Macroeconomic Volatility and Growth

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To my mum and dad

for their love, endless support

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Abstract

This PhD thesis mainly consists of 3 papers that generally focus on the link between macroeconomic volatilities and trade flows and growth, as well as behavior of prices. Chapter 1 gives the introduction. Chapter 2, the first paper, investigates the effect of real exchange rate volatility on sectoral trade flows between the United States and her top thirteen trading partners. My investigation also considers those effects on trade flows that may arise through changes in income volatility, and the interaction between income and exchange rate volatilities. My results show that exchange rate uncertainty has little effect on sectoral trade flows, and income volatility has no significant effect on sectoral trade flows. The interaction term of exchange rate volatility with income volatility takes the opposite sign to that of exchange rate volatility, reversing the impact of exchange rate volatility on trade flows.

Chapter 3 presents my second paper. This chapter investigates the effects of inflation uncertainty on the level of sectoral output growth rate and its cross-sectional dispersion by observing a panel of Japanese manufacturing sectors. Using an augmented profit model with a signal-extraction framework, I demonstrate that increasing inflation volatility will reduce the level of sectoral output growth rate, as well as narrowing its cross-sectional dispersion of output growth.

Chapter 4 investigates the relationship between product specific inflation (PS-inflation) and relative price variability (RPV) in one of the top three economic areas in China. My estimation model contains a broader framework, which combines both effects of expected and unexpected product specific inflation on RPV, and those effects on RPV across various inflation regimes. My empirical results suggest that the absolute value of expected PS-inflation negatively affects RPV, and this effect reverses to be positive under the region of negative inflation, which is consistent with "asymmetric price adjustment" in literature. On the other hand, absolute value of unexpected PS-inflation positively affect RPV when inflation rate is negative. An economical recession has different impacts on the effect of PS-inflation on RPV across different inflation regimes. Also, Chinese New Year has shown to exaggerate the effect of either expected or unexpected PS-inflation on RPV.

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Chapter 1

Introduction

This thesis consists of three independent studies focusing on the relationship between macroeconomic volatility and growth. Chapter 2 investigates empirically the effect of real exchange rate volatility on sectoral bilateral trade flows between the United States and her top thirteen trading partners. My investigation also considers those effects on trade flows that may arise through changes in income volatility and the interaction between income and exchange rate volatilities. The revision work of chapter 2 has been published by the Southern Economic Journal as a joint paper with Prof. Mustafa Caglayan (Caglayan and Di 2010). Chapter 3 investigates the effects of inflation uncertainty on the level of sectoral output growth rate, and its cross-sectional wide dispersion. This chapter uses a panel of Japanese manufacturing sectors covering the period 1970-2002, and finds a narrow dispersion of cross-sectional output growth rate, with an increasing inflation uncertainty. Chapter 4 investigates the effect of expected as well as unexpected product specific inflation (PS-inflation) on relative price variability (RPV) in Jing-Jin-Ji Economic Zone in China.

1.1 Motivation

After the breakdown of the Bretton Woods agreement, the variability of exchange rate movements are found to be important in its role in international business and trades. Economists therefore paid their attention to the impact of exchange rate volatility on trade flows. However, there is no consensus on this subject. Some theoretical studies find a negative impact of exchange rate volatility on trade flows, while some others equally reached a uncertain or positive impact. Similar to the ambiguous conclusions in theoretical literature, empirical studies do not show a firm answer to this question too. I present chapter 2 as my first paper, and investigate the impact of exchange rate volatility on trade flows using a broader dataset.

As to chapter 3, several articals explained how macroeconomic uncertainty affect the allocation of resources and reached a negative relationship between macroeconomic volatility and the dispersion of the investigated objects. Since it is well accepted that the optimal macroeconomic policy is to achieve low and stable inflation, economists would be interested in how inflation volatility affects the physical economy. High and volatile inflation, reduces the informational content of the price system and therefore hinders the efficient allocation of resources. Chapter 3 empirically investigates how inflation volatility affects the industrial output growth for Japan's manufacturing sectors. The reason why I chose Japan is, in just three decades, Japan's economy experienced all situations that one economy could experience: expansion in 1970s, stable growth in 1980s and deep depression in 1990s. In chapter 3, I intend to draw a big picture of the evolution of output growth of Japan's manufacturing industry between 1970-2002.

Chapter 4 further examines the impact of inflation on economy. Following the previous study, inflation affects economy through its impact in price mechanism, therefore contributing to the variability of production and relative price dispersion. However, there is no consensus on the impact of product specific (PS) inflation on relative price variability (RPV). Literature provides large evidence of a positive connection between PS-inflation and relative price variability. A handful of empirical studies nevertheless reached a negative relationship between PS-inflation and relative price variability. Since the impact of PS-inflation on RPV is conflicting according to various factors, I then therefore chose to investigate this relationship using a data set in a specific area in China. Since China's development pattern has its own characteristics, this study is interested in how PS-inflation affect RPV under certain specific situations in China. I therefore raised the effect of Chinese New Year and economical recession in the study in chapter 4.

1.2 Presentation of Thesis Chapters

The thesis mainly consists of 3 chapters. Chapter 2 estimates the effect of exchange rate volatility on sectoral bilateral trade flows. In chapter 2, I review the literature which investigate the impact of exchange rate volatility on sectoral trade flows and present that the impact is ambiguous. Theoretical studies suggest a negative impact of exchange rate volatility on trade flows, while others reach a positive or uncertain impact. Empirical literature also provide non-consistent conclusions. I present several possible reasons that may contribute to conflicting conclusions. These include factors such as: the development of the economy, the scope of data set in terms of the numbers of countries, frequency of data collecting, measurement of exchange rate volatility and specific estimation model.

Most literature focuses on the impact of exchange rate volatility on sectoral trade flows in the United States or G7 advanced economies, which may be different from the impact in emerging economies. In emerging economies, exchange rate volatility may present more influence on trade flows than its impact in advanced economies due to the lack of financial tools in emerging economies. In chapter 2, I investigate advanced economies as well as emerging economies and compare and contrast the similarities and differences between the two.

Methods used in measurement of exchange rate volatility can be imperative on its impact on trade flows. Literature measures exchange rate volatility on annual, quarterly or monthly basis, whereas I evaluate exchange rate volatility on a daily basis. Merton (1980)'s risk methodology is used to evaluate exchange rate volatility, which is more appropriate than ARCH method. Volatility of foreign income will be estimated as well as its interaction with exchange rate volatility. They are suggested as important casual factors which capture the impact of the expansion or the retention of the trade flows as foreign income and exchange rate fluctuate.

The estimation model in chapter 2 investigates the impact of exchange rate volatility for each sector-country specific trade flows separately, which disentangle the linkage between exchange rate volatility and sectoral trade flows across sectors as well as countries. This is different from literature that constrain income and price elasticities across sectors and countries. My empirical model is a simple dynamic distributed lag model where I allow each variable to affect trade flows up to six lags.

My summary of statistics show that the measurement of volatility of exchange rate across advanced and emerging countries are very different from one another. I also detect no systematic relationship across countries with respect to income volatility as well as its interaction with exchange rate volatility. I finally detect no systematic associations across sectors. These statistics are the necessary conditions to estimate the impacts of exchange rate volatility and income volatility and their interaction term on trade flows across specific country-sectors.

My investigation results of chapter 2 are as follows: I find that exchange rate volatility makes significant impact on sectoral trade flows only for a handful of cases, and the sign of this impact is ambiguous for both emerging and advanced trading partners of the United States. In terms of the impact of exchange rate volatility at different levels of economic development, this impact is more pronounced for emerging countries. Then I discuss about the effect of income volatility on exporters' behavior. My results do not provide convincing evidence that income volatility is an important determinant of sectoral trade flows.

As to the effect of the interaction term of exchange rate and foreign income volatility, it has a minor effect on sectoral trade flows. However, the interaction term is significant if the corresponding coefficient for exchange rate volatility is significant. Moreover, the sign of the interaction term is the opposite of that of exchange rate volatility, which is an interesting finding that has not been reported in literature. This finding suggests that the impact of exchange rate volatility would be nullified depending on the relative size of exchange rate volatility and income volatility. Therefore models that do not take this interaction term into consideration could lead to wrong conclusion on the effect of exchange rate volatility.

Finally, I estimate the robustness of the model by investigating a less restricted model. My previous model constrains the effects of independent variables on trade flows to a single coefficient per model while placing more weight on the most recent lags. In this semi-restricted mode, I relax the restrictions on exchange rate, income volatilities and their interaction while keeping other variables same as before. The results indicate that coefficients are model dependent and the impact of exchange rate and income volatilities and their interaction term on sectoral trade flows are similar across these two approaches, providing evidence that my results are reasonable.

Chapter 3 investigates how inflation uncertainty affects the level of sectoral output growth rate and its cross-sectional dispersion for Japan's manufacturing sectors. The theory is based on the idea that high inflation variability reduces the predictability of future prices so that managers tend to decrease production until uncertainty falls or until the expected payoff from taking risk of increasing production increases enough to offset the higher uncertainty. Therefore, the level of sectoral output growth rate tends to fall and the cross-sectional dispersion of output growth narrows down due to similar conservative decisions of managers. Quite a few studies support a negative effect of inflation volatility on the level of sectoral growth rate and its cross-sectional dispersion of output growth.

My study in Chapter 3 presents an augmented profit model with a signal-extraction framework that has been largely applied in recent literature. In a signal-extraction model, the accuracy of the prediction of next-period output prices depends on informational content of unobservable shock to prices, which is called the noise in the signal. My theoretical framework proposes two sets of hypothesis regarding the effects of volatility of noise in the signal on sectoral output growth and its dispersion. The first hypothesis is that the effect of noise in signal on sectoral output growth is ambiguous. The other is that the effect of noise in signal is negatively related to the cross-section distribution of sectoral output growth.

Literature considers macroeconomic uncertainties as the proxy of noise in the signal and my study investigates inflation volatility as the noise in the signal. I test if the distribution of Japan's manufacturing sectoral output growth will fit my theoretical models. The reason for choosing Japan's economy is that, within only 3 decades, its CPI inflation experienced rapid expansion, stability and recession over the 1970s to 1990s. Therefore, one can expect distinct differences in the influence of inflation variability on sectoral output growth and its cross-sectional distribution during these years.

In my empirical study, I use GARCH model to evaluate conditional variance of log difference of CPI inflation rate to capture inflation volatility. I present 2 sets of empirical models testing the responses of level of sectoral output growth and its cross-sectional dispersion to the changes in inflation volatility. Inflation variability as well as other related variables are implemented into the regressions in four steps respectively. The first regression investigates the effect of inflation variability only and then it extends to estimate the effect of inflation rate as well as the effect of changes in interest rate in the second regression. The third regression contains the same variables with the last two, but incorporates two more explanatory variables — the change in oil price and its volatility. The last regression also considers the effect of credit changes.

The empirical findings of my two sets of models, provides a big picture for the evolvement of the Japanese manufacturing industry under varying inflation regimes. When macro-economy is in a turmoil thereby higher inflation uncertainty, (1) Japanese manufacturing sectors generally lower their output growth rate and (2) the cross-sectional dispersion of sectoral output growth rates falls. (3) On average, level inflation rate, changes in interest rate, change in oil price and its volatility failed to have impact for the variations of the dispersion of cross-section output growth. (4) Bank credit reduces the wide range of cross-section dispersion of output growth rates.

Chapter 4 uses product-level prices to investigate the impact of product specific inflation on relative price variability (RPV). I first look at theoretical models on inflation-RPV link and find conflicting conclusions about the relationship between inflation and RPV. Earlier studies are in favor of a positive relationship, while others reach a negative or inconclusive link. After reviewing literature, I summarise various theories on inflation-RPV link.

Literature reviews in chapter 4 summarises predictions of theoretical models that mainly consist of menu cost, signal extraction, information investment and monetary search models. In menu cost models, inflation is fully anticipated and agents follow (S, s) pricing strategy to make decisions on product prices. The interval range of upper bound and lower bound of this price strategy widens with the increasing of expected inflation rate. Menu cost model also predicts a V-shaped relationship between expected inflation and RPV.

Since the inflation rate can not be fully anticipated in the real world, signal extraction models suggest that incomplete information of inflation have a robust role in determining relative price variability. Even though large evidence in empirical literature suggest a positive relationship between unexpected inflation and RPV, a handful of studies reach a negative relationship. I therefore investigate that in what sign of the unexpected inflation-RPV link for my data set will present.

I then review the information investment model that displays an important role in the stock of information in contemporaneous price information. It assumes that buyers purchase the same item more than once, and they accumulate a stock of information about prices. Therefore the information investment model indicates an important effect of information stock on contemporaneous price dispersion: current price dispersion is positively affected by lagged price dispersion.

Another popular theory on expected inflation-RPV link recently is monetary search model. In this framework, increasing expected inflation depreciates the flat money, which leads to wider relative price dispersion due to the increasing sellers' market power. While on the other hand, wider relative price dispersion will stimulate more search from buyers, which narrows down the relative price dispersion due to the decreasing sellers' market power.

Even though theories described above reach various conclusions, they share a common point of assuming a linear relationship between inflation and RPV. Recent literature tends to suggest a more complex relationship between inflation and RPV: the impact of inflation on RPV varies across different inflation regimes, positive or negative. This chapter investigates the non-linear relationship between expected PS-inflation and RPV, as well as the relationship between unexpected PS-inflation and RPV. Alongside this, I introduce a dummy variable for negative inflation and search for the presence of an asymmetric relation between PS-inflation and RPV across positive and negative inflation regimes.

Chapter 4 empirically estimates PS-inflation-RPV link for a specific area in China: Jing-Jin-Ji Economic Circle. It is true that the relative price variability attracts worldwide attention, but most studies shed light on this link in a country-wide area, which may be biased from the link in a smaller exclusive region due to different level of economic development. After reviewing China's economies across different regions, one can easily find out that China's development is mainly driven by a handful of key regions: Pearl River Delta, Yangtze River Delta and Jing-Jin-Ji Economic Circle. Among these economic regions Jing-Jin-Ji Circle is not developed as much as other regions, thus it has greater development potential and attracts more and more investment interests in this area.

My data set comprises of 174 products in 11 cities in Jing-Jin-Ji area and provides information of prices every fortnight from January 2005 to September 2009. Methods of generating expected and unexpected product specific inflation and relative price variability are consistent with the literature.

My estimations start from a basic model and expand to broader framework by introducing effects caused by the Chinese New Year on the impact of PS-inflation and effects caused by recession economy and negative inflation rate.

I then replace the aggregate PS-inflation with expected and unexpected PS-inflation to clarify the partial effects of expected and unexpected component of PS-inflation on RPV.

The result of my basic model supports the prediction of a positive relationship between absolute value of PS-inflation on RPV which is the same with what menu cost models expectation. As I predicted, lagged RPV positively affects contemporaneous RPV in my basic model.

In my broader framework, Chinese New Year is found to be able to increase the impact of PS-inflation on RPV. However, the dummy variable of recession economy itself does not display a significant impact on RPV. For the impact of expected and unexpected PS-inflation on RPV under varying inflation regimes, the effect of expected PS-inflation on RPV has a negative sign under positive inflation regime but a positive sign under negative regime during non-recession years; however, signs are negative in either positive or negative regimes during recession years. Unexpected PS-inflation appears the same signs of effects on RPV across regimes under non-recession years. My conclusion about the effect from Chinese New Year is that Chinese New Year exaggerates the effect of expected and unexpected PS-inflation.

Chapter 5 gives conclusions on my thesis.

Chapter 2

The Effect of Exchange Rate Volatility on Sectoral Trade Flows

This chapter investigates empirically the effect of real exchange rate volatility on sectoral bilateral trade flows between the United States and her top thirteen trading partners. My investigation also considers those effects on trade flows which may arise through changes in income volatility and the interaction between income and exchange rate volatilities. I provide evidence that i) exchange rate volatility does not systematically affect sectoral trade flows; ii) income volatility has little impact on trade flows; iii) the effect of the interaction term on trade flows is opposite that of exchange rate volatility, dampening its impact on trade flows.

2.1 Introduction

A review of the empirical and the theoretical literatures that span the period after the breakdown of the Bretton Woods agreement reveals that there is no consensus on the impact of exchange rate volatility on trade flows. Several theoretical studies arrive at the conclusion that exchange rate volatility can have a negative impact on trade flows.[1] Equally, several others conclude that the effect is uncertain or positive.[2] Interestingly, one cannot reach a firm conclusion from empirical studies, either. Results are conflicting and sensitive to various factors.[3]

When I focus on the recent empirical literature, I come across several possible reasons why researchers have reached conflicting conclusions. Early empirical research, which concentrated on aggregate U.S. or G7 data, suggests that exchange rate uncertainty may have a positive or negative effect on trade flows.[4] Recent research that focuses on bilateral rather than aggregate trade data of advanced countries concludes that exchange rate volatility has no or little effect on trade flows.[5] In this study, I utilize a broader dataset, which contains both advanced and emerging top trade partners of the United States. Hence, one can avoid the narrow focus on the United States and the advanced country data that has characterized much of the literature.

I should point out that the inclusion of advanced and emerging countries

[1] See for instance Clark (1973), Baron (1976), Peree and Steinherr (1989).

[2] Franke (1991), Sercu and Vanhulle (1992) show that exchange rate volatility can have a positive or an ambiguous effect on trade flows. Barkoulas, Baum and Caglayan (2002) claim that the types of shocks that firms are exposed to will determine the relationship which may be positive, negative or ambiguous.

[3] Although researchers implementing gravity models consistently conclude that exchange rate volatility has a negative impact on trade flows, Clark , Tamirisa, Wei, Sadikov and Zeng (2004) indicate that this finding is not robust to a more general setting which embodies the recent theoretical advances in a gravity model.

[4] For instance, while Cushman (1983, 1988), Akhtar and Hilton (1984), Thursby and Thursby (1987), Kenen and Rodrik (1986), among others, find negative effects, Hooper and Kohlhagen (1978) Koray and Lastrapes (1989), and Gagnon (1993) report insignificant effects.

[5] See for instance Baum, Caglayan and Ozkan (2004a) and Baum and Caglayan (2010) who use the same bilateral trade flows data from thirteen advanced countries while implementing different empirical methodologies.

in my investigation is important as recent research suggests that exchange rate volatility has a significant negative impact on trade flows of emerging countries. For instance, Grier and Smallwood (2007) conclude that while real exchange rate volatility has a significant negative impact on international trade for emerging countries, there is no such effect for the advanced economies. Several other researchers also report similar findings for different sets of emerging countries on the linkages between exchange rate volatility and trade flows.[6] Although one can claim that the presence of a significant relationship may be due to the lack of proper financial tools in emerging countries that firms can use to hedge against exchange rate fluctuations, Wei (1999) cannot find an empirical evidence to that end. In this chapter, I utilize data from nine advanced and five emerging countries.

Although the use of country specific bilateral trade data is an improvement over aggregate trade data, sectoral trade data can help us further disentangle the linkages between exchange rate volatility and trade flows that may exist across sectors but not in bilateral data. However, there are only a handful papers that use sectoral data to investigate the impact of exchange rate uncertainty on sectoral trade flows. Also, the early literature that used sectoral data summarizes the impact of exchange rate volatility on sectoral trade flows in one coefficient as researchers implement panel data methodologies. In contrast, I focus on country sector-specific bilateral relationships and investigate dozens

[6] Also see including Arize, Osang and Slottje (2000), Clark et al. (2004), Peridy (2003) and Sauer Bohara (2001).

of models.[7] My data are organized with respect to bilateral sectoral trade flows between the United States and her top 13 trading countries. The 14-country dataset includes the United States, Japan, Germany, the U.K., France, Italy, Netherlands, Ireland, Canada, South Korea, Singapore, Malaysia, China, and Brazil and covers the period between 1996–2007 on a monthly basis.

Another important factor that may affect the results in this literature is the method that one uses to generate a proxy for real exchange rate volatility.[8] Generally, the early research has used a moving average standard deviation of the past monthly exchange rates or variants of ARCH methodology to generate a proxy for exchange rate volatility. I utilize daily spot exchange rates to proxy for exchange rate volatility employing a method proposed by Merton (1980). This method, also used by researchers including Baum et al. (2004a) and Klaassen (2004) in similar contexts, exploits daily exchange rate movements to proxy for monthly exchange rate volatility. Furthermore, both studies indicate that this approach yields a more representative measure of volatility avoiding problems associated with proxies derived from ARCH methodology or moving standard deviations. In particular, Merton (1980) methodology avoids potential problems including high persistence of shocks when moving average representations are used, or low correlation in volatility when ARCH/GARCH models are applied.

[7]One problem with our approach is the lack of monthly data on sectoral export prices which render us to use monthly aggregate export prices to construct monthly sectoral real export data.

[8]Although generally researchers consider the effect of real exchange rate variability on trade flows, nominal exchange rate variability has also been used in the past. For instance, Tenreyro (2004) shows that nominal exchange rate volatility does not affect trade flows.

Last but not least, My empirical model takes the form of a simple distributed lag model where I allow each variable to affect trade flows up to six lags, which is shown to be adequate to capture the explanatory variables' impact. I keep those models that yield a stable dynamic relationship and discard the remaining models which are dynamically unstable. In total, I scrutinize over two hundred models where I discuss the impact of volatility measures across sectors and countries. To address an interesting suggestion raised by Baum et al. (2004a), I also allow for income volatility and an interaction term between income and exchange rate volatilities in our model. They suggest that higher volatility of foreign income may signal greater profit opportunities inducing entry into the market or delaying exit from the market. Also, the interaction term between foreign income and exchange rate volatilities may help capture indirect effects emanating from any of these variables which may capture the impact of the expansion or retention of trade flows as foreign income and the exchange rate fluctuates while addressing the presence of nonlinearities in the model.

My results provide evidence that exchange rate uncertainty has little effect on sectoral trade flows. I find that the impact of real exchange rate volatility on trade flows is significant in about only six percent of the models at the 5% significance level where the effect is positive. Furthermore, although this relationship is slightly stronger for the emerging countries, my findings do not support earlier findings that exchange rate volatility plays an important role for emerging country trade flows. Overall, results show that there is little effect of exchange rate volatility on sectoral trade flows of advanced and emerging economies.

When I investigate the effects of income volatility and the interaction term between exchange rate volatility and income volatility on trade flows, I come across some interesting observations. It turns out that the interaction term is significant in almost all cases when exchange rate volatility plays a significant role in the model. Furthermore, it takes the opposite sign to that of exchange rate volatility, reversing the impact of exchange rate volatility on trade flows. From this perspective, it is apparent that omitting the interaction term from the analysis would lead to wrong policy prescriptions. When I observe the role of income uncertainty, we see that this variable significantly affects trade flows in six percent of the models at the 5% level while its sign is generally the same with that of exchange rate volatility. This variable seems to play a more important role when we concentrate on exports of the United States to her trading partners. This is not surprising as the income of the trading partners over the period under investigation was much more volatile than that of the United States.

I finally check for the robustness of our findings by implementing a semi-restricted model to test those effects arising from exchange rate and income volatilities and their interaction. My investigation provides support for my earlier conclusion that exchange rate uncertainty has negligible impact on trade flows.

The reminder of this chapter is organized as follows. Section 2 outlines the model, discusses our volatility measures and provides information on the data. Section 3 reports the empirical results and section 4 concludes.

2.2 Model Specification

Most of the early research which concentrated on the impact of exchange rate volatility on trade flows used country level aggregate or bilateral trade flow data. However, as Bini-Smaghi (1991) indicates, because sectoral data do not constrain income and price elasticities across sectors, one should employ sector specific data when exploring the linkages between trade flows and exchange rate movements. Yet, there are only a handful of studies that utilize sectoral data.[9] These studies follow an Armington (1969) approach and estimate both the price and output elasticities. In particular, to capture export flows from country i to j, the model takes the form

$$X_{ijt} = f(P_{ijt}, Y_{jt}, \sigma_{ijt}) \tag{2.1}$$

where Y_{jt}, X_{ijt}, P_{ijt} and σ_{ijt} denote income of country j and exports, relative price, and exchange rate volatility from country i to j, respectively. The price and output elasticities (coefficients associated with relative prices and output) are estimated in a panel context using sectoral trade flow data for each sector. Naturally, this approach yields a single sector specific price and output elasticity along with the impact of exchange rate volatility, which is then compared across sectors.

[9] See Klein (1990), Belanger et al. (1992), Peridy (2003), De Vita and Abbott (2004), Saito (2004), Mckenzie (1999), Doyle (2001) and Byrne, Darby and MacDonald (2008).

My approach differs from the above specification as I model the impact of exchange rate volatility for each sector–country specific trade flow separately. Given that we have 14 countries where data are ordered with respect to i) 10 sectoral exports of 13 countries to the United States and ii) 10 sectoral exports of the United States to the same set of countries. the maximum number of models that we can estimate is 260 (13 pairs of bilateral trade flows in 10 sectors). However, due to lack of data on exports from Ireland to the United States for sectors 4 and 5, I estimate 258 models. Of these 258 cases, I discard 28 models as they fail the dynamic stability conditions rendering us with 230 models to scrutinize. My model takes the form

$$X_{k,t}^{i \rightarrow j} = f\left(Y_{j,t}, s_t, \sigma_{s,t-n}, \sigma_{Y,t-n}, \sigma_{s,t-n} \times \sigma_{Y,t-n}\right) \tag{2.2}$$

where $i \longrightarrow j$ implies exports from country i to country j, k stands for the sector and t denotes the time. We introduce the real exchange rate, s, and real exchange rate volatility and income volatility, (σ_s and σ_Y, respectively) in the model. The joint impact of the two volatilities as suggested by Baum et al. (2004a) is captured by $\sigma_s \times \sigma_Y$. In my investigation, we are interested in the sign and the significance of the coefficients associated with exchange rate and income volatilities as well as that of the interaction term between income and exchange rate volatilities, $\sigma_s \times \sigma_Y$ and I report and compare the effects of these variables across sectors and countries. All variables are allowed to have up to n lags which is set to 6 in my empirical investigation.

Prior to providing information on my data and the empirical model that I use, in the next subsection I explain how to generate a proxy for exchange rate and income volatilities. I first provide details of the Merton (1980) methodology that I implement to derive a proxy for exchange rate volatility. I then discuss the approach that we use to generate income volatility. The interaction term in the model is the product of the two volatilities.

2.2.1 Generating Exchange Rate Volatility

To generate a proxy of exchange rate volatility, one can pursue different methodologies. One of the most commonly employed methods to proxy for exchange rate volatility is the moving standard deviation of exchange rate changes. As this methodology includes the past 12 or 24 months of data, the proxy may contain substantial correlation. Alternatively, it is possible to use ARCH/GARCH models to generate such a proxy. This approach may find weak persistence of shocks and the generated proxy will be very much model dependent. In this study I adopt a measure of risk proposed by Merton (1980).[10] This measure considers the daily changes in the exchange rates between each pair of countries in our data set to calculate monthly exchange rate volatility. Given that traders export their products to several countries, the exchange rate volatility perceived by an exporter in a sector will differ across the countries which she trades with by design.

