



University of
Connecticut

Department of Economics Working Paper Series

**Does Financial Development Cause Higher Firm Volatility and Lower
Aggregate Volatility?**

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Working Paper 2012-07

March 2012

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This working paper is indexed on RePEc, <http://repec.org/>

Does Financial Development cause Higher Firm Volatility and Lower Aggregate Volatility?

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Abstract

The period before the financial crisis was characterized by unprecedented calm in the U.S. and other developed countries. Volatility of aggregate output growth declined in the U.S. beginning in the early 1980's until the fall of 2007 (the phenomenon has been widely called the Great Moderation). Meanwhile micro level evidence suggests increasing volatility at the firm level over the last 60 years including the period of the Great Moderation. I conduct a quantitative analysis of the role played by financial development in the divergence of firm and aggregate volatilities. In a DSGE setting based on Kiyotaki and Moore (1997) type borrowing constraints I show that financial development is associated with increasing firm growth volatility

and declining aggregate volatility. The reason for the divergence is a decline in correlation of the firm with the aggregate as financial development occurs.

Journal of Economic Literature Classification: D21, D58, E27, E32.

Keywords: Great Moderation, Firm-Level Volatility, Borrowing Constraints, Heterogenous Firms, Business Cycle.

1 Introduction

The period of the so-called Great Moderation was characterized by a significant decline in volatility of aggregate output. However, at the firm level this period saw increasing and high levels of volatility across variables like sales growth, employment growth, equity and turnover. The increase in volatility at the micro level has also been documented by studies using household level data. For instance, Dynan et al. (2006), Davis & Kahn (2008) show that household consumption and income had become more volatile during the period of the Great Moderation. This paper focuses on increasing firm volatility during the period following the early 1980's and quantitatively analyzes the effect of financial development in the divergence of firm and aggregate growth volatility.

In a DSGE setting along the lines of Kiyotaki and Moore (1997) with heterogeneous agents I show that financial development is associated with an increase in firm growth volatility in the U.S. while also generating decreases in aggregate output growth volatility. The decline in aggregate volatility in the model is observed for key periods in the data, like the beginning of the Great Moderation in the early 1980's and the mid 1990's onwards, a time when financial markets expanded significantly in the U.S. riding on the back of recent financial liberalization measures. An interesting feature of the model is that it generates significantly higher and increasing aggregate volatility at high values of the financial development parameter as was observed during 2008 and 2009.

Comin and Philippon (2005) and Comin and Mulani (2006) show that the divergence in volatilities during the Great Moderation was due to a fall in the correlation between the aggregate economy and the sector. They decompose aggregate volatility

into an average volatility of sectors and the correlation of growth across sectors. They find that the observed decline in aggregate volatility is not due to a fall in the average volatility of sectors but due to a reduction in the correlation across sectors. This suggests that during the period under consideration firms became increasingly detached from the aggregate economy resulting in their higher volatility even as aggregate volatility fell. The model with financial development is also able to generate this fall in correlation of growth rates between individual firms and the aggregate suggesting that financial development may be a potential cause behind the observed firm and aggregate dynamics.

The importance or the implications of diverging macro and micro behavior is manifold. The fact that macroeconomic and microeconomic volatilities were disconnected during the period seems paradoxical and being able to explain the reason behind the mismatch may have significant welfare causing implications going forward. If a decline in aggregate volatility does not generate simultaneous or subsequent declines in individual volatility as is often assumed, then implications and interpretations of policy, theory and data need to be accordingly modified. For instance, then we need to be concerned with how differently individual firms respond to aggregate shocks and how relevant aggregate data is in representing business cycle dynamics. Especially relevant, post-crisis, is the role played by financial development. If financial development was a reason behind the diverging aggregate and firm behavior, how should such development be interpreted? Is it inducing or reducing welfare? Further research and quantifying of implications of financial development in this regard is then in order.

A systematic decline in aggregate output volatility was recorded beginning in the early 80's leading up to the financial crisis, a period termed the Great Moderation.

