_{t+1}\right)/R_t$ for the external finance premium or credit spread

To analyze the sources of the Great Moderation, we consider a counterfactual economy in which only the parameters linked to the institutional framework have changed, which is reported in row 1 of Table 6, and then examine a counterfactual economy in which only the size of shocks has changed, which is shown in row 2. Comparing row 1 with row 2, we conclude that the slowdown in cyclical volatilities characterizing the post-1985 period cannot be delivered by the model without the estimated institutional changes. The increase in the size of financial shocks combined with the decrease in the size of the remaining shocks, reported in row 2, can only account for 56% of the smoothing in wages. The effect on the remaining variables is at odds with the empirical evidence.

However, as shown in row 1, the estimated institutional changes by themselves account for 65% of the model-implied moderation in investment and over 50% of the smoothing in output, hours, inflation, and interest rate variability. Moreover, the new institutional framework overestimates the moderation in credit spreads by about 30%.

We now assess the relative role played by each of the estimated institutional changes in accounting for the Great Moderation. The effects of the change in the conduct of monetary policy are reported in row 3 of Table 6 and the effects of the estimated change in the average level of financial rigidities are reported in row 4. As shown in row 3, the monetary authority's tighter response to deviations of inflation and output growth from their respective targets accounts for an average of 40% of the model-implied moderation in investment, output, and hours worked. Moreover, this tightening has delivered half of the slowdown in inflation seen since the mid-1980s and about 30% of the slowdown in nominal interest rates, although their role in driving the model-implied volatility slowdown for the other variables is negligible.[16]

The improvement in the conditions of access to credit during the Great Moderation is key in accounting for the slowdown in credit spreads, as shown in row 4 of Table 6. In particular, the estimated reduction in the level of financial rigidities at the steady state is enough to over predict the moderation in credit spreads and to account for about 30% of the slowdown in the volatility of investment and almost 15% of that of output, consumption, and hours worked. More importantly, the estimated reduction in $\mu_\star$ is key in delivering the moderation in nominal variables: it accounts for about 40% of the slowdown in the volatility of inflation and the nominal interest rate.

The counterfactual *nonfinancial shocks*, row 5 of Table 6, shows that the good luck hypothesis still plays a relevant role in driving the model-implied moderation in real and nominal variables. Comparing the results of the counterfactual *all institutions*, row 1, and the counterfactual *nonfinancial shocks*, row 5, we conclude that good luck is the main driver of the slowdown in consumption and wages, but that the moderation in the other real variables and in nominal variables cannot be accounted for without the estimated institutional changes. As shown in row 6 of Table 6, the moderation in real and nominal variables can be accounted for by the model with the estimated changes in the institutional framework and the reduction in the size of nonfinancial shocks. However, the combination of better institutions and smaller real and nominal shocks is not enough to deliver the increase in cyclical volatility of net worth, as shown in row 6 of Table 6.

The increase in the size of financial shocks implies an increase in the volatilities of all variables, as shown in row 7 of Table 6. Looking across rows for net worth in Table 6, we conclude that the only mechanism available in the model to deliver the increase in balance sheet volatility is larger financial shocks.

Finally, we analyze the interaction between the drivers of the Great Moderation and of the increase in balance sheet volatility. When comparing the results for the counterfactuals *all institutions* and *all institutions and financial shocks*, reported in row 1 and row 8 of Table 6, respectively,

[16] This counterfactual generates swings in volatility of about 2-3%, which can be directly attributed to parameter uncertainty.

we conclude that the larger exposure to financial risk does not significantly decrease the moderation in real and nominal variables driven by institutional changes, with the exception of credit spreads and investment. It is noteworthy that the estimated institutional changes are able to ameliorate the effects of being subject to higher financial risk, as the increase in the volatility of all variables linked to *financial shocks*, as shown in row 7, reverts to a decline in volatility for real and nominal variables once institutional changes are taken into account, as reported in row 8.

We conclude that, in our model, the Great Moderation is the result of both good luck in the form of smaller shocks and good policy in the form of a more proactive monetary authority as well as better access to credit for firms. The observed increase in financial volatility is accounted for by larger financial shocks hitting the U.S. economy beginning in the mid-1980s, which poses a challenge to the model because larger financial shocks also imply more volatile real and nominal variables. Moreover, as the combination of larger financial shocks and smaller real and nominal shocks is not enough to deliver a moderation of cyclical volatilities, institutional changes arise as the key source of stability in cyclical volatilities in our model.

6.2 Institutions and the role of financial shocks as business cycle drivers

As shown in Section 6.1, the increase in cyclical volatility for all variables linked to larger financial shocks is partially overridden by the estimated changes in the institutional framework. In this section, we analyze the role of the monetary policy stance and the average level of financial rigidities in determining the relative importance of financial shocks as drivers of business cycle fluctuations. To do so, we first review the contribution of financial shocks to cyclical volatilities in the 1970s and during the Great Moderation period. Despite the increase in the size of financial shocks since the mid-1980s, their relative role in driving business cycle fluctuations is significantly smaller. Thus, we argue that the role of financial shocks as business cycle drivers is sensitive to the institutional framework characterizing the U.S. economy. To explore this hypothesis, we use counterfactual exercises as in Section 6.1. We conclude that while the estimated change in the conduct of monetary policy reduces the role of financial shocks in driving business cycle fluctuations for nominal variables, the more flexible financial system is key in significantly reducing such a role for all variables. In particular, without the estimated reduction in the average level of financial rigidities, financial shocks would have been the main driver of the U.S. business cycle.

Table 7 shows the contribution of financial shocks to the median variance decomposition at business cycle frequencies.[17] As shown in row 3, during the 1970s and early 1980s, financial shocks were the main source of the variance in investment, hours worked, the policy rate, the credit spread, and business wealth. Financial shocks also played quite a relevant secondary role in driving output. While the relative role of the shock to the marginal bankruptcy cost, row 1, is smaller than the role of the wealth shock, row 2, for most variables, the shock driving time-variation in the level

[17] We compute the spectral density of the observable variables implied by the DSGE model evaluated at each $1000th$ posterior draw and use an inverse difference filter to obtain the spectrum for the level of output, investment, consumption, wages, and net worth. We define business cycle fluctuations as those corresponding to cycles between 6 and 32 quarters and consider 500 bins for frequencies covering these periodicities.

of financial rigidities is the key driver of the credit spread. Using aggregate data and a general equilibrium framework, we reach a similar conclusion as Levin, Natalucci and Zakrajšek (2004) who estimate a partial equilibrium version of the BGG model using micro data and find that exogenous disturbances in the marginal bankruptcy cost are the main driver of the external finance premium. In other words, in order to deliver empirically plausible swings in the cost of external financing in a model with the financial accelerator, time variation in the level of financial rigidities should be incorporated.

As shown in row 6, the relative role of financial shocks in driving business cycle fluctuations decreases significantly during the Great Moderation. For example, comparing rows 3 and 6 shows that, while financial shocks account for about 50% of the variance of investment and the policy rate during the 1970s and early 1980s, the shocks only account for about 25% of these variances during the Great Moderation. The most dramatic decline in the contribution to business cycle fluctuations is for inflation: financial shocks accounted for 43% of the volatility of inflation in the 1970s but just 4% in the post-1985 period.