To implement Merton's methodology, I calculate the daily real exchange

[10]Researchers use Merton's (1980) methodology to generate proxies for exchange rate, interest rate, (monetary) policy or stock market volatilities. See for instance Baum, Caglayan, Ozkan and Talavera (2006) for an implementation of Merton's method on stock returns.

rate series (s_t^d) for the countries in my data set. Hence, I first compute daily prices by interpolating the relative prices for all countries within the month while taking into account the intervening business days. Then, I generate the daily real exchange rate series by multiplying the daily spot exchange rate series with the exporting country to domestic country price ratio. Finally, I calculate the squared first difference of the log real exchange rate series and deflate it by the number of elapsed days between observations

$$\varsigma_t^d = \left(100\frac{\Delta s_t^d}{\sqrt{\Delta\phi_t}}\right)^2 \tag{2.3}$$

where the denominator ($\Delta\phi_t$) captures the calendar time difference between each successive observation on the s process. For our case $\Delta\phi_t \in [1, 5]$ due to weekends and holidays. The value we compute in equation (2.3) is the daily volatility faced by the exporter. I then define the monthly volatility as $\Phi_t [s_t] = \sqrt{\sum_{t=1}^{T} \varsigma_t^d}$ where the time index for exchange rate volatility is at the monthly frequency.

The price series for each country are taken from the *Main Economic Indicators* published by the *Organization for Economic Cooperation and Development* (OECD) and the exchange rate series are downloaded from the *Pacific Exchange Rate Service* which is provided by the University of British Columbia (UBC)'s Sauder School of Business.

2.2.2 Generating Income Volatility

My empirical investigation requires a proxy for real income volatility for the importing countries on a monthly basis. Given that we will be exploring the behavior of sectoral trade flows, I believe that it would be preferable to use monthly industrial production series. My choice is appropriate as most of the trade between countries is intra-sectoral. I should note that some researchers interpolate GDP to monthly frequency when they use aggregate data. However, this process may add significant noise into the process in particular for the case of emerging countries.

To generate a measure of monthly income volatility, σ_y, I first test whether the first difference of real income series exhibit time-varying heteroskedasticity. Observing that all the industrial production series exhibit time varying conditional heteroskedasticity, I use ARCH methodology to generate a proxy for income volatility.[11] Since income volatility has been derived using ARCH models, thus it brings the estimated error in the generated regressor to the main model. To solve the generated regressor problem, standard errors are bootstrapped using Jackknife Method.

2.2.3 The Dynamic Model of Exports

In my empirical investigation, I concentrate on the log difference of deseasonalized sectoral real exports, x_t, of country i to j and employ a dynamic dis-

[11]Details are available in table 2.15.

tributed lag model to capture the effects of exchange rate volatility σ_s along with income volatility σ_y and the interaction of income and exchange rate volatility, $\sigma_s \times \sigma_y$, on sectoral trade flows.[12] As explained earlier, in total I investigate 230 models and focus on the significance of coefficients associated with exchange rate and income volatilities as well as the interaction between the two series. Each model includes the standard variables such as the change in log importing country real income, y_t and change in log real exchange rate, s_t, as well as the lagged dependent variable. My model takes the following form:

$$\begin{aligned} x_{k,t}^{i \to j} &= \alpha_0 + \beta_0 \sum_{n=1}^{N} \delta^n x_{k,t-n}^{i \to j} + \beta_1 \sum_{n=1}^{N} \delta^n y_{t-n} + \\ &\beta_2 \sum_{n=1}^{N} \delta^n s_{t-n} + \beta_3 \sum_{n=1}^{N} \delta^n \left[\sigma_s\right]_{t-n} + \\ &\beta_4 \sum_{n=1}^{N} \delta^n \left[\sigma_y\right]_{t-n} + \beta_5 \sum_{n=1}^{N} \delta^n \left[\sigma_s \times \sigma_y\right]_{t-n} + \epsilon_t \end{aligned} \tag{2.4}$$

where $k \in [1, 2, ..., 10]$ denotes sector and δ is a fixed coefficient. The two additional terms in our model—the impact of foreign income volatility on trade flows and the interaction between foreign income and exchange rate volatility—have been suggested by Baum et al. (2004a) to capture the impact of the expansion or the retention of the trade flows as foreign income and the exchange rate fluctuates. Such an approach, according to Baum et al. (2004a), requires a simultaneous consideration of the behavior of the exchange rate, foreign income and the risks which can be captured through the interaction between income and exchange rate volatilities. Although they find mixed

[12] Sectoral trade series are seasonally adjusted using seasonal dummies.

results on the effect of income volatility on trade flows, a subsequent analysis by Grier and Smallwood (2007) provide evidence in support for the importance of income volatility.[13]

Prior to estimating equation (2.4), one must determine the maximum lag that the variables should take. Earlier research suggests that empirical models which embody 6 to 12 lags successfully capture the potential effects regarding the agent's decision to purchase and complete their transactions.[14] In general, seeking new opportunities to expand, establish, retain or shut down the business in a market requires suppliers not to react instantaneously to changes in market conditions when faced with high short term profits or losses. This behavior seems reasonable as any change in a business model requires substantial resource allocation problems and implies that exporters' reactions to exchange rate or income volatility should be modeled with several lags. In order to select the lag length, I start with a maximum lag of 12 and pare it down to 3 lags by examining the Akaike Information Criterion (AIC) and the Schwarz information criterion (SIC). In my empirical analysis, to be parsimonious, I report results while allowing variables to take up to 6 lags.[15] The most recent past is more heavily weighted than the more distant past, and the weights never reach zero. The lag weights decline toward zero as time-delay gets larger. In this work, I apply the distributed geometric lag model and set δ to a specific value

[13]Koren and Szeidl (2003) suggest that exchange rate volatility should affect trade volumes through the covariances of the exchange rate with the other key variables.

[14]See Baum and Caglayan (2009) and Baum et al. (2003) on this issue.

[15]Results, which are available upon request from the authors, that allow variables to take up to 12 lags do not differ from those that we present here.

$\delta = 0.3$, which controls the rate at which the weights decline[16]. For instance, the most recent lag value takes the lag weights of 0.3, lag2 value takes the weights of 0.3^2, and so on. I should note that I also experimented with linear weights giving higher weights to more recent observations. This modification did not lead to any significant changes in the results.

Given the vast number of models, in Tables 2.6-2.8, I depict the country-industry pairs and the sign of the impact of exchange rate, income uncertainty and the interaction between the two as the associated coefficient with those variables attains significance at the 1%, 5% or 10% levels. I present two panels per table. While the upper panel presents my summary results for the sectoral exports of 13 countries to the United States, the lower panel concentrates on the sectoral exports of the United States to the same set of countries. These tables also reveal the differences across emerging versus advanced countries.

2.2.4 Data

In my investigation I utilize deseasonalized monthly data on sectoral bilateral real exports, in each direction, over the period of January 1996 and September 2007 between the United States and her top thirteen trading countries. Nine of the countries including the United States, Japan, Germany, the U.K., France, Italy, Netherlands, Ireland and Canada, have highly advanced economics. The remaining five countries, namely South Korea, Singapore, Malaysia, China,

[16]My model displays a fixed lag structure, therefore estimations on effects of lagged regressors is restricted by the fixed weight on lags. One can also relax the fixed rate at which weights decline.

and Brazil, are considered emerging economies. Given the earlier findings that exchange rate volatility has a significant impact on the trade flows of emerging rather than the advanced economies, my dataset which contains advanced and emerging countries can help us find out if this observation holds true for sectoral trade flows. Furthermore, the use of sectoral data can help us determine if the significant effects of exchange rate volatility on emerging country trade flows is an artifact of data aggregation. In particular, my dataset includes trade flows gathered from 10 sectors which is available from the *Foreign Trade Division* (FTD) in the United States *Census Bureau.* The sectors are: 1) food and live animals; 2) beverages and tobacco; 3) crude materials; 4) mineral fuels, lubricants and related materials; 5) animal and vegetable oils, fats and waxes; 6) chemicals and related products; 7) manufactured goods; 8) machinery and transport equipment; 9) miscellaneous manufactured articles; 10) commodities and transactions.

The sectoral trade data are in current U.S. dollars, which are then converted into local currency units using the spot exchange rate *vis-à-vis* the U.S. dollar. Then, I deflate the sectoral trade data by the export price index for both advanced and emerging countries to obtain real trade flows.[17] As I discussed earlier, the real exchange rate data are constructed using the spot rate and the local and the U.S. consumer price indices. Spot daily exchange rates are obtained from the *Pacific Exchange Rate Service.* Consumer price

[17]Converting nominal monthly sectoral trade flows into real flows by using monthly aggregate export prices rather than sectoral export prices is a weakness of our study which we cannot rectify due to lack of data. Though, researchers who use annual sectoral data (see for example Byrne et al. (2008)) in their investigation are not constrained to that effect.

indices for the United States and the remaining countries are obtained from the *Main Economic Indicators* published by the OECD. Export price indices are extracted from the IMF's *International Financial Statistics*. Finally, deseasonalized industrial production series, which I proxy for the income of a country, are extracted from the *Main Economic Indicators* published by the OECD.

2.3 Empirical Findings

2.3.1 Descriptive Statistics

Given that I will be investigating the linkages between sectoral trade flows and real exchange rate and real income variations, we first provide some statistics on the common features, as well as the dissimilarities, of these series. Table 2.1 presents the real exchange rate volatility correlations among those countries that we have in our dataset. These correlations show that similar real exchange volatility patterns are experienced by many of the advanced countries, except for Japan, perhaps reflecting these countries' sizable exports to the United States. High correlations between these countries may also reflect the agreements between the European countries which eventually led to the launch of the Euro. When we turn our attention to the correlations between the real exchange rate volatility measures of the emerging countries, we observe some similarities but the correlations are not as strong as that between the European countries. Table 2.1 shows that the real exchange rate volatility measures across advanced and emerging countries are very different from one another. This observation gives the impression that the impact of exchange rate uncertainty on trade flows could differ between advanced and emerging economies.

I next focus on descriptive measures of foreign income volatility and the interaction term that I introduce in the model. The correlations of foreign income volatility measures and that of the interaction term—the product of the exchange rate volatility and foreign income volatility—for our exporting countries are presented in Tables 2.2 and 2.3, respectively. Inspecting Table 2.2, I do not detect much comovement of income volatility between the countries in our dataset. Similarly, as shown in Table 2.3, I detect no systematic relationship across countries with respect to the interaction term.

To evaluate how the exchange rate and income volatility measures can affect the sectoral bilateral trade of advanced and emerging countries, in Tables 2.4 and 2.5, I present sectoral export flow correlations for Germany and China, respectively. Table 2.4, which gives the correlation matrix for Germany does not reveal any significant sector specific trade flow correlations. This observation can be explained by the fact that Germany has a well developed economy whose sectoral exports to the United States are not much affected by movements in the export volume of one sector or another. However, Table 2.5, which provides information on Chinese sectoral exports to the United States, shows high correlations between most sectoral trade flows. This finding can be explained by the acceleration of sectoral trade flows from China to the United States over the last 10 years. Similar patterns can be observed for the other emerging countries as well.

Given the information presented in the correlation tables, it seems reasonable to conjecture that the intensity of development could be important regarding the role of exchange rate uncertainty on trade flows. For emerging countries where international trade is consistently improving and where trading partners or exportable products are not diverse, significant effects of exchange rate volatility on trade flows should not be too surprising. Whereas, for countries whose economies are well developed and have established trade links, the impact of exchange rate volatility may be insignificant. I finally check if there are any sector specific correlations across countries, but find no systematic associations.[18]

I must note that prior to estimating my model, I test each series for a unit root using the augmented Dickey-Fuller (see Dickey and Fuller (1981)) and the Phillips and Perron (1988) unit root tests. These tests verify that each series that enter the model is stationary. I also check for the presence of autocorrelation and normality of the error terms. Breusch-Godfrey and the Q tests show that the model's error term does not suffer from autocorrelation. It is possible to check for normality of the errors using visual methods or numerical methods. While graphical methods are intuitive and easy to interpret, numerical methods provide an objective means to examine normality. Inspection of the graphs for several series lead us to believe that the errors are normally

[18]Sector specific correlation tables are not provided for space considerations but are available upon request.

distributed. Then, I subject these series to the Shapiro-Wilk W test which is the ratio of the best estimator of the variance to the usual corrected sum of squares estimator of the variance (Shapiro and Wilk, 1965). The test results confirm my visual inspection that the errors are normally distributed. Finally, to avoid problems that may arise from heteroskedasticty, I report robust standard errors.

In the next section I investigate the role of exchange rate and income volatilities, and the interaction between exchange rate and income volatilities on trade flows. Given that I am working with dozens of models to understand sectoral bilateral trade flows between the United States and her 13 trading partners, I provide summary statistics on the significance of those coefficients broken down into sectors and the destination of exports (exports to and from the United States) for the full sample and the advanced countries. I must also note that the other variables in our model (lagged dependent variable, income and exchange rate) take the expected signs for all country pairs that I investigate. In that, lagged dependent variable is always significant while the other two variables are significant for the preponderance of the models.

2.3.2 Results

In what follows, I first discuss the impact of exchange rate volatility on sectoral trade flows. Next, I examine the effect of income volatility and the interaction term on trade flows.

The role of exchange rate volatility

I first focus on the sign and the significance of the coefficient associated with exchange rate volatility, β_3, which is coming from equation (2.4). The number of significant effects detected for sectoral exports to the United States and from the United States are reported in Table 2.6. An quick look at the table reveals that exchange rate uncertainty has a significant effect on sectoral trade flows only for a handful of cases. When I concentrate on sectoral exports to the United States, one can see that there are 4 (9) out of 110 possible models where β_3 is significantly different from zero at the 5% (10%) level. The tally when I turn to the significance of β_3 for the exports of the United States, is similar in nature; 9 (12) out of 120 models are significant at the the 5% (10%) level. That is overall for about six percent of the cases does exchange rate uncertainty have a significant impact on sectoral trade flows to and from the United States at the 5% significance level. When I scrutinize sign of the impact, we find that exchange rate uncertainty has a slight positive effect at the median.

Given earlier findings that exchange rate volatility has a significant negative impact on the trade flows of emerging countries, it is important to investigate the regression results for the set of emerging countries closely. To that end, we find that at the median, this effect is positive, yet small. When we consider all possible models for the emerging economies, we come across 8 significant models out of possible 92 cases which correspond to 9% of all cases at the 5% level. Overall, the effect of exchange rate uncertainty on trade flows between the United States and her emerging trade partners is stronger in comparison to that of advanced countries. However, this is, too, a small number of significant cases in comparison to earlier studies setting a serious doubt on the claim that exchange rate uncertainty affect emerging country trade flows.

Overall my findings confirm that the effect of exchange rate volatility on trade flows is negligible and the sign of the effect is ambiguous for both emerging and advanced trading partners of the United States. While this effect is more pronounced for emerging economies, the significant models are not more than a handful where there is almost an equal number of positive and negative impacts are observed. As a whole, there is no obvious association between periods of high exchange rate volatility and periods of low growth in trade. From the perspective of promoting world trade, exchange rate volatility is probably not a major policy concern. Note that this does not imply necessarily that exchange rate fluctuations should be viewed with equanimity. For example, currency crises–special cases of exchange rate volatility–have required painful adjustments in output and consumption. In this case, however, what is important is not that measures need to be taken to moderate currency fluctuations directly, but that appropriate policies need to be pursued in order to avoid the underlying causes of large, unpredictable, and damaging movements in exchange rates.

The role of income volatility

We discuss the observed effect of income volatility, captured by β_4 in our model, on exporters' behavior. Table 2.7 provide the number of significant coefficients for exports to and from the United States. When I consider the impact of income volatility on exports to the United States, we observe that β_4 is significantly different from zero in only 4 (9) cases out of 110 models at the 5% (10%) significance level. Perhaps the low significance of the U.S. income volatility on trade flows reflects the fact that the U.S. economy over the period of my investigation did not experience much variation. However, when we turn to understand trade flows from the United States, we see that the effect of income uncertainty becomes somewhat more noticeable; we record 10 (15) significant cases out of 120 possible models at the 5% (10%) level. This difference can be explained by the fact that the trade partners of the United States have experienced much more volatile income patters than that of the U.S. over the period of investigation. The impact of income volatility can be equally positive or negative where the median effect happens to be negative, yet small. Nevertheless, these results do not provide convincing evidence that income volatility is an important determinant sectoral trade flows. If we were to look at the big picture, we have to conclude that income volatility does not play a significant role in international trade. Also, it seems that developing countries are not sensitive to their trade partner's economic activity variation when they are trading with a big brother.

The role of the interaction term between income and exchange rate volatility

I finally explore whether the interaction term (captured by β_5) between the real exchange rate and IP volatility has any effect on sectoral trade flows. As in the previous two subsections, I provide summary information on the role of the interaction for exports to and from the United States in Table 2.8.

Considering exports to and from the United States, we see that the effect can be positive or negative, where we observe 18 (37) significant cases at the 5% (10%) significance level. When we focus on exports to the United States, we observe that only 7 (17) out of 110 cases have the significant effect which are mainly negative at the 5% (10%) significance level—5 of those 7 significant cases are realized for emerging countries: China, South Korea, Brazil and Malaysia. When we observe the results for U.S. exporters, 11 cases are significant and 6 of them are registered for emerging countries.

Given these observations, one may conclude that the interaction term has a minor role in the determination of trade flows. However, considering Tables 2.6 and 2.8 together we see that the interaction term is generally significant if the corresponding coefficient for exchange rate volatility is significant. Moreover, the sign of the interaction term is the opposite of that of exchange rate volatility negating the impact of exchange rate uncertainty on trade flows. This is an interesting observation, which is not reported in the earlier literature, implies that depending on the relative size of exchange rate volatility and income volatility the impact of exchange rate volatility would be nullified. Models that do not incorporate this interaction term are clearly misspecified and interpretations regarding the impact of exchange rate uncertainty on trade flows that are based on these models will yield erroneous conclusions.

Robustness Check Using A Semi-Restricted Model

The distributed lag model that I estimate in the previous section constraints the effects of my variables on trade flows to a single coefficient per model while placing more weight on the most recent lags. In this subsection, I relax the restrictions that I place on exchange rate, income volatilities and their interaction while keeping the structure of the other variables same as before. This modeling approach, which we call semi-restricted model, although sacrifices the parsimony of the earlier model, allows the data to determine the sign and the significance of the variables coefficients that are of most interest to us up to 6 lags. Hence, we can check the robustness of our claims regarding the role of exchange rate and income uncertainty and their interactions on trade flows. The semi-restricted model takes the following form

$$\begin{aligned} x_{k,t}^{i\to j} &= \alpha_0 + \beta_0 \textstyle\sum_{n=1}^{N} \delta^n x_{k,t-n}^{i\to j} + \beta_1 \sum_{n=1}^{N} \delta^n y_{t-n} + \\ &\beta_2 \textstyle\sum_{n=1}^{N} \delta^n s_{t-n} + \sum_{n=1}^{N} \beta_{3,n} \left[\sigma_s\right]_{t-n} + \\ &\textstyle\sum_{n=1}^{N} \beta_{4,n} \left[\sigma_y\right]_{t-n} + \sum_{n=1}^{N} \beta_{5,n} \left[\sigma_s \times \sigma_y\right]_{t-n} + \epsilon_t \end{aligned} \tag{2.5}$$

In this new model, the coefficients associated with exchange rate and income volatility and their interaction, where $n \in [1, 2, ..., 6]$ denotes lags, are now allowed to take a different value for each lag. For the other variables I keep the same structure as before where $\delta = 0.3$. Estimating all possible combinations I report summary results gathered from 233 models (25 models failed the dynamic stability conditions) in Tables 2.9 to 2.14. Observing these tables I see that the coefficients, $\beta_{3,n}, \beta_{4,n}$ and $\beta_{5,n}$, take significant values at the 5% level for various lags for different sectors. However, I do not see a systematic pattern of significance across sectors or countries. Furthermore, the sign of the coefficients can be positive as well as negative. To gain a better view of the impact of the variables of interest, I compute their joint effect over the 6 lags. In the case of exports, (see Tables 2.9 and 2.10) from the United States to her partners I find that exchange rate volatility affects trade flows in 8 cases across 6 countries including the U.K.(9), France(8), Italy(5), Brazil(4, 6), Canada(10), Malaysia(6, 10), where affected sectors are shown in brackets. In the reverse case when I inspect the exports to the United States by her trade partners, I find that exchange rate volatility affects trade flows in 5 cases for 5 countries including Japan(8), the U.K.(5), South Korea(11), Netherlands(6), Malaysia(3).

A similar exercise is carried out to understand the impact of income volatility on trade flows where Tables 2.11 and 2.12 present the results for equation (2.5) above. Similarly, income volatility too has significant effects at various lags for different sectors with no systematic pattern across sectors or countries. When we consider exports from the United States to her partners, joint effect of the 6 lags are found to be significant for 7 cases across 5 countries including the U.K.(9), Italy(5), Brazil(4, 6, 7), Canada(10), Malaysia(2). When we turn to investigate the joint significance of the coefficients for exports to the United States by her trade partners we find four significant cases including Japan(8), South Korea(11), France(3), Malaysia(3).

Finally Tables 2.13 and 2.14 present results for the interaction term. Here, too, I observe that various lags of the interaction term take significant coefficients without a systematic pattern. The joint impact of the interaction term when we consider exports from the United States to her trade partners is significant for 9 cases across 7 countries including the U.K.(9), South Korea(10), France(8), Italy(5), Brazil(4, 6), Canada(10), Malaysia(6, 10). When I concentrate on the exports to the United States by her trade partners, the joint significance of the coefficients is observed for four cases, including Japan(8), South Korea(11), Netherlands(6), Malaysia(3).

Overall these results verify my earlier findings that exchange rate volatility, income volatility and the interaction of these two variables do not play a significant role in explaining the trade flows between the United States and her top trading partners. Furthermore, results from the semi-restricted models imply that coefficients are model dependent, yet my conclusion regarding the impact of exchange rate and income volatilities and the interaction term on trade flows are similar across the two approaches.[19]

[19]In fact results for the semi-restricted model are worse than those from the restricted model.

Is there a systematic change in the behavior of real exchange rate volatility?

Given the paucity of significance of the measure of exchange rate volatility in the regressions, I wonder if the behavior of the real exchange rate volatility measure changed dramatically over the last decade in comparison to the earlier decade. The answer to this question is not straightforward for several reasons. As mentioned, earlier research utilized different uncertainty measures based on different methodologies. Here, rather than employing sophisticated tools, I compare the mean and variance of exchange rate volatility measure for several of the countries with that in Baum et al. (2004a) who also implement the same methodology to derive a volatility proxy for the exchange rate. Although this approach does not give a definitive answer, I can check for any systematic changes in the volatility series. Overall, I find no dramatic changes over the last two decades with respect to exchange rate volatility. For instance for Japan, I find that Japan has a little higher exchange rate volatility in 1988-1998 period compared with the period observed in this chapter, whereas for the UK I observe no difference in the mean and the volatility of the exchange rate uncertainty proxy. In contrast for China the real exchange rate volatility is higher for the period I study here than the earlier decade. But in general, I detect no significant deviations in the behavior of exchange rate volatility proxy.

Is there a aggregation bias of using aggregate data?

Compared with my result, I believe that much of the significant results arrived in earlier literature seems to suffer from data aggregation. I then carry out an aggregation practice which allows sectors to vary to confirm this hypothesis. The model we follow is the same with the sectoral export model in this study. To capture aggregate export flows, I sum up 10 sectoral export flows for each country. Naturally, it yields 26 models for bilateral trade between the US and her 13 trading partners. Result, at 5% level, shows that 12 out of 26 cases are significant for the effect of real exchange rate volatility. Exporters in Japan, Italy, Netherlands, China, Singapore and Brazil are significant affected by real exchange rate volatility when they trade with U.S.. For US's exporters, they are affected by real exchange rate volatility when they trade with China, Canada, Brazil, UK, France and Netherlands. The improvement of significant result of using aggregate data support our supposition of aggregation bias.

2.4 Conclusion

In this paper I investigate the impact of exchange rate volatility on sectoral bilateral trade flows between the United States and her 13 top trading countries over the period between 1996-2007. My monthly dataset includes both emerging and advanced economies allowing us to avoid the narrow focus on the United States or the G7 country data which has characterized much of the literature. Furthermore, concentrating on the behavior of sectoral trade flows we avoid potential biases that may arise due to the use of aggregate data. Overall, I investigate bilateral trade flows for dozens of sector-country pairs separately to shed a broader view on the linkages between the variables of interest. In my investigation, I also entertain an idea suggested by Baum et al. (2004a) that income volatility and its interaction with exchange rate volatility may have an impact on trade flows.

My results provide evidence that exchange rate uncertainty has little effect on sectoral trade flows. I find that the impact of real exchange rate volatility on trade flows is significant in about only six percent of the models at the 5% significance level where the effect is yet positive. Furthermore, although this relationship is slightly stronger for the emerging countries, my findings do not allow us to confirm earlier findings that exchange rate volatility plays an important role for trade flows of emerging countries. Overall, my results show that there is little effect of exchange rate volatility on sectoral trade flows which hold for both advanced and emerging economies.

Next, I turn my attention to the impact of income volatility and the interaction term between exchange rate volatility and income volatility. It turns out that the interaction term is significant in almost all cases when exchange rate volatility has a significant role in the model. Furthermore, it takes the opposite sign to that of exchange rate volatility, reversing the impact of exchange rate volatility on trade flows in the opposite direction. From this perspective, omitting the interaction term from the analysis would lead to the wrong conclusion and inappropriate policy prescriptions. Finally, when I investigate the impact of income volatility on trade flows, I observe that income uncertainty has a significant effect in only five percent of the models. The sign of this coefficient is negative at the median. However, this variable seems to play a more important role when I investigate the exports of the United States to her trading partners— as the trading partners experience more volatile income patterns. This is reasonable for the income pattern of the trade partners of the United States over the period of investigation was much more volatile than that of hers.

Finally, I check for the robustness of the model by investigating a less restricted model. Results from this experiment verify my earlier conclusion that exchange rate, income uncertainty as well as the interaction of these terms do not have a meaningful impact on trade flows. However, given that we concentrated the investigation on the United States and her top trading partners' sectoral trade flows, it would be useful to investigate data from other countries to generalize these findings.

Table 2.6: Significant Exchange Rate Volatility (σ_{s_i}) Effects

	10%	5%	1%
		Export to the United States	
+	CN(2) ML(2,8)	BR(5)	CN(9) GE(6)
-	CAN(3,6)	IT(5)	
		Export from the United States	
+	BR(4) CAN(7)	KR(7) BR(8) SG(8) GE(6) FR(8)	
-	FR(9)	CN(3) U.K.(8)	BR(3) ML(5)

Notes: Sectoral indices are given in brackets. See notes to Table 2.4 for sector names.

