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What Drives Productivity Volatility of Chinese Industrial Firms?*

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Résumé/abstract

The Chinese economy has witnessed impressive development since the enterprise reforms in the 1990s. With the restructuring of the private sector and the development of market economy, the level and volatility of firm level productivity have become increasingly important aspects of the micro performance of the economy.

This paper examines the role of different firm characteristics - such as size, age, ownership, and geographic location - in productivity volatility using a firm-level dataset collected annually by China's National Bureau of Statistics in 1998-2007. It follows the methodology developed in Comin and Philippon (2005; 2007) to measure firm productivity volatility as the standard deviation of the annual growth rate of output per worker. Its objectives are to investigate the drivers of productivity volatility of Chinese industrial firms, and to shed light on the sources of output volatility and its evolution over time.

The results suggest that in general, firm productivity volatility declined over time. Among firms of different characteristics, larger firms, older firms, foreign firms, and firms located in the coastal provinces are less volatile. Firm size and location are the two major factors that drive changes in productivity volatility – one positively and one negatively. While the gaps of volatility between smaller firms and larger firms declined, the gaps between firms located in the coastal provinces and inland provinces increased.

Mots clés/Keywords : Enterprise reform, productivity, volatility, China.

Codes JEL/JEL classification: C21, D21, E23

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1. Introduction

The Chinese economy has witnessed impressive development since the economic reforms in the late 1970s. Over the past three decades, there have been important reforms and transformations: expansion of Township and Village-ship Enterprises (TVEs), privatization of small and medium state-owned enterprises, modernization of large state-owned enterprises, as well as development of foreign enterprises. Since the late 1990s, the economy continued rapid and steady growth as the government deepened the reforms, after its accession to the World Trade Organization, as well as during challenging periods such as the Asian financial crisis and the dot.com bubble.

While many studies of the Chinese economy focus on investigating the factors that contributed to the aggregate productivity and the inequality between coastal and inland regions as well as rural and urban areas, this paper takes a closer look at the firm level output growth and examines the drivers of its volatility over time. The objective is to understand the micro foundation of the economic growth performance. It aims at shedding light on sources of output volatility and its evolution over time. The literature on firms' economic performance is abundant. However, most previous studies focus on firm's productivity level. To our knowledge, the present paper is the first analysis of the volatility of productivity of firms in China.

This study is based on a firm-level dataset collected annually by China's National Bureau of Statistics. This dataset covers about 300 thousands firms in 1998-2007. This paper examines the role of different firm characteristics - such as size, age, ownership, and geographic location - in productivity volatility. It follows the methodology developed in Comin and Philippon (2005; 2007) to measure firm productivity volatility as the standard deviation of the annual growth rate of output per worker.

Our empirical work is composed of three parts. First, the paper compares the productivity of firms in three groups - those that survived the entire 10 year period, that survived any consecutive 5 years, and all firms in the sample - and focuses on the second group for the analysis of evolution of productivity volatility over time.

Second, it describes the changes in composition of different types of firms (size, age, ownership, and location) and examines the roles that these different firm characteristics, along with investment in long-term and intangible assets, innovation, export intensity, and insurance and pension payments, play in the determination of firm productivity volatility and its evolution over time.

Third, it realizes an investigation into the role of various firm characteristics – size, age, ownership, location, investments, export, insurance and pension, etc. – in the changes in the volatility of firm productivity. Applying of the method of Oaxaca decomposition as developed in Smith and Welch (1989), we quantify the influence of various variables in the changes in volatility of firm productivity by decomposing their effect into (i) main effect that occurs because of change in firm characteristics and (ii) year effect that ensue from a change in return to these characteristics.

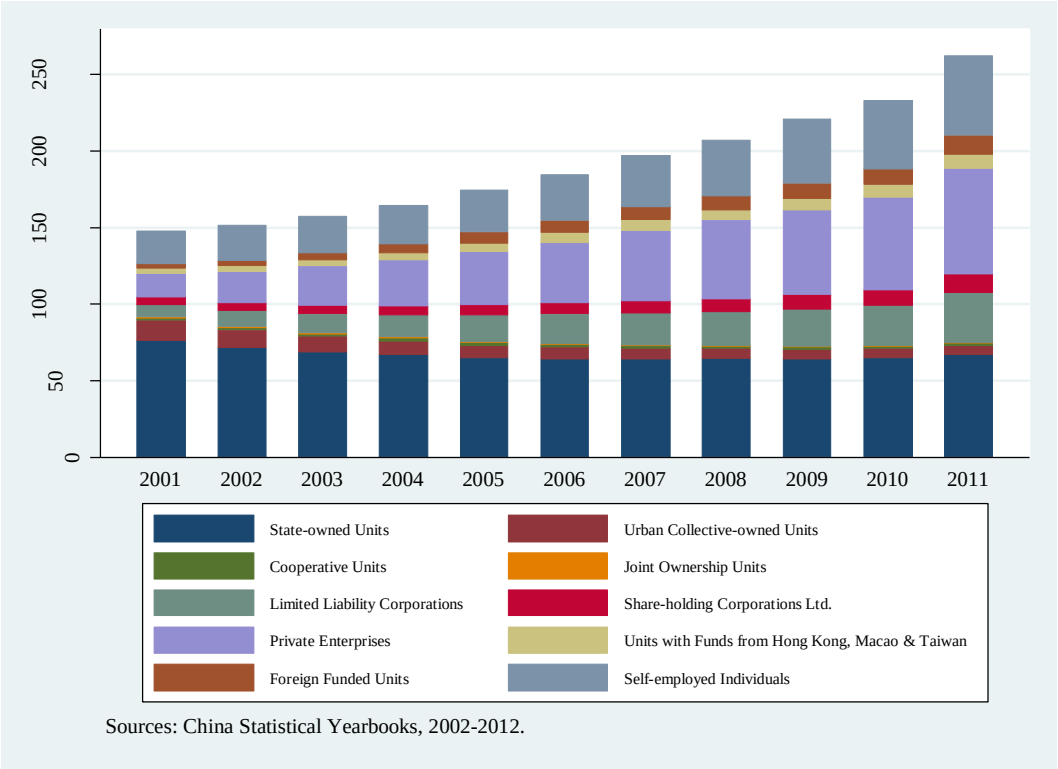
2. Enterprise reforms

Before the enterprise reforms in the 1990s, state-owned and collective-owned enterprises played a dominant role in the economy. Many urban workers worked for one firm in their entire working life. The state-owned enterprises (SOEs) were not independent entities - they were completely subordinate to the government. Production and market were separated. Due to the absence of a general social security system, the enterprises had to provide benefits of various aspects to workers and their families. An enterprise was often a relatively small independent community. As social stability is always a major concern of Chinese government, laying off employees was generally prohibited, even in the enterprises in deficit. In contrast, firms could still benefit from financial support from the government, which severely limited enterprises' motivation to get out of the difficult situation by improving their operation and efficiency. Many SOEs were therefore in deficit and suffered from a relatively low efficiency. In the central planning era, many loss-making SOEs were kept alive and redundant workers employed with their guaranteed jobs - "iron rice bowl" (or "*tie fan wan*") – and social entitlements.[1]

[1] See for instant Bari (1997); de Beer and Rocca, 1997; Putterman, 1992; etc.