Table 7: Variance decomposition at business cycle frequencies: contribution of financial shocks

	Y	**I**	**C**	**H**	**W**	π	R^n	**N**	**Spread**
1970:Q3–1984:Q4									
1. Bankruptcy cost	6	9	0	8	5	5	8	3	67
2. Wealth	17	33	8	22	11	38	47	71	28
3. Total	23	41	8	30	16	43	55	74	95
1985:Q1–2006:Q4									
4. Bankruptcy cost	2	4	1	3	1	2	10	0	70
5. Wealth	6	20	9	9	3	2	13	99	29
6. Total	8	24	10	12	4	4	23	99	99

Notes: We compute the spectral density of the observable variables at each $1000th$ posterior draw. We define business cycle fluctuations as those corresponding to cycles between 6 and 32 quarters and consider 500 bins for frequencies covering these periodicities. Y stands for real output, I for real investment, C for real consumption, H for hours, W for real wages, π for inflation, R for the policy interest rate, N for real net worth, and $\mathbb{E}\left(R^k_{t+1}\right)/R_t$ for the external finance premium or credit spread

We assess the role played by the two estimated changes in institutions in shaping the smaller contribution of financial shocks to business cycle volatilities since the mid-1980s by examining the contribution to cyclical volatilities in two counterfactual scenarios as shown in Table 8. Row 2, *Monetary Policy of the 1970s*, compiles the contributions of financial shocks in a counterfactual economy characterized by the monetary policy stance of the 1970s with the flexible financial environment and the size of shocks of the mid-1980s. *Financial Institutions of the 1970s*, shown in row 3, refers to a counterfactual economy characterized by the monetary policy stance and shocks of the mid-1980s with the average level of financial rigidities estimated in the 1970s.

Comparing rows 1 and 2, we conclude that the relative role played by financial shocks in driving inflation and the interest rate is significantly reduced under the tighter policy regime characterizing the Great Moderation. If the monetary policy regime in place during the 1970s had been in place

Table 8: Counterfactual variance decomposition: contribution of financial shocks

	Y	**I**	**C**	**H**	**W**	π	R^n	**N**	**Spread**
1. Actual	8	24	10	11	4	4	23	99	99
2. Monetary Policy of the 1970s	12	28	7	17	8	37	52	99	100
3. Financial institutions of the 1970s	74	93	74	82	56	62	93	99	99

Notes: Y stands for real output, I for real investment, C for real consumption, H for hours, W for real wages, π for inflation, R for the policy interest rate, N for real net worth, and $\mathbb{E}\left(R^k_{t+1}\right)/R_t$ for the external finance premium or credit spread

during the Great Moderation, financial shocks would have accounted for 37% of the variance in inflation and 52% of the variance in the interest rate instead of 4% and 23%, respectively.

If the innovations in the financial sector and regulatory changes had not taken place so that the conditions of access to credit during the Great Moderation were identical to the ones in the 1970s, financial shocks would have been the main source of variability in the U.S. economy, as shown in row 3 of Table 8. For example, financial shocks would have accounted for 74% of the variance of output and 74% of the variance of consumption instead of the estimated 8% and 10%, respectively, or 93% of the variability in investment rather than the 24% implied by our estimates. Moreover, these shocks would have explained 93% of the variation in the policy rate and 62% of the variance in inflation instead of 23% and 4%, respectively. We conclude that the regulatory changes and financial innovations described in Section 3.1 and Section 3.2, which are captured by the estimated reduction in marginal bankruptcy costs at the steady state, significantly alleviated the role played by financial disturbances in driving real and nominal variables.

6.3 The transmission mechanism of financial shocks and institutional changes

Section 6.2 shows that the estimated institutional changes have large effects on determining the relative role of financial shocks in driving business cycle fluctuations. In this Section, we explore the predominant role of institutions in further detail by looking at the effects of institutional changes on the transmission mechanism of financial shocks. To do so, we analyze the impulse response functions (IRFs) for wealth shocks, Figure 3, and shocks to the marginal bankruptcy costs, Figure 4. We consider financial shocks that generate an increase in entrepreneurial net worth equal to a 1% deviation from its steady-state value in the 1970s. We use the same shocks across subsamples and across counterfactuals in order to facilitate the comparison. We first describe the transmission mechanism of financial shocks in the model and then proceed to discuss the effects of the two institutional changes in the dynamics implied by the shocks.

From our analysis, we conclude that both institutional changes significantly affect the transmission mechanism of financial shocks. Easier access to credit is key in delivering the change in dynamics for balance sheet variables and credit spreads in response to the two financial shocks. Moreover, the reduction in the financial accelerator also significantly dampens the real and nominal effects of financial shocks at all frequencies. The tighter monetary policy regime beginning in the mid-1980s reduces the real effects of financial shocks in the short and medium run[18] and is key in shaping the overall response of nominal variables.

6.3.1 Wealth shock

Figure 3 reports four IRFs for each variable. The the solid blue line is the IRF computed using the parameter vector characterizing the 1970:Q4–1985:Q1 sample period, the dashed red line is the IRF for the post-1985 period, the dotted green line is the IRF corresponding to a counterfactual economy characterized by the level of financial rigidity of the 1970s and early 1980s era with the monetary policy stance of the Great Moderation, and the starred black line is the IRF of the counterfactual economy with the low levels of financial rigidities of the Great Moderation with the monetary policy stance of the 1970s.

We first describe the transmission mechanism of the wealth shock using the IRFs corresponding to the institutional framework characterizing the 1970s, which are represented by the solid blue lines in Figure 3. We then explore the effects of the institutional changes in the transmission mechanism of wealth shocks.

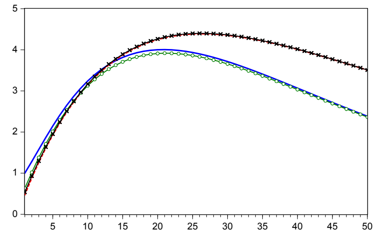
As shown in Figure 3(a), a positive wealth shock has persistent expansionary effects on business wealth. As reported in Figure 3(b), entrepreneurs proceed to readjust their funding portfolio by reducing their dependence on external financing. A positive wealth shock that increases the value of collateral reduces the probability of default so that financial intermediaries are willing to lend at a lower premium, which translates into a negative response on impact for the external finance premium, as shown in Figure 3(c). As entrepreneurs engage in a deleveraging process, financial intermediaries reduce the price of credit even further in subsequent periods. The lower price of credit and the availability of additional resources caused by the boost in business wealth translate into persistent favorable economic effects,[19] as shown in Figure 3(d) . The expansionary effects in real variables of a wealth shock translate into an inflationary episode, as shown in Figure 3(e), that triggers a tightening of monetary policy, as shown in Figure 3(f).

Let us analyze the changes in the transmission mechanism of wealth shocks linked to the tightening of the monetary policy stance in the mid-1980s. To do so, we compare the IRFs computed with the estimated parameters for the 1970s, the solid blue lines, with the IRFs computed using the estimated financial rigidity for the 1970s with the Taylor rule coefficients of the Great Moderation,

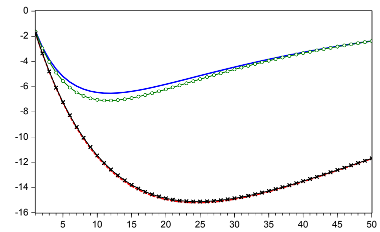
[18] We define short-run dynamics as the response on impact and up to 2 quarters after the shock, medium-run dynamics as the response at business cycle frequencies, that is, 2 to 32 quarters, and long-run dynamics as the response from 33 quarters until 200 quarters after the shock.