Table 2.1: Real Exchange Rate Uncertainty Correlations across Countries

	JP	GE	U.K.	FR	IT	NL	IE	CAN	SG	KR	ML	CN	BR
JP	1.0000												
GE	0.1064	1.0000											
U.K.	-0.0937	0.8468	1.0000										
FR	0.0782	0.9985	0.8553	1.0000									
IT	-0.0479	0.9761	0.8817	0.9853	1.0000								
NL	-0.0323	0.9760	0.8409	0.9847	0.9944	1.0000							
IE	-0.2181	0.9111	0.8489	0.9283	0.9734	0.9691	1.0000						
CAN	-0.2581	0.7248	0.7254	0.7444	0.7999	0.7795	0.8541	1.0000					
SG	0.6604	0.5051	0.2487	0.4651	0.3249	0.3259	0.1701	0.1045	1.0000				
KR	0.1081	0.5373	0.3538	0.5386	0.5428	0.5569	0.5774	0.6524	0.3550	1.0000			
ML	0.5363	0.4232	0.0778	0.3898	0.2771	0.3021	0.1917	0.1487	0.8784	0.5891	1.0000		
CN	0.7466	0.2023	-0.0755	0.1571	-0.0043	0.0118	-0.1814	-0.2892	0.8915	0.0239	0.7465	1.0000	
BR	0.2805	0.5262	0.4353	0.4971	0.4051	0.3720	0.2866	0.4023	0.7497	0.2827	0.5448	0.5602	1.0000

Notes: The currencies are ordered for Japan, Germany, the U.K., France, Italy, Netherlands, Ireland, Canada, Singapore, South Korea, Malaysia, China and Brazil.

Table 2.2: Income Volatility Correlations across Countries

	U.S.	JP	GE	U.K.	FR	IT	NL	IE	CAN	SG	KR	ML	CN	BR
U.S.	1.0000													
JP	-0.0706	1.0000												
GE	-0.1263	0.6271	1.0000											
U.K.	-0.2816	0.4538	0.3979	1.0000										
FR	0.2812	0.1368	0.2023	0.2334	1.0000									
IT	0.2951	0.1442	0.2086	0.2687	0.9686	1.0000								
NL	-0.4920	0.3470	0.6116	0.5979	0.0588	0.0890	1.0000							
IE	-0.1477	0.2359	0.8126	0.1669	0.0129	0.0133	0.6339	1.0000						
CAN	-0.1308	0.2400	0.7488	0.3371	0.0681	0.0922	0.6498	0.8866	1.0000					
SG	-0.2071	-0.0045	-0.0228	0.0002	-0.1867	-0.1929	0.0111	-0.0045	0.0191	1.0000				
KR	-0.2115	0.0638	0.0758	0.0894	-0.0827	-0.0989	0.0787	0.0702	0.1008	0.5972	1.0000			
ML	0.2546	-0.1144	-0.2948	-0.2777	-0.1639	-0.1686	-0.3506	-0.2458	-0.2378	0.0352	0.0212	1.0000		
CN	-0.1692	0.3295	0.1468	0.2909	-0.1520	-0.1347	0.2656	0.0683	0.1379	0.0815	0.2119	-0.0226	1.0000	
BR	-0.2265	-0.2429	-0.1329	-0.1918	-0.1937	-0.2018	0.0185	-0.0255	-0.0808	0.2127	0.2805	0.0662	-0.0430	1.0000

Notes: The countries are ordered as the United States Japan, Germany, the U.K., France, Italy, Netherlands, Ireland, Canada, Singapore, South Korea, Malaysia, China and Brazil.

Table 2.3: Interaction Terms Correlations across Countries

	JP	GE	U.K.	FR	IT	NL	IE	CAN	SG	KR	ML	CN	BR
JP	1.0000												
GE	0.1466	1.0000											
U.K.	0.1931	0.7495	1.0000										
FR	0.2938	0.9378	0.8096	1.0000									
IT	0.2109	0.9697	0.7417	0.9510	1.0000								
NL	0.3033	0.8813	0.8187	0.9144	0.8881	1.0000							
IE	-0.0555	0.7681	0.4495	0.6242	0.7616	0.5196	1.0000						
CAN	-0.1155	0.1566	0.1059	0.2115	0.1887	-0.0159	0.2045	1.0000					
SG	0.2602	0.0514	0.0398	0.0860	0.0555	-0.0213	-0.1049	0.2038	1.0000				
KR	0.0201	-0.0371	-0.0916	-0.0916	-0.0401	-0.1088	-0.0526	-0.0275	0.3807	1.0000			
ML	0.2847	-0.0587	0.0280	-0.0269	-0.0466	0.0167	-0.2206	0.0048	0.3114	0.2457	1.0000		
CN	0.1804	-0.2374	-0.0228	-0.1802	-0.2264	-0.1476	-0.2358	-0.0037	0.4431	0.2365	0.3475	1.0000	
BR	0.1667	-0.1360	-0.2362	-0.1777	-0.0719	-0.2254	0.0233	-0.0262	0.1858	0.3226	0.3643	0.0756	1.0000

Notes: See notes to Table 2.2.

Table 2.4: Correlations of German Sectoral Exports to the United States

	1	2	3	4	5	6	7	8	9	10
1	1.0000									
2	-0.0110	1.0000								
3	0.1844	0.0837	1.0000							
4	0.2883	0.2522	0.2306	1.0000						
5	0.2070	0.0245	-0.0198	0.1274	1.0000					
6	0.4710	-0.0356	0.2515	0.2348	-0.0111	1.0000				
7	0.4567	0.1890	0.3502	0.2888	0.0696	0.8028	1.0000			
8	0.3392	0.2891	0.2323	0.2047	0.0853	0.6720	0.8732	1.0000		
9	0.4199	0.2923	0.2759	0.2507	0.0590	0.7241	0.9034	0.8958	1.0000	
10	0.3350	0.2999	0.2738	0.1751	0.1480	0.4826	0.7320	0.7519	0.7284	1.0000

Notes: Numbers 1 to 10 denote sectors, namely 1) food and live animals; 2) beverages and tobacco; 3) crude materials; 4) mineral fuels, lubricants and related materials; 5) animal and vegetable oils, fats and waxes; 6) chemicals and related products; 7) manufactured goods; 8) machinery and transport equipment; 9) miscellaneous manufactured articles; 10) commodities and transactions.

Table 2.5: Correlations of Chinese Sectoral Exports to the United States

	1	2	3	4	5	6	7	8	9	10
1	1.0000									
2	0.6077	1.0000								
3	0.8411	0.5932	1.0000							
4	0.4425	0.3647	0.4488	1.0000						
5	0.0131	0.0258	-0.0979	0.1517	1.0000					
6	0.7979	0.6743	0.9014	0.4671	0.0031	1.0000				
7	0.8167	0.6961	0.9311	0.4348	-0.0571	0.9246	1.0000			
8	0.7964	0.6781	0.9065	0.4496	-0.0170	0.8978	0.9309	1.0000		
9	0.8282	0.6765	0.9369	0.4585	-0.1051	0.9260	0.9566	0.9456	1.0000	
10	0.7660	0.6663	0.8642	0.4353	-0.0208	0.9054	0.9157	0.8993	0.9075	1.0000

Notes: See notes to Table 2.4.

Table 2.7: Significant Income Volatility (σ_y) Effects

	10%	5%	1%
		Export to the United States	
+		CN(2,9)	GE(6)
-	CN(3) U.K.(2,10) IE(11) CAN(6)	IT(5)	
		Export from the United States	
+	CN(4)	GE(6) FR(8,11) NL(2) SG(8)	
-	U.K.(2) FR(7,9) SG(6)	CN(3) KR(5) U.K.(8) CAN(9)	ML(4)

Notes: See notes in Table 2.6.

Table 2.8: Significant Interaction ($\sigma_{s_i} \times \sigma_y$) Effects

	10%	5%	1%
		Export to the United States	
+	CN(3) U.K.(2) IE(11) CAN(3)	IT(5)	
-	CN(2) KR(8) SG(2) CAD(4) ML(2,6)	KR(3,9) BR(5) ML(8)	CN(3) GE(6)
		Export from the United States	
+	U.K.(8) KR(5,8) FR(6,9) SG(6) ML(11)	CN(3) ML(4) GE(6) FR(7) CAN(9)	BR(3)
-	GE(10) BR(4)	KR(7) BR(8)	FR(11) NL(2) SG(8)

Notes: See notes in Table 2.6.

Table 2.9: Significant Exchange Rate Volatility (σ_{s_i}) Effects for the Semi-Restricted Model: Exports to the United States

Index	Developed	Economies			Emerging	Economies		
1	GE	(L6,-)	CAN	(L3,+)	KR	(L5,-)	BR	(L5,+)
2	JP	(L2,-)	U.K.	(L2,-)	CN	(L1,-)		
3	GE	(L5,+)	U.K.	(L2,-)	KR	(L3,-)	BR	(L3,-)
				(L3,+)	SG	(L5,-)		
4	GE	(L4,-)	NL	(L3,+)	KR	(L2,-)	SG	(L2,+)
		(L6,-)		(L4,-)				
5	GE	(L1,+)			CN	(L2,-)	ML	(L1,+)
		(L6,+)						(L3,-)
								(L4,+)
								(L5,+)
6	JP	(L3,+)	GE	(L5,+)	CN	(L1,-)	BR	(L5,+)
	FR	(L1,+)	CAN	(L3,+)	KR	(L1,+)		
						(L5,-)		
						(L6,+)		
7	FR	(L3,+)	IT	(L2,-)	KR	(L1,+)	SG	(L2,+)
		(L4,+)				(L5,-)		
	IE	(L5,-)	CAN	(L3,+)				
8	U.K.	(L2,-)	NL	(L2,-)	ML	(L4,+)	SG	(L3,+)
						(L6,-)		(L5,-)
					CN	(L1,+)		
9	GE	(L5,+)	FR	(L4,+)	BR	(L5,+)		
	NL	(L2,+)	CAN	(L3,+)				
10	FR	(L4,+)	IE	(L3,+)	KR	(L4,-)	SG	(L3,+)

Notes: Significance at the 5% level only. Index denotes the sector. See Table 2.2 for country codes. The sign and the lag (L1-L6) when significance is attained are given in the brackets.

Table 2.10: Significant Exchange Rate Volatility (σ_{s_i}) Effects for the Semi-Restricted Model: Exports from the United States

Index	Developed	Economies			Emerging	Economies		
1	GE	(L5,-)	IT	(L3,-)	KR	(L2,+)		
		(L6,-)						
	CAN	(L3,+)						
2	FR	(L2,-)	IT	(L3,-)	BR	(L1,-)	CN	(L1,-)
				(L5,+)				(L2,+;L5,-)
3	JP	(L5,-)	NL	(L3,-)	CN	(L2,+)		
				(L6,+)				
4	NL	(L3,-)	JP	(L2,+)	CN	(L4,+)		
		(L4,-)		(L6,-)				
	IT	(L5,+)	U.K.	(L6,-)				
5	JP	(L5,-)	GE	(L6,+)	KR	(L4,+)	BR	(L5,-)
	IT	(L5,+)	CAN	(L6,-)	SG	(L6,-)		
		(L6,-)						
6	GE	(L2,-)	IT	(L2,-)	SG	(L3,-)	ML	(L4,-)
	NL	(L3,-)						
7	GE	(L1,+)	IT	(L5,+)	SG	(L3,+)	BR	(L2,+)
								(L3,-)
8	JP	(L2,-)	GE	(L3,-)				
	FR	(L2,-)	NL	(L6,-)				
	CAN	(L5,-)	IT	(L1,+)				
				(L6,-)				
9	GE	(L5,+)	U.K.	(L5,+)				
				(L6,-)				
10	JP	(L6,+)	GE	(L1,-)	BR	(L2,+)		
						(L4,-)		
	NL	(L5,+)						

Notes: See notes to Table 2.9.

Table 2.11: Significant Income Volatility (σ_y) Effects for the Semi-Restricted Model: Exports to the United States

Index	Developed	Economies			Emerging	Economies		
1	JP	(L6,-)	FR	(L4,-)	KR	(L5,-)	ML	(L3,-)
	CAN	(L3,+)			BR	(L1,-)		
		(L5,+)				(L2,+)		
						(L5,+)		
						(L6,-)		
2	JP	(L1,+)	FR	(L3,+)	CN	(L1,-)	SG	(L2,+)
		(L2,-)		(L4,-)				(L5,-)
	GE	(L3,+)	U.K.	(L2,-)				
3	GE	(L5,+)	U.K.	(L2,-)	KR	(L1,+)	BR	(L2,-)
						(L3,+)		(L3,-)
								(L5,+)
					SG	(L5,-)		
4	JP	(L5,-)	GE	(L4,-)	KR	(L6,-)		
	NL	(L3,+)						
		(L4,-)						
5	GE	(L1,+)	CAN	(L4,-)	KR	(L4,-)		
		(L6,-)						
6	JP	(L3,+)	CAN	(L3,+)	CN	(L1,-)	BR	(L5,+)
	GE	(L3,+)	FR	(L1,+)	KR	(L1,+)		
		(L5,+)		(L6,+)		(L5,+)		
						(L6,+)		
	NL	(L1,+)	IE	(L2,+)				
7	FR	(L3,+)	IT	(L2,-)	SG	(L2,+)		
	IE	(L1,-)	CAN	(L3,+)				
		(L5,-)						
8	GE	(L1,-)	U.K.	(L2,-)	ML	(L3,+)	CN	(L1,+)
						(L4,+)		(L3,-)
						(L6,+)		
	FR	(L5,+)	IT	(L1,-)				
9	GE	(L5,+)	U.K.	(L6,-)	KR	(L1,+)	BR	(L5,+)
	NL	(L1,-)	CAN	(L3,+)				
		(L2,+)	FR	(L4,+)				
10	IE	(L1,-)			KR	(L4,+)		
		(L3,+)						

Notes: See notes to Table 2.9.

Table 2.12: Significant Income Volatility (σ_y) Effects for the Semi-Restricted Model: Exports from the United States

Index	Developed	Economies			Emerging	Economies		
1	JP	(L4,-)	U.K.	(L1,-)	BR	(L6,+)		
				(L4,+)				
	FR	(L5,-)	IT	(L3,-)				
	NL	(L1,+)	CAN	(L1,+)				
2	FR	(L2,-)			CN	(L1,-)	ML	(L5,-)
		(L3,+)				(L5,-)		(L6,-)
					BR	(L3,+)		
3	GE	(L2,+)	NL	(L3,-)	ML	(L1,-)	CN	(L2,+)
				(L6,+)				
4	JP	(L6,-)	U.K.	(L6,-)	CN	(L2,+)		
	NL	(L4,-)				(L6,-)		
5	JP	(L3,+)			KR	(L3,+)	BR	(L5,-)
		(L5,-)			SG	(L6,-)		
6	GE	(L5,-)	FR	(L3,+)	SG	(L3,-)		
	NL	(L5,-)	CAN	(L1,+)		(L6,-)		
				(L3,-)				
7	JP	(L4,+)	IT	(L4,-)	SG	(L3,+)	ML	(L6,-)
	CAN	(L1,+)						
8	JP	(L2,-)	FR	(L2,-)	ML	(L3,+)		
	NL	(L3,+)				(L5,-)		
9	JP	(L3,+)	FR	(L5,+)				
	CAN	(L4,+)						
10	FR	(L1,+)	NL	(L5,+)	ML	(L1,-)		
						(L3,+)		

Notes: See notes to Table 2.9.

Table 2.13: Significant Interaction ($\sigma_{s_i} \times \sigma_y$) Effects for the Semi-Restricted Model: Exports to the United States

Index	Developed	Economies			Emerging	Economies		
1	JP	(L6,-)	GE	(L6,+)	KR	(L5,+)	BR	(L1,+)
	FR	(L4,+)	CAN	(L3,-)				(L5,-)
2	JP	(L1,-)	U.K.	(L2,+)	CN	(L1,+)	SG	(L2,-)
	FR	(L3,-)						(L5,+)
3	JP	(L2,-)	GE	(L5,-)	BR	(L3,+)	SG	(L2,-)
								(L5,+)
4	JP	(L4,-)	NL	(L3,-)				
		(L5,+)		(L4,+)				
	GE	(L4,+)	U.K.	(L5,-)				
5	GE	(L1,-)	CAN	(L4,+)	KR	(L1,-)	ML	(L2,- L4,-)
		(L6,+)				(L6,-)		(L3,+)
								(L4,-)
					CN	(L2,+)		
6	JP	(L3,-)	IE	(L2,-)	BR	(L5,-)	CN	(L1,+)
	GE	(L3,-)	FR	(L1,-)				
		(L5,-)		(L6,-)				
7	FR	(L3,-)	IE	(L1,+)	BR	(L5,-)	KR	(L1,-)
		(L4,-)		(L5,+)				(L5,+)
	IT	(L2,+)	CAN	(L3,-)	SG	(L2,-)	ML	(L3,-)
8	GE	(L1,+)	U.K.	(L2,+)	CN	(L1,-)	SG	(L3,-)
	IT	(L1,+)				(L3,+)		(L5,+)
					KR	(L1,-)		
9	GE	(L5,-)	FR	(L4,-)	BR	(L5,-)	CAN	(L3,-)
	NL	(L2,+)			ML	(L4,-)		
10	FR	(L4,-)	IE	(L1,+)	ML	(L1,+)		
				(L3,-)		(L2,-)		

Notes: See notes to Table 2.9.

Table 2.14: Significant Interaction ($\sigma_{s_i} \times \sigma_y$) Effects for the Semi-Restricted Model: Exports from the United States

Index	Developed	Economies			Emerging	Economies		
1	JP	(L4,+)	U.K.	(L1,+)	KR(L2,-)			
	FR	(L5,+)	IT	(L3,+)				
	NL	(L1,-)		(L4,+)				
				(L5,-)				
2	GE	(L4,-)	FR	(L2,+)	BR	(L1,+)	CN	(L1,+)
	IT	(L5,-)				(L3,-)		(L3,-)
								(L5,+)
3	JP	(L5,+)	GE	(L5,+)				
	IT	(L2,-)	NL	(L3,+)				
		(L5,-)		(L6,-)				
4	JP	(L6,+)	U.K.	(L6,+)	CN	(L6,+)		
	IT	(L6,-)	NL	(L4,+)				
5	JP	(L3,-)	IT	(L1,-)	KR	(L4,-)	BR	(L5,+)
		(L5,+)		(L5,-)				
	NL	(L3,-)			SG	(L6,+)		
		(L5,-)						
6	GE	(L1,-)	IT	(L4,+)	SG	(L3,+)		
		(L2,+)		(L5,-)		(L6,+)		
	FR	(L3,-)	NL	(L5,+)				
7	JP	(L4,-)	IT	(L1,-)	BR	(L2,-)		
				(L4,+)				
				(L5,-)				
8	JP	(L2,+)	GE	(L4,+)	ML	(L5,+)		
	FR	(L2,+)	IT	(L1,-)				
	CAN	(L5,+)		(L3,-)				
9	JP	(L3,-)	GE	(L1,-)				
	FR	(L5,-)						
10	GE	(L6,+)	FR	(L1,-)	KR	(L5,+)		
	IT	(L5,+)	NL	(L5,-)				

Notes: See notes to Table 2.9.

Table 2.15: Conditional Variance of 14 Countries' Income Using ARCH models

		Coef.	Std.Err	P-value	LM test
U.S.					
	L.income	.479	.064	0.000	563
	L2.income	.342	.0729	0.000	
	L3.income	.173	.0664	0.009	
	ar(2)	0.99	.0086	0.000	
	arch(4)	.3864	.1892	0.041	
JP					
	L.income	.5699	.0787	0.000	252
	arch(2)	.4549	.2096	0.030	
CN					
	L.income	.3103	.1341	0.021	193
	arch(1)	.4142	.2048	0.043	
GE					
	L.income	.1803	.0872	0.039	200
	ar(4)	.2252	.1112	0.043	
	ma(4)	.8785	.0532	0.000	
	arch(2)	.0545	.032	0.027	
	garch(2)	.9298	.0829	0.000	
U.K.					
	L.income	.7772	.102	0.000	222
	L2.income	.1314	.064	0.000	
	L3.income	.3417	.078	0.000	
	ar(2)	-.0645	.0234	0.000	
	ma(2)	-.8771	.06242	0.000	
	arch(4)	.0766	.0012	0.000	
KR					
	L2.income	-.0707	.0012	0.000	200
	arch(1)	.1496	.0326	0.000	
FR					
	L.income	-.2226	.1133	0.050	200
	arch(1)	.2933873	.1917	0.020	
IT					
	L.income	-.9938	.024	0.000	197
	L2.income	-.988	.046	0.000	
	ma(3)	-.8914	.055	0.000	
	arch(3)	.1475	.0776	0.05	
	garch(3)	.842	.0678	0.000	

		Coef.	Std.Err	P-value	LM test
NL					
	L.income	-.32514	.0500	0.000	205
	L2.income	-.2328	.046	0.000	
	L3.income	.5499	.0666	0.000	
	ar(3)	-.9823	.0223	0.000	
	ma(3)	.6930	.0737	0.000	
	arch(6)	.775	.2309	0.001	
IE					
	L2.income	-.1903	.1053	0.071	150
	ar(3)	-.995	.0264	0.000	
	ma(3)	.9158	.061	0.000	
	arch(1)	.2394	.1023	0.043	
BR					
	L.income	.7772	.102	0.000	222
	L2.income	.1314	.064	0.000	
	L3.income	.3417	.078	0.000	
	ar(2)	-.0645	.0234	0.000	
	ma(2)	-.8771	.06242	0.000	
	arch(4)	.0766	.0012	0.000	
SG					
	L.income	-.5743	.0828	0.000	105
	arch(2)	.2857	.1451	0.054	
CAN					
	L.income	-.6259	.1652	0.000	238
	ma(2)	-.6432	.1147	0.000	
	arch(2)	-.1079	.0309	0.000	
	garch(2)	.7814	.2819	0.006	
ML					
	L.income	-1.300	.1483	0.000	212
	L2.income	-.5514	.1613	0.001	
	ma(1)	.839	.0956	0.000	
	arch(1)	.3278	.1615	0.042	

Chapter 3

The Link between Inflation Volatility and Sectoral Output Variability in Japan

This chapter investigates the effects of inflation uncertainty on the level of sectoral output growth rate and its cross-sectional dispersion. Using an augmented profit model with a signal-extraction framework, I demonstrate that an increase in inflation volatility will narrow decrease the cross-sectional distribution of sectoral output growth rate. I test this prediction on a panel of Japanese manufacturing sectors drawn from the annual UNIDO database covering the period 1970-2002. My results show that as inflation uncertainty increases, managers behave more homogeneously leading to a narrow cross-sectional dispersion of output growth rate. The negative effect of inflation uncertainty is also applied to the level of the sectoral output growth dispersion.

3.1 Introduction

It is well accepted that the optimal macroeconomic policy is to achieve low and stable inflation; since uncertainties of inflation reduces the predictability of next-period's prices, and therefore hinders the efficient allocation of resources. However, what really matters to the physical economies is: high and volatile inflation variability is like sand in the price mechanism system, and individual managers will have to behave conservatively to produce decisions in next period, due to the unanticipated informational content of prices. As to the whole market, output variability will be less, as all individuals similarly take conservative responses to increasing inflation volatility, leading to a narrow dispersion of outputs across the whole markets. Therefore one can expect a negative impact of inflation uncertainty on the level and the range of the cross-sectional dispersion of output growth, respectively.

Quite a few studies have reported a negative relationship between inflation uncertainty and output variability: Friedman's (1977) Nobel Lecture presents a potential negative impact of inflation uncertainty on output growth, see also in Jansen (1989), De Gregorio (1992), Hayford (2000), Grier and Perry (2000), Grier et al. (2004), Apergis (2004), Karanasos and Kim (2005), Wilson (2006), Fountas and Karanasos (2007).

The literature presents various methodologies to estimate the relationship between inflation variability and output variability. The investigation framework in this chapter is constructed around the work of Beaudry et al. (2001)

and Baum et al. (2004b, c). These studies augment a macro model with a signal-extraction framework to explain how macroeconomic uncertainty affects the allocation of resources. Beaudry et al. (2001) investigates the effect of monetary instability on the distribution of sectoral investment rate in UK using firm level data, and proposes a significant link of predictability of monetary policy and the dispersion of sectoral investment rate. Baum et al. (2004b) uses signal extraction framework to investigate the effect of macro economic uncertainty on allocation of loanable funds that is captured by distribution of loan-to-asset (LTA) ratio. Baum et al. (2004c) estimates effect of macroeconomic volatility on non-financial firms' cash holding behavior. All these studies find a negative effect of macroeconomic uncertainty on the dispersion of the investigated objects.

In this chapter I present a simple model based on the idea that increased inflation volatility will lead to higher price variability, to analyze how price variability affects the evolution of sectoral output growth and its cross-sectional dispersion. A simple signal extraction model is used to explain how the noise in the signal — in our case inflation volatility — influences predictability of next-period's prices. In my theoretical framework, I propose two sets of hypotheses regarding the effects of noise in the signal on sectoral output growth and its dispersion. The first hypothesis is that the effect of noise in signal on sectoral output growth is ambiguous. The second is that the effect of signal noise is negatively related to the cross-section distribution of sectoral output growth.

I then test my propositions of how inflation variability affects sectoral output and its dispersion, using a data set for Japan's manufacturing sectors over the 1970s, and in the early 2000s. The reason why I chose Japan's industry is because, over these three decades, it experienced a long period of expansion followed by a deep recession and Japanese CPI inflation experienced dramatic changes. It was high and fluctuated largely in the 1970s and 1990s and relatively low and stable in the 1980s. One can, therefore, expect to see differences in the influence of inflation variability on sectoral output growth and its cross-sectional distribution during these years[1].

In my empirical investigation, I consider inflation variability (conditional variance of inflation rate) as a proxy for the noise in signal. GARCH model is used to calculate the conditional variance using CPI inflation on a monthly basis. I then simply sum up monthly inflation variance by year to represent annual inflation volatility. In the first set of hypotheses, I investigate the effect of inflation variance on the level of sectoral output growth. My model initially comprises of inflation variances as regressors, and it then is augmented with several other variables, presenting in 3 different models, to check for the robustness of my results. In total, I run 4 different models on 28 sectors. I therefore have 112 regressions in total for the first hypothesis. For my second hypothesis, I estimate the effect of inflation variance on the cross-sectional dispersion of sectoral output growth.

[1]Japan is ranked as the forth largest exporter in the world. Its main exports are transportation equipment, motor vehicles, electronics, electrical machinery and chemicals, which are the main parts of Japan's manufacturing industry. Therefore, its output growth is strongly correlated with its export performance. This chapter does not take account of international trade and importing countries' demand, but only focus on domestic economy of Japan. Overlooking Japan as an open economy is the weakness of this chapter.

My results show a negative relationship between inflation variability and level of output growth, indicating greater inflation variability generally reduces Japan's manufacturing output growth on a sectoral level. With respect to its effect on the dispersion of sectoral output growth, inflation variability adversely affect the cross-sectional dispersion of output growth. It strongly shows that volatile inflation narrows the cross-sectional dispersion of output growth, with an increasing inflation.

It also suggests that inflation rate, interest rate and oil prices have no significant impacts on either level of sectoral output growth or its cross-sectional dispersion. Besides the aforesaid, I also introduce the availability of credit, to check if it will lessen the impact of inflation uncertainty as Aghion et al. (2004) suggests. My results imply that bank loans to private sectors mitigates price uncertainties faced by manufacturing sectors, therefore less constraints of credit widen the cross-sectional dispersion of output growth, whereas more constraints of credit narrows down the dispersion.