The reforms fundamentally restructured the enterprise sector. Firm closures or mergers and workers laid-off from secure and lifetime jobs, which were rare for SOEs in the past, became crude reality. Millions of workers found themselves unemployed and open unemployment emerged in urban areas. A large share of state-owned or collective-owned enterprises were restructured to corporate-owned or private-owned. At the same time, private enterprises, foreign enterprises, and Hong Kong, Macao, and Taiwan-owned enterprises rapidly developed, which created a large share of employment opportunities. In 1999, almost two-thirds of the enterprises are state-owned or collective-owned; in 2007, the ratio declined to less than one-tenth, according to our firm level dataset. In 1994, the share of employment in SOEs was 60.9% of the urban labor; it decreased to 23.7% in 2005, and 18.7% in 2011 (see Figure 1). The informalization of the Chinese enterprise sector provided jobs of a different nature to a large share of the labor force (World Bank, 2007).

Figure 1 - Number of employed persons by ownership in Urban China (2001-2011)



Sources: China Statistical Yearbooks, 2002-2012.

With the restructuring of the enterprise sector, firm turnovers and job churnings became normal phenomena. Workers no longer tied to one firm. Spurred by the rapid development in the coastal provinces and urban areas, millions of migrant workers left their hometowns to pursue better opportunities. The supply of inexpensive labor further stimulated the economic growth and attracted more domestic private investment and foreign direct investment, which supported the deepening of the enterprise reforms. The spillover effects of foreign direct investment on domestic firms vary. Wei and Liu (2006) indicated that there are positive inter-industry productivity spillovers from R&D and exports, and positive intra- and inter-industry productivity spillovers from foreign presence to domestic firms within regions. Du et al (2011) elaborated different channels and mixed effects through forward linkages and backward linkages, and argued that the positive spillover is insignificant for horizontally integrated firms.

With the development of the market economy, the volatility of firm level productivity becomes a crucial aspect of the micro performance for an economy. It reflects responses of firms to idiosyncratic shocks and frictions in product, factor and credit markets. Firm level volatility often links to their investment patterns, access to external finance, and regulation reforms. The volatility of the entire private sector reflects the joint forces of the entries and exit of firms and the trends of changes of volatility of the firms in the market.

2 Evolution of productivity volatility

Firm level productivity volatility is an important aspect of whole economic development. In previous studies, volatility is measured by different methods. In Loayza and Servén (2010), macroeconomic volatility is represented by the standard deviation of the output gap, obtained as the difference between actual and trend real GDP per capita. Trend output is estimated using the band-pass filter of Baxter and King (1999). In Hausmann and Gavin (1996), macroeconomic volatility is defined as the standard deviation of the level of GDP per capita. In Breen and García-Peñalosa (2005), output volatility is defined as the standard deviation of the annual growth rate real per capita GDP.

In the present study, we follow the methodology developed in Comin and Philippon (2005). They used aggregate data from the NIPA, and firm level data from COMPUSTAT and CRSP. This dataset is composed of time series that vary from 1955 to 2000. For each firm i at time t, they compute the volatility as the standard deviation of the annual growth rate of sales during each ten-years:

$$\sigma_{i,t} = \sqrt{\frac{1}{10}\sum_{\tau=-4}^{+5}\left(\gamma_{t+\tau,i} - \bar{\gamma}_{t,i}\right)^2} \tag{1}$$

Our study is based on a firm-level dataset collected annually by China's National Bureau of Statistics. This dataset covers about 300 thousands firms in 1998-2007, but the length is only 10 years and only available for a subset of approximately 32000 firms. Thus we use two methods to measure the productivity volatility.

For the firms survived the entire 10 year period (1998-2007), we define the productivity volatility as the standard deviation of the annual growth rate of total output per worker during 1999-2007:

$$\sigma_{\bar{i}} = \sqrt{\frac{1}{9}\sum_{k=1999}^{2007}\left(\gamma_{i,k} - \bar{\gamma}_i\right)^2} \tag{2}$$

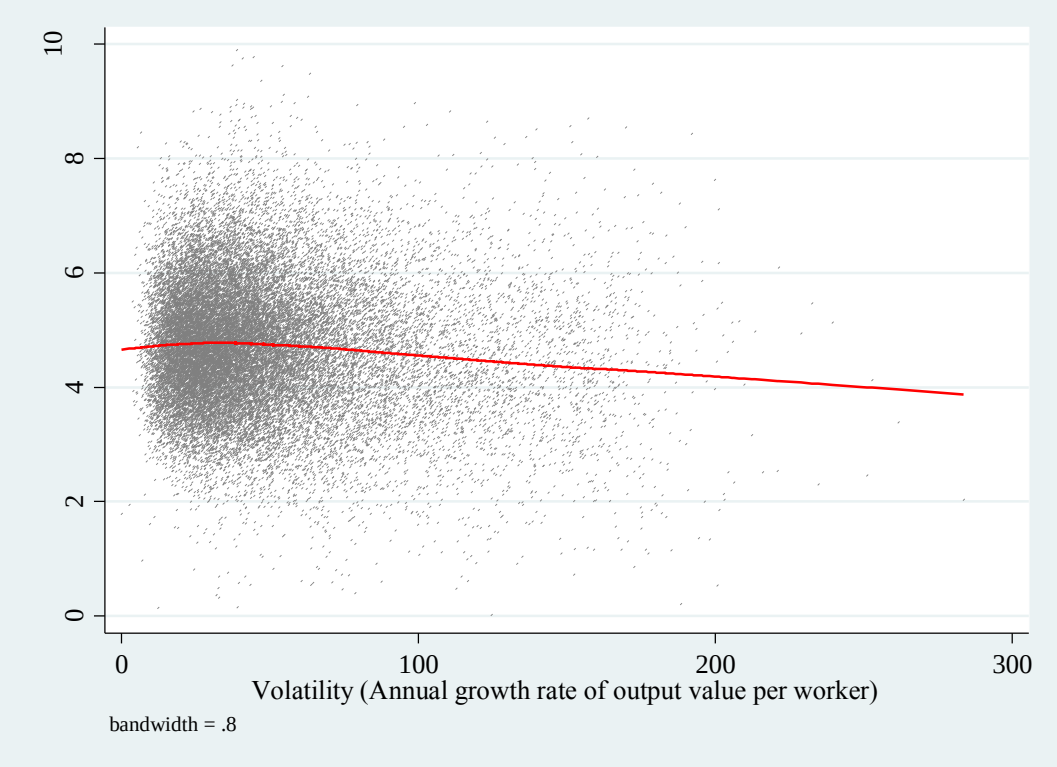
where $\gamma_{i,k}$ is the annual growth rate of output per worker for firm i at year k, and $\bar{\gamma}_i$ the average growth rate between 1999 and 2007. However, this measure only allows us to realize some cross-section analyses. To study the evolution of volatility over time, we adopt an alternative method by computing, for the firms survived at least 5 years, the productivity volatility as the standard deviation of the annual growth rate of total output per worker during each 5 consecutive years:

$$\sigma_{i,\bar{t}} = \sqrt{\frac{1}{5}\sum_{k=t-2}^{t+2}\left(\gamma_{i,k} - \bar{\gamma}_i\right)^2} \tag{3}$$

where $\gamma_{i,k}$ is the annual growth rate at year k for firm i, and $\bar{\gamma}_i$ the average growth rate between $t-2$ and $t+2$; t varies from 2001 to 2005. This measure is similar to that of Comin and Philippon (2005). It allows us to analyze the change of productivity volatility during the period 2001-2005.

Figure 2 presents the smoothing relationship between volatility and productivity. We can observe that, as productivity increases, its volatility shows a downward trend. In other words, overall productivity is negatively associated with volatility for Chinese firms.

Figure 2 – Relationship between volatility and productivity



Note: The firms in the sample are those that survived for the entire 10 year period.

Table 1 shows that the average magnitudes of firm level volatility in the annual growth rate of output per capita declined in 2001-2005. This downward trend of production volatility also applies to most firms of different characteristics, such as size, age, ownership, and in inland and coastal regions.

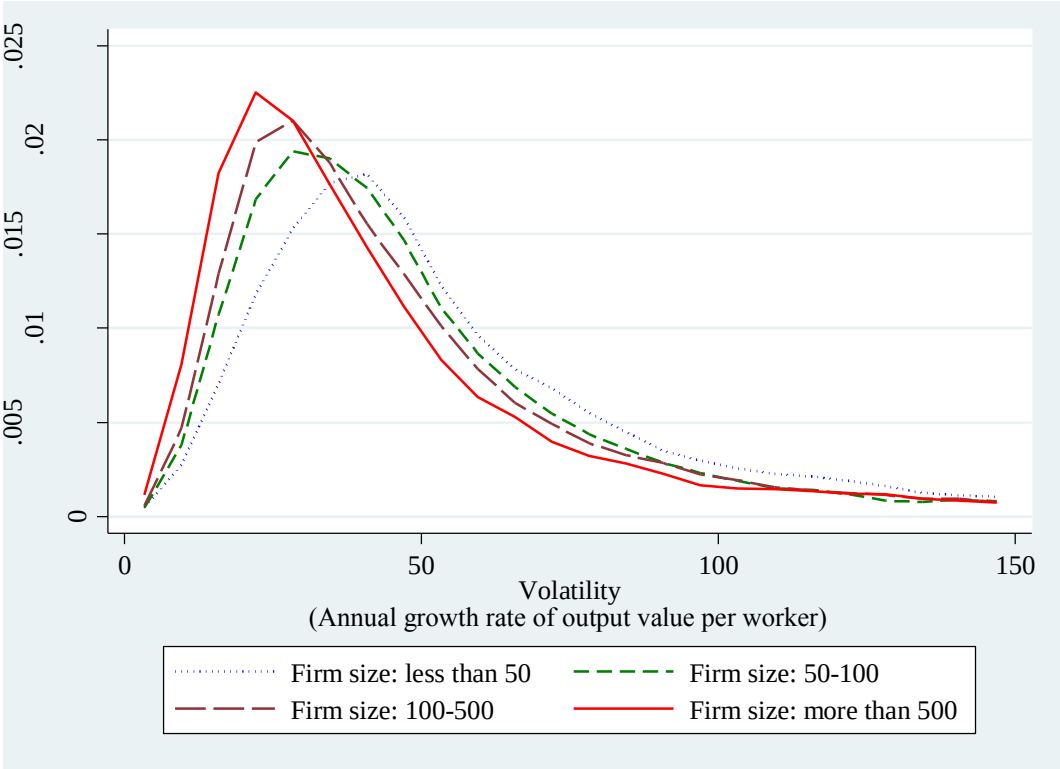
Table 1 – Evolution of firm's productivity volatility

	Firms survived the entire 10 year period	Firms survived for at least five consecutive years [t-2, t+2]					
		2001	2002	2003	2004	2005	Change in volatility between 2001 and 2005
Total	48.2	43.71	42.69	42.41	42.54	42.76	-0.95
Firm size							
Less than 50	56.0	53.53	52.10	51.40	52.32	51.43	-2.11
50-100	49.2	46.90	45.06	44.65	45.04	45.01	-1.89
100-500	47.8	43.07	42.05	41.74	41.64	42.04	-1.03
More than 500	44.3	37.16	37.45	37.25	36.04	36.65	-0.51
Firm's age							
Less than 5 years	49.3	48.89	47.25	46.58	48.39	48.86	-0.03
6-10 years	47.9	43.50	42.27	41.90	42.12	43.13	-0.36
11-20 years	47.2	42.63	41.65	41.48	40.63	39.94	-2.69
More than 20 years	47.1	41.69	41.44	41.29	39.84	39.36	-2.33
Main part of paid-in capital							
State capital	49.3	44.48	44.65	44.12	43.56	42.12	-2.36
Collective capital	50.0	44.10	42.54	43.68	42.84	42.86	-1.25
Corporate capital	48.9	44.09	43.52	43.76	44.10	45.10	1.00
Personal capital	48.9	43.15	42.42	42.13	42.92	43.07	-0.08
Hong Kong, Macao and Taiwan c apital	48.0	44.93	42.13	40.82	40.36	40.72	-4.21
Foreign capital	45.3	40.01	38.72	38.26	38.56	38.87	-1.15
Region							
Inland province	51.3	45.43	44.49	44.59	45.87	46.92	1.49
Coastal province	46.6	42.66	41.79	41.45	41.01	40.88	-1.79
Number of observations	29483	49375	46045	51929	68965	78330	

Note: The volatility is measured as standard deviation of annual growth output per worker at the firm level. The output value in each year is adjusted to 1998 price using Producer Price Index for Manufactured Goods provided by China Statistical Yearbooks.