[19] As standard in models with the financial accelerator à la BGG, the initial responses of investment and consumption are negatively correlated. The negative response of consumption on impact is linked to the general equilibrium effects of the model because a nonfundamental increase in entrepreneurial wealth shifts resources from households to the entrepreneurial sector. The reduction in disposable income is not large enough to generate a decrease in consumption of the same magnitude as the increase in entrepreneurial wealth because other sources of household wealth, such as labor income, react positively to wealth shocks. Moreover, the increase in investment in response to the wealth shock more than compensates for the decline in consumption so that the response of output is positive. In this model, credit supply is funded by deposits so that a reduction in business leverage requires a smaller percentage of household income captured through deposits. Thus, the deleveraging process in the business sector frees up resources for consumption in the household sector.

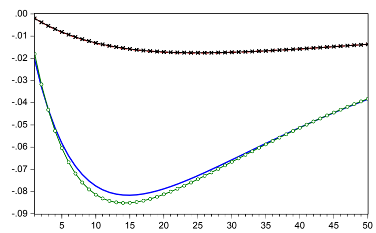
Figure 3: Impulse response functions with respect to a wealth shock



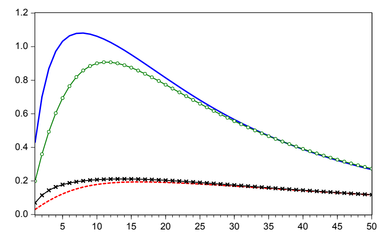
(a) Net worth



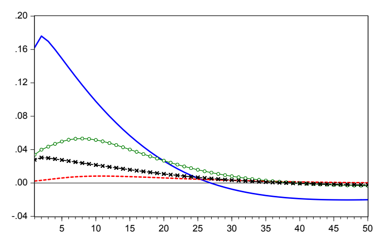
(b) Debt



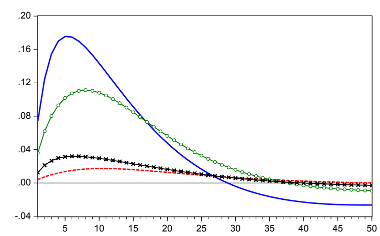
(c) Credit spread



(d) Output



(e) Inflation



(f) Policy rate

Note: The solid blue line is the IRF for 1970:Q4–1985:Q1, the dashed red line is the IRF for the post-1985:Q1 period, the dotted green line is the IRF when only the monetary policy coefficients change, and the starred black line is the IRF when only $\mu_\star$ changes.

the dotted green lines. We conclude that the tighter monetary policy stance of the mid-1980s has little, if any, effect on the transmission mechanism of wealth shocks for balance sheet variables and credit spreads. However, the change in monetary policy coefficients dampens the short- and medium-run effects of wealth shocks for output, although it has no impact on the long-run effects, as shown in Figure 3(d). The estimated changes in the conduct of monetary policy have significant effects on the transmission of wealth shocks at all frequencies for nominal variables. The response on impact of inflation in the counterfactual economy is about 1/4 of the response during the 1970s and the response of the policy rate is about half. More importantly, the persistence of the responses for both variables is very close to the lower persistence characterizing the responses during the Great Moderation, the dashed red lines.

To assess the effects of the estimated reduction in the size of the financial rigidity on the transmission of wealth shocks, we compare the IRFs linked to the 1970s, the solid blue lines, with the IRFs calculated using the low levels of financial rigidities of the Great Moderation with the monetary policy stance of the 1970s, the starred black lines. For variables other than balance sheet variables, the lower level of financial rigidity mutes the effects of wealth shocks at all horizons. Moreover, the responses for balance sheet variables, credit spreads, and output in the counterfactual, the starred black lines, are almost identical to the estimated responses during the Great Moderation, the dashed red lines. For balance sheet variables, the lower financial rigidity implies relatively large effects in the medium and long run. Lower average default costs alleviate the deadweight loss associated with bankruptcy, $\mu_t G(\bar{\omega}_t) P_{t-1} R_t^k Q_{t-1} K_t$, which implies that for the same initial increase in wealth, the effects are longer lasting, as more resources are accumulated from period to period. As shown in Figure 3(b), the size of the deleveraging process in the medium and long run is a negative function of the size of the financial accelerator.

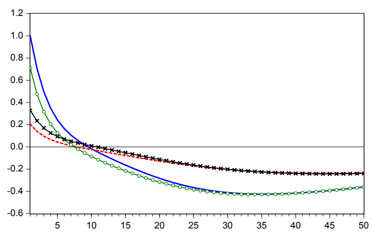
We conclude that while the more flexible financial environment is key to delivering the distinct dynamics in response to wealth shocks during the Great Moderation, the tighter monetary policy regime contributes to dampening the real effects of wealth shocks in the short and medium run and their nominal effects at all frequencies.

6.3.2 Shock to the marginal bankruptcy cost

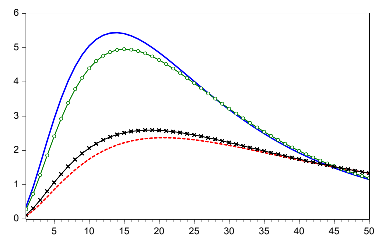
Figure 4 reports the IRFs to shocks to marginal bankruptcy costs. A negative shock to agency costs reduces the deadweight loss associated with bankruptcy. Thus, as all other defining components of net worth are predetermined, the response on impact to a shock reducing the agency problem must be positive for business wealth, as shown in Figure 4 (a). We consider a negative shock to bankruptcy costs that generates a 1% increase in net worth on impact in the 1970s. To have some perspective about the different size of the shocks under analysis, note that a wealth shock increasing net worth by 1% implies a reduction on impact in the spread of 3 basis points, while a shock to agency costs that increases net worth by 1% on impact generates an 18 basis points decline in credit spreads. As Figure 3 and Figure 4 show, the persistence of the propagation dynamics of a shock to the marginal bankruptcy cost is significantly smaller than the persistence of the responses to a wealth shock. The expansionary effects of a shock that reduces agency costs die out about five years after the shock, while the favorable effects of a wealth shock have an "almost permanent" effect.

An expansionary shock to agency costs creates an incentive for entrepreneurs to select contractual terms with a larger debt-to-net-worth ratio, as shown in Figure 4(a) and Figure 4(b), given that the deadweight loss linked to bankruptcy is smaller. There are two opposing effects operating as a result of higher debt-to-net-worth ratios. On the one hand, both the default probability and the default productivity threshold increase, offsetting the effect of lower bankruptcy costs in the event of default – the *default effect*. On the other hand, there is an increase in capital investment given that a larger set of resources is available – the *mass effect*. Larger amounts of capital holdings imply a larger equity value through an increase in total capital returns. The impulse response for net worth shows that while the mass effect dominates at first, the default effect becomes the driving force after 10 quarters. Irrespective of the relative dominance of the mass effect in terms of shaping the response of entrepreneurial wealth, the increase in the pool of resources available for purchasing capital enhances investment activity in the economy and, therefore, output increases after a shock to marginal bankruptcy costs.