Yearly real GDP growth in the U.S. declined from 2.7 percent in 1959-1983 to 1.28 percent in 1984-2007. The phenomenon has been extensively documented in the literature for the U.S. as well as other OECD economies. McConnell and Perez-Quiros (2000), Blanchard and Simon (2001) and Stock and Watson (2002) all confirm the downward trend in aggregate output volatility in the last couple of decades. Several reasons for the occurrence of the Great Moderation have been advanced in the literature. Clarida, Gali and Gertler (2000) attribute it to better monetary policy while Kahn, McConnell and Perez-Quiros (2000) show that it is better inventory management that has led to milder fluctuations. Campbell and Hercowitz (2006); Dynan, Elmendorf and Sichel (2006a,b); Jermann and Quadrini (2009) all cite financial development as the most important factor while Stock and Watson (2002) attribute the decline to milder economic shocks or the 'good luck' factor. Although the Great Moderation is usually used to refer to the developed country business cycles, studies (Gregorio, 2008) show that the developing world also witnessed declining aggregate volatility in recent times just before the crisis.

Meanwhile, at the firm level, volatilities have been increasing over the past 60 years. Median firm sales growth volatility as measured by Comin and Philippon (2005) increased steadily from about 9 percent in 1955 to around 20 percent in 2000. Chaney, Gabaix and Philippon (2002) show an increase in the firm level volatility of employment, sales, earnings and capital expenditure in the last 50 years. Comin and Mulani (2006) and Comin and Philippon (2005) confirm that the volatilities of sales and employment growth for publicly traded firms have been increasing in a fairly robust way across sample compositions over the said period. They also report similar trends in the turnover rates of industry leaders and firm's credit default risk. Similar studies in finance (Pastor and Versonesi (2002), Wei

and Zhang (2006), Campbell et al (2001)) have shown a strong upward trend in the volatility of firm stock returns. Campbell, Lettau, Malkiel and Xu (2001) use stock market data to show an increase in firm level volatility while detecting no such trend in market volatility and attributes the phenomenon to an increase in risk over and above an increase in heterogeneity at the firm level. While these studies are specific to the U.S., similar trends in firm volatility have been documented for other developed countries as well. For instance, Thesmar and Thoenig (2004) and Buch, Dopke and Stahn (2008) report a similar direct relationship between firm volatility and the level of financial development for France and Germany respectively.

2. Financial development and firm volatility

There is no doubt that financial markets around the world have gone through major changes in recent decades and have come to play increasingly important roles in the national and world economy. Financial development index scores constructed by the International Monetary Fund for industrialized countries in its World Economic Outlook (see IMF, 2006) for two years, 1995 and 2004 shows that the advanced economies have gone through varied degrees of financial development. Other estimates by the IMF (2006) report that between 1970-75 and 2000-05 the financial development index for advanced economies as a group has gone up by 55%. Financial development was cited as one of the main reasons for the reduced volatility at the aggregate level before the advent of the 2008 crisis. The idea that, as countries become more financially developed not only do they experience fewer credit crunch episodes but are also able to better absorb external shocks which leads to lower volatility at the aggregate level was prevalent. While ideally this must also be true of individual firms and sectors, increased financial development

at the firm level is also associated with higher risk taking (Arrow (1971), Obstfeld (1994)) due to more relaxed borrowing constraints, easy entry of new firms etc. thereby creating the possibility of higher volatility.

Additionally, firm volatility may increase in spite of a moderation in aggregate activities due to external financing becoming more easily available to firms in more financially developed countries causing these firms to become less dependent on profits or internal financing. Aggregate shocks which affect firm profits become less relevant in the firm's production structure and volatility measure while availability of external financing leads to increased borrowing and investment which implies more risk taking and greater volatility at the individual firm level.

While some good attempts have been made towards unifying Great Moderation with higher firm volatility in a single story, with a few exceptions, the focus has not been on the importance of financial development in the puzzle. Philippon (2003) shows that increased competition among firms leads to faster adjustment of prices which reduces the effect of aggregate demand shocks thus causing the departure between firm and aggregate volatility. Comin and Mulani (2005) present an endogenous growth model where growth is driven by the development of both idiosyncratic R&D innovations and general innovations. They show that an increase in R&D investments leads to a decline in the rate of development of general innovations which reduce TFP growth correlations across sectors and hence aggregate volatility falls while increasing volatility of the firms' output. Even less attempts have been made that explore the importance of development of financial markets in explaining the volatility divergence.

Thesmar and Thoenig (2004) hypothesize that improved risk sharing of listed firms prompts them to make riskier bets and investments which increase firm level

volatility in profits, sales and employment. They use French data to show support for the idea that firm volatility is directly related to financial development. Kaas (2009) develops a real business cycle model with credit constraints and heterogeneous agents to show that increasing credit market development leads to increasing spreads between internal rates of return across firms.