The reminder of this chapter is organised as follows: section 2 presents a literature review. Section 3 gives the background of Japan's economy concerning the period 1970-2002. Section 4 outlines my theoretical model. Section 5 presents my empirical models and the volatility measures, it also provides information on the data. Section 6 reports the empirical results and section 7 concludes.

3.2 The Empirical Literature Review

There is a large literature basis analyzing the use of the signal-extraction framework to explain how economic agents behaviors can be affected by macroeconomic uncertainty. Beaudry et al. (2001) is the first paper using this approach that investigates the relationship between monetary instability and the allocation of investment rate. Their paper is based on the idea that inflation reduces the price stability so as to reduce the information content of prices. They assume that price stability allows investments to be more effectively allocated towards high-profit projects since the firms' own relative prices are easily identified. Thus, under a stable inflation, predictability of prices will result in a more unequal distribution of investment rate across firms. In contrast, an unstable monetary policy should lead to a narrowing of the dispersion of investment rate across firms due to the similar conservative behavior of managers towards macroeconomic uncertainty. Beaudry et al. (2001) focused on a panel of firms in the UK over the period 1970-1990, during which wide variation of dispersion of cross-sectional investment rate was experienced. The distribution of cross-sectional investment rate was significantly narrower in the 1970s and it widened in the 1980s. In the meanwhile, UK's monetary policy frequently changed in the 1970s leading to greater uncertainty in the macro-economy, which was followed by a stable period in the 1980s. By augmenting the simple macro model with a signal-extraction framework, they derived a negative relationship between inflation variance and the distribution of cross-sectional investment rate. The implications of their theoretical model received a strong empirical support from a panel of UK firms. One can see that UK firms' investment rates are unequal to each other, and the range of the distribution is narrower when there is higher inflation uncertainty; while the range becomes wider when there is a stable monetary environment.

Following Beaudry et al. (2001)'s idea, Baum et al. (2004b) investigated the response of bank lending behavior to macroeconomic uncertainty. Bank loans mitigate firms' inability to access to the public securities due to asymmetric information problems. Hence, supply of bank loans are very important to relative weak firms in terms of finding finance resources. However, banks will extend loans only if they are able to accurately forecast best lending opportunities due to the better economic condition. Baum et al. (2004b) assumed higher uncertainty leads to a reduction of loan-to-asset ratios' (LTA) dispersion ratio, and then detect the relationship between the macroeconomic uncertainty and cross-sectional dispersion of banks' loan-to-asset ratios. Their results show that as macroeconomic uncertainty increases, the dispersion of cross-sectional banks' loan-to-asset ratios will narrow due to banks' homogeneous reaction to ambiguous return predictability. In contrast, the cross-sectional dispersion of banks' loan-to-asset ratios become wider when the uncertainty falls as managers have better information on the lending opportunities and banks have more latitude to behave in an idiosyncratic nature. Thus, stable macroeconomic environment allows for a more efficient allocation of loanable funds for firms.

Baum et al. (2004c) use the same signal framework to describe how cash holdings for non-financial firms behave when managers face higher macroeconomic uncertainty. To explore the effect of macroeconomic uncertainty on firms' cash-holdings behaviors, they extended a cash-buffer model with a signal extraction framework. Their theory is based on the idea that a higher volatility will result in a higher degree of asymmetric information and subsequently, potential difficulties for non-financial firms in getting access to external finance. In order to mitigate the adverse effect of credit restrictions and lower the cost of external financing, all managers have a choice of appropriate level of cash holdings. Baum et al. (2004c) expect that changes in macroeconomic stability will trigger the adjustment of managers' decisions of the level of cash holdings. Their model identifies a negative effect of macroeconomic uncertainty on the dispersion of firms' cash holdings. This hypothesis receives supports from a panel of 200,000 U.S. firms. In sum, increasing macroeconomic uncertainty reduces the accuracy of managers' predictions about future cash flows, subsequently, they exhibit conservative behavior, leading to a narrow range of dispersion of cross-sectional firms' cash holdings. On the contrary, less macroeconomic uncertainty allows managers to have better quality information and make more accurate predictions about cash flows, leading to a wider range of dispersion of cross-sectional firms' cash-holdings.

Besides reviewing literature with signal-extraction approach, this section also reviews literature that explains the relationship between inflation uncertainty and the level of sectoral output growth, or its cross-sectional dispersion.

Lucas (1973) reported that changes in inflation rates will increase the variance in average prices, however it can not increase average output. Therefore studies started to examine the association looking at the possibility that it could be entirely contemporaneous.

Economists then debated the issue of "does inflation variability affect the allocation of resources?". Friedman (1977) argued: more noise in the price system reduces economic efficiency. Hence, inflation volatility lowers economic efficiency and reduces output through its adverse effect on extracting information from the price system. Following Friedman's (1977) Nobel lecture which emphasizes the potential negative impact of inflation uncertainty on output growth, many researches empirically show that the presence of an adverse relationship between inflation uncertainty and output growth.

Jansen (1989) provided further evidence of a negative relationship between inflation uncertainty and output growth. De Gregorio (1992) proposed that both level inflation and its variability have negative effects on growth, and may have negative effects on the rate of investment. Moreover, both Jansen (1989) and De Gregorio (1992) postulated that the negative effect is valid in general and not only in countries that had a high inflation rate. However, Hayford (2000) suggested that increases in inflation uncertainty results in temporarily slower output growth. Grier and Perry (2000) showed that increases in inflation uncertainty are significantly associated with lower rates of real output growth in the United States during the 1948-1996. Grier et al. (2004) suggested that higher inflation uncertainty is significantly negatively correlated with lower output growth. Apergis (2004) and Wilson (2006) investigated the links between inflation uncertainty and output growth for G7 countries and post-war Japan. Their results indicated that increased inflation uncertainty is associated with lower average growth in Japan. Fountas and Karanasos (2007) found a negative relationship between inflation and output growth for the G7 between 1957-2000. While Katsimbris (1985), Thornton (1988), Jansen (1989), Levine and Renelt (1992), Levine and Zervos (1993), Bohara and Sauer (1994) and Clark (1997) failed to provide such support.

Apart from using aggregate data, some studies use cross-sectional data to detect the effects of inflation uncertainty on growth rate. Huizinga (1993) implemented his empirical work based on quarterly data in aggregate U.S. manufacturing for the period of 1954-1989. He carried out both time-series and cross-sectional analyses and showed a negative link between the variance of inflation and output price. Based on a sectoral analysis of 450 4-digit-SIC-code manufacturing industries during 1958-1986, his results are different. Some industries are positively associated with uncertainty while some are negatively associated.

Other studies provided a positive relationship between inflation volatility and output growth. Dotsey and Sarte (2000) showed that more inflation uncertainty can have a positive output growth effect. According to their argument, an increase in the variability of monetary growth makes the return to money balances more uncertain and leads to a fall in the demand for real money balances and consumption. Hence, agents increase savings, and the pool of funds available to finance investment increases. Thus, inflation uncertainty is positively related to output growth, through the firms' financing channel.

In this chapter, I investigated the effect of inflation variance on both aggregate output growth, and the variation of dispersion of sectoral output growth. Cross-sectional variance of sectoral output growth is calculated as the proxy of the dispersion of sectoral output growth. I then apply the GARCH model to capture the proxy of inflation uncertainty (see Engle 2001).

3.3 The Macroeconomic History of Japan and Its Manufacturing Industry

This section reviews the Japanese macroeconomy over the three volatile decades from 1970 to 2002. Japan's real economy experienced a period of "miracle" growth of around 10% average in the 1960s. It then dramatically fell after the 1973 oil crisis and has not recovered back to its pre-crisis level since then. Beginning with oil price increases, the economic growth declined from 10% to an average of 5% in the 1970s. The oil price shock affected the CPI inflation rate wandering around an unusually high level of above 30% in 1973 and 1974, which then fell down to 4% in 1978 and reached 8% in 1979. After the oil crisis episode in the 1970s, Japan's economy shifted away from oil-intensive industries, such as "Petroleum refineries", towards other sectors including "electronics", paving the way to huge corporations.

After the 1970s, Japan experienced a bubble in 1980s. CPI inflation rate quickly fell to below 3% in 1982 and fluctuated at the low range of 0-3%

for the rest of the 1980s. Japan's economic growth rate was around 5% in comparison to 2% for other western advanced economies during the same period. Economists around the world therefore highly praised the growth rate at which Japan has experienced in those years. Meanwhile, asset prices tripled in a rather short time period. However, since the CPI inflation rate remained low in this period, monetary policy did not respond to the expansion of the bubble economy. The monetary policy was too lax until 1989, and tightened with successive rises in interest rate as CPI inflation rate increased. Accordingly, the stock prices and land prices dropped by two-thirds within only two years — the bubble finally had burst.

For the first two years after the burst of bubble, the public had not seen any immediate effect. Robust consumption and investment continued and the growth rate remained around 3% until 1992 followed by a dramatic slow down. CPI inflation fell from 2% to 0% by mid-1995. In 1997, having not fully recovered from the bubble crisis, Japan began to experience the Asian currency and bank crisis. The economy continued to deteriorate in 1998, and had recorded negative growth for the first time since 1976. Reduction in the interest rate failed to rescue the economy. During this period, banks curtailed lending due to the financial crisis. Thereafter the severe credit crunch adversely affected aggregate demand pushing prices down, and impeded the production decision. From 1999, the Bank of Japan carried out a zero interest rate policy (ZIRP). However, the economy did not respond to it at all implying that Japan's monetary policy of the short-term interest rate reduction was no longer effective.

My study in this chapter investigates how Japanese manufacturing industries reacted toward inflation uncertainty during these volatile 30 years. Some sectors evolved systematically during our estimation period 1970-2002. For instance, the Transport Equipment industry was hit by a lengthy recession from the late 1970s through most of the 1980s, which resulted in a drastic cutback in the use of facilities, but there was a sharp revival in 1989. The electric and electronics sector become one of the first three key manufacturing industries to be affected by the oil crisis. The food industry maintained its important role during the whole period. Given that sectors behaved differently under the same economic environment, it would be interesting to find out the movement of cross-section dispersion of sectoral output growth along with the volatile period in Japan.

3.4 Theoretical Model

In this section, I present a simple model to analyze how price variability affects the evolution of sectoral output growth and its cross-sectional dispersion. My model is based on the view that increased inflation leads to higher price volatility. In this context, it's generally accepted that increases in volatility impede the ability of managers to predict future changes in prices.

3.4.1 Modeling Dynamic Pricing Process

It assumes the sectoral prices follow a simplc stochastic process by

$$P_{t,i} = \bar{p} + \varepsilon_{t,i} + \psi_{t,i} \tag{3.1}$$

$\bar{p}$ is the permanent component of the price for sector i, while $\varepsilon_{t,i}$ is the stochastic component of the fundamentals determining the long-run sectoral price. The stochastic component of the sectoral price is assumed to follow a random-walk process, $\varepsilon_{t,i} = \varepsilon_{t-1,i} + \nu_{t,i}$, where $\nu_{t,i} \sim N(0, \sigma_t^2)$. $\psi_{t,i}$ represents the temporary unobservable shock to the fundamentals and is considered as a white noise with mean zero and variance η_t^2, $\psi_{t,i} \sim N(0, \eta_t^2)$. $\nu_{t,i}$ and $\psi_{t,i}$ are mutually uncorrelated.

I assume that agents in each sector know this pricing process ($\bar{p}$ and σ_ν^2). Using that information, agents could make a prediction on the next-period's price for sectoral output, which would guide decisions of optimal output level in the next period. So the more information the decision-maker could gather on $\nu_{t,i}$, the more precise predictions on prices will be. However, the decision-maker can not observe $\nu_{t,i}$, but instead observes a noisy signal on $\nu_{t,i}$ due to the last component in equation (3.1). In other words, the accuracy of the prediction depends on information content of the signal ($S_{t,i}$), which is structured by

$$S_{t,i} = P_{t,i} - P_{t-1,i} = \nu_{t,i} + \Delta\psi_{t,i} \tag{3.2}$$

where $\psi_{t,i}$ represents the unexpected shock in each sector, which we call noise, that hinders economic agents from having a precise forecast of the permanent component. Given the signal $S_{t,i}$, the expected value of the permanent component of the one-period-ahead price at time t in sector i is $E(\varepsilon_{t,i} \mid S_{t,i}) = \varepsilon_{t-1,i} + \lambda_{t,i} S_{t,i}$, where $\lambda_{t,i} S_{t,i} = E(\nu_{t,i} \mid S_{t,i}) = \frac{Cov(\nu_{t,i}, S_{t,i})}{Var(S_{t,i})} S_{t,i} = \frac{\sigma^2_{t,i}}{\sigma^2_{t,i} + \eta^2_{t,i} + \eta^2_{t-1,i}} S_{t,i}$. Hence, given the signal $S_{t,i}$, the one-period ahead prediction of price will be:

$$E(P_{t,i} \mid S_{t,i}) = \bar{p} + \varepsilon_{t-1,i} + \lambda_{t,i} S_{t,i} \tag{3.3}$$

Using the signal extraction formula above, the decision-maker can predict next-period's price and choose the optimal sectoral output for the next period. However, the presence of the noise in the signal will affect the decision of the manager. In what follows, I will lay out the details of the model to show how noise in the signal can affect the sectoral output behavior.

3.4.2 Modeling Output Behavior under Inflation Volatility

Firms in all sectors are profit maximised. Denoting output, capital stock, investment and labor input by $y_{t,i}$, $K_{t,i}$, $I_{t,i}$ $L_{t,i}$, one can write the sectoral profit (π) as :

$$\pi_{t,i} = P_{t,i} y_{t,i} - w_{t,i} L_{t,i} - r_{t,i} K_{t,i} \tag{3.4}$$

where w is the price of labour and r is the price of capital. Assuming that firm's output can be captured by a simple Cobb-Douglas production function. The manager aims to maximize the profit function with respect to its capital and labour. I maximise the profit function with respect to labour and substitute the optimal labour back into the profit function[2]. The expected value of sectoral

[2]See Baum, Caglayan and Barkoulas (2001) for a similar approach. Maximising the profit

profit can be expressed as:

$$\pi_{t,i} = E_{t,i} \sum_{n=o}^{\infty} \beta^n \left[P^{\gamma}_{t+n,i} A_{t+n,i} K^{\theta}_{t+n,i} - P^I_{t+n,i} I_{t+n,i} \right] \qquad (3.5)$$

where I is investment and p^I is the price of new investment goods. Assuming that it takes time to increase capital. The evolution of the capital stock takes the format: $K_{t,i} = (1-\delta)K_{t-1,i} + I_{t-1,i}$. Using the constrains imposed by the evolution of the capital stock, I maximize equation (3.5) with respect to $K_{t+1,i}$ to obtain the optimal capital stock as:

$$\frac{\partial \pi_{t,i}}{\partial K_{t+1,i}} = \beta E_{t,i} \left[\theta P^{\gamma}_{t+1,i} A_{t+1,i} K^{\theta-1}_{t+1,i} + p^I_{t+1,i}(1-\delta) \right] - p^I_t = 0 \qquad (3.6)$$

Then rewrite equation (3.6) as

$$E_{t,i} \left[\theta P^{\gamma}_{t+1,i} A_{t+1,i} K^{\theta-1}_{t+1,i} \right] = \beta^{-1} p^I_{t,i} - E_{t,i} p^I_{t+1,i}(1-\delta) \qquad (3.7)$$

where the right hand side of the equation may be defined as, $c_{t,i}$, Jorgenson's user cost of capital (see Baum, Caglayan and Barkoulas, 2001). Taking the log of both side of the equation, one can derive

$$(1-\theta) log K_{t+1,i} = log E_{t,i} P^{\gamma}_{t+1,i} + m_{t+1,i} \qquad (3.8)$$

where $m_{t+1,i} = -log c_{t,i} + log\theta + log A_{t+n,i}$. Using the properties of log normality:

function $\pi_{t,i} = P_{t,i} T_i K^{\alpha}_{t,i} L^{\zeta}_{t,i} - w_{t,i} L_{t,i} - r_{t,i} K_{t,i}$ (where T and $w_{t,i}$ denote the nonstochastic coefficient for technical progress and the wage rate, respectively) with respect to L and substituting back into the profit function yields $\pi_{t,i} = P^{\gamma}_{t,i} A_{t,i} K^{\theta}_{t,i}$, where $\gamma = 1/(1-\zeta)$, $\theta = \alpha/(1-\zeta)$ and $A_{t,i} = (\zeta T/w_{t,i})^{\zeta\gamma} - w_{t,i}(\zeta/w_{t,i})^{\gamma} > 0$

$$(1-\theta)logK_{t+1,i} = \gamma E_{t,i}logP_{t+1,i} + \frac{\gamma^2}{2}Var_{t+1|t}(logP_{t+1,i}) + m_{t+1,i} \qquad (3.9)$$

Given the behavior of the prices described in section 3.4.1, one can use $E_{t,i}(\log P_{t,i}|S_{t,i}) = \log P_{t-1,i} + \lambda_t S_{t,i}$ and simplify Equation (3.9) as

$$\log K_{t+1,i} = \frac{\gamma}{1-\theta}\left[\log P_{t-1,i} + \lambda_t S_{t,i}\right] + \frac{1}{1-\theta}\zeta_{t,i} \qquad (3.10)$$

where $\zeta_{t,i} = \frac{\gamma^2}{2}\left[\sigma^2_{t+1,i} + (1-\lambda_t)\sigma^2_t\right] + m_{t+1,i}$. Equation (3.10) shows that the log of one-period-ahead capital is related to the past value of the permanent component of the output price and the noisy signal, $S_{t,i}$, on the stochastic component of the sectoral prices. Recalling that the production technology is Cobb-Douglas, rewrite the log of sectoral output ($\log y_{t,i}$) as

$$\log y_{t+1,i} = \frac{\gamma\theta}{1-\theta}\left[\log P_{t-1,i} + \lambda_{t,i} S_{t,i}\right] + \frac{1}{1-\theta}\zeta_{t,i} + \log A_{t+1,i} \qquad (3.11)$$

then, derive the sectoral output growth rate as:

$$\log\frac{y_{t+1,i}}{y_{t,i}} = \tfrac{\gamma\theta}{1-\theta}\left[\nu_{t-1,i} + \lambda_{t,i}S_{t,i} - \lambda_{t-1,i}S_{t-1,i}\right] + \tfrac{\theta}{1-\theta}\Delta\zeta_{t,i} + \log\tfrac{A_{t+1,i}}{A_{t,i}} \qquad (3.12)$$

From Equations (3.11) and (3.12), given $\lambda_{t,i}S_{t,i} = \frac{\sigma^2_{t,i}}{\sigma^2_{t,i}+\eta^2_{t,i}+\eta^2_{t-1,i}}S_{t,i}$, one can see that output growth is affected by the current and lagged variance of the noise on the signal depicted by $\eta^2_{t,i}$ and $\eta^2_{t-1,i}$. As the variance of the noise approaches 0, $\lambda_{t,i}$ will approach 1. This therefore means that the signal provides full information on the stochastic component of prices. Contrarily, the larger $\eta^2_{t,i} + \eta^2_{t-1,i}$, the smaller $\lambda_{t,i}S_{t,i}$ impeding the managers ability to predict the price so as to lead to a fall in production. I set $\tau^2_{t,i} = \eta^2_{t,i} + \eta^2_{t-1,i}$, the effect of noise on output growth can be studied by observing the derivative of equation (3.11) with respect to $\tau^2_{t,i}$ as follow:

$$\frac{\partial \log \frac{y_{t+1,i}}{y_{t,i}}}{\partial \eta^2_{t,i}} = -\frac{\gamma\theta}{1-\theta}\left[\frac{\sigma^2_{t,i}}{(\sigma^2_{t,i} + \tau^2_{t,i})^2}S_{t,i} - \frac{\gamma}{2}(\frac{\sigma^4_{t,i}}{(\sigma^2_{t,i} + \tau^2_{t,i}})\right] \tag{3.13}$$

The sign of the equation depends on the size and the sign of the signal $S_{t,i}$. Ceteris paribus, an increase in the variance of the noise can lower the sectoral output growth, while a decrease in the variance of the noise can raise the sectoral output growth.

Now I examine if the volatility of the noise has a robust effect on the dispersion of the cross-sectional output growth. To understand the impact of the volatility in the signal, I first calculate the variance of the cross-sectional output growth

$$Var\left(\log \frac{y_{t+1,i}}{y_{t,i}}\right) = G\left[(1-\lambda_{t-1,i})\sigma^2_{t-1,i} + \lambda_{t,i}\sigma^2_{t,i} + 2\lambda_{t,1}\lambda_{t-1,i}\eta^2_{t-1,i}\right] \tag{3.14}$$

where $G = (\frac{\gamma\theta}{1-\theta})^2$. Differentiating Equation (3.14) with respect to $\eta^2_{t,i}$ yields the effect of volatility in the signal on the cross-sectional output growth volatility, which is given by

$$\frac{\partial Var(\log \frac{y_{t+1,i}}{y_{t,i}})}{\partial \eta_{t,i}^2} = -G(\sigma_{t,i}^2 + \frac{2\sigma_{t-1,i}^2\eta_{t-1,i}^2}{\sigma_{t-1,i}^2 + \tau_{t-1,i}^2})(\frac{\sigma_{t,i}^2}{(\sigma_{t,i}^2 + \tau_{t,i}^2)^2}) < 0 \qquad (3.15)$$

Equation (3.15) illustrates that the variance of noise has a negative impact on the cross-sectional output growth dispersion. In this case, if the economic environment is tranquil, all firms in sectors are able to get more information on the behavior of prices. Thus, economic tranquility will help managers to make optimal decisions on the capital stock, while in return leading them to produce at the output that maximises their company profits. If the economic environment is volatile, managers will make conservative decision on capital stock leading to a narrowing of the cross-sectional dispersion of output growth rate.

3.5 Empirical Investigations

This section proposes two sets of models to study the effects of the noise in the signal in output prices on the sectoral output growth, as well as the cross-sectional dispersion of the sectoral output growth. Inflation volatility is the proxy of the noise of the signal in the prices. Since variation of sectoral output growth rate are also determined by several other macroeconomic related variables, I therefore incorporated these variables into my empirical models to test the robustness of the effect of inflation volatility, such as level of inflation, growth of real interest rate, changes of oil price in local currency, variance of oil price growth and credit constrains[3]. Several studies have confirmed the effects of those related variables on output growth (see Talan Iscan and Lars Osberg, 1998).

The simplest empirical model that I used to understand the linkage between output growth and the variance of inflation rate takes the following form:

$$\Delta \log y_{t,i} = \alpha + \beta_1 \eta_{t,i}^2 + \beta_2 \eta_{t-1,i}^2 + D_{yr} + D_{<0} + Inf\_D + \phi_{t,i} \qquad (3.16)$$

where $\Delta \log y_{t,i}$ is the first difference of the log annual real sectoral output growth-rate in sector i at time t; η^2 is the conditional variance of the inflation rate; D_{yr} captures the 1973-74 oil price shock[4]. Since Japan's economy has been through both inflationary and deflationary period during the investigated time, this chapter assumes a different slope for the link between inflation volatility and sectoral output variability. I incorporate a dummy variable $D_{<0}$ which stands for deflationary period. $D_{<0} = 1$ when inflation rate is negative and zero otherwise. Inf_D is the interaction term of inflation volatility with deflation $D_{<0}$, which describes a different impact of inflation volatility on sectoral output growth rate under deflation. I then augment the basic model with aforementioned variables.

The second model will investigate the effects of inflation volatility on dispersion of sectoral output growth:

[3]Aghion et al.(2005) show robust negative relationship between credit constrains and volatility of output growth.

[4]The error term in the estimated equation is meant to capture changes in η which are uncorrelated with inflation volatility and which are not captured by the additional regressors we include in our robustness checks.

$$Var_i(\Delta \log y_{t,i}) = \gamma + \delta_1 \eta^2_{t,i} + \delta_2 \eta^2_{t-1,i} + D_{yr} + D_{<0} + Inf\_D + \omega_{t,i} \quad (3.17)$$

where $Var_i(\Delta \log y_{t,i})$ is the cross-section variability of sectoral output growth rate. To characterize the variability of sectoral output growth rate, the dispersion measure is the cross sectional standard deviation of the annual growth rates in (3.16), computed in an equal-weighted manner. Real sectoral output is obtained by deflating nominal output by annual CPI index. To generate the cross-sectional dispersion of output growth, I compute cross-sectional standard deviation of 28 sectors' of output growth rate for each year.

Since conditional variance of inflation rate $\eta^2_{t,i}$ has been derived using GARCH model, thus it brings the estimated error in the generated regressor to the main model. To solve the generated regressor problem, standard errors are bootstrapped using Jackknife Method.

3.5.1 Generating the Conditional Variance of Inflation Rate

Given a monthly CPI dataset, I first compute the variance of monthly CPI changes using GARCH methodology and then aggregate monthly variances per year, to obtain an annual inflation uncertainty. Earlier literature applied a moving window methodology to calculate the moving standard deviation of inflation rate. However, since moving standard deviation methodology includes average weighted data of past 12 months, it may contain substantial correlation.

Alternatively, GARCH (Engle 2001) techniques estimate a model of the variance of unpredictable innovations in a variable, rather than simply calculating a variability measure from past values (moving standard deviation). Furthermore, GARCH method gives an explicit test of whether the movement in the conditional variance of a variable over time is statistically significant. That is, one can reject the null hypothesis that the uncertainty is constant over the sample period, while the real inflation uncertainty does fluctuate over time.

Figure 3.1 shows the pattern of inflation rate ($\Delta \log CPI_t$) on a monthly basis. Formal testing and estimation is carried out by the maximum likelihood method. $\Delta \log CPI_t$ is shown to be time-varying conditional heteroscedasticity[5]. Thereby, the GARCH model adequately yield a consistent proxy for inflation uncertainty during the sample period of 1970-2002. The GARCH model for capturing the aggregate inflation volatility is taken the following formulae:

$$\Delta \log CPI_t = \beta_0 + \Sigma_{n=t}^{12} \beta_n \Delta \log CPI_{t-n} + \mu_t + \theta_1 \mu_{t-1} \qquad (3.18)$$

and

$$h_t = \alpha_0 + \alpha_1 \mu_{t-1}^2 + \alpha_2 h_{t-1} \qquad (3.19)$$

where μ_t is the residual of the inflation regression and h_t denotes the condi-

[5]The null hypothesis of a unit root in the inflation process is rejected at the 1% level indicating that log difference of CPI is stationary.

tional variance. The inflation process appears to be a one order moving average trend, so I construct GARCH(1,1) model with MA(1). Table 3.2 shows the econometric results. The standard Lagrange Multiplier (LM) test cannot reject the presence of GARCH effects. Figure 3.2 plots the monthly inflation volatility generated by the GARCH model.