Consistent with the literature, smaller firms are more volatile than larger firms. Using Kernel density, we examine the distribution of productivity volatility by firm size. Figure 3 shows that, as firm size increases, both level and variance of productivity volatility decrease. Similarly, we observe that younger firms are more volatile than older firms, and firms in the inland region are more volatile than firms in the coastal region. Firms with foreign capital as the main part of paid-in capital are the least volatile. From 2001 to 2005, the volatility decreased in the coastal region, but increased in the inland region.

Figure 3 – Kernel distribution of firm productivity volatility



Note: The firms in the sample are those that survived for the entire 10 year period.

Two interesting findings emerge when looking at the role of firm characteristics in productivity volatility over time: first, the marginal impact of firm size on volatility is converging – larger firms are less volatile compared with smaller firms, but over time, the gap of volatility between large firms and small firms tend to decline. Second, the marginal impact of firm age on volatility is diverging – younger firms are more volatile than older firms, and over time, the gap of volatility between younger firms and older firms tend to increase. This might indicate, on the one hand, that the government's support to the SMEs has been taking effect; and on the other hand, that younger firms are more likely to experience experimentation and adjustment in the market and they are more volatile when competition is higher.

As mentioned above, we select only the firms that survived at least 5 years in the analysis of the evolution of volatility. The firms that disappeared before 2002 and those appeared after 2003 and some others whose data are not available are excluded from our analysis. One might raise the

following question: how different are the selected firms compared with all firms in the population? For example, are the selected firms more or less productive than others? We compare the productivity of the selected firms with that of all firms (Table 2). The statistics show, in general, the difference in productivity between selected firms and all firms is not significant. However, this difference is negative in a significant manner for several sub-groups, implying that the selected firms are likely those whose productivity is higher.

Table 2 – Average of output per worker

	2001				2005			
	All firms	Selected firms	Difference		All firms	Selected firms	Difference	
Total	218.4	227.3	-8.9 ***	(-2.93)	346.5	367.1	-20.5 ***	(-4.86)
Firm size								
Less than 50	357.9	402.9	-44.9 ***	(-3.05)	517.9	708.8	-190.9 ***	(-10.42)
50-100	206.8	281.8	-75.0 ***	(-15.33)	301.6	391.2	-89.6 ***	(-14.85)
100-500	153.4	191.2	-37.7 ***	(-12.94)	247.1	300.2	-53.1 ***	(-12.08)
More than 500	153.1	178.9	-25.8 ***	(-5.59)	282.7	321.4	-38.7 ***	(-4.41)
Firm's age								
Less than 5 years	263.9	287.7	-23.9 ***	(-2.86)	371.4	389.8	-18.4 **	(-2.19)
6-10 years	243.7	305.9	-62.2 ***	(-10.26)	347.5	418.5	-71.0 ***	(-6.97)
11-20 years	185.0	213.5	-28.5 ***	(-5.27)	298.6	362.1	-63.6 ***	(-9.86)
More than 20 years	100.8	112.6	-11.8 ***	(-5.11)	194.0	227.0	-32.9 ***	(-5.39)
Main part of paid-in capital								
State capital	128.5	120.0	8.5	(1.40)	269.3	320.1	-50.8 **	(-2.18)
Collective capital	226.6	223.7	2.9	(0.39)	360.5	370.1	-9.6	(-0.62)
Corporate capital	251.2	249.4	1.7	(0.17)	376.9	401.0	-24.1 ***	(-2.58)
Personal capital	228.9	222.1	6.8	(1.11)	329.7	332.2	-2.5	(-0.56)
Hong Kong, Macao and Taiwan capital	266.3	288.1	-21.8	(-1.35)	312.3	349.0	-36.7 ***	(-2.59)
Foreign capital	375.7	467.4	-91.6 ***	(-3.71)	469.2	602.6	-133.4 ***	(-4.96)
Region								
Inland province	147.9	142.9	5.0	(1.41)	303.6	286.9	16.6 ***	(2.87)
Coastal province	254.0	261.6	-7.6 *	(-1.84)	362.8	391.1	-28.3 ***	(-5.34)
Number of observations	117457	49375			192734	78330		

Note: t-statistics in brackets. *** significant at 1%; ** significant at 5%; * significant at 10%. The selected firms are those that survived at least 5 years.

3 Sources of change in productivity volatility

As we observed in previous section, firm's productivity volatility depends largely on firms' characteristics. The change in firm composition over time inevitably leads to a change in aggregated volatility. In addition, the effect of various firm characteristics on productivity volatility may vary over time, which could also change the aggregated volatility. In this section,

we try to analyze the effect of firm characteristics on productivity volatility on one hand, and to identify the sources of change in productivity volatility on the other hand. To do that, we use a development of Blinder-Oaxaca decomposition to analyze the change in productivity volatility during the period 2001 and 2005 (Blinder, 1973; Oaxaca, 1973; Smith and Welch, 1989; The World Bank, 2007).

Mathematically, starting from two productivity volatility equations for each firm:

$$y_i = \sum_{j=1}^{J} \beta_j^{01} x_{j,i} + \mu_i^{01} \qquad \text{for 2001} \qquad (4)$$

$$y_i = \sum_{j=1}^{J} \beta_j^{05} x_{j,i} + \mu_i^{05} \qquad \text{for 2005} \qquad (5)$$

where y_i represents the productivity volatility of firm i; and $X_i = \left\{x_{j,i}\right\}_{j=1}^{J}$ are the independent variables, we estimate:

$$\log \hat{y}_i = \hat{\beta}^{01} X_i \qquad \text{for 2001} \qquad (6)$$

$$\log \hat{y}_i = \hat{\beta}^{05} X_i \qquad \text{for 2005} \qquad (7)$$

We can decompose the influence of various attributes into (i) main (characteristic or endowment) effects that occur because of changes in firm characteristics and (ii) year (price or coefficient) effects which are due to changes in return to the specific characteristics. This decomposition allows one to assess the sources of volatility variation during the period studied (2001-2005).

The change in productivity volatility during the period 2001-2005 can be decomposed as follows:

$$\Delta y = \bar{y}_{05} - \bar{y}_{01} = \hat{\beta}^{01}(\overline{X}_{05} - \overline{X}_{01}) + (\hat{\beta}^{05} - \hat{\beta}^{01})\overline{X}_{05} = \hat{\beta}^{01} \cdot \Delta\overline{X} + \Delta\hat{\beta} \cdot \overline{X}_{01} \qquad (8)$$

where $\bar{y}_{01}$ and $\bar{y}_{05}$ are arithmetic mean volatility in 2001 and 2005, respectively. $\hat{\beta}^{01}(\overline{X}_{05} - \overline{X}_{01}) = \hat{\beta}^{01} \cdot \Delta\overline{X}$ denotes the main effect of the independent variables, that is, endowment or characteristic effects, and $(\hat{\beta}^{05} - \hat{\beta}^{01})\overline{X}_{05} = \Delta\hat{\beta} \cdot \overline{X}_{05}$ the year effect, which represents changes in returns to specific characteristics.