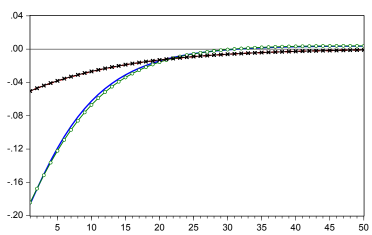
Figure 4: Impulse response functions with respect to a shock to the marginal bankruptcy cost



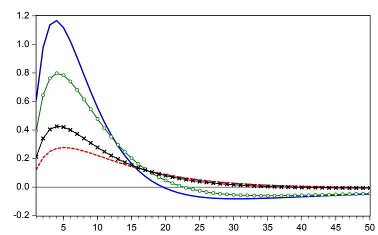
(a) Net worth



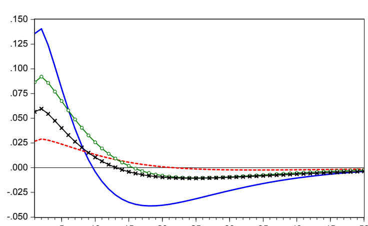
(b) Debt



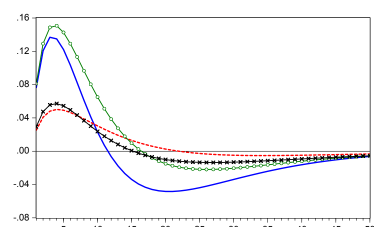
(c) Credit spread



(d) Output



(e) Inflation



(f) Policy rate

Note: The solid blue line is the IRF for 1970:Q4–1985:Q1, the dashed red line is the IRF for the post-1985:Q1 period, the dotted green line is the IRF when only the monetary policy coefficients change, and the starred black line is the IRF when only $\mu_\star$ changes.

Let us compare the IRFs for the 1970s, the solid blue lines in Figure 4, with the IRFs for the counterfactual economy characterized by the Taylor rule coefficients during the Great Moderation and the level of financial rigidity in the 1970s, the dotted green lines. We conclude that the more proactive monetary policy stance slightly dampens the short- and medium-run effects of shocks to marginal bankruptcy costs for balance sheet variables, but that it has a negligible effect in credit spreads. For output, the tighter monetary policy stance implies a reduction in the short- and medium-run effects, but the long-run dynamics are unaffected. For nominal variables, the undershooting in the middle of the medium run is smaller in the counterfactual economy than in the 1970s. But, the effect on the short-run dynamics is quite different for inflation and the policy rate. While the change in monetary policy conduct dampens the short-run effects for inflation, Figure 4(e), it has no effect on the response on impact for the policy rate but the peak of the response is larger than in the 1970s, Figure 4(f).

When comparing the IRFs for the 1970s, the solid blue lines, with the IRFs for the counterfactual economy characterized by the level of financial rigidity in the mid-1980s with the monetary policy stance of the 1970s, the starred black lines, we conclude that the estimated reduction in the size of the financial rigidity mutes the effects of marginal bankruptcy costs for all variables at all horizons. In particular, with the exception of output and inflation, the responses in the counterfactual economy, the starred black lines, are almost identical to the estimated responses during the Great Moderation, the dashed red lines. For output and inflation, the overall magnitude of the change in the IRFs cannot be accounted for without the estimated changes in the conduct of monetary policy.

As with wealth shocks, we conclude that the easier access to credit since the mid-1980s is the most important driver of the estimated changes in the transmission of shocks to the marginal bankruptcy cost. However, the more proactive monetary policy stance plays a relevant role in shaping the dynamics of the response of output in the short and medium run as well as inflation at all horizons.

7 Conclusion

The Great Moderation is a widely studied empirical regularity, so, why is another paper revisiting it? First, the literature on the Great Moderation has provided little, if any, attention to the evolution of financial variables. However, we document that, contrary to the slowdown in real and nominal variables, the cyclical volatility of financial variables has increased significantly since the mid-1980s, which implies that the Great Moderation era is more complex than usually assumed. Second, since the 1980s, the U.S. has been characterized by significant changes in financial factors, which, therefore, arise as natural candidates to account for the empirical evidence. Thus, a comprehensive study of U.S. business cycles since the 1980s should incorporate financial variables in the analysis and explore the role of financial factors.

In this paper, we use an estimated DSGE model with financial frictions and financial shocks to explore the role of the traditional drivers of the Great Moderation in addition to the role of changes in financial factors in driving the observed divergent patterns in cyclical volatilities. We conclude that abstracting from financial factors significantly biases the interpretation of the slowdown in macroeconomic variables, as the easier access to credit for firms characterizing the U.S. economy since the 1980s is key to accounting for the volatility slowdown in investment and nominal variables. Moreover, the more flexible financial institutional framework is key to significantly reducing the vulnerability of the economy to financial shocks, whose size have been increasing over time.

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A Data

We use U.S. data from the Bureau of Economic Analysis (BEA) national income and product accounts (NIPA), the Bureau of Labor Statistics (BLS) Current Population Survey (CPS), the Federal Reserve Economic Data(FRED) database, and the flow of funds accounts from the Federal Reserve Board for the 1954:Q4–2006:Q4 period.

The following series are used in the estimation of the DSGE model:

- *Growth rate of real per-capita gross value added by the nonfarm business sector.* Data on nominal gross value added are available in NIPA Table 1.3.5. The real per-capita gross value added is obtained by deflating with the implicit price index from NIPA Table 1.3.4 and dividing the resulting series by the civilian noninstitutional over16 (BLS ID LNU00000000) series. The data provided by the BEA are annualized, so we divide the series by four to obtain quarterly values for the measures of interest.

- *Growth rate of real per capita investment.* Investment is defined as the sum of personal consumption expenditures of durables and gross private domestic investment from NIPA Table 1.1.5. We use the same transformations as before to obtain the real per-capita counterpart. We weight the resulting series using the relative significance of the nonfarm, nonfinancial corporate business sector in total GDP.

- *Growth rate of real per capita consumption.* Consumption is defined as the sum of personal consumption expenditures of nondurables and services from NIPA table 1.1.5. We perform the transformation described for the investment series.

- *Growth rate of net worth.* Using data from the March 2014 vintage for the flow of funds accounts constructed by the Federal Reserve Board, net worth is defined as tangible assets[20] (Table B.102, line 2) minus credit market instruments at market value (Table B.102, line 22[21]) in the nonfinancial corporate sector. Tangible or nonfinancial assets are defined as real

[20] Coded tables post-2013 refer to this variable as nonfinancial assets. Since 2015 Table B.102 has been labeled as B.103.

[21] Line 25 in the post-2013 tables and line 26 plus line 30 in the post-2015 tables.

estate, equipment, intellectual property products, and inventories. Credit market instruments consist of commercial paper, municipal securities, corporate bonds, depository institutions loans, other loans and advances, and mortgages. Net worth is transformed to real per-capita terms.

- *Hours worked.* This series is defined as the log level of the hours of all persons in the nonfarm business sector (provided by the BLS) divided by 100 and multiplied by the ratio of the civilian population over 16 (CE16OV) to a population index. The population index is equal to the ratio of the population in the corresponding quarter divided by the population in the third quarter of 2005. This transformation is necessary, as the series on hours is an index with 2005=100.