I then define annual inflation volatility as the sum of the monthly conditional variance of inflation by year. The estimated annual inflation volatility yields very high inflation uncertainty in the 1970s, a stable macroeconomic trend in 1980s, a continually decreasing movement in the early 1990s and increasing inflation variations in the late 1990s indicating a volatile environment. As expected from the statistical results, Japan's CPI inflation rate came down from 12% in 1974 to below 4% in 1978 and suddenly went up to 8% in 1979 due to two oil crises. It then moved to the low range of 0-3% in 1980s due to the stable economy, and kept dropping down from 2% to 0% in 1990s. Since the financial crisis in 1998, the inflation rate stayed negative until the end of 2003.

3.5.2 Data

The data set used in this study covers the output growth in 28 sectors in Japan's manufacturing industry over the period 1970-2002. The sectoral output growth is collected from UNIDO Industrial Statistics Databases, which corresponds to the definitions of the 3-digit International Standard Industry Classification (ISIC). All output data are in national currency (Japanese Yen) at current prices. Annual CPI is obtained from International Monetary Fund. Real interest rates are the percentage changes of the treasury bill rate per annum. Credits are the bank loans to private sector in the unit of trillions of Japanese yen. They are downloaded from annual series in International Financial Statistics (IFS). Annual oil price is obtained from History of Crude Oil Prices from The Illinois Oil Gas Association (IOGA). Exchange rate of Japanese yen against the U.S. dollar is collected from PACIFIC Exchange Rate Service.

Given that this study investigates how cross-sectional dispersion of output growth evolves along varying inflation volatility, I first provide a visual summary of the dispersion changes that occurred over the period 1970-2002, see figure 3.3. It displays the first 5%, the first decile, the first quartile, the median, the third quartile, the ninth decile and the last 5% of the dispersion of sectoral output growth.

The level manufacturing output growth rate fell from 9% in 1970 to −5% in 2002 on average. While the distribution of sectoral output growth has attained substantial fluctuations during 1970s and 1990s, it was relatively wide and stable during 1980s compared to the rest of time and experienced a substantial narrowing from late 1980s to early 1990s. I also found narrowing dispersion of sectoral output growth in periods corresponding to most of the recessions. This is true for the oil shocks in the 1970s, "Japanese asset price bubble" in late 1980s and the Liquidity Trap in late 1990s.

When I look through the common feature of each sectoral growth, one can find that output of sectors 13,16,17,23,24,27,29 are more volatile than others. Petroleum Refineries sector (16) is upto three times more volatile than normal sectors, with the standard error of 0.213 while others have the average value of 0.7. The changing degree of growth for sectors are not only due to the degree of inflation volatility, but also the elasticity feature of the specific sector.

3.6 Empirical Results

This section presents the empirical results of two hypothesis. Proposition 1. The effect of the variance of inflation rate on the sectoral output growth rate is ambiguous. Proposition 2. The cross-sectional dispersion of sectoral output growth is negatively affected by the variance of inflation rate.

3.6.1 The Effect of Inflation Volatility on Sectoral Output Growth

Four sets of regressions are operated for each of those 28 sectors. Table 3.3 presents the empirical results in 4 columns showing the effect of inflation volatility on output growth in sectoral level. I augmented the simplest model by variables that are shown to be playing an important role by other researchers. In total, I investigated 112 models. My results list the number of cases out of 28 sectors and their significant sign of effects.

Column (1) presents the simplest model. There are 16 out of 28 sectors taking a significant negative price elasticity of growth rate, implying a reduction in growth rate when there is a high volatility in the macroeconomic environment. Those sectors are sectors 4, 8, 9, 10, 12, 13, 16, 17, 19, 20, 21, 22, 23, 24, 25, 27, see in table 3.1. Only for sector (15), Miscellaneous Petroleum and Coal products, it's a significant positive elasticity indicating an increasing output growth when there is a high inflation uncertainty. The rest of the sectors' output growth rates reveal an insignificant relationship towards inflation volatility. Thus, on average, sectors in manufacturing industry shrink their output growth rate when there is a higher a inflation volatility. Oil crisis and deflationary period are found to be significant for all 28 sectors. The relationship between inflation volatility and sectoral output growth varies during inflation and deflation period. The asymmetric effect of inflation and deflation exists in all the other 3 columns too.

In Column (2), I augment the basic model in column (1) with the level of inflation rate and change in interest rate. My findings are similar to those given earlier. 16 out of 28 sectors observe a negative effect of inflation volatility on sectoral growth. Also, those sectors become more sensitive to inflation uncertainty, showing that the impact of inflation variance exacerbates when level of inflation rate and change in interest rates are inclusive. Sector 15 positively responds to increasing inflation volatility. As for impact of inflation rate, the majority (16/28) of sectors' output growth rates are not relevant to the level of inflation rate. Similarly, sectors' output growth rates are not relevant to the change in interest rate too. Only Leather products (sector 6) and Printing and publishing (sector 11) sectors' output growth rate is positively affected by the change in interest rate.

Column (3) augments the model in column (2) with oil price and the variance of oil price. 14 out of 28 sectors have negative and significant effect of inflation variance on the growth rate, sector 8, 10, 12, 13, 14, 16, 17, 19, 20, 21, 22, 23, 24, 25. Textiles (4), Furniture, except metal (9) and Professional and scientific equipment (27) are no longer significantly affected by inflation variance when I included the impacts of changes in oil price and its volatility. Sector (14) Petroleum refineries becomes sensitive to the inflation variance combined with oil related effects. Regarding inflation's impact, 18 out of 28 sectors were found not to be affected by inflation. For the impact of the change in interest rate, only the output growth rate of sector (11) Printing and publishing has a positive coefficient. The augmented variables such as change in oil price and its volatility, displayed a weak effect on output growth. For change in oil price, 7 out of 28 sectors (12, 14, 15, 16, 21, 22, 26) demonstrated a positive effect of oil price on their output growth rates. Only sector (26) Transport equipment showed a negative and significant effect of oil price volatility on its output growth rate. Thus, in general, changes in oil price and its uncertainty failed to have impact on Japan's manufacturing sectoral output growth rates.

In column (4), I add changes in credit into column (3) to investigate if the development of credit in Japan helps the effect of inflation variance on changes of sectoral output growth rate. The coefficients of inflation variance are similar to previous presentations. 16 out of 28 sectors (8, 10, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27) are significantly and negatively affected by inflation variance on their sectoral output growth rate. For the impact of the level inflation rate, 17 out of 28 sectors are insignificantly related to level inflation rate. The change in interest rate failed to find evidence to show a significant impact on the sectoral output growth rates. Change in oil price failed to affect sectors' output growth rates in 18 out of 28 sectors. For sector 11, 26, 28, their output growth rates are nevertheless negatively related to oil price's volatility. Among 28 sectors, 6 of them — Leather products (6), Printing and publishing (11), Pottery, china and earthenware (18), other none metallic mineral products (20), Machinery, except electrical (24) and Other manufacturing products (28)— are positively affected by credit. It shows that, an increase in credit amount to private sectors, helps those sectors' output growth rates. Thus those sectors are therefore more depend on external financial resources through bank loans, than rest of the sectors in Japan.

3.6.2 The Effect of Inflation Volatility on the Variance of Cross-sectional Output Growth

This section presents my second proposition. I estimate four sets of models that are similar to the previous section but investigate the aforementioned effects on the wide dispersion of cross-sectional output growth rate. The results are presented in table 3.4. Firstly, I regressed the dispersion of sectoral output growth on the current and one-year lag inflation variances, as well as a dummy variable for the year of the oil crisis in the 1970s, giving us the basic model in column (1). A deflation dummy and an interaction term of inflation volatility with deflation can help us to distinguish asymmetric effect of inflation and deflation. In column (2), I added inflation and interest rate to the basic model in column (1), which provided us with the second model of sectoral output growth, regressing on inflation variances, inflation and interest rate. Column (3) was created by adding oil prices and oil price variance to column (2). Finally I added credit to column (3) to give us the final model in column (4).

Column (1) presents the results of the basic model. It exhibits a negative and significant effect of the contemporary inflation volatility on the dispersion of sectoral output. An one unit increase in percentage change in inflation volatility in current year, will lead to a 23% reduction in the dispersion of cross-sectional output growth. Contrariwise, lagged inflation uncertainty has a positive effect on the spread of cross-sectional growth. An one unit increase in percentage change in lagged uncertainty causes a 18.63% increase in the spread of sectoral output growth. Nevertheless, when I detect the joint effect of the current and lagged inflation volatility on the dispersion of growth rate, the effect is significantly negative. The dispersion of cross-sectional output growth narrows 4.4% if the joint effect of inflation variance in last two years was increased by one unit. The interaction term of inflation volatility with the deflation dummy variable is significant and positive. The joint effect of inflation volatility under deflation on sectoral output growth variability is 36%, showing an opposite direct to the same effect under inflation. Thus, the asymmetric impact of deflation exists in this study.

Column(2) augments the model in column (1) with two more variables: the level of inflation rate and the change in interest rate, which are considered to affect sectoral output growth. Consistent with what I proposed, current inflation uncertainty has a negative and significant effect on the current dispersion of sectoral output growth. The joint effect of current and lagged inflation variance on the dispersion of output is both negative and significant. The level of inflation rate takes a positive but insignificant impact on the dispersion of cross-sectional output growth. Changes in interest rates takes an negative impact on the dispersion of cross-sectional output growth. As the increase of interest rate will discourage the investment therefore leads to a similar output produce decision across sectors, with a narrower dispersion of sectoral output growth.

Since recent literature reports a significant impact of oil price and its volatility on output growth, I therefore introduced those two variables in column (3) to detect their effects on Japan's economy. The results indicate that the negative effect of inflation variance on the dispersion of sectoral growth is getting larger, if one takes the effect of changes in oil prices into consideration. However, there is no evidence confirming that oil price itself and its variance can affect sectoral output growth significantly.

Column (4) extends the model in column (3) with the changes in credit. The results show that the effect of inflation variance on the dispersion of sectoral output growth is still negative and significant, as in the earlier models. Increases in the joint effect of current and lagged inflation variance still leads to a reduction in the dispersion of cross-sectional output growth. There is, however, still no evidence showing that inflation rate and the change in interest rate can have an impact on the variation of dispersion of cross-sectional output growth. With respect to the impact of credit, my result is consistent with recent literature findings that credit is taking a negative and significant effect on the cross-sectional dispersion of output growth. Increase in credit will reduce the negative effect of inflation uncertainty on sectoral output growth. As increasing in credit encourages investment and derestricts firms' external financing problems. Therefore it reduces the difference of output growth across sectors. Increasing credit narrows the dispersion of cross-sectional output growth due to the reduction of credit constrains for all sectors.

Finally, I combined the empirical findings of two sets of models and provided a big picture for the evolvement of the Japanese manufacturing industry. When a macro-economy is in a turmoil, thereby higher inflation uncertainty, (1) Japanese manufacturing sectors generally lower their output growth rate. The more inflation uncertainty, the less predictability of output price for producers. Managers' decisions on capital stock and output in the next period is based on their prediction of output prices. Therefore when there is a higher inflation uncertainty, producers are more conservative to their future output decisions, with lower output growth rate. (2) the cross-sectional dispersion of sectoral output growth rates shrinks due to each individual output growth reduction. (3) Changes in interest rate have an impact on the variations of the dispersion of cross-section output growth. Rising interest rate discourages investment and output production for both individuals and whole industry. (4) Bank credit reduces the wide range of cross-section dispersion of output growth rates while each sector goes off in an ambiguous direction. More bank credit relieves producers who were suffered from external financing problems. It leads to less distance of output growth rate from stronger firms to weaker firms.

3.7 Conclusion

This chapter sheds light into how inflation uncertainty affects sectoral output growth and its cross-sectional dispersion. It is assumed that: if higher inflation uncertainty raises uncertainty about the output price, it can be in a firm's best interest to decrease production until uncertainty has decreased; or until the expected payoff from taking risk of increasing production increases enough, to offset the higher uncertainty. In order to test these hypotheses, I constructed an augmented profit function with a signal-extraction framework. My propositions then demonstrate: (1) an ambiguous effect of the signal noise on level of sectoral output growth rate; (2) a negative effect of signal noise on the cross-section dispersion of sectoral output growth rate.

I proxy inflation uncertainty as the noise in the signal in the signal-extraction framework. Consequently, it show thats the volatility of inflation negatively affected the dispersion of sectoral output growth rate. Reduction in inflation variance will widen the range of cross-section output growth rate, and it will increase the output growth rate in certain sectors and decrease the output growth rate in other sectors.

I then empirically investigated my theoretical propositions using a data set for 28 sectors in the Japanese manufacturing industry. The inflation uncertainty is captured by $\Delta \log CPI$ generating by GARCH model. The results show that the inflation volatility in Japan has an adverse impact on the sectoral output growth rate in manufacturing industry. The inflation volatility, also negatively influences the cross-sectional spread of sectoral output growth.

The final issue to be considered is the connection between empirical results and recommendations about economic policy. This chapter proposes that monetary instability, through its effect on the information content of prices, hinders the efficient supply of output. Thus low and stable inflation is expected to be the major goal of macroeconomic policy.

Table 3.1: The Investigated 28 Manufacturing Sectors

1. Food Products
2. Beverages
3. Tobacco
4. Textiles
5. Wearing apparel, except footwear
6. Leather products
7. Footwear, except rubber or plastic
8. Wood products, except furniture
9. Furniture except metal
10. Paper and products
11. Printing and publishing
12. Industrial Chemicals
13. Other chemicals
14. Petro refineries
15. Miscellaneous petroleum and coal products
16. Rubber products
17. Plastic products
18. Pottery, china, earthenware
19. Glass and products
20. Other none metallic mineral products
21. Iron and Steel
22. None-ferrous metals
23. Fabricated metal products
24. Machinery, except electrical
25. Machinery, electric
26. Transport equipment
27. Professional and scientific equipment
28. Other manufactured products

Table 3.2: Conditional Variance of Inflation Rate

α_0	α_1	α_2	θ_1	LM test	Number of Observations
2.17e-07	.039	.953	.566	3.702	478
(1.27e-07)	(.011)	(.013)	(.110)		

Notes: Standard errors are in the parentheses.

Table 3.3: Sectoral Output Growth Regressions

Regressors	Sign	1	2	3	4
η^2	$-$	16	16	14	16
	$+$	1	1	1	1
Inflation rate	$-$		1	0	2
	$+$		11	10	9
$\Delta \log IR$	$-$		0	0	0
	$+$		2	1	0
$\Delta \log Oilprice$	$-$			0	0
	$+$			7	10
$\sigma^2_{oil_{t-1}}$	$-$			2	3
	$+$			0	0
$Credit_{t-1}$	$-$				0
	$+$				6

Notes: the number in the figure stands for the number of sectors.

Table 3.4: Results for the Dispersion Model

Regressors	(1)	(2)	(3)	(4)
η_t^2	-23.035***	-22.784***	-22.375***	-21.423***
	(6.676)	(7.728)	(7.729)	(7.217)
η_{t-1}^2	18.63***	17.997***	17.671**	17.268**
	(5.963)	(6.293)	(7.508)	(6.999)
1973 dummy	0.038***	0.037***	0.036***	0.035***
	(0.0057)	(0.007)	(0.009)	(0.008)
$\text{Dummy}_{d}eflation$	-0.008	-0.014**	-0.017	-0.019**
	(0.0056)	(0.006)	(0.01)	(0.01)
$\text{Int\_D}_{<0}$	40.805**	53.622**	63.106*	67.332**
	(18.78)	(19.717)	(33.558)	(31.33)
Inflation rate	–	0.143	0.149	0.313
	–	(0.343)	(0.408)	(0.388)
Change in interest rate	–	-0.003*	-0.004	-0.0015
	–	(0.0016)	(0.002)	(0.0025)
Change in oil price	–	–	5.94e-07	2.45e-08
	–	–	(1.89e-06)	(1.79e-06)
$\sigma^2_{oil_{t-1}}$	–	–	0.0043	0.004
	–	–	(0.024)	(0.022)
$Credit_{t-1}$	–	–	–	-0.0206**
	–	–	–	(0.01)
$\bar{R}^2$	0.6886	0.7132	0.7155	0.7647
SEE	0.0048	0.0048	0.0052	0.0046

Notes: Dependent variable is the variance of cross-sectional growth. SEE is the standard error of the regressions. $*$is significant at the 10 percent level. $***$ is significant at the 1 percent level. Standard errors are in the parentheses.

Figure 3.1: Moving Trend of Log. Difference of Monthly CPI

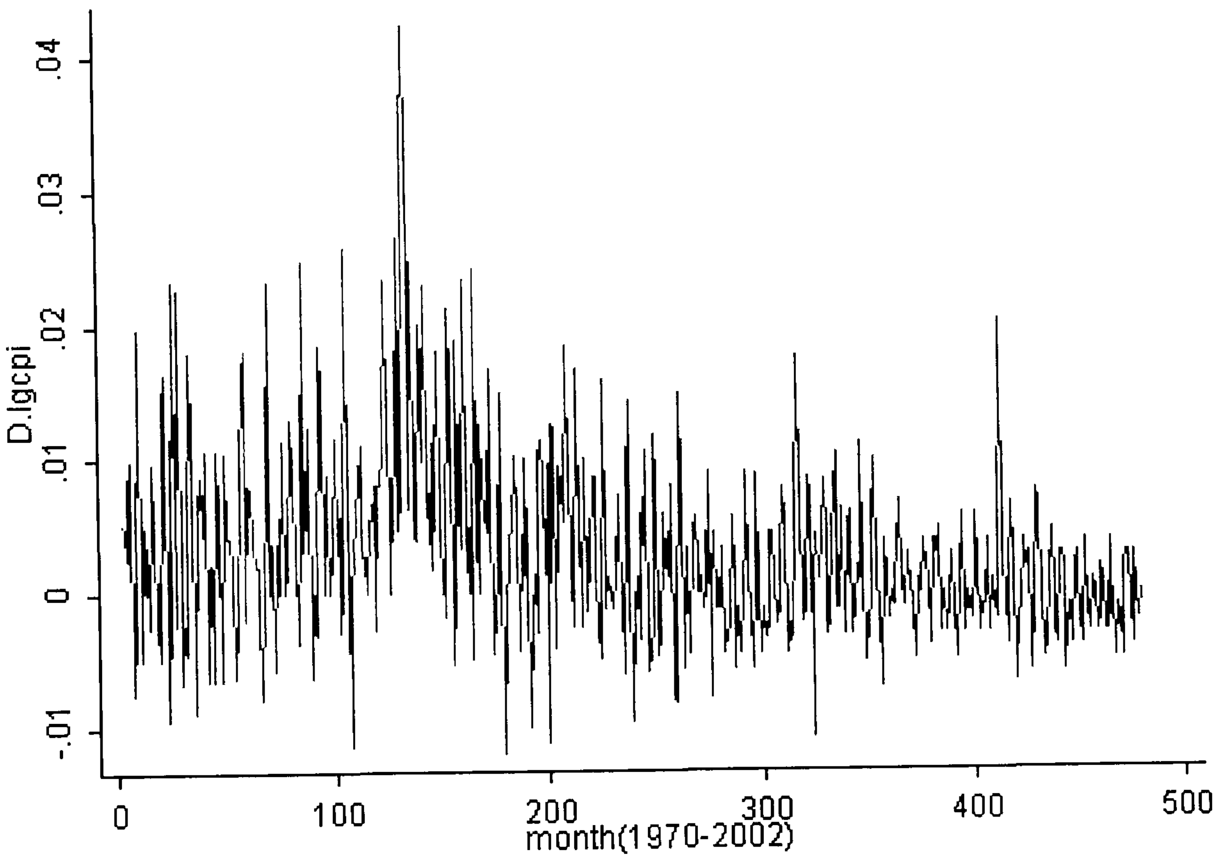


Figure 3.2: The Variance of Monthly CPI from GARCH (1,1)

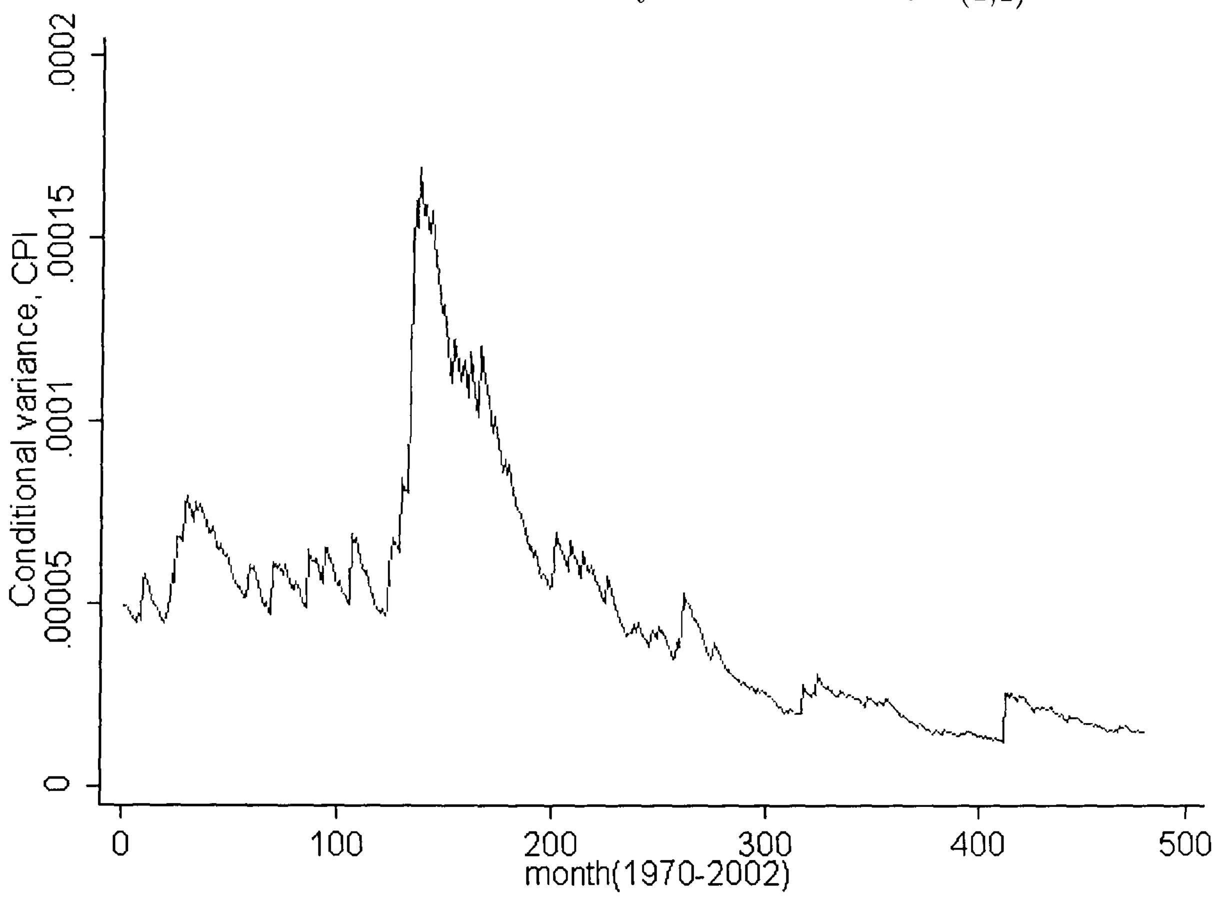
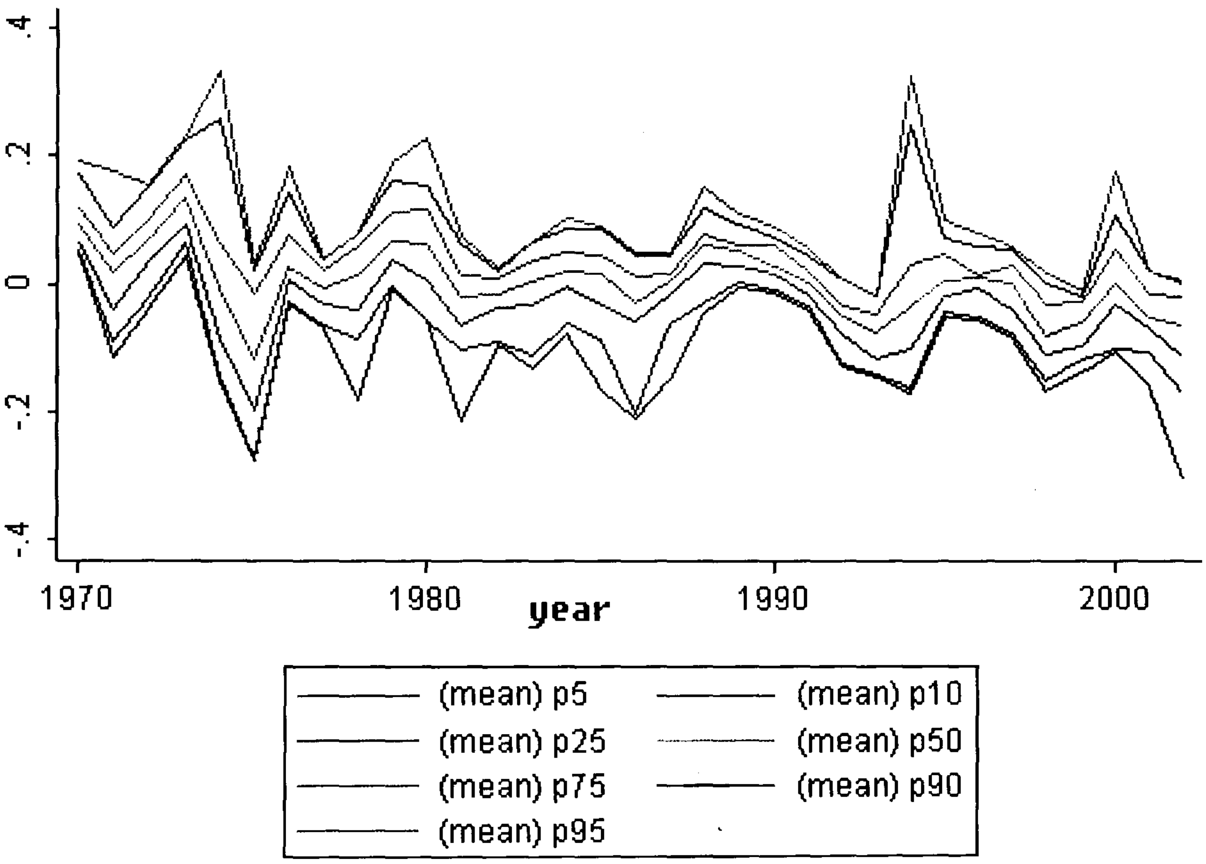


Figure 3.3: Cross-section Wide Dispersion



Chapter 4

Inflation and Price Dispersion: New Evidence for China Jing-Jin-Ji Economic Zone

This paper investigates the effect of expected as well as unexpected product specific (PS) inflation on relative price variability (RPV) in Jing-Jin-Ji Economic Zone in China. Our results suggest that the absolute value of expected PS-inflation negatively affects RPV, and this effect reverses to be positive if the expected PS-inflation is less than zero, which is consistent with "asymmetric price adjustment" in already well established literature. On the other hand, absolute value of unexpected PS-inflation positively affects RPV, when the inflation rate is negative. Recession economy has a different impact on RPV across different inflation regimes. Also, Chinese New Year is shown to be able exaggerate the effects of either expected or unexpected PS-inflation on RPV.