In addition, with the estimation results, we can analyze the contribution of each independent variable to the change in volatility between 2001 and 2005. Let $X = \{x_j\}_{j=1}^{J}$ stand for the vector of explanatory variables, and $\hat{\beta} = \{\hat{\beta}_j\}_{j=1}^{J}$ the vector of estimated coefficients. The decomposition of equation (8) can be written as follows:

$$\Delta y = \bar{y}_{05} - \bar{y}_{01} = \sum_{j=1}^{J} \left(\hat{\beta}_j^{01} \left(\bar{x}_{j,05} - \bar{x}_{j,01} \right) + \left(\hat{\beta}_{j,05} - \hat{\beta}_{j,01} \right) \bar{x}_{j,01} \right) \quad (9)$$

Attributes influencing firm's productivity volatility will be included in the equations (4) and (5). They consist of firm's size and age; main part of paid-in capital, which is a proxy of firm ownership; ratio of long-term investment to output value; ratio of intangible assets to output value; ratio of export delivery value to sales total output value; ratio of new product to output value; ratio of labor, unemployment insurance to output value; ratio of medical and retirement insurance to output value. We also introduce a dummy variable indicating coastal province.

Table 3 presents descriptive statistics for the 2001 and 2005 samples. Average productivity volatility decreased from 2001 to 2005.[2] During this period, the share of small and medium firms has increased, while that of large firms declined. The share of state-owned and collective firms experienced a significant reduction, but the share of firms financed by private capital has seen a sharp increase from 22% to 40%. Export has become more important in the production of enterprises over time. The share of firms located in coastal provinces rose from 72% to 77%.

[2] As we removed some observations for which the information is incomplete or certain values are extreme, the difference in productivity volatility between 2001 and 2005 is slightly different from the results presented in Table 1.

Table 3 – Sample description

	2001 ($\bar{y}_{01}$ and $\bar{X}_{01}$)	2005 ($\bar{y}_{05}$ and $\bar{X}_{05}$)	Difference (Δy and $\Delta \bar{X}$)
Productivity volatility	43.60	42.74	-0.86
Firm size (%)			
Less than 50 workers	10.68	10.95	0.27
50-100 workers	17.64	20.40	2.76
100-500 workers	52.16	51.73	-0.43
More than 500 workers	19.51	16.92	-2.59
Firm age (%)			
Less than 5 years	16.93	19.86	2.93
5-10 years	33.49	35.72	2.23
10-20 years	20.43	29.17	8.74
More than 20 years	28.95	15.25	-13.7
Main part of paid-in capital (%)			
State capital	26.46	9.60	-16.86
Collective capital	20.47	8.86	-11.61
Corporate capital	17.15	23.62	6.47
Private capital	21.99	40.42	18.43
Hong Kong, Macao and Taiwan capital	9.74	10.25	0.51
Foreign capital	8.96	10.48	1.52
Ratio of long-term investment to output value (%)	4.53	3.12	-1.41
Ratio of intangible assets to output value (%)	4.48	4.30	-0.18
Ratio export delivery value to sales total output value (%)	18.17	21.54	3.37
Ratio of new product to output value (%)	3.17	4.31	1.14
Ratio of labor, unemployment insurance to output value (%)	0.12	0.09	-0.03
Ratio of medical and retirement insurance to output value (%)	0.80	0.25	-0.55
Coastal province (%)	71.16	76.95	5.79
Number of observations	49167	78186	

Table 4 presents the estimation results of the productivity volatility equations (4) and (5). A negative (positive) sign of the coefficient signifies the factor plays a role in reducing (enhancing) productivity volatility. The size of firms have a the negative effect on productivity volatility (or, more directly, larger firms are less volatile); however, the negative effect of the size of firms on volatility seems to weaken over time. This is consistent with the results that we observed in the previous section: larger firms are less volatile compared with smaller firms, but over time, the gap of volatility between large firms and small firms tend to decline. The age of firms has a negative effect on volatility, and this effect has become stronger from 2001 to 2005.

Table 4 – Determinant of firm's productivity volatility

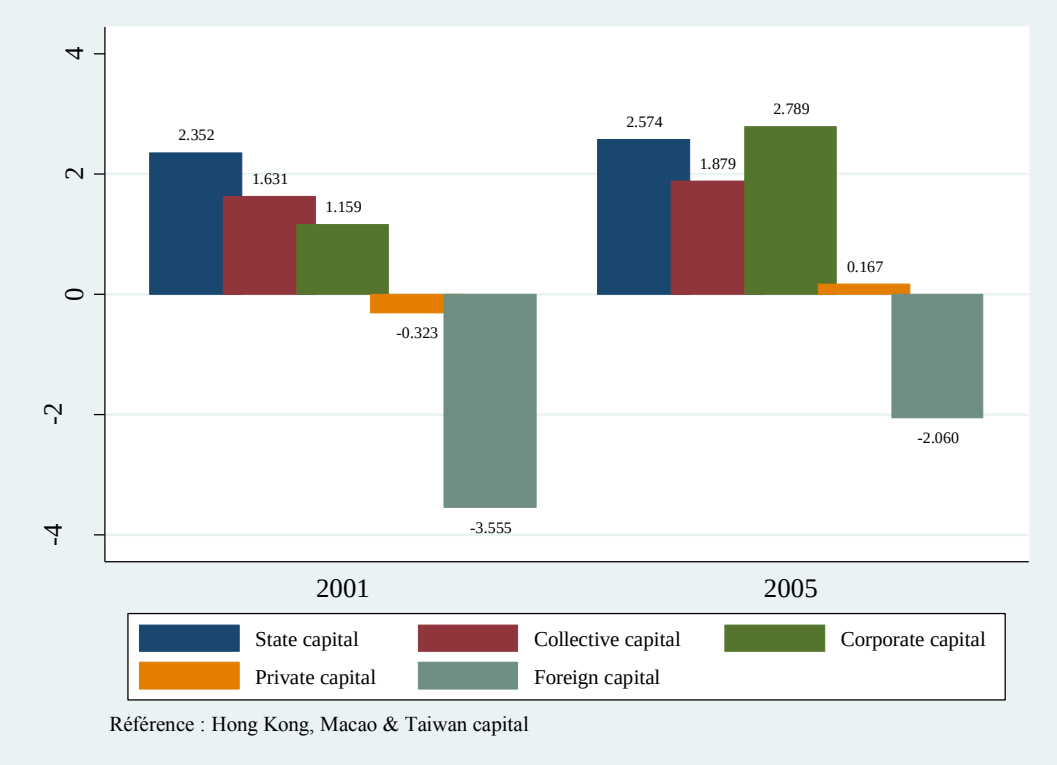
Dependant variable: Standard deviation of annual growth rate of output value per worker