This paper belongs to a large literature class on financial constraints and financial development and contributes to research using Kiyotaki-Moore (1997) type collateral constraints to amplify and better represent business cycles. The main aim of this paper is to quantitatively analyze the effect of financial development on the volatility of aggregate and firm output growth. I introduce an additional dimension of heterogeneity in the model through productivity differences. Specifically, entrepreneurs in the model are either more productive or less and the more productive entrepreneurs are also less patient. They borrow from the less productive, patient entrepreneurs to hire more labor for production. The creditor limits her loan so that the amount the debtor has to repay does not exceed the value of collateral - a fraction θ of his current output. The degree of asset availability (θ) for collateral depends upon the technology and institutional quality of the economy which in turn affects the overall financial development of the economy and is used as a measure of the same. The model generates increasingly higher volatility of firm output growth compared to the aggregate economy as the level of financial development is increased. I also find that aggregate output volatility declines or at best remains constant as the economy becomes more financially developed.

3.1 Model

Entrepreneur's Problem

Entrepreneurs employ labor and produce a homogeneous good. Their technology is subject to idiosyncratic productivity shocks. In particular, the entrepreneurs' preferences are given by

$$\text{Max } E_t \sum_t \beta_{i,t} \ln c_{i,t} \quad (1)$$

where $i = 1$ stands for productive and $i = 2$ for unproductive entrepreneurs. The productive entrepreneurs want to take advantage of the higher productivity and are therefore less patient such that $\beta_2 > \beta_1$. So heterogeneity in the model stems from both a difference in productivity as well as a difference in discount factors. I show that the difference in productivity across sectors in addition to the different discount factors is able to better generate the type of volatilities observed in the data at both the firm and aggregate level for different measures of financial development. I also present the results for the case where entrepreneurs discount the future at different rates but are all equally productive and show that the divergence in volatility is less pronounced.

The entrepreneurs produce according to the following production technology

$$y_{t+1} = A_{i,t}(l_{i,t})^\alpha \quad (2)$$

where y_{t+1} is output at date $t+1$, l_t is labor input at date t and A_t is a productivity parameter that is known at date t .

I follow Kaas (2009) in that an entrepreneur i 's productivity attains a high level $A_{i,t} = A_t$ (productive state) with probability π and the lower level $A_{i,t} = B < A_t$ (unproductive state) with probability $1 - \pi$. Thus at each date a fraction π of

entrepreneurs are productive while the others are unproductive. Factor productivity at the technology frontier A_t is subject to aggregate productivity shocks and $\ln A_t$ follows an AR(1) process with $\rho < 1$ and SD σ . Again as in Kaas (2009), B fluctuates less than proportionately with productivity at the frontier A_t .

Production technology is specific to the entrepreneur and only the entrepreneur who started the production has the necessary skill to obtain the full amount of output described by the production function. Besides the entrepreneur, there is a lead creditor who monitors the production process and has a specific skill to obtain $\theta (\leq 1)$ fraction of output if she takes over the entrepreneur's production process (see Kiyotaki et al., 2009). Thus the domestic lead creditor restricts her loan so that it does not exceed θ fraction of output.

$$R_t b_{i,t} \leq \theta y_{i,t}$$

where θ is the level of financial development in the economy and plausibly represents things like technological advancement, quality of institutions and markets in the country like creditor rights and availability of credit market instruments. $\theta = 0$ corresponds to an economy with no borrowing while $\theta = 1$ represents maximum borrowing. The flow of funds constraint of the entrepreneurs is then given by

$$c_{i,t} + R_t b_{i,t} + w_t l_{i,t} = y_{i,t} + b_{i,t}$$

where w_t is the real wage rate and $b_{i,t}$ is the amount the entrepreneur borrows. Consumption $c_{i,t}$ and investment on wage bill $w_t l_{i,t}$ in the left hand side is financed by the net worth $y_{i,t} - R_t b_{i,t-1}$ of the entrepreneurs and new borrowing $b_{i,t}$ in the right hand side. Entrepreneurs choose consumption, labor input, output and domestic borrowing $c_{i,t}, l_{i,t}, y_{i,t+1}, b_{i,t}$ to maximize utility subject to the constraints of

production technology, the flow-of-funds constraint and the borrowing constraint.