4.1 Introduction

There is a growing consensus that inflation affects the economy through the its impact in price mechanism, thus affecting the allocation of resources, leading to greater relative price variability (RPV). Economists found a large evidence basis in favor of a positive relationship between inflation and relative price variability. However, there are some studies that suggest a negative inflation-RPV relation, such as Dana (1994), Reinsdorf (1994), Fielding and Mizen (2001) and Silver and Ioannidis (2001). Although aforementioned literature suggests conflicting conclusions about the inflation-RPV link, the common feature of the available research is that they all consider a linear relation between inflation and RPV. Unlike previous theoretical studies, recent literature proposes the presence of a non-linear relationship between inflation and relative price variability given various inflation regimes, such as Jaramillo (1999), Caglayan and Filiztekin (2003), Head and Kumar (2005) and Caglayan et al. (2008).

Theoretical models that support a significant inflation-RPV link mainly consist of menu cost models, signal extraction models, information investment models and monetary search models. In menu cost models, inflation is fully anticipated and nominal price changes are subject to the (S, s) pricing strategy. When faced with inflation, sellers will raise the nominal price only if the real price is down to the lower bound s, at which the real price will be raised to the upper bound S; when faced with deflation, sellers will accordingly adjust the nominal price only if its real price is out of the bounds, see Sheshinski and Weiss (1977), Rotemberg (1983) and Bénabou (1988, 1992). Thus, menu cost models suggest that increasing the absolute value of expected inflation will widen the two bounds of price interval, and amplify the effect of price adjustment on relative prices variability. This paper starts from the above mentioned basic hypothesis and tests if the data provides support for a positive inflation-RPV link in China.

In signal extraction models, input price is not fully predicted, due to the unexpected part of inflation, see Barro (1976), Parks (1978), Ashley (1981), Hercowitz (1981), Bénabou and Gertner (1993). In periods of high inflation, both producers and consumers tend to confuse absolute price changes with relative price changes. The larger the unexpected inflation, the more they postulate that general inflation is the cause of the price volatility. Therefore, increases in unexpected product-specific inflation, reduces the expected value of search. Less searches increase the relative price variability, so that unanticipated inflation raises RPV. Considering predictions of signal extraction models, this paper scrutinizes the effects of unexpected inflation as well.

In information investment models, consumers accumulate an information stock as they repeatedly purchase the same item. The model suggests that a consumer's current price search is not only based on current information, it is also affected by pre-search from the stock of information, due to the persistence nature of price movements (Van Hoomissen, 1988). Empirical studies also showed that the current price dispersion is positively associated with lagged dispersion, such as Caglayan et al. (2008). This paper considers the lagged RPV as an important explanatory variable for current RPV, and we expect that the current RPV is positively affected by lagged RPV. In my empirical investigation, lagged RPV is assumed to capture all previous price information. Hence we use the contemporaneous rather than the lagged value for all price-related regressors, such as the current value of expected and unexpected product-specific inflation and CPI inflation.

In monetary search models, the expected or unexpected inflation-RPV relation is not always robust, as an increase in inflation can lead to a depreciation on real money, leading to a seller's market where price dispersion widens. On the other hand, a wider price dispersion increases search utility, thereby, reduces sellers' market power, leading to narrower price dispersion. Thus, in monetary search models, there is no one unambiguous answer for the relationship between inflation and RPV.

Instead of concentrating on a linear link, recent literature predict a non-linear relationship between inflation and relative price variability, such as Caglayan and Filiztekin (2003), Head and Kumar (2005), Caraballo et al. (2006), Fielding and Mizen (2008), Caglayan et al. (2008). These studies indicate a changing inflation-RPV relationship under various inflation regimes or market structures. In this paper, I will split inflation rate into negative and positive regimes, and investigate the possibility of a non-linear inflation-RPV relationship across different regimes, for this data set.

Theoretical models have given rise to an extensive empirical literature. A large number of empirical studies based on menu cost and signal extraction models have provided evidence in favor of a positive relationship between inflation and RPV for various countries, such as: Parks (1978), Fischer (1981), Domberger (1987), Van Hoomissen (1988), Lach and Tsiddon (1992), Diamond (1993), Tommasi (1993), Grier and Perry (1996), Parsley (1996), Debelle and Lamont (1997), Aarstol (1999), Jaramillo (1999), Chang and Cheng (2000), Konieczny and Skrzypacz (2005), and Nautz and Scharff (2005).

However, there are some exceptions. Drifill et al. (1990) suggest that there is little or no empirical evidence that higher aggregate inflation causes greater relative price variability. Bomberger and Makinen (1993) find an insignificant relationship between inflation and relative price variability. Lastrapes (2006) shows that the established relationship between U.S. inflation and relative price variability breaks down in the mid-eighties. Reinsdorf (1994) found that the relationship is even negative during disinflation in the early 1980s. In the same field, Fielding and Mizen (2000) and Silver and Ioannidis (2001) showed that price variability decreased with an increased inflation for several European countries in mid-eighties.

The various conclusions may have been reached due to several possible reasons. Earlier studies, which focused on aggregate price level or average inflation rate across all goods, did not reveal the different connections between inflation and relative price variability, that may exist across industries. While recent studies, which investigate industry-level or micro-level price, suggested a more complex relationship between inflation and relative price variability.

For example, Caucutt et al. (1994, 1998) looked at industry-level pricing data and concluded that: the differences in the relationship between relative price variability and inflation across industries is high. This study collected product-level price data and shed light on product-specific (PS) inflation rate to test the validity of the basic implications of menu cost and monetary search models.

Another important factor is the measurement of inflation. Earlier literature suggested that inflation is fully anticipated, therefore the conclusion of a positive relationship refers to the link between *expected* inflation and relative price variability. However, recently researchers began to decompose inflation into its *expected* and *unexpected* components, and incorporate the effect of each component on RPV. For example, Caglayan et al. (2008) found the evidence for a non-significant relationship between *expected* PS-inflation and price dispersion, but a significant relationship for *unexpected* PS-inflation and price dispersion. In this paper, we start from a very basic model, regressing RPV against the absolute value of PS-inflation, since this model can help us find out if there is a V-shaped inflation-RPV relationship as predicted in the menu cost literature. A dummy variable for deflation, $D_{<0}$, was introduced to investigate the possibility of an "asymmetric price adjustment". Then I replaced the absolute value of PS-inflation with both *expected* and *unexpected* absolute values of PS inflation to identify wether the *expected* or *unexpected* component of PS-inflation affects the relative price variability.

This paper uses product-level prices in China's Jing-Jin-Ji Economic Zone (one of the top three economic circles) from January 2005 to September 2009, to investigate the impact of PS-inflation on relative price variability (RPV). Results from this paper point out a negative relationship between the absolute value of expected PS-inflation and RPV when inflation rate is positive, and this effect will be reversed if inflation rate is less than zero.

Regarding the decomposition of overall PS inflation, both the *expected* and *unexpected* absolute value of PS-inflation have a positive effect on relative price variability when its deflationary, which is consistent with monetary search models. The aggregate inflation rate (CPI inflation) fails to have a robust effect on the relative price variability. My result also shows that, during the Chinese Spring Festival, the effect of expected as well as unexpected PS-inflation on RPV increases, due to excess demand in the Festival. A recession economy is found to have a different impact on the effect of PS-inflation on RPV across different inflation regimes.

The remainder of this chapter is structured as follows. Section 2 reviews both theoretical and empirical inflation-RPV link literature. Section 3 gives an introduction about the Jing-Jin-Ji Economic Circle, and why investors should pay attention to this area. Section 4 describes the data set and presents measurements for the dependent and relevant independent variables. Section 5 shows model specifications. Section 6 presents results and discuss the findings. Section 7 summarises results and concludes.

4.2 Literature

Theoretical literature consists mainly of: menu cost, signal extraction, information investment and monetary search models. In what follows, I summarize predictions from those models on the effect of inflation on RPV.

4.2.1 Menu Cost Models

Menu cost models predict a positive relationship between expected inflation and relative price variability. The inflation rate is considered as exogenous and can be fully anticipated. For example: Sheshinski and Weiss (1977, 1983), Mussa (1981), Rotemberg (1982, 1983), Bénabou (1988), Caplin and Spulber (1987), Diamond (1993) and Ball and Romer (1993). In such theory, price adjustment requires a fixed cost (menu cost), for instance: as Bénabou (1988) stated, product prices must be relabeled, new price lists and catalogues must be printed and sent. Thus, instead of keeping pace with inflation rate, monopolists find it optimal to follow the (S, s) pricing strategy to maintain maximum profits, due to menu cost.

The (S, s) pricing strategy is originally suggested for establishing inflation-RPV relationship in Sheshinski and Weiss (1977). In Sheshinski and Weiss (1977)'s model, (S, s), the range where the real price is located, enables the firm to make the maximum profits. The width of the discontinuous range (S, s) is built on firm-specific menu costs. Given a non-zero menu cost, a firm will adjust nominal prices only if the real prices are out of the two bounds. For instance, in the case of inflation, if real prices fall to a level lower than

s, a firm will lift nominal prices, at which point real prices will once again equate to the upper bound of S. The width of range also widens to conserve menu costs. Thus, Sheshinski and Weiss (1977) concluded that an increase in aggregate inflation rate is shown to increase the initial price S, and to decrease the terminal price s in each period, therefore expanding the dispersion of the price changing.

Bénabou (1988) extended Sheshinski and Weiss (1977)'s menu cost model and pointed out that only the expected part of inflation has a robust contribution in price dispersion. In the case of positive expected inflation, firms adjust nominal prices due to the fact their real prices fall out of the interval range $(S,\ s)$. The width of interval thereby widens to converse menu costs. In the case of a negative inflation rate, prices decrease accordingly, which also widens the price dispersion due to the symmetry in firms' pricing strategy. Thus, the menu cost model predicts a V-shaped relationship between the expected inflation and relative price variability.

Empirical studies thereby use the absolute value of expected inflation to investigate V-shaped inflation-RPV link, such as Reinsdorf (1994), Jaramillo (1999), Caglayan and Filiztekin (2003) and Caglayan et al. (2008). This chapter follows the idea of V-shaped expected inflation-RPV link, and takes the absolute value of all related inflation terms.

In terms of the measurement of inflation rate, one can use average inflation over aggregate goods, CPI inflation or product-specific inflation (inflation rate for each specific individual good). In the literature, Sheshinski and Weiss

(1977) used aggregate inflation rate, also in Bénabou (1988); Fischer et al. (1981) used the rate of increase of the consumption price deflator (CPI inflation). This chapter adopts product-specific inflation (PS-inflation), as product A's relative price variability is supposed to be associated with product A and its related products' inflation rates (Caglayan et al., 2008). Therefore, I use both the expected PS inflation and CPI inflation as well as the unexpected PS inflation.

4.2.2 Signal Extraction Models

Different from menu costs models emphasising on expected inflation, signal-extraction models pay attention to the unexpected inflation, such as that in Lucas (1973), Barro (1976), Parks (1978), Ashley (1981), Hercowitz (1981), Cukierman (1983), Bénabou and Gertner (1993), Dana (1994) and Grier and Perry (1996). Signal extraction models are based on imperfect information where inflation is not fully anticipated. Such models suggested that the unexpected part of inflation may have a robust role in determining relative price variability. Although most of the signal-extraction literature support a positive relationship between unexpected inflation and relative price variability, Dana (1994) suggested a negative relationship between the two.

Lucas (1973) and Barro (1976) considered incomplete information as the key element leading to the positive relationship between unexpected inflation and relative price dispersion. In their theories, consumers do not have access to the unanticipated information. Thus, producers can not identify whether the observed nominal prices are caused by general inflation or the local excess demand variations. The higher the unexpected inflation, the more likely the producers are to prefer general inflation as the real reason for price movements. Thereby producers adjust output less in response to the excess demand changes, in other words excess demand becomes less elastic. This leads to larger fluctuations in individual prices whenever demand changes, so that the dispersion of prices across markets increases with the *unexpected* inflation rate rather than the *expected* inflation. This is because sellers respond the same to the expected inflation, therefore there are no changes for relative price variability.

Hercowitz (1981) extended Lucas-Barro signal extraction model by looking at specific products rather than general markets. Different products have different specific price elasticities so that the unexpected inflation shock will affect individual relative price dispersion inconsistently and differently. The empirical result from the investigation of the unexpected inflation-RPV link across different products is also shown to support the signal-extraction proposition that a positive relationship exists between unexpected inflation and RPV.

Bénabou and Gertner (1993)'s search with learning model is another extension of the signal extraction model. The reason for highlighting Bénabou and Gertner (1993) in this paper is that they proved a negative unexpected inflation-RPV link, when the search cost is sufficiently low. According to Bénabou-Gertner's model, the positive or negative relationship between unexpected inflation and relative price dispersion depends on how costly the search is. If the search cost is high, Bénabou-Gertner model has the same positive conclusion with previous theories. However, if the search cost is sufficiently low, higher inflation uncertainty, which means more additional incomplete information, will induce more searching. More searching makes the market more competitive, leading to narrower price dispersion. Therefore the higher the inflation uncertainty, the less the relative price variability. Another search with learning model that predicts a negative relationship between unexpected inflation and RPV is Dana (1994). There are a few examples of empirical research that were also in favour of the negative relationship between unexpected inflation and RPV, namely Dana (1994), Reinsdorf (1994), Fielding and Mizen (2000) and Silver and Ioannidis (2001).

Since the literature has shown that *unexpected* inflation is an important factor in determination of relative price variability, later empirical studies embodied the role of both *expected* and *unexpected* inflation in the inflation-RPV link. For example: Grier and Perry (1996) not only pointed out that "*inflation uncertainty dominates trend inflation as a predictor of relative price dispersion*", but also suggested that, in the case that both expected and unexpected inflation are included in the inflation-RPV model, only *unexpected* inflation appears to play a significant role. They also found that *expected* inflation can only be significant if the *unexpected* inflation is excluded.

According to the signal-extraction and search models, this chapter predicts an important role of unexpected inflation, and therefore applies both expected and unexpected inflation as regressors in the inflation-RPV model, in order to distinguish the significance of these two roles. As for the measure of unexpected inflation, this chapter uses the absolute value of unexpected inflation to investigate the presence of V-shaped unexpected inflation-RPV link: "*Since what matters is inflation uncertainty, unanticipated deflation will have a similar impact and the relationship between unexpected inflation and RPV is again V-shaped.*" (Caglayan et al., 2008). Therefore both expected and unexpected inflation will be included in the regression model as their absolute value.

4.2.3 Information Investment Model

Menu cost and search models only focus on the effects from contemporaneous price information while in this section, stock of information about price level also plays an important role with regards to relative price variability. In the information investment model (see Van Hoomissen (1988)) consumers purchase the same item more than once, and they accumulate a stock of information about prices. This stock replenishes new information and eliminates old ones in each period. So that during an inflationary period, as sellers do not respond to inflation instantaneously, consumers would rather "buy" less information, because inflation increases the depreciation rate on information, leading to its diminished future use. Consumers are less informed, sellers therefore can take advantage by choosing their prices so that price dispersion increases during an inflationary period.

Since the model suggests an important effect of information stock on contemporaneous price dispersion, one can predict that the current price dispersion is positively affected by a lagged price dispersion. Therefore this study follows this idea and uses lagged RPV as a explanatory variable for current RPV. There is no additional lagged RPV, because Van Hoomissen (1988) did not suggest a role for additional lags, see also Caglayan et al. (2008).

4.2.4 Monetary Search Model

There are a handful of papers applying monetary search models to analyze the inflation-RPV link, such as Kiyotaki (1991), Molico (1998), Camera (1999), Peterson and Shi (2004) and Head and Kumar (2005). In the original monetary search models, buyers' search intensity is fixed, and they have only incomplete information offered by different sellers. For example: Peterson and Shi (2004) divide goods into desirable and less desirable types and showed that the price dispersion is generated by heterogeneous preferences. For desirable goods, buyers would like to spend their money. For less desirable goods, buyers do not like the item good enough to spend their money. Therefore when a consumer has a better preference for a good, the seller can sell the good for a high price. In contrast, when the consumer does not prefer the good, the seller may have to charge a lower price. In the case of inflation, an increase in money growth depreciates the value of money thereby increasing the real price of the desirable goods. However, sellers have to lower the price of less desirable goods in order to attract consumers because consumers would not spend their money on less desirable goods in normal times, not to mention in the inflationary period. Therefore, an increase in the expected inflation widens the relative price dispersion.

Peterson and Shi (2004) then extend the monetary model by allowing various search intensity and show that expected inflation on price dispersion in a monetary search framework is ambiguous. They suggested a multiple equilibria of the effects of increasing money growth, showing a positive expected inflation-RPV link in the high welfare equilibrium, and a negative expected inflation-RPV link in an inferior welfare equilibrium. The multiple equilibria are ranked by the inefficiency of allocations. The larger the inefficiency, the lower is the search intensity and the welfare. In an inferior equilibrium, an increase in money growth (inflation) pushes the search intensity, and therefore enhances welfare. Thus, in this case, higher inflation shrinks the dispersion of relative prices. To summarize: in monetary search models, the overall effect of inflation on relative price dispersion is not always obvious. On one side, increasing inflation depreciates the real money so that expands sellers' market power, leading to wider price dispersion. On the other side, higher inflation increases utility of search, so that reduces sellers' market power leading to narrower price dispersion.

Head and Kumar (2005) also suggested an ambiguous relationship between expected inflation and RPV in a monetary search framework. Their proposition is similar to Peterson and Shi (2004) that increasing expected inflation depreciates the flat money, which induces larger RPV by increasing sellers' market power. On the other hand, larger RPV will also stimulate more search, which in tern induces smaller RPV by decreasing sellers' market power. "*As* *inflation rises, the RPV increasing effect will eventually dominate. Yet there will be a region within which small changes in expected inflation have little effect on RPV*" (citation from Becker and Nautz, 2009). Therefore Head and Kumar (2005) showed that only if the expected inflation is higher than a particular value, is there an effect of expected inflation on RPV.

4.2.5 Non-linear Effect of Inflation

Despite the wide evidence base in favour of either a positive or negative inflation-RPV link, recent empirical literature suggests that the inflation-RPV link is more complex than a linear relationship. One opinion is that the marginal impact of inflation on relative price variability may be ambiguous for different inflation regimes. Parks (1978) suggested that there could be a different degree of association between unexpected inflation and RPV depending upon the sign of the inflation rate. He allows for "asymmetric price adjustment", which means different responses for positive and negative price changes respectively. This explains why sellers adjust prices less often under a deflation period than under an inflation period.

Another possibility is that the marginal impact of inflation on RPV may turn to be weak and insignificant when large supply shocks are excluded. Driffill et al. (1990) and Bomberger and Makinen (1993). Driffill et al. (1990) presented little evidence for higher inflation causing larger RPV not counting some specific large supply shock in such as the large oil and food supply shock in 1970s and 1980s (Fisher, 1981; Taylor, 1981). Bomberger and Makinen

(1993) reexamined Parks (1978)'s study by excluding the two large oil shocks in 1974 and 1980 and found an insignificant impact of inflation on relative price dispersion.

Jaramillo (1999) is another Parks (1978)'s follower who agreed "asymmetric price adjustment" and suggested different inflation roles across different inflation regimes. He introduced the interaction term of PS inflation and the dummy variable for deflation, "$|PSinflation| * D_{inflation<0}$", which enabled him to test the hypothesis that a different slope of this inflation-RPV relationship exists during deflation episode. According to his empirical results, the coefficient of this interaction term is positive and significant, showing an asymmetrical relationship, which means that inflation's impact on relative price variability is greater during deflation than inflation.

More literature is in favour of a nonlinear inflation-RPV linkage, such as Caglayan and Filiztekin (2003), Head and Kumar (2005), Caraballo et al. (2004, 2006), Nautz and Scharff (2006), Thornton (2006), Fielding and Mizen (2008) and Caglayan et al. (2008). This study follows an approach similar to that in Caglayan and Filiztekin (2003) and Caglayan et al. (2008). These two studies test the impacts of both expected and unexpected PS inflation on RPV, and present a nonlinear relationship between PS inflation and RPV. The former study considers Turkey's 1976 payment crisis as a breaking point and incorporates dummy variables for the two distinct inflationary periods, while the latter study creates a dummy variable for deflation rates. Finally, Caglayan et al. (2008) used a wider empirical framework and incorporated various inflation measures such as PS inflation and aggregate inflation, expected and unexpected inflation and absolute value of inflation. They suggested a variety of different relationships with different inflation measures and a significant impact of market structure on average price variability. Those findings support most of the predictions of menu costs, signal extraction, information investment, monetary search models.

This chapter follows the above two studies to investigate the nonlinear relationship between PS inflation and RPV. Combined with predictions from signal extraction and monetary search models, the model in this chapter contains both absolute value of expected and unexpected PS inflation. Besides, in order to test for the "asymmetric price adjustment" (Jaramillo, 1999 and Caglayan et al., 2008), this chapter applies a dummy variable for deflation rates, and uses the interaction term of absolute value of PS inflation and the dummy variable for deflation, to describe a different impact of PS inflation during deflationary period. In this chapter, Lagged RPV is also considered to be an important explanatory variable for current RPV, according to information investment models. The sign of lagged RPV is expected to be positive.

The data for this study is gathered from the Jing-Jin-Ji Economic Circle. Hence, in the following section, we introduce some background information of the Jing-Jin-Ji Economic Circle.

4.3 Jing-Jin-Ji Economic Circle

Although there are a handful of studies that investigate the relative price variability for China, their data sets are usually either aggregate or city-level across the whole of mainland China. However, due to the geographic locations, economies in the Eastern, Northeastern, Central and Western regions of China are quite different from each other. Although only occupying 9.5% of land, the Eastern region contains 10 provinces and has been the key driving force behind China's economic development. In 2009, 7 out of 10 provinces in "Top 10 Biggest Economies in China at Province Level" belongs to in the Eastern Region. Moreover, tapping on geographic proximity and cultural similarity, some neighboring provinces and cities have begun to create synergies by forming cross-border economic circles, such as Pearl River Delta, Yangtze River Delta, Jing-Jin-Ji Economic Circle and the Northeastern Region. Therefore the research on regional economies will give us a better understanding of China's development.

Among the three economic circles in the Eastern Region, the twin Deltas, namely Yangtze River Delta and Pearl River Delta are the most advanced regions, and these regions are where Shanghai and HongKong are located. They attract most investors' concern. Compared to those advanced regions, the Jing-Jin-Ji economic circle (is comprised of two municipalities: Beijing and Tianjin and one province Hebei) seems to be lagging behind and hardly any research focuses on this region. However, looking at table 4.9 which summarises the three regions economies in 2008, the Jing-Jin-Ji Economic Circle has a similar level of GDP growth rate as the other 2 areas. Differently, the Jing-Jin-Ji Economic Circle has more development space to strengthen on its economic power. It has the highest potential of increasing power among three regions and the advantages of the Jing-Jin-Ji Economic Circle is becoming increasingly apparent.

First of all, this economic circle has the best talent pool in China. The capital city Beijing is the most intensive, high-tech and multi-cultural place in the whole of China. There is the largest number of high skilled labour in this area. Secondly, the Jing-Jin-Ji area has tremendous low-cost advantages compared to the rest of the economic circles. Generally speaking, northern China is less developed than southern China, thereby the Jing-Jin-Ji region in north has lower labour and business costs than those in Pearl River Delta and Yangtze River Delta. Last but not least, infrastructure in the Jing-Jin-Ji area is the best in China. Take the density of motorways per $10,000$ hectares, Hebei Province has the same level as found in Europe and Japan. Thus, this chapter explores price movements in this area.

Before the investigation of the inflation-RPV relationship, we first overlook the macroeconomic situation in this area through plotting the CPI inflation movement, see fugure 4.1. It presents the CPI inflation rate moving trend from January 2005 to September 2009. Observations are plotted every fortnight $t = 1, ..., 114$, so that $t = 1$ stands for the first half month of January 2005, $t = 2$ stands for the latter half month of January 2005. CPI inflation rate in 2005 was relatively low after Chinese Spring Festival (which is around February) and followed by some moderate fluctuations in the year of 2006. The general rate of inflation in the stable period is around 2%. CPI Inflation rate started increasing since the beginning of 2007 (global recession), it then climbed up to the peak (8.9%) in May 2008, followed by a massive fall towards its original level. Afterwards CPI inflation did not stay in its original level, and in fact it turned into a deflation from February 2009. This is in accordance with the real situation that the economy is affected by the global recession from 2007. Following central government's contractionary monetary and fiscal policy, governor in Jing-Jin-Ji applied temporary price-intervention measures on some important commodities and services from December 2007. During the practice period, for a variety of commodities on the lists, firms must make an application for price raise and/or file price adjustment for archival purpose with a competent department of price. The practice stopped in December 2008 in order not to push the economy into a deflationary cycle. As a matter of fact, China did go through deflation from February 2009, and began to rise up from the lowest point in June 2009. Such a nonstable macroeconomic environment is the very background that our investigation based on. It satisfies the requirements of various inflation regimes for our investigation.

4.4 Inflation and RPV

4.4.1 The Data Set

My empirical analysis uses price data of 174 products in 11 cities that are collected every fortnight from January 2005 through September 2009. This data is published by the Price Control Bureau of Hebei Province and it covers almost all categories, such as food (29), tobacco and beverage (11), household electric appliances (19), services in both urban (38) and rural (16) areas, real estate (4), industrial production materials (34), agricultural related production materials (16) and other goods (7).

Product-specific inflation rate is generated from above price data set. To understand the movement of relative price variability, the aggregate inflation is considered as well as PS inflation. The fortnightly aggregate CPI inflation rate is provided by the National Bureau of Statistics.

4.4.2 Relative Price Variability

Following the empirical literature, this paper defines relative price (P_{ijt}) for product $i = 1, ..., 174$ in city $j = 1, ..., 11$ in time t as

$$P_{ijt} = \ln(p_{ijt}/p_{it}) \tag{4.1}$$

where

$$p_{it} = \frac{1}{J}\sum_{j} p_{ijt} \tag{4.2}$$

is the average price of product i at period t, $J = 11$ is the number of cities.

p_{ijt} is the price of product i in city j at time t. Relative price level variability[1] (RPV_{it}) is defined by

$$RPV_{it} = \sqrt{\frac{1}{J-1}\sum(P_{ijt} - P_{it})^2} \tag{4.3}$$

4.4.3 Expected and Unexpected Product-Specific Inflation

The measurements for inflation are different in empirical studies. One can use aggregate inflation such as CPI inflation, while this chapter follows the idea that the product-level price variability is related to a specific product's inflation rate, and therefore used product-specific (PS) inflation. The PS inflation rate for product i at time t is defined by the average PS inflation across cities

$$PS_{it} = \frac{1}{J}\sum_{j}\pi_{ijt} \tag{4.4}$$

where

[1] Alternatively, some empirical studies test on relative price *change* variability. However, as Reinsdorf (1994, Section IV) emphasizes, theoretical literature refers specifically to relative price level variability.

$$\pi_{ijt} = \ln[p_{ijt}/p_{ij(t-1)}] \tag{4.5}$$

is the inflation rate for product i in city j at time t. Similar to the current literature[2], this study decomposes PS inflation into its expected and unexpected components. The method of obtaining expected and unexpected components from PS inflation is in line with the measurement in Reinsdorf (1994), Konieczny and Skrzypacz (2005) and Caglayan et al. (2008). This chapter regresses PS_{it} against $PS_{i(t-1)}$, $PS_{i(t-2)}$, ... up to six lags, lagged values of aggregate CPI inflation up to six lags, time, time squared, monthly dummies and a dummy variable for the recession years of 2007 and 2008. In order to select the lag length, I start with a maximum lag of 12 and pare it down to the appropriate lag[3] by examining the Akaike Information Criterion (AIC) and the Schwarz information criterion (SIC). For each estimation, the residuals are tested for serial correlation and arch effect for six lags. If the results are clean, the fitted values are used as the expected PS inflation (EPS_{it}) and the residuals are used as the unexpected PS inflation (UPS_{it}). If the result failed, I used the second best SIC model, and run the same tests to the residuals and so on.