	2001 ($\hat{\beta}^{01}$)	2005 ($\hat{\beta}^{05}$)	Difference ($\Delta\hat{\beta}$)
Firm size (Reference: less than 50)			
50-100	-6.184***	-6.258***	-0.074
	(-10.09)	(-13.70)	
100-500	-10.033***	-8.974***	1.059
	(-18.66)	(-21.82)	
More than 500	-16.154***	-13.694***	2.460
Firm age (Reference: less than 5 years)	(-26.05)	(-27.79)	
5-10 years	-5.218***	-5.042***	0.176
	(-11.00)	(-14.71)	
10-20 years	-6.922***	-7.917***	-0.995
	(-13.20)	(-21.85)	
More than 20 years	-7.833***	-9.148***	-1.315
	(-14.89)	(-20.43)	
Main part of paid-in capital (Ref.: Hong Kong, Macao and Taiwan capital)			
State capital	2.352***	2.574***	0.222
	(4.42)	(5.03)	
Collective capital	1.631***	1.879***	0.248
	(3.25)	(3.83)	
Corporate capital	1.159**	2.789***	1.630
	(2.29)	(7.23)	
Private capital	-0.323	0.167	0.490
	(-0.67)	(0.47)	
Foreign capital	-3.555***	-2.060***	1.495
	(-5.98)	(-4.54)	
Ratio of long-term investment to output value	0.057***	0.012*	-0.045
	(7.80)	(1.68)	
Ratio of intangible assets to output value	0.011	0.002	-0.009
	(1.38)	(0.33)	
Ratio of export delivery value to sales total output value	0.023***	-0.004	-0.027
	(4.49)	(-1.08)	
Ratio of new product to output value	-2.320*	-5.277***	-2.957
	(-1.94)	(-6.99)	
Ratio of labor, unemployment insurance to output value	-1.274***	-0.368	0.906
	(-4.17)	(-0.98)	
Ratio of medical and retirement insurance to output value	0.292***	-0.116	-0.408
	(6.59)	(-1.63)	
Coastal province	-2.947***	-4.261***	-1.314
	(-7.91)	(-13.83)	
Constant	59.093***	59.160***	0.067
	(77.37)	(97.77)	
R^2	0.027	0.027	
Number of observations	49146	78182	

Note: t-statistics in brackets. *** significant at 1%; ** significant at 5%; * significant at 10%.

As to main part of paid-in capital, we take the firms with the main part of paid-in capital from Hong Kong, Macao, and Taiwan as reference group, because their share in the total remained relatively stable in 2001-2005. The results show that firms with state capital, collective capital or corporate capital are more volatile, and their positive effect on productivity volatility is enhanced from 2001 to 2005, especially for corporate capital (Table 4 and Figure 4). On the contrary, foreign capital plays a role in reducing productivity volatility.

Figure 4 – Effect of main part of paid-in capital on firm's production volatility



The coefficients of long-term investment and export are significant in a positive way for the 2001 sample, but not significant for the 2005 sample. The ratio of new product to output value has a negative effect on productivity volatility, and this effect became much stronger from 2001 to 2005. The ratio of labor unemployment insurance to output value is used as a proxy of the insurance that workers could have during job transitions. Its coefficient is significantly negative for the 2001 sample, but not significant for the 2005 sample. On the contrary, the ratio of medical

and retirement insurance to output value has an effect enhancing productivity volatility for the 2001 sample, however its effect is not significant for the 2005 sample. This result could be explained by the reforms of social security system. Previously, medical insurance and retirement was mainly the responsibility of firms, especially for state-owned enterprises. This expense was a heavy burden for firms that were in deficit or facing negative shocks and for older firms with many retirees. As economic reforms deepened, the burdens on firms were alleviated in two ways, on the one hand, non-state-owned enterprises have been developing rapidly and, on the other hand, social security system, including unemployment insurance, medical insurance and pensions, has gradually established. Both contributed to reducing the effect of medical and retirement insurance on the increase in firm productivity volatility.

Finally, we note the important effect of located in coastal provinces on reducing firms' productivity volatility. This effect is greatly enhanced from 2001 to 2005. This is likely be related to the vibrancy of the business environment in the coast. Although firms compete for inputs and markets, they themselves, and the thicker and deeper market they created in the coast through clustering and agglomeration, reduce some idiosyncratic risks (such as shortage of supply of a specific input) and increase the diversity of markets. As observed, the joint forces reduce the productivity volatility of firms in coastal provinces.

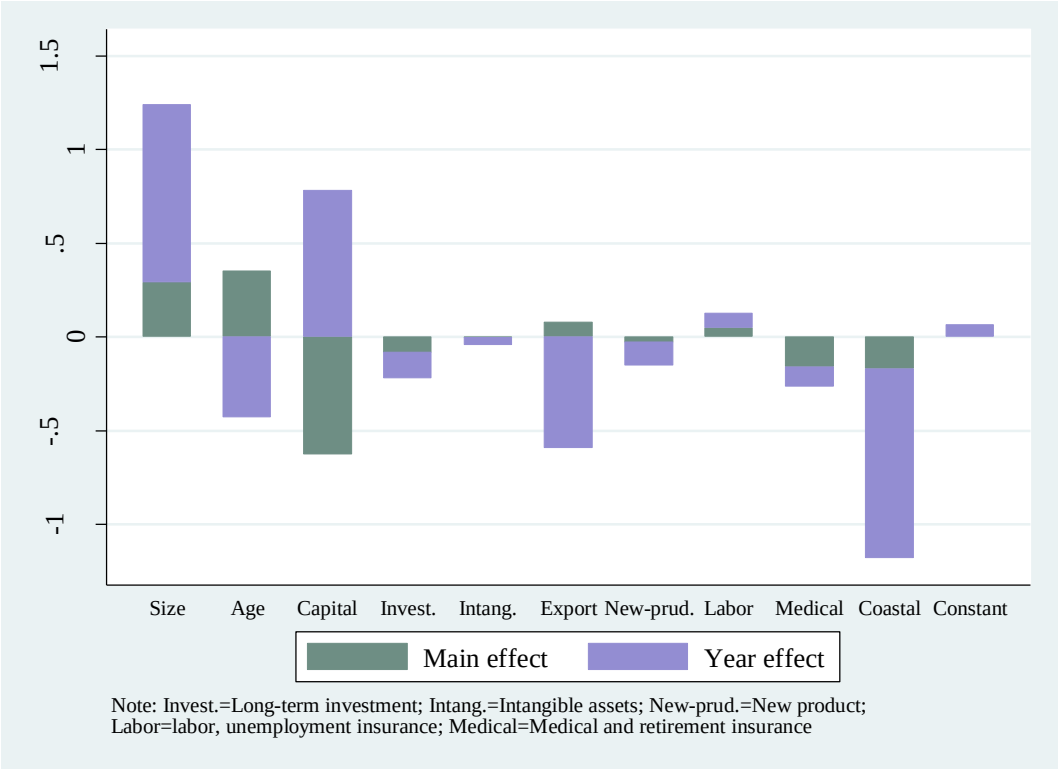
The Oaxaca decomposition confirms that both main effect and year effect play a role in the evolution in volatility (Table 5). One-third and two-third of volatility reduction are explained by main effect and year effect, respectively.