The Entrepreneurs' first order conditions with respect to labor and credit are given by the following equations,

$$\begin{aligned}\frac{MU_{i,t}}{R_{t,i}} &\geq \beta_{i,t} E_t MU_{i,t+1} \\ w_t &\geq \beta_{i,t} E_t \frac{MU_{i,t+1}}{MU_{i,t}} MPL_i\end{aligned}\tag{3}$$

Where MU_1 and MU_2 are the marginal utilities with respect to consumption for the productive and unproductive entrepreneurs respectively, λ_t is the Lagrange multiplier for the borrowing constraint. The first equation relates the marginal benefit of borrowing to its marginal cost while the second equation shows that the opportunity cost of employing one unit of labor is greater than or equal to the marginal product of labor.

More specifically, the demand for labor equations for the two entrepreneurs can be written as,

$$\begin{aligned}\beta E_t \frac{MU_{1,t+1}}{MU_{1,t}} MPL_1 &= w_t - \lambda \theta \frac{MPL_1}{MU_{1,t}} \\ \beta_{i,t} E_t \frac{MU_{2,t+1}}{MU_{2,t}} MPL_2 &= w_t\end{aligned}\tag{4}$$

where the productive entrepreneurs or the borrowers internalize the effect of the labor hours they employ on their financial constraints. Thus the marginal benefit of employing one more unit of labor for them lies not only in its marginal product but also in the marginal benefit of being able to borrow more through greater production.

Worker's Problem

The workers do not own production technology and cannot borrow in financial markets given that they have no collateral. They simply supply labor and consume their wages every period. Specifically, the worker's problem is given by

$$\text{Max} \quad E_t \sum_t \beta_{2,t} \left(\ln c_{w,t} - \frac{l_{s,t}^{1+1/\eta}}{(1+1/\eta)} \right) \quad (5)$$

subject to the flow-of-funds constraint

$$c_{w,t} = w_t l_{s,t} - R_{t-1} b_{w,t-1} + b_{w,t}$$

where

$$b_{w,t} \leq 0.$$

They supply labor according to the following first order condition with respect to labor,

$$l_{s,t}^{(1-\eta)} = w_t.$$

3.2 Market Clearing and Equilibrium

The workers are the only suppliers of labor in the economy and work a total of l_s hours for the two entrepreneurs. Market clears when the total labor demanded by the Entrepreneurs is equal to the total labor supplied by the Workers such that

$$l_{1,t} + l_{2,t} = l_s(w_t).$$

Note here that the unproductive agents produce at equilibrium rendering the equilibrium suboptimal because of the credit constraints.

The bond market clears

$$b_{1,t} + b_{2,t} = 0.$$

Since workers do not borrow in equilibrium, the above condition implies that total borrowing by the productive entrepreneurs must equal total lending by the unproductive entrepreneurs in the economy. The goods market clearing condition can then be written as

$$c_{1,t} + c_{2,t} + c_{w,t} = y_t,$$

where $y_t = y_{1,t} + y_{2,t}$ is the aggregate output in the economy.

The necessary and sufficient conditions that characterize the solutions to the problem of the entrepreneurs and workers are then given by the relevant flow-of-funds constraints, the technology and borrowing constraints and the first order conditions of the Entrepreneurs and Workers. Note the productive agents being the borrowers in the economy are borrowing constrained while the unproductive agents and the workers are not.

4. Model Solution

4.1 Calibration

The model is calibrated to the U.S. economy at a quarterly frequency. I set the discount factor of the borrowers in the model to $\beta_1 = 0.94$ and lenders' to $\beta_2 = 0.96$, such that borrowers are more impatient. The labor share of income α is set at the standard value of 0.66.

Micro studies for η , the Frisch elasticity of labor supply, estimate a low value ranging from 0.1 to 0.4 (MaCurdi 1981), 0.7 (Hall, 2009), 1 (Kimball and Shapiro, 2008) and 1.5 (Gourio and Noual, 2007) while macroeconomic models typically use higher values: for instance, King and Rebelo (1999) use 4 in their survey of RBC

models and an infinite elasticity in an extension of their model. New Keynesian models also use high values of η . Rotemberg and Woodford (1998) and Woodford (2003) use an elasticity of almost 9. In my model, given that my results are not too sensitive to the value of η I set the elasticity to 3, higher than that suggested by micro studies but lower than that used in macro models.