[2]Lach and Tsiddon 1992; Reinsdorf 1994; Grier and Perry 1996; Parsley 1996; Debelle and Lamont 1997; Arstol 1999; Jaramillo 1999; Head and Kumar 2005; Nautz and Scharff 2005, 2006; Fielding and Mizen 2008; Caglayan et al. 2008

[3]One can adjust lags from 3 lags to 12 lags. However, data set in this paper is collected every fortnight, therefore, 6 lags is more appropriate in this case. I also tried from 3 lags to 6 lags of both PS inflation and aggregate CPI inflation, no significant difference occurs that could affect the final result. This paper focuses on just 6 lags.

4.5 Model Specification

4.5.1 Basic Specification

The empirical analysis starts with a simple model that is based on Caglayan and Filiztekin (2003) and Caglayan et al. (2008):

$$RPV_{it} = \alpha + \beta|PS_{it}| + \gamma|CPI_{it}| + D_{month} + D_{yr} + \mu_{it} \tag{4.6}$$

where RPV_{it} is the relative price variability (price dispersion) as defined in equation (4.3), α is a constant, $|PS_{it}|$ is the absolute value of product-specific inflation, $|CPI_{it}|$ is the absolute value of CPI inflation, D_{yr} is the dummy variable for the recession years of 2007 and 2008, D_{month} stands for dummy variables for all months, μ_{it} is the error term. I use panel data techniques and control for fixed effects specific to particular products.

The reason behind using the absolute value of PS_{it} is because I want to test if the price data in this paper can be explained by the V-shaped inflation-RPV relationship, which is predicted in literature. The aggregate CPI inflation is taken into account as well as PS inflation since we believe the product-specific relative price dispersion may also be influenced by the aggregate inflation in whole market. Moreover, earlier literature in the 1970s found significant effect for aggregate inflation rate. This model also includes a dummy variable to control effects specific to recession years, in which CPI inflation was relatively high while it was low and stable at around 2% before the recession.

Due to propositions from information investment models, the price information pool is helpful for predicting forthcoming RPV trend, so I represent the lagged RPV as previous information, and predict a positive impact of lagged RPV on current RPV:

$$\begin{aligned} RPV_{it} &= \alpha_0 + \alpha_1 RPV_{i(t-1)} + \beta|PS_{it}| + \gamma|CPI_{it}| \\ &+\lambda(|PS_{it}| \times D_{yr}) + D_{month} + D_{yr} + \mu_{it} \end{aligned} \quad (4.7)$$

$|PS_{it}| \times D_{yr}$ is the interaction term of absolute value of PS inflation and dummy variable for recession years. If the coefficient λ is significantly different from zero, then there is a different slope for the impact of inflation in recession years on RPV in the Jing-Jin-Ji Circle.

4.5.2 Chinese Spring Festival Effect

I further extended the above model by adding the interaction term of absolute PS inflation with the dummy variable for February D_{Feb}. This is because Chinese Spring Festival is around February, so that one can find their buying behavior is somehow influenced by the festival environment. To test my hypothesis regarding Spring Festival effect, I take into account the coefficient of this interaction term. A significant parameter (δ) will support the effect of February on the impact of PS-inflation on relative price variability. The model is in the following:

$$\begin{aligned}
RPV_{it} &= \alpha_0 + \alpha_1 RPV_{i(t-1)} + \beta|PS_{it}| + \gamma|CPI_{it}| \\
&+\lambda(|PS_{it}| \times D_{yr}) + \delta(|PS_{it}| \times D_{Feb}) \qquad (4.8) \\
&+D_{month} + D_{yr} + \mu_{it}
\end{aligned}$$

Since one period lag of price dispersion is shown to have a strong connection with the performance of current price dispersion in my study, which supports an important impact of price information stock on contemporaneous price dispersion. Therefore, one period lag value of price dispersion, $RPV_{i(t-1)}$, is correlated with the regression error term μ_{it}, indicating biased and inconsistent estimates. I apply IV-GMM approach to provide a way to obtain consistent parameter estimates that are robust to arbitrary heteroskedasticity and autocorrelation.

I attempt to estimate the causal effect of $RPV_{i(t-1)}$ on RPV_{it} by using two instruments: $RPV_{i(t-2)}$, and a dummy variable for the periods during which administrative price control is implementing (December 2007-December 2008). $RPV_{i(t-2)}$ is obviously correlated to $RPV_{i(t-1)}$ according to the aforementioned significant effect of price information stock, however, there is no significant evidence for a valid connection between RPVs from non-successive collection time (Van Hoomisen, 1988; Caglayan et al., 2008). Thus, $RPV_{i(t-2)}$ is a valid instrument as it is relevant to the endogenous variable $RPV_{i(t-1)}$, and irrelevant to the dependent variable RPV_{it} and error term μ_{it}. The administrative price control dummy variable in this study refers to the temporary price-intervention in Jing-Jin-Ji area during December 2007 and December 2008. In order to restrict the adverse impact of the global recession in 2007, the government temporarily control prices of some important commodities and services to stabilize the fluctuations of prices and its variability.

Since my number of instruments is greater than the number of endogenous variable, one may test whether the excluded instruments are appropriately independent of the error process. A test of overidentifying restrictions regresses the residuals from my IV-GMM regression on all exogenous variables. Under the null hypothesis that all instruments are uncorrelated with the error terms , the test has a large-sample $\chi^2(r)$ distribution where r is the number of instruments minus the number of endogenous variables. Over-identification tests (Hansen J test) are held after each regression.

4.5.3 Asymmetric V-shaped Inflation-RPV Link

According to monetary search models, the PS inflation-RPV link might be asymmetrically V-shaped, see in Reinsdorf (1994), Jaramillo (1999), Head and Kumar (2005) and Caglayan et al. (2008). Some conclusions are in favour of a positive optimal rate of inflation, while others support a stronger negative rate, such as Reinsdorf (1994), Jaramillo (1999) and Caglayan et al. (2008). In order to test if price data exhibits an asymmetric V-shaped connection between PS inflation and RPV, and to test if this asymmetric V shape is implying a positive or negative optimal rate of inflation, I incorporated a dummy variable $D_{<0}$ which stands for deflation. $D_{<0} = 1$ when product-specific inflation is negative and zero otherwise:

$$\begin{aligned} RPV_{it} &= \alpha_0 + \alpha_1 RPV_{i(t-1)} + \beta|PS_{it}| + \gamma|CPI_{it}| \\ &+\lambda(|PS_{it}| \times D_{yr}) + \delta(|PS_{it}| \times D_{Feb}) \\ &+\theta(|PS_{it}| \times D_{<0}) + \phi(|CPI_{it}| \times D_{<0}) \\ &+\psi(|PS_{it}| \times D_{yr} \times D_{<0}) + \omega(|PS_{it}| \times D_{Feb} \times D_{<0}) \\ &+D_{month} + D_{yr} + \mu_{it} \end{aligned} \tag{4.9}$$

where the interaction terms with $D_{<0}$ in (4.9) describe a different impact of deflation on relative price variability and an asymmetric V-shaped link if those coefficients are positive and significant.

4.5.4 Expected and Unexpected Inflation

Due to the rich theoretical and empirical findings using various inflation measurements, I replaced the absolute value of PS inflation rate for the absolute value of both expected and unexpected PS inflation, keeping the rest of the regressors in the model unchanged. We investigate three equations to test effects of expected and unexpected PS-inflation across different inflation regimes separately. The first equation shows as:

$$\begin{aligned} RPV_{it} &= \alpha_0 + \alpha_1 RPV_{i(t-1)} + \beta|EPS_{it}| + \gamma|CPI_{it}| \\ &+\lambda_1(|EPS_{it}| \times D_{yr}) + \delta_1(|EPS_{it}| \times D_{Feb}) \\ &+\delta_2(|EPS_{it}| \times D_{yr} \times D_{Feb}) + D_{month} + D_{yr} + \mu_{it} \end{aligned} \tag{4.10}$$

Then we incorporate the dummy variable for negative rate of inflation into above equation, as follow:

$$
\begin{aligned}
RPV_{it} \quad &= \alpha_0 + \alpha_1 RPV_{i(t-1)} + \beta|EPS_{it}| + \gamma|CPI_{it}| \\
&+\lambda_1(|EPS_{it}| \times D_{yr}) + \delta_1(|EPS_{it}| \times D_{Feb}) \\
&+\theta_1(|EPS_{it}| \times D_{<0}) + \theta_2(|CPI_{it}| \times D_{<0}) \\
&+\tau_1(|EPS_{it}| \times D_{yr} \times D_{<0}) + \chi_1(|EPS_{it}| \times D_{Feb} \times D_{<0}) \\
&+\chi_1(|EPS_{it}| \times D_{Feb} \times D_{<0} \times D_{yr}) + D_{month} + D_{yr} + \mu_{it}
\end{aligned} \tag{4.11}
$$

The final specification with both expected and unexpected PS-inflation shows as follow:

$$
\begin{aligned}
RPV_{it} \quad &= \alpha_0 + \alpha_1 RPV_{i(t-1)} + \beta|EPS_{it}| + \zeta|UPS_{it}| + \gamma|CPI_{it}| \\
&+\lambda_1(|EPS_{it}| \times D_{yr}) + \delta_1(|EPS_{it}| \times D_{Feb}) \\
&+\lambda_2(|UPS_{it}| \times D_{yr}) + \delta_2(|UPS_{it}| \times D_{Feb}) \\
&+\theta_1(|EPS_{it}| \times D_{<0}) + \theta_2(|UPS_{it}| \times D_{<0}) + \theta_3(|CPI_{it}| \times D_{<0}) \\
&+\tau_1(|EPS_{it}| \times D_{yr} \times D_{<0}) + \chi_1(|EPS_{it}| \times D_{Feb} \times D_{<0}) \\
&+\tau_2(|UPS_{it}| \times D_{yr} \times D_{<0}) + \chi_2(|UPS_{it}| \times D_{Feb} \times D_{<0}) \\
&+D_{month} + D_{yr} + \mu_{it}
\end{aligned} \tag{4.12}
$$

As before, the new regression runs IV-GMM approach. In the IV-GMM model, estimates are efficient only in the case of homoscedasticity, I thereby correct the heteroscedasticity by running the regression model with robust standard errors. Hansen J Statistic for these models, indicate that there is no the over-identification problem of all instruments.

In the next section, I will summarise the regression results for regressions (4.7) to (4.12).

4.6 Empirical Findings for China Price

4.6.1 Basic Specification

Table 4.1 reports estimates which are obtained from my basic regression (4.7). As it is predicted that the lagged relative price variability (RPV) should be positively related to the current relative price variability, the coefficient for $RPV_{i(t-1)}$ is positive and significant at 1% significance level. This supports the idea of incorporating lagged RPV in explaining the movement of current RPV. However, the correlation between the two is relatively high at 0.92, which may be because the data is collected every fortnight so that the model captures a strong persistence in prices. The strong connection between RPVs from two successive collection time indicates an important impact of the stock of price information on the performance of contemporaneous price dispersion across variety of products. As consumers base their purchase decision on the price information accumulated in the past, their buying behaviors reflects a strong persistence with their past behaviors.

Table 4.1: Inflation-RPV Link in Equation(4.7)

RPV_{it}	Coef	Std.	P-value
$RPV_{i(t-1)}$	.9203	.0038	0.000
$\lvert PS_{it}\rvert$	.0121	.0036	0.001
$\lvert CPI_t\rvert$	-.0000	.0002	0.848
$\lvert PS_{it}\rvert D_{yr}$	.0882	.011	0.000
D_{Feb}	.0039	.0017	0.018
D_{yr}	-.0014	.001	0.211
R^2 : .797 F-value: 3790.62 No. of Obs: 18247			
$\lvert PS_{it}\rvert + \lvert PS_{it}\rvert D_{yr} = 0$	.1003	.0109	0.000

The results of my basic model supports the prediction of a positive relationship between absolute value of PS-inflation and relative price variability (RPV). An one unit increase in absolute change in PS-inflation widens the overall price dispersion by 1.21%. In terms of individual firm's price setting, higher price level widens their target price range by postponing their lower bound price adjustment point and enhancing the initial price level. The overall price dispersion of the market widens accordingly.

However, aggregate CPI inflation is barely able to affect the movement of RPV in the Jing-Jin-Ji Circle. At this point, it is in line with Peterson and Shi (2004)'s monetary search model that increasing aggregate inflation leads to bigger sellers' market power and a larger RPV. On the other hand, the larger RPV will be diminished by the increasing search intensity, due to higher price level. Combining two possible effects, CPI inflation in the Jing-Jin-Ji area is shown to have no significant influence on RPV. Also, the Consumer Price Index in China which is used as a measure of aggregate CPI inflation in my work presents a very unique feature, that is, food is the single biggest contributor to China's CPI (34%), followed by entertainment (14%) and rental (13%). It is worth noting that the housing price is not included in the CPI at all. However, the observed 174 products in my study contains almost all categories in life, food and entertainment is only a small part of all 174 products. For those categories that contributes to CPI inflation, its relative price dispersion can be significantly affected by aggregate CPI inflation; while others may find a weak connection with aggregate CPI inflation. Therefore, it makes sense that aggregate CPI inflation fail to explain the movement of overall product-specific relative price dispersion. The positive coefficient of lagged RPV is consistent with indications of the Information Investment Model that the contemporaneous RPV is positively affected by one period lagged RPV.

Since I allow for a different slope for the impact of absolute value of PS-inflation during recession years, the impact of interaction term $|PS_{it}|D_{yr}$ will be added to the performance of PS-inflation on RPV. The result indicates a significantly different slope for the absolute value of PS-inflation in recession years. During 2007 and 2008 in which the aggregate price level was high and volatile, the absolute value of PS-inflation tends to have a positive and significant impact (8.82%) on the relative price variability. This also supports the basic indication of the monetary search model in Peterson and Shi (2004). If we investigate the combined coefficient of PS-inflation and its interaction term with the dummy variable for recession years, a one unit increase in absolute value of PS-inflation widens the price dispersion by 10.03% $(0.0121 + 0.0882 = 0.1003)$ during volatile period. However, the dummy variable for recession years itself fails to have influence on RPV.

4.6.2 Chinese New Year and Asymmetric Price Adjustment

There is a regular phenomenon of a short-term higher price level over the whole market during every Chinese New Year. People consider the increasing PS-inflation as the result of excess demand, so consumers will not do much search due to the lack of supply. Therefore Chinese New Year leads to a "seller's market" and a wider price dispersion. In order to verify the effect of Chinese New Year, I introduce the interaction term of $|PS|$ with a dummy variable for Chinese New Year (D_{Feb}) so one can investigate PS-inflation with respect to exhibiting a different impact on RPV in Spring Festival around February. Table 4.2 summarises estimates in equation (4.8).

Table 4.2 presents similar results as Table 4.1, suggesting a significant and positive impact of absolute value of PS-inflation on RPV, besides, CPI inflation again has no significant effect on RPV. In terms of the Chinese New Year Effect, the coefficient of the interaction term, $|PS_{it}|D_{Feb}$, supports the prediction that a positive Chinese New Year Effect on the effect of PS-inflation on RPV in Jing-Jin-Ji area. When there is an increase in inflation during Chinese New year (February), consumers would assume that high prices only remain for temporary time due to large excess demand in the Festival, and prices will move back to the original level afterwards. Therefore, sellers take advantage of the fact that consumers research less during the Festival to maximize their profits, so price dispersion widens. In normal times, one unit change in the absolute value of PS-inflation widens the RPV by 0.81%. While, during Chinese New Year, the effect of PS-inflation on price dispersion increases to 29.3%. Even though it has been shown that Chinese New Year exaggerates the effect of absolute value of PS-inflation on RPV, economists and policymakers should not be panic on the large fluctuations in prices. The level of inflation during Chinese New Year is mainly driven by soaring food prices. The basic supply and demand situation remain unchanged, with production surpassing consumption. Therefore this high price level in Chinese New Year is a short-term harmless phenomenon .

Table 4.2: Inflation-RPV Link in Equation(4.8)

RPV_{it}	Coef	Std.	P value
$\text{RPV}_{i(t-1)}$	.9223	.0037	0.000
$\lvert PS_{it}\rvert$	.0081	.0036	0.023
$\lvert CPI_t\rvert$	-.0002	.0002	0.45
$\lvert PS_{it}\rvert D_{yr}$	.0695	.011	0.000
$\lvert PS_{it}\rvert D_{Feb}$	.2849	.0194	0.000
D_{Feb}	-.0016	.0016	0.342
D_{yr}	-.0005	.001	0.637
R^2 : .7994 F-value: 3621.75 No. of Obs: 18247			
$\lvert PS_{it}\rvert + \lvert PS_{it}\rvert D_{yr} = 0$	.0776	.0109	0.000
$\lvert PS_{it}\rvert + \lvert PS_{it}\rvert D_{Feb} = 0$	.293	.0195	0.000

Similar to the result in table 4.1, the dummy variable itself for the recession years in 2007 and 2008 in table 4.2 does not display a significant role on price dispersion. However, the combined effect of PS-inflation and its interaction term with the dummy variable for recession years is both significant and positive at 7.76%.

Equation (4.9) displays "asymmetric price adjustment" of the link between PS-inflation and RPV. I take account of the asymmetric effects of inflation and deflation. Following the method already published in literature, I interact a dummy variable for deflation $D_{<0}$ with each element in equation (4.8), see examples in Reinsdorf (1994), Jaramillo (1999), Head and Kumar (2005) and Caglayan et al. (2008). Table 4.3 summarises the results in equation (4.9).

In terms of the effect of the absolute value of PS-inflation, equation (4.9) provides a significant but negative effect on price dispersion, which is opposite to the positive results from table 4.1 and 4.2. However, Peterson and Shi (2004)'s multiple equilibria theory suggests that higher PS-inflation narrows the dispersion of relative prices in an equilibrium, with less efficiency of allocations. The Jing-Jin-Ji Circle is an economy with less efficiency of allocations, as this area is not as developed as those with the highest welfare level in advanced economies, such as Shanghai and Hong Kong.

I then incorporate a dummy variable for recession years in order to identify the different impacts of PS-inflation on RPV during non-recession and recession time. In non-recession years, an one unit increase in absolute value of PS-inflation reduces RPV by 5.23%; while in recession years, the effect of PS-inflation remains negative but reduces less to 3.39%. Thus, a recession economy in the Jing-Jin-Ji area decreases the negative effect of PS-inflation on RPV. This result is in line with Jing-Jin-Ji's real economic situation that price movements of important products are controlled by the governor during periods of turmoil in order to stabilise aggregate price level. When there is a noticeable increase in inflation rate, Price Bureau will constrain specific price movements as they did during 2007 and 2008. Therefore, economic depression reduces the impact of PS-inflation on RPV through government control.

I then discover the impact of PS-inflation on RPV across different inflation regimes. In non-recession periods, the effect of PS-inflation on RPV is negative at -5.23%, when the PS-inflation rate is above zero; while such negative effects turn to be positive at 8.01% ($-0.0523 + 0.1323 = 0.0801$) when PS-inflation is below zero (PS-deflation). Therefore, this result shows a greater absolute value of impact of PS-inflation on RPV, when inflation is less than zero, indicating a supportive evidence for "asymmetric pricc adjustment". I also compared the effect of PS-deflation in non-recession periods with its effect in recession periods. In both non-recession and recession years, the effects of PS-inflation on RPV are positive and significant, which are 8.01% and 9.84% respectively. The positive impact of PS-deflation on RPV becomes more effective in recession years.

Table 4.3: Inflation-RPV Link in Equation(4.9)

RPV_{it}	Coef	Std.	P value
$\text{RPV}_{i(t-1)}$	.9232	.0037	0.000
$\lvert PS_{it}\rvert$	-.0523	.0046	0.000
$\lvert PS_{it}\rvert D_{Feb}$	.4005	.0239	0.000
$\lvert PS_{it}\rvert D_{yr}$	.0183	.0152	0.229
$\lvert PS_{it}\rvert D_{<0}$	.1323	.0066	0.000
$\lvert PS_{it}\rvert D_{Feb}D_{<0}$	-.249	.0374	0.000
$\lvert PS_{it}\rvert D_{yr}D_{<0}$	.0838	.021	0.000
$\lvert CPI_t\rvert$	0.000	.0002	0.857
$\lvert CPI_t\rvert D_{<0}$	-.0009	.0003	0.001
D_{yr}	-0.0007	0.0011	0.531
R^2 : .8048 F-value: 3023.5 No. of Obs: 18247			
$\lvert PS_{it}\rvert + \lvert PS_{it}\rvert D_{yr} = 0$	-.0339	.015	0.024
$\lvert PS_{it}\rvert + \lvert PS_{it}\rvert D_{Feb} = 0$	.3483	.0239	.000
$\lvert PS_{it}\rvert + \lvert PS_{it}\rvert D_{<0} = 0$	.0801	.005	0.000
$\lvert PS_{it}\rvert + \lvert PS_{it}\rvert D_{<0} + \lvert PS_{it}\rvert D_{yr} = 0$	.0984	.0162	0.000
$\lvert PS_{it}\rvert + \lvert PS_{it}\rvert D_{Feb} + \lvert PS_{it}\rvert D_{<0} = 0$	.4806	.0245	0.000
$\lvert CPI_{it}\rvert + \lvert CPI_{it}\rvert D_{<0} = 0$	-.0008	.0003	0.007

With respect to the contribution of Chinese New Year on the effect of PS-inflation on RPV, the absolute value of PS-inflation takes a positive and significant impact (at 34.83%) on RPV during Chinese Spring Festival. I then investigate the effect of Chinese New Year across positive and negative inflation regimes. When the product specific inflation rate is less than zero, the absolute value of PS-inflation plays bigger role in RPV at 48%. Chinese New Year makes greater positive impact on the price dispersion for those products which is experiencing deflation. The effect of CPI-inflation on RPV in table 4.3 is significant but negative at −0.08%.

4.6.3 Expected and Unexpected Inflation

Recent published research such as monetary search and signal extraction models, pay more attention to the effect of expected and unexpected PS-inflation, instead of the effect of aggregate PS-inflation. Table 4.7 displays coefficients and statistics for equation (4.10), (4.11) and (4.12) using *expected* and *unexpected* absolute values of PS-inflation. Column (1) and (2) consider *expected* PS-inflation only and investigate the impact of expected PS-inflation on RPV through a depression economy, Chinese New Year and different inflation regimes. Column (1) displays the contributions of a recession economy and Chinese New Year to the effect of expected PS-inflation on RPV, see in equation (4.10). Column(2) displays results of equation (4.11), taking negative inflation rate into consideration. Column (3) shows the results of equation (4.12), investigating the effect of unexpected PS-inflation as well as expected PS-inflation on RPV.

This section not only presents individual coefficients in each equation of (4.10), (4.11) and (4.12), but also investigates combined coefficients of variables and their interaction terms, so I provide a clear table of various effects of PS-inflation on RPV under various situations. The following Table 4.4 summarises the effect of the absolute value of expected PS-inflation on RPV in Column (1). The absolute value of expected PS-inflation can significantly widen or narrower the relative price dispersion under different situations. Global recession in 2007 and 2008 stimulated greater relative price variability. In Jing-Jin-Ji area, during non-recession times, higher price level narrower down the price dispersion by -1.79%, which indicates more stable price variability. However, higher price level in recession times triggers greater relative price variability, with a wider price dispersion. Economic recession is therefore harmful to price stability in this area.

No matter positive or negative effect of PS-inflation on RPV is, Chinese New Year is shown to exaggerate the size of its effect. During Chinese New Year, an one unit increase in the absolute value of PS-inflation will leads to more than 20% change to the relative price dispersion.

With respect to replacing absolute value of aggregate PS-inflation with expected PS-inflation, the expected PS-inflation is found to be less effective (-1.79%) on RPV than the effect of aggregate PS-inflation (-5.23%). This is because economic agents have their rational expectations on prices in the future. They will base their produce and selling decisions on their expectations. Therefore, the expected change in PS-inflation has been taken account into consideration when they are making decisions on the selling price. This predictable feature makes the expected PS-inflation less effective on RPV.

Table 4.4: Expected PS-Inflation in Column (1)

	Non-Recession	Recession
Normal Time	$-1.79\%^{***}$	$4.47\%^{***}$
Chinese New Year	$23.06\%^{***}$	$-20.62\%^{**}$

Notes: $*$ stands for 10% confidence level, $**$ is 5% level and $***$ is 1% level.

I then investigated the interaction term of expected PS-inflation with a dummy variable for recession years, in order to find out if expected PS-inflation had different influence on RPV during recession years, in which aggregate PS-inflation positively affects RPV as previously observed findings. My results indicate that, economic recession not only reverse the effect of expected PS-inflation on RPV to opposite direction (4.47%, while it was −1.79% for non-recession years) but also exaggerates the its absolute size. Generally speaking, the absolute value of expected PS-inflation has a stronger connection with RPV during economic recession and Chinese New Year, which is what we predicted. Moreover, Chinese New Year plays a more important role in the connection between expected PS-inflation and RPV compared with the role of a recession economy.

Column (2) takes the negative rate of inflation ($D_{<0}$) into consideration, so that we can investigate the asymmetric impact of absolute value of expected PS-inflation on RPV across positive and negative inflation regimes. Table 4.5 summarises the combined coefficients. Expected PS-inflation is shown to have a significant but opposite impact on relative price dispersion under inflation and deflation regimes with a absolute value of average mean of 7.85%, which is valid outside of the non-recession time and Chinese New Year. Absolute value of expected PS-inflation itself displays a negative effect (-8.76%) on RPV. However, for those negative expected PS-inflations, its effect on RPV is positive at 6.94%. Therefore, the opposite effects of expected PS-inflation on RPV across different inflation regimes support the "asymmetric PS-inflation and RPV link" proposed in menu cost and monetary search models. During Chinese New Year, expected PS-inflation is significantly effective only if it is under deflation regime.