Table 5 – Decomposition of the change in firm's productivity volatility (2001-2005)

	Main effect $(\hat{\beta}^{01} \cdot \Delta\overline{X})$	Year effect $(\Delta\hat{\beta} \cdot \overline{X}_{05})$
Total	-0.292	-0.561
Firm size (Reference: less than 50)		
50-100	-0.171	-0.015
100-500	0.044	0.548
More than 500	0.419	0.416
Firm age (Reference: less than 5 years)		
5-10 years	-0.116	0.063
10-20 years	-0.606	-0.290
More than 20 years	1.074	-0.200
Main part of paid-in capital (Ref.: Hong Kong, Macao and Taiwan capital)		
State capital	-0.396	0.021
Collective capital	-0.189	0.022
Corporate capital	0.075	0.385
Private capital	-0.060	0.198
Foreign capital	-0.054	0.157
Ratio of long-term investment to output value	-0.081	-0.140
Ratio of intangible assets to output value	-0.002	-0.038
Ratio export delivery value to sales total output value	0.079	-0.590
Ratio of new product to output value	-0.026	-0.127
Ratio of labor, unemployment insurance to output value	0.048	0.078
Ratio of medical and retirement insurance to output value	-0.160	-0.104
Coastal province	-0.171	-1.012
Constant		0.067

Figure 5 summarizes the contribution of various factors to the change in firm's productivity volatility over time. Firm size is the major factor that increases productivity volatility over time due to its large positive main effects and year effects; while location the major factor that reduces productivity volatility due to its large negative main effects and year effects Other factors, such as firm age, capital and export ratios, also play a role, but with smaller net effect as their main effects and year effects partially cancel out each other.

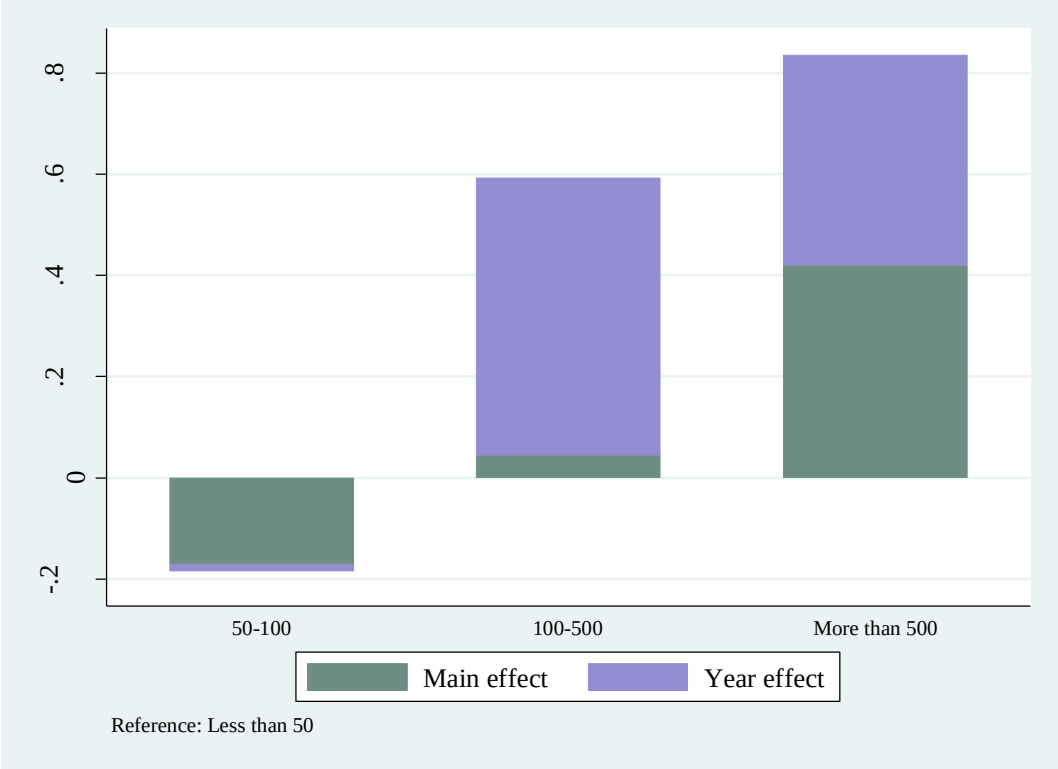
Figure 5 – Contribution of various factors to the change in firm's productivity volatility



Note: Invest.=Long-term investment; Intang.=Intangible assets; New-prud.=New product; Labor=labor, unemployment insurance; Medical=Medical and retirement insurance

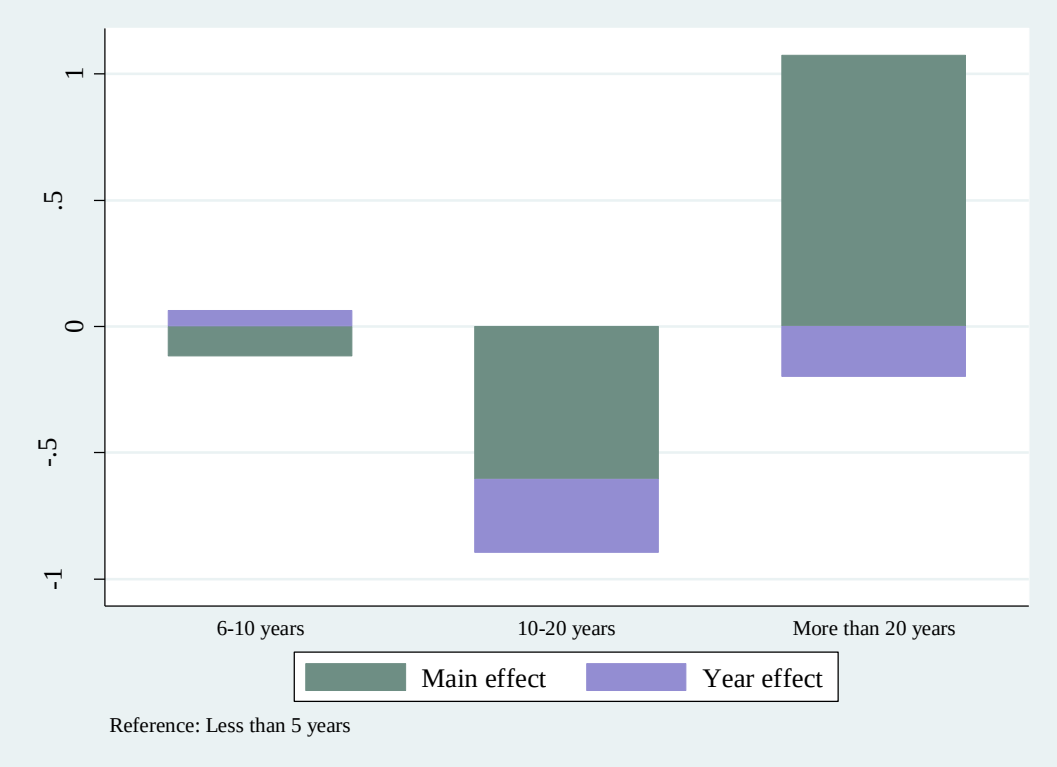
Figure 6 illustrates the role of various categories of firm size in volatility change. We observe that the positive main effect of firm size results essentially from the reduction of large firms whose number of workers is more than 500. The positive year effect is mainly due to the weakening of the effect of medium (100-500) and large (more than 500) firms on reducing productivity volatility from 2001 and 2005.