- *Growth rate of real wages.* Real wages are defined as the real per-capita counterpart of compensation of employees provided by NIPA Table 1.12. Total compensation is corrected by the relative size of the nonfinancial corporate sector.

- *Inflation* is defined as the log difference of the price index for gross value added by the nonfarm business sector (NIPA Table 1.3.4).

- The *federal funds rate* is taken from the Federal Reserve Economic Data (FRED).

- *Credit spread (Baa-10year)* is defined as the spread of the Moody's seasoned Baa corporate bond yield and the 10-year Treasury constant maturity rate. We consider the log of the gross quarterly counterpart.

In Section2, we consider the following additional data series from the flow of funds accounts:

- *Corporate net worth 1* is defined as total assets (Table B.102, line 1) minus total liabilities (Table B.102, line 21) in the nonfinancial nonfarm corporate sector in the U.S. It is defined in real per-capita terms.

- *Tobin's q* is the ratio of the sum of equities (market value of equities outstanding, series with mnemonics FL103164103) and total liabilities to total assets.

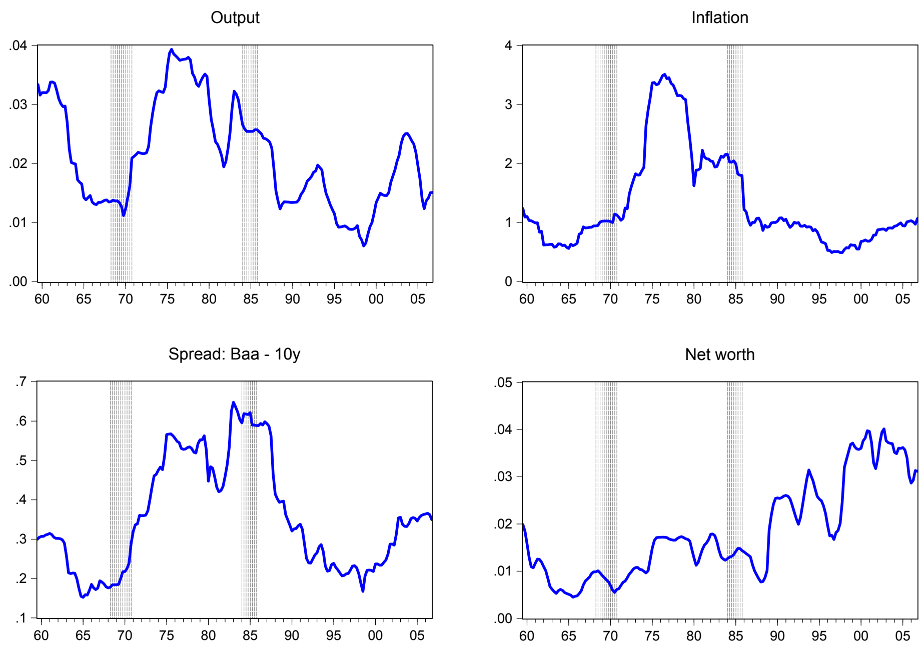
- *Corporate bonds* is defined in real per capita terms and corresponds to line 26 of Table B.102.

- *Net increase in credit market liabilities* is given by Table F.102, line 40. This is the measure of credit used by Christiano, Motto and Rostagno (2014).

- *Net increase in corporate bonds* is given by line 43 in Table F.102.

- *Equity payout*, in Jermann and Quadrini (2012) is defined as net dividends (Table F.102, line 3) minus net equity issues (Table F.102, line 39) of nonfinancial corporate businesses.

Figure 5: 5-YEAR ROLLING WINDOW CYCLICAL VOLATILITY



Note: The first set of dotted grey lines corresponds to the range of dates considered for the Great Inflation: 1970:Q3-1984:Q4. The second set of dotted grey lines corresponds to the range of dates considered for the Great Moderation: 1984:Q1-1985:Q4.