Table 4.5: Effect of Expected PS-Inflation in Column(2)

	Non-Recession		Recession	
PS-Inflation	Normal	CN New Year	Normal	CN New Year
≥ 0	-8.76%***	3.08%	0.2%	-11.58%
< 0	6.94%***	19.51%***	-7.61%***	5.09%

Notes: $*$ stands for 10% confidence level, $**$ is 5% level and $***$ is 1% level.

I then compare those effects in non-recession with recession years. Generally speaking, economic recession is harmful to the overall price stability, expect for the products that is facing product-specific deflation. Economic recession narrows down the wider price dispersion for those cases. The negative effect of the absolute value of expected PS-inflation in non-recession years vanishes to be insignificant during recession years. On the other hand, if expected PS-inflation is less than zero, its effect on RPV becomes significant but negative, which is opposite to its effect on RPV when there is no recession. Therefore, generally speaking, a recession economy delivers on an opposite impact on the effect of expected PS-inflation on RPV.

Chinese New Year is found to be significant in its role in influencing the effect of expected PS-inflation on RPV. In non-recession years, Chinese New Year does not have a significant impact on the effect of absolute value of expected PS-inflation on RPV. However, if the expected PS-inflation is negative, Chinese New Year increases the positive effect of expected PS-inflation on RPV from 6.94% in normal times to 19.51% during the Festival. This suggests that if expected PS-inflation is negative in non-recession time, it widens RPV by 6.94% in normal time; while it widens RPV by 19.51% during Chinese New Year. However, those effects became opposites in the recession years. The only situation that expected PS-inflation is able to influence the dispersion of price variability is when the expected PS-inflation is less than zero during non-Chinese New Year time. Therefore, according to Column (2), Chinese New Year fails to affect the effect of expected PS-inflation on RPV unless the expected PS-inflation is negative during non-recession time. CPI inflation performs the same as before, fails to have a connection with RPV.

Table 4.6 is based on Column (3) and contains expected as well as unexpected PS-inflation to clarify what percentage of change of RPV is contributed by expected and unexpected PS-inflation respectively, see signal extraction models and recent literature (Caglayan and Filiztekin, 2003 and Caglayan et al. 2008). With respect to the effect of expected PS-inflation, it displays opposite directions of the effect on RPV across positive and negative inflation regimes in non-recession years, while this effect nevertheless keeps in negative when its in recession years. With respect to unexpected PS-inflation, its negative effect on RPV changes to positive when its in a negative inflation regime.

Table 4.6: Summary of Effect of Expected PS-Inflation in Column (3)

		Non-Recession		Recession	
PS-Inflation		Normal	CN New Year	Normal	CN New Year
EPS	≥ 0	-8.02%***	-43.16%***	-8.62%***	-22.28%**
	< 0	6.03%***	53.23%***	-5.22%**	-46.48%**
UPS	≥ 0	-5.47%***	1.5%	-1.81%	-10.94%
	< 0	7.77%***	22.79%**	9.83%***	29.95%**

Notes: $*$ stands for 10% confidence level, $**$ is 5% level and $***$ is 1% level.

The economic recession appears to have different influences on the effect of expected and unexpected PS-inflation on RPV. During normal time, it increases the negative effect of expected PS-inflation on RPV by 0.6% when the inflation rate is no less than zero; while when the inflation rate is less than zero, the recession can change the positive effect of expected PS-inflation on RPV to negative effects. In general, increasing expected PS-inflation, reduces the dispersion of price variability during recession periods in Jing-Jin-Jin area, which is consistent with what we predicted.

With respect to the effect of unexpected PS-inflation on RPV, an one unit increase leads to 5.47% falling in RPV in a non-recession period. However, it positively increase RPV by 7.77% if the inflation rate is less than zero. Generally speaking, when unexpected PS-inflation is less than zero, it positively affects RPV regardless of a recession period or Chinese New Year. When unexpected PS-inflation is no less than zero, it can only affect RPV when there is no recession or Chinese New Year.

I also investigated the contribution of Chinese New Year to the impact of expected as well as unexpected PS-inflation on RPV. Chinese New Year does not reverse the direction of effects of both expected and unexpected PS-inflation on RPV, but it increases their impacts on RPV by at lease three times. Therefore Chinese New Year exaggerates the effect of expected and unexpected PS-inflation, which is in line with the reality in China, that sellers take advantage of the shortage of supply around the Festival to expand the price variability.

In sum, in Jing-Jin-Ji area, increasing anticipated and unanticipated PS-inflation can narrow down the relative price dispersion. Unanticipated PS-inflation takes greater impact than anticipated PS-inflation. Firms' behavior are more influenced by the unexpected change of prices since their rational expectation can reduce the disturbances of their prediction of future prices. Policymakers should aim to low and stable inflation rate so as to reduce the unexpected uncertainties in prices. Deflation is shown to widen the price dispersion, thus policymaker's inflation target should be low but away from negative rate. The short-term high price level is a regular phenomenon during Chinese New Year, thus it is not necessary for policymakers to be panic about the turmoil. Price dispersion during economic recession is actually narrower than it was in non-recession time, which can be explained by the administrative price control in China. Although price control in China has been criticized by economists as it discourages the supply expansion in the products where prices are being controlled, the appropriate application of administrative control does work for China, it stabilizes the price turmoil that caused by economic recession. All in all, my study supports China's inflation targeting monetary policy combining with an appropriate administrative price control.

Table 4.7: Expected and Unexpected Inflation

	(1)	(2)	(3)
$\mathrm{RPV}_{i(t-1)}$	0.9271***	0.9271***	0.9277***
	(0.0037)	(0.0037)	(0.0036)
$\|EPS_{it}\|$	-0.0179***	-0.0876***	-0.0802***
	(0.0066)	(0.0083)	(0.0088)
CPI_t	-0.0000	-0.0001	0.0001
	(0.0002)	(0.0002)	(0.0002)
D_{yr}	-0.0008	-0.0007	-0.0011
	(0.0011)	(0.0011)	(0.0011)
$\|EPS_{it}\|D_{yr}$	0.0626***	0.0896***	-0.0059
	(0.0135)	(0.0185)	(0.0244)
$\|EPS_{it}\|D_{Feb}$	0.2484***	0.1183	-0.3513***
	(0.0622)	(0.098)	(0.1303)
$\|EPS_{it}\|D_{Feb}D_{yr}$	-0.2509***	-0.1465	0.2087
	(0.0821)	(0.1298)	(0.1664)
$\|EPS_{it}\|D_{<0}$	–	0.157***	0.1406***
	–	(0.0114)	(0.0113)
$CPI_tD_{<0}$	–	0.0002	-0.0008**
	–	(0.0002)	(0.0003)
$\|EPS_{it}\|D_{yr}D_{<0}$	–	-0.0781***	0.034
	–	(0.0241)	(0.0271)
$\|EPS_{it}\|D_{Feb}D_{<0}$	–	0.1644	0.472***
	–	(0.1212)	(0.1291)
$\|EPS_{it}\|D_{Feb}D_{<0}D_{yr}$	–	-0.1443	-0.4126**
	–	0.1667	(0.1727)
$\|UPS_{it}\|$	–	–	-0.0547***
	–	–	(0.0067)
$\|UPS_{it}\|D_{yr}$	–	–	0.0366 *
	–	–	(0.0191)
$\|UPS_{it}\|D_{Feb}$	–	–	0.070
	–	–	(0.0945)
$\|UPS_{it}\|D_{Feb}D_{yr}$	–	–	-0.0913
	–	–	(0.1029)
$\|UPS_{it}\|D_{<0}$	–	–	0.1324***
	–	–	(0.0085)
$\|UPS_{it}\|D_{yr}D_{<0}$	–	–	0.0206
	–	–	(0.0248)
$\|UPS_{it}\|D_{Feb}D_{<0}$	–	–	0.1502*
	–	–	(0.0920)
$\|UPS_{it}\|D_{Feb}D_{<0}D_{yr}$	–	–	0.2012
	–	–	(0.1273)

Table 4.8: Combined Coefficients of Independent Variables in Table 4.7

$Column(1)$
$|EPS_{it}| + |EPS_{it}|D_{yr} = .0447^{***}$
$|EPS_{it}| + |EPS_{it}|D_{Feb} = .2306^{***}$
$|EPS_{it}| + |EPS_{it}|D_{yr} + |EPS_{it}|D_{yr}D_{Feb} = -.2062^{**}$

$Column(2)$
$|EPS_{it}| + |EPS_{it}|D_{<0} = 0.0694^{***}$

$|EPS_{it}| + |EPS_{it}|D_{yr} = 0.002$
$|EPS_{it}| + |EPS_{it}|D_{yr} + |EPS_{it}|D_{yr}D_{<0} = -0.0761^{***}$

$|EPS_{it}| + |EPS_{it}|D_{Feb} = -0.0308$
$|EPS_{it}| + |EPS_{it}|D_{Feb} + |EPS_{it}|D_{Feb}D_{<0} = 0.1951^{**}$
$|EPS_{it}| + |EPS_{it}|D_{Feb} + |EPS_{it}|D_{Feb}D_{yr} = -0.1158$
$|EPS_{it}| + |EPS_{it}|D_{Feb} + |EPS_{it}|D_{Feb}D_{<0} + |EPS_{it}|D_{Feb}D_{<0}D_{yr} = 0.0509$

$Column(3)$
$|EPS_{it}| + |EPS_{it}|D_{yr} = -0.0862^{***}$
$|EPS_{it}| + |EPS_{it}|D_{Feb} = -0.4316^{***}$
$|EPS_{it}| + |EPS_{it}|D_{Feb} + |EPS_{it}|D_{Feb}D_{yr} = -0.2228^{**}$

$|EPS_{it}| + |EPS_{it}|D_{<0} = 0.0603^{***}$
$|EPS_{it}| + |EPS_{it}|D_{<0} + |EPS_{it}|D_{Feb}D_{<0} = 0.5323^{***}$
$|EPS_{it}| + |EPS_{it}|D_{yr} + |EPS_{it}|D_{yr}D_{<0} = -0.0522^{**}$
$|EPS_{it}| + |EPS_{it}|D_{yr} + |EPS_{it}|D_{yr}D_{<0} + |EPS_{it}|D_{Feb}D_{<0}D_{yr} = -0.4648^{**}$

$|UPS_{it}| + |UPS_{it}|D_{Feb} = 0.015$
$|UPS_{it}| + |UPS_{it}|D_{yr} = -0.0181$
$|UPS_{it}| + |UPS_{it}|D_{yr} + |UPS_{it}|D_{Feb}D_{yr} = -0.1094$

$|UPS_{it}| + |UPS_{it}|D_{<0} = 0.0777^{***}$
$|UPS_{it}| + |UPS_{it}|D_{<0} + |UPS_{it}|D_{Feb}D_{<0} = 0.2279^{**}$
$|UPS_{it}| + |UPS_{it}|D_{<0} + |UPS_{it}|D_{yr}D_{<0} = 0.0983^{***}$
$|UPS_{it}| + |UPS_{it}|D_{<0} + |UPS_{it}|D_{yr}D_{<0} + |UPS_{it}|D_{Feb}D_{<0}D_{yr} = 0.2995^{**}$

Notes: $*$ stands for 10% confidence level, $**$ is 5% level and $***$ is 1% level.

4.7 Conclusion

Reviewing both theoretical and empirical literature, it is apparent that the relationship between inflation and relative price variability is controversial. Theoretical studies mainly consist of: menu cost models, signal extraction models, information investment models and monetary search models. With regards to empirical studies, early research supports a positive relationship, which indicates that higher inflation leads to a greater variability in price. However, a handful of studies have provided evidence for a negative relationship between inflation and relative price variability, such as Dana (1994), Reinsdorf (1994), Fielding and Mizen (2000) and Silver and Ioannidis (2001). Despite earlier literature presenting inconsistent conclusions, the common feature of their results is that they concentrate on a linear relationship between inflation and RPV. Instead of providing a linear inflation-RPV link as predicted by earlier studies, recent literature sheds more light on the non-linear relationship between inflation and relative price variability. They allow different inflation regimes or different market structures, which may affect the association of PS inflation and RPV (Caglayan et al., 2008).

This chapter investigates the relationship between PS-inflation and RPV in a specific area in China, called the Jing-Jin-Ji Economic Circle. My data set provides information from January 2005 through September 2009 at fortnightly intervals. I collected prices for 174 products from 11 cities in the Jing-Jin-Ji Circle and investigated the effect of product specific inflation on

RPV during both non-recession and recession years. This study commenced with the testing of basic hypothesis of the menu cost model and is extended to a broader framework. I firstly investigated the relationship between relative price variability and the absolute value of PS-inflation in order to identify a V-shaped inflation-RPV link. My results are in line with aforementioned literature that the absolute value of PS-inflation takes a significant and positive effect on RPV, and CPI inflation fail to affect RPV significantly.

According to information investment models (Van Hoomissen, 1988), this study also considers the impact of the lagged RPV as the information stock, and suggests that the contemporaneous RPV is positively related to lagged RPV. This study only uses the contemporaneous value of related variables in the regression, since lagged RPV in my regression is assumed to capture all previous information related to these variables. This is consistent with what I predicted, the coefficients of lagged RPV is significantly positive.

Since economists have not yet yielded any firm conclusions about the optimal rate of inflation, policymakers therefore must reply on their judgment in weighing the different considerations. Following Jaramillo (1999) and Caglayan et al. (2008), I investigate the effect of interaction term of PS-inflation with a dummy variable for deflation, $|PS| * D_{<0}$, to distinguish a different slope of the inflation-RPV link across both positive and negative inflation regimes. My results for the coefficient of the interaction term are significant and positive, indicating a widen price dispersion under higher deflation. Therefore, from policymakers' point of view, in China, deflation is of little benefit, and even harmful to price stability. Deflation in China not only accompanies a slow growth, but also widens price dispersion with greater relative price variability. Its harmful influence tempered during the big recession in 2007-2008 mainly due to the emergency short-term "price controls". Therefore, monetary policy in China should aim to keep average inflation low to moderate but away from zero and negative. Short-term price control in China is also preferable. Even though administrative price control is facing criticism for discouraging supply expansion in the products where prices are being controlled, my study supports its short-term effectiveness for stabilizing relative price variability under higher PS-inflation.

The innovative point in this study is the introduction of a dummy variable for Chinese New Year, as I believe that sellers' and consumers' behavior may be different from how it was in normal times, due to excess demand during Spring Festival. I expect to see a wider relative price variability during Chinese New Year because of the excess demand, as well as the seller's market power. Even though it has been shown that Chinese New Year exaggerates the effect of PS-inflation on RPV, economists and policymakers should not be panic on the large fluctuations in prices. The level of inflation during Chinese New Year is mainly driven by soaring food prices, and this short-term high price level will recover very soon after Chinese New Year. The basic supply and demand situation remain unchanged, with production surpassing consumption. Therefore, policymakers should not base their tightening policy on what's happening during Chinese New Year as it can not present a broad-based price rise.

Also, if one can certify that the high price level is just because of celebration of Chinese New Year, it is not necessary for policymakers to respond to this short-term harmless phenomenon.

Due to the fact that different inflation measurements show different influences on relative price dispersion, this study tests the effects of both expected and unexpected PS-inflation, and the aggregate inflation (CPI inflation). For both expected and unexpected PS-inflation, their effects on RPV are significant but negative. As it is known, central bank of China has an explicit target for inflation ($3\% - 4\%$) each year, its emphasis on hitting the inflation target can affect the level of expected PS-inflation. By anchoring expectations at the target level, inflation targeting reduces the disturbances of the predictability of product prices for both sellers and buyers. Therefore, higher expected PS-inflation does not leads to greater relative price variability under inflation targeting, it nevertheless narrower the price dispersion. This aforementioned negative influence is also the result of the administrative "price controls" in Jing-Jin-Ji area.

China's economy embraces many unique features which can contribute to the relationship between PS-inflation and RPV and its implications to policy, besides the effect of Chinese New Year. With different regions, the effect of PS-inflation will also present various impacts on RPV. Therefore, more studies focusing on this subject are expected in the future.

Table 4.9: Production in Three Economic Circles in China in 2008

	LocalGDP (trillion)	*LocalGDP/GDP*	GDPGrowthrate
Pearl River Delta	2.97	9.1%	12.6%
Yangtze River Delta	6.55	20%	11%
Jing-Jin-Ji Circle	2.98	9.1%	11.9%

Figure 4.1: CPI-Inflation in Jing-Jin-Ji from 2005 to 2009

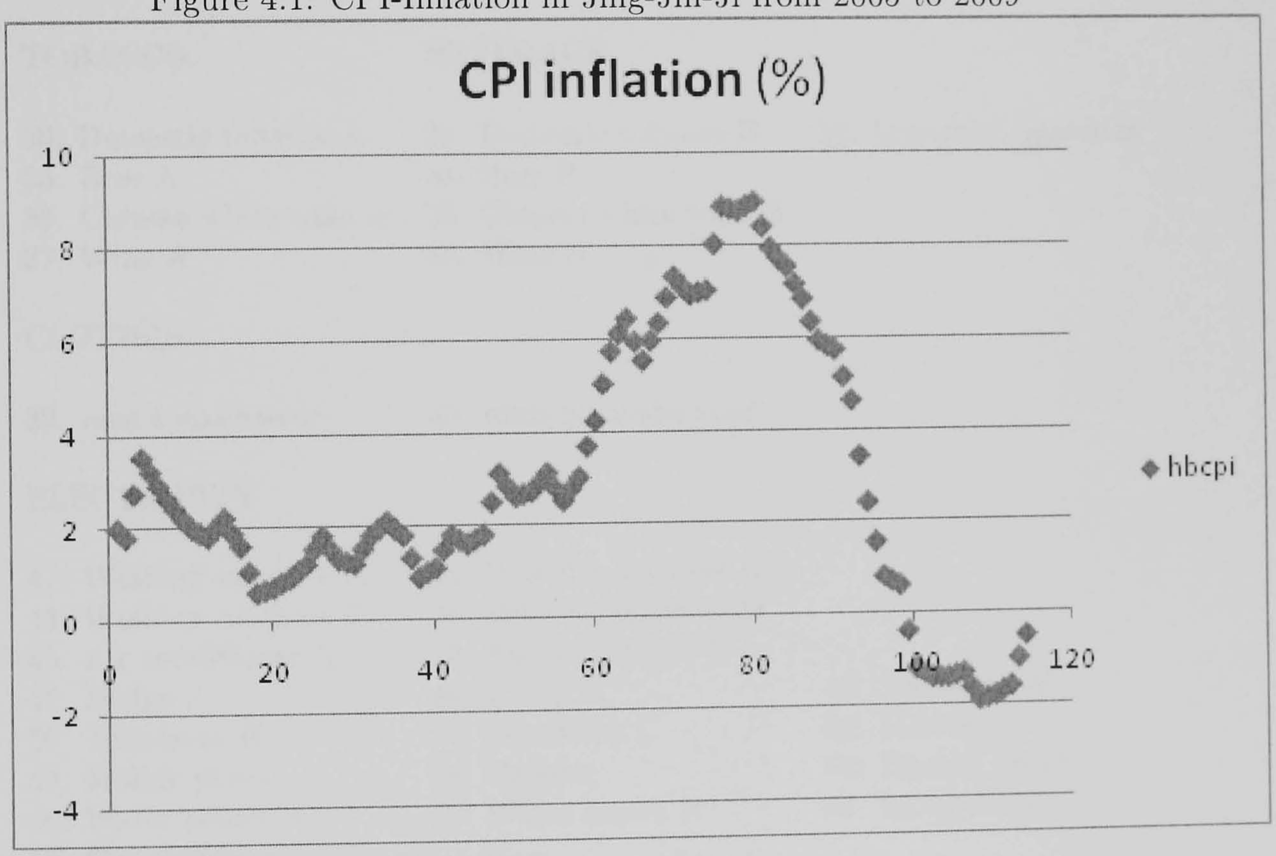


Table 4.10: 174 Products Index

FOOD		
1. Flour	2. Japonica rice	3. Refining cornmeal
4.Peanut oil	5. Salad oil	6. Pork Ribs
7. Pork rear meat	8. Beef	9. Lamb
10.Ribbonfish	11. Carp	12.Chicken
13. Eggs	14. Milk	15. Chinese Leaf
16. Cabbage	17. Chives	18. Green pepper
19. Cucumber	20. Tomatoes	21. Eggplant
22. Celery	23. Spinach	24. Potatoes
25. Beans	26. Garlic bolt	27. Cauliflower
28. Squash	29. White gourd	
TOBACCO	BEVERAGE	
30. Domestic tobacco A	31. Domestic tobacco B	32. Imported cigarettes
33. Beer A	34. Beer B	
35. Chinese white wine A	36. Chinese white wine B	
37. Wine A	38. Wine B	
CLOTHES		
39. men's underwear	40. women's underwear	
ELECTRICITY		
41. Washing machine A	42. Washing machine B	
43. Washing machine C	44. Washing machine D	
45. Air conditioner A	46. Air conditioner B	
47. Fridge A	48. Fridge B	49. Television A
50. Television B	51. Television C	52. Microwave
53. Mobile phone	54. Camera	55. Electric heater
56. Water heater A	57. Water heater B	58. Range hood
59. Gas cooker		

INDUSTRIAL MATERIAL

60. Hot rolled round bar
61. Rebar
62. Angle iron
63. Carbon steel
64. Plain carbon hot-rolled plate
65. Plain carbon hot-rolled sheet
66. Common carbon steel cold-rolled sheet
67. Galvanized plate
68. Copper
69. Aluminum
70. Lead
71. Anthracite
72. Bituminous coal
73. Coke
74. Gasoline A
75. Gasoline B
76. Ethanol
77. Diesel fuel A
78. Diesel fuel B
79. Caustic soda
80. Soda ash
81. Sulfuric acid
82. Polyethylene
83. Polypropylene
84. Rubber
85. Cement A
86. Cement B
87. Plate glass
88. glass plate floating
89. Electricity
90. Natural gas
91. Gas
92. Industrial water
93. Automobile

SERVICES

94. Bus monthly pass
95. Bus fare
96. Taxi rent
97. Coach fare
98. Road transport
99. House rent
100. Property management fees
101. Student accommodation
102. Household water
103. Sewage fee
104. General Water rate
105. Residential electricity
106. Natural gas
107. Liquefied petroleum gas
108. Honeycomb briquette
109. Central heating A
110. Central heating B
111. Landline monthly rent
112. Internal network call rates A
113. Internal network call rates B
114. Mobile call rates A
115. Mobile call rates B
116. TV license
117. Internet costs
118. Hospital registration fee
119. Injection fee
120. Surgery fee
121. Hospitalization costs
122. Hospital inspections A
123. Inspections B
124. Lab fee
125. University tuition
126. High school tuition1
127. High school tuition2
128. Middle school fees
129. Primary school fees
130. Nursery fee
131. Land price
132. Real estate A
133. Real estate B
134. Affordable housing A
135. Affordable housing B

AGRICULTURAL PRODUCTS, MATERIALS and SERVICES IN RURAL AREA

136. Wheat
137. Corn
138. Soybean
139. Peanut
140. Swine
141. Piglet
142. Cotton
143. Urea
144. Ammonium bicarbonate
145. Potassium chloride
146. DAP
147. SSP
148. NPK A
149. NPK B
150. Insecticide
151. Omethoate
152. High-pressure polyethylene greenhouse film
153. LDPE film
154. Diesel oil A
155. Diesel oil B
156. Wheat bran
157. Pig feed
158. Chicken feed
159. Residential electricity
160. Irrigation power
161. Residential water
162. Irrigation water A
163. Irrigation water B
164. TV license
165. Landline rent
166. Primary school fee
167. Middle school fee
168. High school tuition
169. Homestead land certificate fee
170. Hospital registration fee
171. Injection fee
172. Surgery fee
173. Hospitalization costs
174. Hospital inspection fee

Chapter 5

Thesis Conclusion

This thesis mainly consists of 3 chapters which investigate the link between volatility and trade flows and growth, as well as the behavior of prices. The second chapter estimates the impact of exchange rate volatility on sectoral bilateral trade flows between United States and another 13 countries. I also investigate those effects on sectoral trade flows, which are caused by income volatility and its interaction term with exchange rate volatility. My results suggest that, in general, exchange rate volatility has very little effect on sectoral trade flow. There is also no evidence to suggest that exchange rate volatility plays a more important role in the trade flows for emerging countries, which is opposite to the observation that exchange rate volatility influences emerging countries due to the absence of financial tools. Income volatility appears to execute little effect on trade flows too, but the effect of the interaction term of exchange rate volatility with income volatility has the opposite sign to that of exchange rate volatility. This finding has not been reported before, and it indicates that depending on the relative size of exchange rate volatility and income volatility, the effect of exchange rate volatility would be nullified. Overlooking this interaction term may lead to a misinterpretation of the impact of exchange rate volatility on trade flows.

My third chapter explores the importance of price stability and investigates the effect of inflation volatility on the level of sectoral output growth rate, and its cross-sectional wide dispersion for Japan's manufactory industry. Current literature suggests that inflation uncertainty, through its impact on the informational content of price mechanism, hinders the efficient allocation of resources, which causes the output level as well as the cross-sectional dispersion to vary. I present a simple signal extraction model to explain how the the noise in the signal can affect the predictability of future prices. In the empirical investigations, I use the GARCH model to measure inflation volatility as a proxy for the noise in the signal, and empirically investigate the effect of inflation volatility. I also add several variables into my model including CPI inflation, interest rate, oil price and its volatility and credit limits in banking section.

My results indicate a negative relationship between average inflation volatility and output growth and its dispersion. Increasing inflation variability reduces Japan's manufacturing output growth on a sectoral level and narrows down the cross-sectional dispersion of output growth. CPI inflation, interest rates and level of oil price are found to have no significant influence in either sectoral output growth or its cross-section wide dispersion.

My fourth chapter further explores the link between inflation and price variability. I concentrate on product specific inflation's (PS-inflation) effect and estimate how inflation affects allocation of resources through its effect on relative price variability (RPV), by using a local data set from one of the top three economic zone in China, the Jing-Jin-Ji Economic Circle. My estimation model embraces a broader framework than that have been presented in the literature and incorporates new factors which are special for my data set. My estimation starts from the basic mode as suggested by menu cost models. My initial result implies the same conclusion as current literature, that product specific inflation positively influences RPV and that this effect shows opposite signs across positive-negative regimes. I then take effects that caused by Chinese New Year and a recession economy into consideration, to detect if those effects will influence the impact of PS-inflation on the RPV. My results suggest that both Chinese New Year and economic recession can strengthen the positive effect of inflation volatility on the the RPV.

According to current accepted literature, expected and unexpected parts of PS-inflation may display different influences on the RPV. Therefore I decompose the aggregate effect of PS-inflation into its expected and unexpected components. The results show that, for the Jing-Jin-Ji economic area, both expected and unexpected PS-inflation make a negative influence on RPV in the case of a positive inflation region. Moreover, RPV is more influenced by expected PS-inflation than its unexpected components. On the other hand, in a negative inflation region, expected and unexpected PS-inflation turn to have positive influence on RPV, except the special case that under economic recession, expected PS-inflation makes negative effect on RPV. In summary, the effect of PS-inflation presents various impacts on RPV depending on the various environments.

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