Figure 6 – Contribution of firm size to the change in production volatility



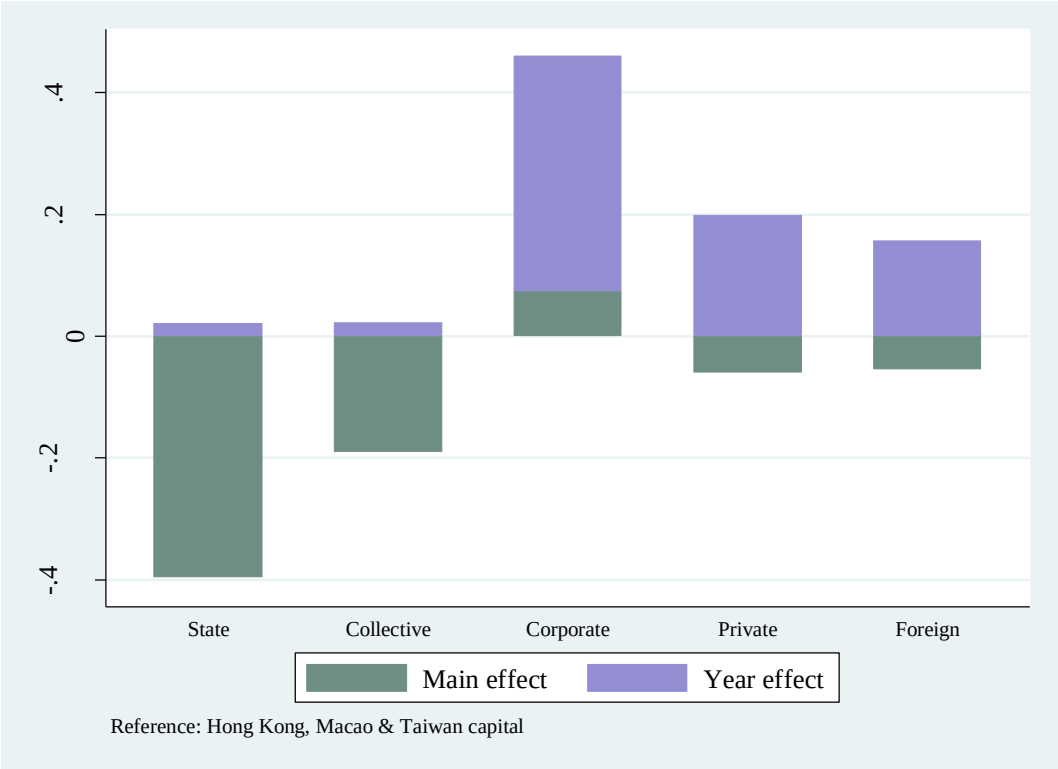
Firm's age has a positive main effect but a negative year effect on volatility change. Its positive main effect is essentially due to the reduction of large firms whose productivity is less volatile (Tables 1, 3 and Figure 7).

Figure 7 – Contribution of firm age to the change in production volatility



The source of paid-in capital has a negative main effect and a positive year effect on volatility change (Figure 5). Figure 8 shows that the negative main effect results essentially from the reduction of state-owned firms and collective firms, which are generally more volatile in the period of this study (see Tables 1 and 3); whereas the positive year effect is due to the strengthening of the effect of firms with corporate capital on enhancing productivity volatility and the weakening of the role of firms with foreign capital in reducing productivity volatility (see Table 4).

Figure 8 – Contribution of firm type to the change in firm's production volatility



As we have seen above (Table 4), the ratio of export delivery value to sales total output value has a positive effect on volatility in 2001; but the effect is not significant in 2005. That leads to a negative year effect, reducing productivity volatility.

Finally, the portion of firms located in coastal provinces, that are less volatile, increased in 2001-2005 (Table 3), resulting in a negative main effect. On the other hand, the effect of coastal region on reducing firm's productivity volatility also increased in 2001-2005 (Table 4), leading in an important year effect. Because of the two negative effects, the growth of firms located in the coastal provinces plays the most important role in reducing productivity volatility.

4 Conclusions

In this paper, we examined the drivers of productivity volatility of Chinese industrial firms. In general, firm productivity volatility declined over time in 2001-2005. Among firms of different characteristics, larger firms, older firms, foreign firms, and firms located in the coastal provinces are less volatile. Firm size and location are the two major factors that drive changes in productivity volatility – one positively and one negatively. While the gaps of volatility between smaller firms and larger firms declined, the gaps between firms located in the coastal provinces and inland provinces increased.

Two findings might be of interest of further research and might contribute to policy design:

- The first one is related to the role on productivity volatility of firms' contribution to medical and retirement insurance to the output ratio. It has a significant effect in increasing firm productivity volatility at the beginning of the period of study while the effect became insignificant at the later stage. In the context of enterprise reforms, health care reforms, and pension reforms, this finding might shed light on the favorable impact of a more inclusive social protection system along and the alleviation of burdens on enterprises.
- The second one is related to the role of firms' location. Firms in coastal provinces were less volatile than those in inland provinces, and the gap widened over time. This suggests that, the negative effects on firm productivity volatility (which means reducing volatility) of the more enabling business environment in the coast dominate the positive effect of competition (which means increasing volatility). It is to note that, in no ways that a higher volatility at the individual firm level is to be considered as unfavorable as it might well represent resources reallocation (or creative destruction). However, a lower aggregate level of firm productivity in the coast offers support to the argument that a better business environment is not only good for productivity growth but also for resilience in the face of adverse shocks

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