B Model: log-linearized equilibrium conditions

Table 9: Log-linearized equilibrium conditions of the core model

Bonds Euler equation	$\widehat{\Lambda}_t = \widehat{R}^n_t + \mathbb{E}_t\left[\widehat{\Lambda}_{t+1} - \widehat{\pi}_{t+1} - \widehat{\mathfrak{z}}_{t+1}\right]$
Consumption Euler equation	$\widehat{\Lambda}_t = \left(\frac{\rho_z \beta h \mathfrak{z}_\star - \mathfrak{z}_\star h}{(\mathfrak{z}_\star - \beta h)(\mathfrak{z}_\star - h)}\right)\widehat{\mathfrak{z}}_t + \left(\frac{\mathfrak{z}_\star - \beta h \rho_b}{\mathfrak{z}_\star - \beta h}\right)\widehat{b}_t - \left(\frac{\mathfrak{z}_\star^2 + \beta h^2}{(\mathfrak{z}_\star - \beta h)(\mathfrak{z}_\star - h)}\right)\widehat{C}_t + \left(\frac{\mathfrak{z}_\star h}{(\mathfrak{z}_\star - \beta h)(\mathfrak{z}_\star - h)}\right)\widehat{C}_{t-1} + \left(\frac{\beta h \mathfrak{z}_\star}{(\mathfrak{z}_\star - \beta h)(\mathfrak{z}_\star - h)}\right)\mathbb{E}_t\widehat{C}_{t+1}$
Deposits Euler equation	$\widehat{\Lambda}_t = \widehat{R}_t + \mathbb{E}_t\left[\widehat{\Lambda}_{t+1} - \widehat{\pi}_{t+1} - \widehat{\mathfrak{z}}_{t+1}\right]$
Wage	$\widehat{w}_t = \frac{1}{1+\beta}\widehat{w}_{t-1} + \frac{\beta}{1+\beta}\mathbb{E}_t\widehat{w}_{t+1} - \kappa_w\left[\widehat{w}_t - \left(\nu\widehat{H}_t + \widehat{b}_t - \widehat{\Lambda}_t + \widehat{\lambda}_{w,t}\right)\right] - \frac{\iota_w}{1+\beta}\widehat{\pi}_{t-1} - \frac{1+\beta\iota_w}{1+\beta}\widehat{\pi}_t + \frac{\beta}{1+\beta}\mathbb{E}_t\widehat{\pi}_{t+1} + \frac{\iota_w}{1+\beta}\widehat{\mathfrak{z}}_{t-1} - \frac{1+\beta\iota_w - \rho_z\beta}{1+\beta}\widehat{\mathfrak{z}}_t$
Price of capital	$\widehat{Q}_t = \xi\left(\mathfrak{z}^\star\right)^2\left[(1+\beta)\widehat{I}_t - \beta\mathbb{E}_t\widehat{I}_{t+1} - \widehat{I}_{t-1} + (1-\beta\rho_z)\widehat{\mathfrak{z}}_t\right] - \widehat{\zeta}_t$
Capital accumulation	$\widehat{K}_{t+1} = \frac{1-\delta}{\mathfrak{z}^\star}\left(\widehat{K}_t - \widehat{\mathfrak{z}}_t\right) + \frac{\widetilde{I}^\star}{\widetilde{K}^\star}\left(\widehat{\zeta}_t + \widehat{I}_t\right)$
Effective capital	$\widehat{k}_t = \widehat{u}_t + \widehat{K}_t - \widehat{\mathfrak{z}}_t$
Optimal capital-to-labor ratio	$\widehat{k}_t = \widehat{w}_t - \widehat{r}^k_t + \widehat{H}_t$
Optimal capital utilization	$\widehat{r}^k_t = \frac{a''_\star}{r^k_\star}\widehat{u}_t$
New Keynesian Phillips curve	$\widehat{\pi}_t = \frac{(1-\xi_p\beta)(1-\xi_p)}{(1+\iota_p\beta)\xi_p}\left[\widehat{\chi}_t + \frac{\lambda^p}{1+\lambda^p}\widehat{\lambda}^p_t\right] + \frac{\iota_p}{1+\iota_p\beta}\widehat{\pi}_{t-1} + \frac{\beta}{1+\iota_p\beta}\mathbb{E}_t\widehat{\pi}_{t+1}$
Taylor rule	$\widehat{R}^n_t = \rho_R\widehat{R}^n_{t-1} + (1-\rho_R)\rho_\pi\widehat{\pi}_t + (1-\rho_R)\rho_Y\left(\widehat{Y}_t - \widehat{Y}_{t-1} + \widehat{\mathfrak{z}}_t\right) + \varepsilon_{R,t}$
Production technology	$\widehat{Y}_t = (1+\Phi)\,\alpha\widehat{k}_t + (1+\Phi)\,(1-\alpha)\widehat{H}_t$
Real marginal cost	$\widehat{\chi}_t = (1-\alpha)\widehat{w}_t + \alpha\widehat{r}^k_t$
Average gross return on capital	$\widehat{R}^k_t = \frac{\pi_\star r^k_\star}{R^k_\star}\widehat{r}^k_t + \frac{\pi_\star r^k_\star}{R^k_\star}\widehat{u}_t + \frac{(1-\delta)\pi_\star}{R^k_\star}\widehat{Q}_t - \widehat{Q}_{t-1} + \widehat{\pi}_t$
Credit market clearing	$\widehat{Q}_t + \widehat{K}_{t+1} = \frac{\widetilde{B}_\star}{\widetilde{K}_\star}\widehat{B}_{t+1} + \frac{\widetilde{N}_\star}{\widetilde{K}_\star}\widehat{N}_{t+1}$
Total resources constraint	$\frac{1}{g}\widehat{Y}_t - \frac{1}{g}\widehat{g}_t = \frac{\widetilde{C}_\star}{\widetilde{Y}_\star}\widehat{C}_t + \frac{\widetilde{I}_\star}{\widetilde{Y}_\star}\widehat{I}_t + \mu_\star R^k_\star\frac{G(\bar{\omega}_\star)\widetilde{K}_\star}{\widetilde{Y}_\star\mathfrak{z}_\star}\widehat{\mu}_t + r^k_\star\frac{\widetilde{K}_\star}{\widetilde{Y}_\star\mathfrak{z}_\star}\widehat{u}_t + \frac{\mu_\star G(\bar{\omega}_\star)R^k_\star\widetilde{K}_\star}{\widetilde{Y}_\star\mathfrak{z}_\star}\left[\widehat{R}^k_t + \widehat{Q}_{t-1} + \widehat{K}_t - \widehat{\mathfrak{z}}_t + \frac{G_\omega(\bar{\omega}^\star)}{G(\bar{\omega}_\star)}\bar{\omega}_\star\widehat{\bar{\omega}}_t\right]$

Notes: $\kappa_w = \frac{(1-\xi_w\beta)(1-\xi_w)}{\xi_w(1+\beta)\left[1+\nu\left(1+\frac{1}{\lambda_w}\right)\right]}$

Table 10: Log-linearized stochastic processes

Price markup shock	$\widehat{\lambda}_t^p = \rho_{\lambda^p}\widehat{\lambda}_{t-1}^p + \varepsilon_{\lambda^p,t} - \theta_p\varepsilon_{\lambda^p,t-1}$
Wage markup shock	$\widehat{\lambda}_t^w = \rho_{\lambda^w}\widehat{\lambda}_{t-1}^w + \varepsilon_{\lambda^w,t} - \theta_w\varepsilon_{\lambda^w,t-1}$
Neutral technology (growth) shock	$\widehat{\mathfrak{z}}_t = \rho_z\widehat{\mathfrak{z}}_{t-1} + \varepsilon_{a,t}$
Investment-specific technology shock	$\widehat{\zeta}_t = \rho_\zeta\widehat{\zeta}_{t-1} + \varepsilon_{\zeta,t}$
Inter-temporal preference shock	$\widehat{b}_t = \rho_b\widehat{b}_{t-1} + \varepsilon_{b,t}$
Shock to the marginal bankruptcy cost	$\widehat{\varphi}_t = \rho_\varphi\widehat{\varphi}_{t-1} + \varepsilon_{\varphi,t}$
Net worth shock	$\widehat{x}_t = \rho_x\widehat{x}_{t-1} + \varepsilon_{x,t}$
Government spending shock	$\widehat{g}_t = \rho_g\widehat{g}_{t-1} + \varepsilon_{g,t}$
Monetary policy shock	$\widehat{\eta}_{mp,t} = \rho_g\widehat{\eta}_{mp,t-1} + \varepsilon_{R,t}$

Notes: The growth rate of the neutral technology progress is assumed to follow an AR(1) process with an average growth rate of Υ_z. The the marginal bankruptcy cost evolves as $\mu_t = \frac{1}{1+e^{\varphi_t}}$ so that $\mu_t \in [0,1]$ for any realization of $\varepsilon_{\varphi,t}$.

C Estimation

Table 11: Model fit: Marginal data densities and log-posterior odds.

Model	MDD	Posterior odds
Baseline	6950	0
Baseline, breaks in $F(\omega_\star)$	6902	48
Baseline, breaks in γ	6927	23
Baseline, breaks in σ_ω	6897	53
Baseline, breaks in $F(\omega_\star), \gamma$	6907	43
Baseline, breaks in $F(\omega_\star), \sigma_\omega$	6932	18
Baseline, breaks in γ, σ_ω	6922	28
Baseline, breaks in $F(\omega_\star), \gamma, \sigma_\omega$	6913	37
Baseline, constant $\mu_\star$, breaks in $F(\omega_\star)$	6876	74
Baseline, constant $\mu_\star$, breaks in γ	6927	23
Baseline, constant $\mu_\star$, breaks in σ_ω	6907	43
Baseline, constant $\mu_\star$, breaks in $F(\omega_\star), \gamma$	6928	22
Baseline, constant $\mu_\star$, breaks in $F(\omega_\star), \sigma_\omega$	6938	12
Baseline, constant $\mu_\star$, breaks in γ, σ_ω	6896	54
Baseline, constant $\mu_\star$, breaks in $F(\omega_\star), \gamma, \sigma_\omega$	6886	64

Table 12: Calibrated parameters

Depreciation rate	δ	0.03
Steady-state government spending-to-output ratio	$(G/Y)^\star$	0.22
Steady-state price markup	λ_p	0.20
Steady-state wage markup	λ_w	0.20
Steady-state log hours	$100\ln(H^\star)$	0.54
Growth rate	$100\Upsilon_z$	0.45