I follow Kiyotaki et al. (2009) who use as a reference micro-econometric studies that have measured firm level productivity, to characterize the gap between the productive and unproductive agents. They use Syverson (2004) who computes labor productivity measure for 443 four-digit industries using plant-level data from the 1977 Census of Manufactures (CM) for the U.S. Kiyotaki et al. focus on the interquartile range as a proxy for the gap between more productive and less productive firm and find that the ratio of labor productivity between the 75th and 25th percentile plants is about 1.3 slightly higher than what they use to parameterize their economy. Accordingly I set the ratio of productive to unproductive entrepreneurs in my model (ψ) to equal 1.2.

To calibrate the financial development parameter in the model, θ , I use the non-financial business credit series from the Board of Governors' Flow of Funds data for the U.S. for 1955-2010. I choose this series to construct the financial development parameter in my model because the series closely tracks firm level sales growth volatility for the U.S. for 1955 to 2000 (see Kaas, 2009). I calculate for each year the share of non-financial business credit as a percentage of GDP and then I construct θ by averaging over five year groups starting with 1951 up to 2010. The average value of theta obtained for the entire sample period is 0.52 and this is the value I use for my baseline calibration. However, θ increases on average from 0.31 in 1951-55 to 0.75 in 2006-10, which is the range I use to see the effect of increases in

credit market growth on growth rates of y_1 , y_2 and y before and during the Great Moderation.

4.2 Results

In Table 1 I present the volatilities of firm and aggregate growth rates for ten year average values of θ . As θ increases steadily from 0.33 to 0.71 there is a consistent increase in firm output growth volatility while aggregate output growth volatility is either decreasing or not changing at all as θ increases. It is interesting to note however, that as the value of θ goes from its 1971-80 level to its value corresponding to 1981-90, aggregate growth volatility declines from 1.66 to 1.63 while firm volatility continues to increase sharply across sectors. The increase in firm volatility occurs for all periods while aggregate growth volatility is either constant or decreasing.

Table 1: Firm vs. Aggregate Volatility as θ Increases (1955-2010)

	Moments			
θ		$\sigma(y_{1g})$	$\sigma(y_{2g})$	$\sigma(y_g)$
0.33	1951-1960	1.36	1.50	1.48
0.42	1961-1970	1.69	1.60	1.50
0.50	1971-1980	2.01	1.50	1.66
0.59	1981-1990	3.48	4.76	1.63
0.57	1991-2000	2.19	1.86	1.63
0.71	2001-2010	3.84	4.93	1.63

In order to delve deeper into the period of the Great Moderation Table 2 presents an analysis of the period 1980-2010. That is, beginning with the period when the Great Moderation was said to have started we calculate five year average values of

the financial development parameter θ ranging from 0.55 in 1981-85 to 0.75 in 2006-10 and present the standard deviations of firm and aggregate output growth during the corresponding periods. The model generates a fall in aggregate volatility going from 1981-85 to 1986-90 and again from 1996-2000 to 2000-10, both significant periods in the U.S. macroeconomy, given that the Great Moderation began in the 1980's and finance became really large since the mid 90's . Here too firm growth volatility increases consistently throughout the period under consideration. The last two rows in Table 2 present results for really high values of θ like those observed during the financial crisis (0.79 in 2008 and 0.81 in 2009). I find that firm volatility increases significantly and rapidly even for very small increases in θ at high levels of financial market development while aggregate output also becomes more volatile at this stage.

Table 2: Firm vs. Aggregate Volatility as θ Increases (1980-2010)

θ		Moments		
		$\sigma(y_{1g})$	$\sigma(y_{2g})$	$\sigma(y_g)$
0.55	1981-1985	2.17	1.92	1.63
0.62	1986-1990	2.44	2.88	1.56
0.57	1991-1995	2.19	1.86	1.63
0.59	1996-2000	3.48	4.76	1.63
0.66	2001-2005	4.28	5.93	1.55
0.75	2006-2010	4.25	5.77	1.57
0.79	2008	6.89	10.16	1.94
0.81	2009	14.20	21.32	2.85

Table 3 presents the correlations between firm and aggregate growth rates for increasing levels of financial development. The table shows that correlations between