Table 13: PARAMETERS ESTIMATED USING THE FULL SAMPLE

		Prior		*Posterior*	
	Density	*Para 1*	*Para 2*	*Median*	*95% CI*
Economic Parameters:					
Discount rate: $100\,[1/\beta - 1]$	Beta	0.25	0.10	0.19	[0.10, 0.28]
Steady-state inflation rate: $\pi_n^\star$	Normal	3.00	1.00	2.41	[1.97, 2.89]
Steady-state external finance premium: $400\left[\left(R_\star^k/R_\star\right)-1\right]$	Normal	1.75	0.50	1.69	[1.26, 2.15]
Fixed cost of production: $\phi = \Phi/y_\star$	Beta	0.35	0.15	0.47	[0.35, 0.59]
Indexation weight on price setting: ι_p	Beta	0.50	0.15	0.12	[0.03, 0.23]
Indexation weight on wage setting: ι_w	Beta	0.50	0.15	0.06	[0.02, 0.11]
Calvo price stickiness: ξ_p	Beta	0.66	0.15	0.75	[0.70, 0.81]
Calvo wage stickiness: ξ_w	Beta	0.66	0.15	0.55	[0.46, 0.66]
Price-mark shock MA parameter: θ_p	Beta	0.50	0.20	0.62	[0.49, 0.76]
Wage-mark shock MA parameter: θ_w	Beta	0.50	0.20	0.64	[0.41, 0.86]
Capital share: α	Beta	0.30	0.03	0.17	[0.15, 0.19]
Curvature, investment adjustment cost: ξ	Normal	4.00	1.00	0.55	[0.38, 0.80]
Curvature, utilization cost: a”	Gamma	1.00	0.50	1.10	[0.28, 2.47]
Inverse Frisch elasticity: ν	Gamma	2.00	0.75	0.90	[0.36, 1.53]
Degree of habit formation: h	Beta	0.60	0.20	0.81	[0.70, 0.89]
Policy smoothing parameter: ρ_r	Beta	0.50	0.10	0.74	[0.69, 0.78]
Shocks:					
Autocorrelation, shock to marginal bankruptcy cost: ρ_φ	Beta	0.60	0.20	0.94	[0.92, 0.96]
Autocorrelation, wealth shock: ρ_x	Beta	0.60	0.20	0.94	[0.87, 0.98]
Autocorrelation, technology growth shock: ρ_z	Beta	0.40	0.10	0.39	[0.27, 0.51]
Autocorrelation, investment-specific technology shock: ρ_ζ	Beta	0.60	0.20	0.92	[0.87, 0.96]
Autocorrelation, price markup shock: ρ_{λ_p}	Beta	0.60	0.20	0.97	[0.95, 0.99]
Autocorrelation, wage markup shock: ρ_{λ_w}	Beta	0.60	0.20	0.98	[0.97, 0.99]
Autocorrelation, intertemporal preference shock: ρ_b	Beta	0.60	0.20	0.54	[0.30, 0.78]
Autocorrelation, government spending shock: ρ_g	Beta	0.60	0.20	0.99	[0.98, 0.99]
Autocorrelation, monetary policy shock: ρ_{mp}	Beta	0.60	0.20	0.16	[0.07, 0.26]

NOTES: Para 1 and Para 2 list the mean and the standard deviation, respectively, for Beta, Gamma, and Normal distributions.

D Counterfactuals

Given the estimated changes in parameters, we perform a battery of counterfactual exercises in order to assess the role played by theses changes in the evolution of volatilities at business cycle frequencies. For illustration purposes, let me study the role played by the estimated changes in the conduct of monetary policy in accounting for the increase in volatility during the 1970s. We proceed by performing 1000 simulations for each 1000th draw in the posterior simulator using the following procedure:

1. Simulate the model economy for 200 periods (after a burn-in of 1000 observations) using the parameter vector characterizing the 1954-1970 sample period. Obtain the cyclical component.

2. Simulate the model economy for 200 periods (after a burn-in of 1000 observations) using the parameter vector characterizing the 1970-1985 sample period. Obtain the cyclical component.

3. Compute the ratio of standard deviations of the cyclical components.

4. Simulate the model economy for 200 periods (after a burn-in of 1000 observations) using the parameter vector characterizing the 1954-1970 period with the monetary policy coefficients of the 1970-1985 parameter vector. Obtain the cyclical component.

5. Compute the ratio of cyclical standard deviations with respect to those obtained in step 1.

6. Compute the percentage of the ratio obtained in step 3 attributable to the ratio in step 5.

We analyze the following counterfactuals:

- *All institutions*: This counterfactual determines the relative importance of changes on both financial institutions and the monetary policy stance.

- *All shocks*: This counterfactual studies the relevance of the luck hypothesis by only having the size of the shocks hitting the U.S. economy changing across subperiods.

- *Monetary policy*: This counterfactual quantifies the role played by the estimated changes in the response of the monetary authority to deviations of inflation and output growth from the target.

  - *Only* ψ_π: The only parameter changing across subsamples is the response of the monetary authority to deviations of inflation from its target.
  - *Only* ψ_y: The only parameter changing across subsamples is the response of the monetary authority to deviations of output growth from its target.

- *Financial institutions*: This counterfactual analyzes the relative importance of changes in the unconditional mean for the marginal bankruptcy cost.

- *Financial shocks*: In this counterfactual, we determine the relative role played by financial shocks only.
- *Nonfinancial shocks*: This counterfactual is characterized by the size of all shocks, except for financial shocks, changing across subperiods.

E The Great Inflation

The Great Inflation refers to the decade of high levels of and large volatility in inflation and nominal interest rates that started in 1970. The Great Inflation has traditionally been dated from 1965 to 1982, but our empirical analysis described in Section 2 sets as the starting and end points of the Great Inflation 1970:Q3 and 1984:Q4, respectively. As shown in Table 14, the Great Inflation can be described homogeneously for all aggregate variables under analysis as a period characterized by an increase in volatilities at business cycle frequencies.

Table 14: Standard deviation of the cyclical component

	1954 − 1970	1970 − 1985	$\frac{1970-1985}{1954-1970}$
Output	2.33	3.16	1.35
Investment	5.96	8.65	1.44
Consumption	1.46	1.99	1.37
Inflation	0.98	2.48	2.43
Nominal interest rate	0.90	2.36	2.63
Spread	0.24	0.56	2.33
Net worth 1: total assets - total liabilities	0.97	1.66	1.71
Net worth 2: tangible assets - credit market liabilities	1.32	1.52	1.17
Net increase in liabilities: credit market liabilities	50.8	107.7	2.13
Net increase in liabilities: corporate bonds	20.0	33.3	1.66
Equity payout	16.8	47.2	2.81
Tobin q: (equities+total liabilities)/total assets	3.84	4.74	1.24
Equity q: equities/net worth 1	5.52	7.06	1.28
Total liabilities/net worth 1	0.73	2.19	3.02
Credit market liabilities/net worth 2	0.41	1.32	1.32

Note: The first two columns report cyclical volatilities and the last column reports the ratio of the first two. The cyclical component is extracted using the Hodrick-Prescott filter for the quarterly frequency ($\lambda = 1600$) from log-levels for output, investment, consumption, net worth 1 and net worth 2 and from levels for inflation, the nominal interest rate, the two measures of net increase in liabilities, equity payout, Tobin q, equity q, and the two leverage ratios. The volatilities for output, investment, consumption, and the two net worth measures are multiplied by 100. Business wealth measured by net worth 1 is defined as total assets minus total liabilities, and business wealth measured by net worth 2 is defined as tangible assets minus liabilities related to credit market instruments. The latter definition of business wealth is consistent with the model-implied concept of net worth in Section 4. We consider two measures of corporate debt flows: the net increase in credit market liabilities and the net increase in corporate bonds. Following Jermann and Quadrini (2006), equity payout is defined as net dividends minus net equity issues. Tobin's q is defined as the ratio of the sum of the market value of equities and liabilities to total assets. Equity q is defined as the ratio of the market value of corporate equities to corporate net worth 1. The last two entries are indicators of indebtedness of the nonfinancial corporate business sector.

As we describe in the main text, we allow for breaks in three parameters subsets: the size of shocks,the monetary policy coefficients, and the unconditional mean of marginal bankruptcy costs, which summarizes the average level of financial rigidities. The remaining parameters of the model are estimated using the information from the entire sample and reported in Table 13 in Appendix C. Table 15 reports the estimates for the parameters subject to structural breaks during both the pre-Great Inflation period and the Great Inflation.

The first rows in Table 15 report the estimated weights in the monetary policy rule for inflation and output growth. As pointed out elsewhere in the literature, the response of the monetary authority to inflation is looser in the 1970s than in the 1950s-1960s and the Great Moderation. In particular, during the Burns-Miller tenure, the response to inflation was about 15% milder than during Martin's mandate. The response of the monetary authority to the real side of the economy was 22% tighter in the 1970s than in the 1950s-1960s. During the Great Inflation, the size of all shocks increased: the size of the investment-specific technology shock increases by 20%, that of the price and wage markup shocks increased by 50% and 26%, respectively, that of the financial shocks doubled, and that of the monetary policy shock more than doubled.

Table 15: PARAMETERS SUBJECT TO STRUCTURAL BREAKS: STANDARD DEVIATIONS, SHOCK INNOVATIONS. GREAT INFLATION

		Prior		*Posterior:* 1954 − 1970		*Posterior:* 1970 − 1984	
	Density	*Para 1*	*Para 2*	*Median*	*95% CI*	*Median*	*95% CI*
Policy weight on inflation: ψ_ϕ	$\mathcal{N}$	1.50	0.50	1.39	[1.22, 1.56]	1.20	[1.11, 1.31]
Policy weight on output growth ψ_y	$\mathcal{N}$	0.50	0.30	0.18	[0.11, 0.26]	0.22	[0.06, 0.37]
Marginal bankruptcy cost: $\mu^\star$	$\mathcal{N}$	0.28	0.05	0.11	[0.06, 0.20]	0.13	[0.06, 0.20]
Shock to marginal bankruptcy cost: σ_φ	$\mathcal{IG}$	0.001	4.00	0.17	[0.09, 0.35]	0.38	[0.21, 0.85]
Wealth shock: $100 \cdot \sigma_x$	$\mathcal{IG}$	0.10	4.00	0.45	[0.32, 0.59]	0.83	[0.57, 1.21]
Technology growth shock: $100 \cdot \sigma_z$	$\mathcal{IG}$	0.10	4.00	1.39	[1.15, 1.67]	1.30	[1.08, 1.55]
Investment-specific technology shock: $100 \cdot \sigma_\zeta$	$\mathcal{IG}$	0.10	4.00	1.18	[0.89, 1.56]	1.41	[1.07, 1.84]
Price markup shock: $100 \cdot \sigma_{\lambda^p}$	$\mathcal{IG}$	0.10	4.00	0.18	[0.14, 0.22]	0.28	[0.22, 0.35]
Wage markup shock: $100 \cdot \sigma_{\lambda^w}$	$\mathcal{IG}$	0.10	4.00	0.23	[0.18, 0.28]	0.29	[0.22, 0.37]
Intertemporal preference shock: $100 \cdot \sigma_b$	$\mathcal{IG}$	0.10	4.00	2.69	[1.48, 4.45]	3.05	[1.83, 4.70]
Government spending shock: $100 \cdot \sigma_g$	$\mathcal{IG}$	0.10	4.00	0.34	[0.28, 0.41]	0.41	[0.35, 0.49]
Monetary policy shock: $100 \cdot \sigma_r$	$\mathcal{IG}$	0.10	4.00	0.13	[0.11, 0.16]	0.38	[0.31, 0.45]

NOTES: Para 1 and Para 2 list the means and the standard deviations for Beta, Gamma, and Normal distributions. Para 1 and Para 1 list s and ν for the inverse Gamma distribution, where $p_{IG}(\sigma|\nu, s) \propto \sigma^{-\nu-1}e^{-nus^2/2\sigma^2}$.

The results of the posterior predictive checks for the Great Inflation are reported in Table 16. The estimated model delivers an increase in cyclical volatility of all variables and, moreover, is able to deliver the differences in the relative size of such increases. For example, in the model, while the cyclical volatility of wages increases by only 34%, the cyclical volatility of credit spreads more than doubles.

Using the counterfactuals exercises described in Appendix D, we conclude that the increase in cyclical volatility in the 1970s was mostly due to bad luck. As shown in Table 17, the less

Table 16: Model fit: Ratio of standard deviations, cyclical component. Great Inflation

Series	$\frac{1970-1985}{1954-1970}$		
	Data	Model	
		Median	90%
Output	1.35	1.65	[1.43, 1.89]
Investment	1.44	1.69	[1.39, 1.91]
Consumption	1.37	1.14	[0.95, 1.32]
Wage	1.34	1.32	[1.08, 1.50]
Hours	1.52	1.64	[1.41, 1.88]
Inflation	2.43	1.91	[1.56, 2.20]
Nominal interest rate	2.63	2.11	[1.79, 2.44]
Net worth	1.17	1.54	[1.17, 1.82]
Spread	2.33	2.31	[1.76, 2.91]

proactive monetary policy regime is key to deliver the model-implied increase in the volatility of nominal variables, but the larger volatility in the remaining variables can only be explained by the estimated change in the size of the exogenous shocks. Therefore, our model predicts that the Great Inflation was mostly due to bad luck in the form on larger shocks hitting the U.S. economy.

Table 17: Counterfactuals: Percentage of the model-implied change in cyclical standard deviations during the Great Inflation

	Y	**I**	**C**	**H**	**W**	π	R	**N**	$\frac{\mathbb{E}\left(R^k_{t+1}\right)}{R_t}$
All institutions	**8**	**7**	**9**	**9**	**9**	**28**	**18**	**5**	**11**
All shocks	**87**	**89**	**102**	**87**	**93**	**59**	**78**	**94**	**86**
Monetary policy	7	4	7	8	9	22	12	4	1
Financial institutions	3	5	9	3	2	4	6	4	12
Financial shocks	32	50	39	33	8	25	39	81	85
Nonfinancial shocks	65	49	73	64	86	41	50	21	4

Notes: Y stands for real output, I for real investment, C for real consumption, H for hours, W for real wages, π for inflation, R for the policy interest rate, N for real net worth, and $\mathbb{E}\left(R^k_{t+1}\right)/R_t$ for the external finance premium or credit spread.