Table 3: Correlation of Firm and Aggregate Growth

Moment	0.33	0.42	0.50	0.57	0.64	0.66	0.75
$Corr(y_g, y_{1g})$	0.96	0.94	0.98	0.91	0.80	0.69	0.74
$Corr(y_g, y_{2g})$	0.90	0.74	0.73	0.55	0.30	-0.18	-0.26
$Corr(y_{1g}, y_{2g})$	0.81	0.50	0.54	0.19	-0.33	-0.83	-0.85

firms and the aggregate decrease as θ increases from 0.33 to 0.75. While correlation between the productive sector and the aggregate are mostly decreasing, the unproductive entrepreneurs, who are also the lenders in the model face consistently decreasing correlations as θ increases with the model generating negative correlations at the highest observed values of θ . I also find significantly decreasing correlation between the two types of firms in the model, with correlations turning negative at higher values of θ . Comin and Philippon (2005) regard such decline in correlation between the sectors and the aggregate economy as the primary cause for a divergence in macro and micro volatilities. The reason is that as economies become more financially developed firms become more and more risk taking and they can now depend on a highly developed external financial market for undertaking these investments as opposed to their internal cash flows or firm profits. This makes firms more volatile and this higher volatility in turn is not reflected at the aggregate level because of decreased correlation between the firm and the aggregate.

How well does the model replicate empirical data? The first thing to notice is that the model is able to generate a divergence between aggregate and firm level volatility for the period under consideration. Also, the model generates consistently higher firm growth volatility with increasing values of θ . The model is not

able to quantitatively match the low levels of aggregate volatility during the Great Moderation, nor is firm growth volatility generated by the model as high as that observed empirically for the periods studied. However, as will be discussed later in Section 4.3 higher firm volatility can be generated by increasing the share of labor income in the model while a lower labor productivity ratio ϕ can generate lower aggregate output volatility.

I report business cycle properties of other key variables in Table 4, specifically the average standard deviation, correlation with output and first order auto-correlation coefficient for consumption and hours worked are reported. Since there is no investment aggregate consumption in the model is equal to aggregate output. I find that the model does pretty well in matching the business cycle properties.

Table 4: Comparison with Data

	Volatility (%)		Relative Volatility		Autocorrelation		Corr. w/ GDP	
	Data	Model	Data	Model	Data	Model	Data	Model
GDP	1.7	1.5	1.0	1.0	0.84	0.89	1.0	1.0
Consumption	0.8	1.5	0.48	1.0	0.84	0.89	1.0	0.99
Total Hours	1.2	1.1	0.74	0.73	0.74	0.90	0.80	0.98

4.2 Results: Uniform Productivity

In this section I allow firms to be different based only on their rate of discounting the future. In other words, both firms are equally productive such that $\phi = 1$ but some entrepreneurs are more impatient than the others and borrow around steady states while others lend to them. Workers continue to simply supply labor and consume their wage income. Table 5 presents the results showing that in the absence of a productivity wedge the model does worse both qualitatively and quantitatively

although firms continue to experience higher volatility while aggregate volatility is little affected.

Table 5: Firm vs. Aggregate Volatility as θ Increases (1980-2010)

	Moments			
θ		$\sigma(y_{1g})$	$\sigma(y_{2g})$	$\sigma(y_g)$
0.55	1981-1985	1.72	1.51	1.57
0.62	1986-1990	1.85	1.45	1.57
0.57	1991-1995	1.74	1.48	1.57
0.59	1996-2000	1.76	1.48	1.57
0.66	2001-2005	1.91	1.43	1.57
0.75	2006-2010	2.25	1.55	1.58
0.79	2008	2.55	1.75	1.58
0.81	2009	2.74	1.90	1.57

4.3 Sensitivity Analysis

The results obtained in the previous section are fairly robust to alternate assumptions about key parameter values, like the share of productive entrepreneurs in the model (π), the Frisch elasticity of labor supply (η), and the different values of the discount factors (β_1, β_2). I present here a sensitivity analysis of the two parameters that seem to have some effect on firm and aggregate volatilities at different values.

Table 6 reports the standard deviation of output at the aggregate and firm level for different levels of financial development for alternate values of the labor share in income, α . The main result of the model, that firm volatility is consistently increasing while aggregate volatility is more or less constant, holds across different values of alpha. However, at a higher labor share such as 0.80 firm growth volatility

Table 6: Alternative values of Labor Share(α)

	$\alpha = 0.62$			$\alpha = 0.70$			$\alpha = 0.80$		
θ	y_{1g}	y_{2g}	y_g	y_{1g}	y_{2g}	y_g	y_{1g}	y_{2g}	y_g
0.42	1.51	1.45	1.44	1.69	1.60	1.50	2.30	2.59	1.75
0.52	1.59	1.39	1.45	1.82	1.41	1.54	2.62	3.78	1.75
0.62	1.84	1.58	1.46	2.44	2.88	1.56	4.90	10.02	1.78
0.71	2.67	2.77	1.49	3.84	4.93	1.63	9.12	20.76	1.95

is significantly higher for higher values of θ .

In Table 7, results for alternative values of ϕ , the ratio of labor productivity in the model economy are presented. Again we see that no matter what the value of ϕ increasing θ is associated with increasing volatility at the firm level while affecting aggregate volatility much less. However when ϕ is really low at 1.15, at a high level of financial development there is a significant fall in volatilities at the aggregate and firm level.

Table 7: Alternative values of Productivity Ratio(ϕ)

	$\phi = 1.15$			$\phi = 1.20$			$\phi = 1.25$		
θ	y_{1g}	y_{2g}	y_g	y_{1g}	y_{2g}	y_g	y_{1g}	y_{2g}	y_g
0.42	1.33	1.57	1.60	1.69	1.60	1.50	1.71	1.56	1.57
0.52	1.89	1.55	1.60	1.82	1.41	1.54	2.04	2.08	1.59
0.62	7.48	8.46	1.68	2.44	2.88	1.56	3.02	4.30	1.61
0.71	2.31	1.76	1.50	3.84	4.93	1.63	4.89	7.89	1.69

5. Conclusion

The so-called Great Moderation saw real GDP growth volatility going down from

2.7 percent in 1959-1983 to 1.28 percent in 1984-2007. Firm growth volatility at the same time increased consistently from the 1950's with an average median firm sales growth volatility of around 14 percent up until 2000. I argue that financial market innovation and development over the last 20 years contributed significantly to this divergence in volatilities of the firm and the aggregate.

I build upon the lines of Kiyotaki and Moore (1997), who extend the prototypical RBC model to allow financial factors to play a role in business fluctuations. Credit constraints arise endogenously in such a model because lenders cannot force borrowers to repay their debts unless these are secured by collateral. Also, following Kaas (2009) I make some firms more productive than others in the model in each period, which I show is responsible for the difference in firm and aggregate behavior as far as output growth volatility is concerned. In the absence of a difference in productivity levels borrowing firms are more volatile at higher levels of financial development while lending firms are less so leading to constant aggregate volatility on average.

I account for varying levels of productivity as observed in the data in my model and show that firm volatility indeed increases with higher levels of financial development while aggregate output volatility is either decreasing or little affected by the level of financial development of an economy. The model is able to generate significant declines in aggregate volatility at the beginning of the Great Moderation as well as in the mid 1990's when financial markets became especially important in the U.S. thanks to the financial liberalization measures. Firm growth volatility increases throughout the period under consideration thus lending support to the argument that financial development and growth of credit markets since the mid 1990's played an important role in the divergence of aggregate and firm output

growth volatility. For all other periods I find aggregate output growth volatility to be relatively constant. Thus in financially developed economies like the U.S. fiscal and monetary policy effects must be larger than that implied by purely aggregate models and specifically policy must take into account the fact that firm and aggregate output growth rates are affected differently the more developed financial markets are.

I find firm growth volatility to be sensitive to the share of labor income in output with higher shares corresponding to higher and hence more realistic firm growth volatility. The results are robust to changes in other model parameters. The model generates lower correlations across sectors and the aggregate as the economy becomes more financially developed lending support to the finding by Comin and Philippon (2005) that fall in aggregate volatility is in fact due to reduced correlation across sectors and not due to fall in average firm volatility.

Also, a lower labor productivity ratio gives rise to higher firm volatility and lower aggregate volatility. The model is however not able to replicate the consistent decline in aggregate output volatility as observed during the period of the Great Moderation nor as high levels of firm volatility as observed in the data, which suggests that something else might be going on. One line of investigation can be the type of investment the borrowing firms in the economy are engaging in. That could help explain further the high degrees of firm volatility and the divergence between the firm and the aggregate during the period under consideration.

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