

# **Monetary Policy and Its Impact on the Economy**

Inauguraldissertation  
zur Erlangung des akademischen Grades  
eines Doktors der Wissenschaftswissenschaft (doctor rerum oeconomicarum)  
am Fachbereich Wirtschaftswissenschaft  
– Schumpeter School of Business and Economics –  
der Bergischen Universität Wuppertal

vorgelegt von

**Rongrong Sun**  
(M.Sc. in Economics and Finance)

aus Wuppertal

Wuppertal, im November 2012

Die Dissertation kann wie folgt zitiert werden:

urn:nbn:de:hbz:468-20130524-095129-3

[<http://nbn-resolving.de/urn/resolver.pl?urn=urn%3Anbn%3Ade%3Ahbz%3A468-20130524-095129-3>]

## Table of Contents

1. Introduction .....	1
2. Literature Review .....	10
2.1 Money and Income: From Milton Friedman to the VAR Studies in the 1980s .....	10
2.2 Is the Money Stock a Good Measure of Monetary Policy?.....	14
2.3 Non-Neutrality of Monetary Policy Revisited.....	15
2.4 Some Puzzles in the VAR Studies and an Alternative Approach .....	17
2.5 Conclusion .....	18
3. Nominal Rigidity and the Output-Inflation Tradeoff .....	20
3.1 Literature Review on Nominal Rigidity .....	23
3.1.1 Why Are Wages or Prices Sticky? .....	23
3.1.2 How Rigid Are Prices? .....	25
3.2 Data and Sample Description .....	29
3.3 International Evidence (1): Two-Stage Cross-Country Results .....	31
3.3.1 Estimating the Short-Run Output-Inflation Tradeoff .....	31
3.3.2 Determinants of the Tradeoff: Cross-Country Results .....	34
3.3.3 Robustness Test: Supply Shocks .....	38
3.4 International Evidence (2): Two-Stage Cross-Country Panel Results .....	39
3.4.1 Estimating the Output-Inflation Tradeoff with Rolling Regressions .....	40
3.4.2 Determinants of the Tradeoff: Cross-Country Panel Results .....	41
3.4.3 Robustness Test: Cross-Country Heterogeneity .....	43
3.5 International Evidence (3): Two-Stage Country-by-Country Time-Series Results .....	46
3.6 International Evidence (4): One-Stage Country-by-Country Time-Series Results .....	48
3.7 Conclusion .....	53
4. Does Monetary Policy Matter in China? A Narrative Approach .....	55

4.1 What Measures China’s Monetary Policy .....	57
4.1.1 Institutional Background .....	58
4.1.2 Measuring Monetary Policy with M2? .....	59
4.1.3 Measuring Monetary Policy with One Policy Instrument? .....	61
4.2 Financial Markets and the Functioning of Monetary Transmission Channels .....	66
4.3 The Identification Problem .....	70
4.4 Narrative Identification of Monetary Shocks .....	73
4.4.1 Identification of Monetary Shocks .....	73
4.4.2 Were Shocks Predictable? .....	76
4.4.3 Intensions versus Actions .....	82
4.5 How Do Monetary Shocks Affect the Economy? .....	82
4.5.1 Baseline Results .....	82
4.5.2 VAR Results .....	85
4.5.3 Comparison with Other Measures .....	87
4.5.4 Robustness .....	91
4.6 Conclusion .....	92
Appendix A: Data Appendix .....	94
Appendix B: Baseline Regression Results .....	95
5. Monetary Policy and European Unemployment .....	97
5.1 Neutral Output and NAIRUs .....	102
5.2 Asymmetric Monetary Policy .....	106
5.3 Conclusions .....	111
Bibliography .....	113

## List of Figures

Figure 2.1: Responses of output to a rise of the interest rate, US and Germany .....	16
Figure 2.2: Response of the unemployment rate to a rise of the federal funds rate, US .....	16
Figure 2.3: Response of real GDP to a decrease of the federal funds rate, US .....	16
Figure 3.1: The output-inflation tradeoff and average inflation .....	35
Figure 3.2: The output-inflation tradeoff and standard deviation of nominal growth.....	35
Figure 3.3: Inflation in the United States, 1948-2007 .....	40
Figure 3.4: The Output-Inflation Tradeoff, the UK and the US, 1948-2007.....	41
Figure 4.1: Three selected monetary policy instruments in China, 1998-2011 .....	65
Figure 4.2: Components of external financing, China and the USA, 2004 and 2010 .....	67
Figure 4.3: Fast developments of the private sector in China, 1998 and 2007.....	69
Figure 4.4: Inflation, 2000-2011 .....	76
Figure 4.5: Implied probability of an anti-inflationary policy shift.....	81
Figure 4.6: Estimated impact of monetary tightening on industrial production.....	84
Figure 4.7: Estimated impact of monetary tightening on the price level.....	85
Figure 4.8: Estimated impact of monetary tightening (bivariate VAR) .....	87
Figure 4.9: Estimated impact of monetary tightening using other measures .....	89
Figure 5.1: Unemployment trends in Germany, Euro Area and the USA.....	98
Figure 5.2: Business cycles and long-run growth trends.....	100
Figure 5.3: Output gap for Germany according to the Bundesbank (2003) .....	104

## List of Tables

Table 2.1: Selected studies on the money-income relationship, using VAR.....	12
Table 3.1: Monthly average frequency of consumer price changes and average inflation .....	28
Table 3.2: Descriptive statistics on inflation and output, 37 countries.....	30
Table 3.3: Estimates of the output-inflation tradeoff, 37 countries.....	33
Table 3.4: Determinants of the tradeoff, 37 countries.....	37
Table 3.5: Determinants of the tradeoff, panel data, 37 countries.....	42
Table 3.6: Determinants of the tradeoff with fixed effects, panel data, 37 countries.....	45
Table 3.7: Determinants of over-time variations in the tradeoff, 37 countries, two-step procedure.....	47
Table 3.8: Determinants of over-time variations of the tradeoff, 37 countries, one-stage procedure.....	52
Table 4.1: Targeted and actual growth rates of monetary aggregates, 1998-2011 .....	60
Table 4.2: Policy instruments applied by the PBC .....	63
Table 4.3: Decision to shift to contraction: logistic estimates.....	79
Table B-4.1: Baseline regression results for industrial production .....	95
Table B-4.2: Baseline regression results for inflation .....	96
Table 5.1: The Bundesbank's money growth and implicit inflation targets for 1975-1998....	107
Table 5.2: Three recoveries in Germany and the USA .....	110

## 1. Introduction

The recent financial crisis and recession have revived debates about the role of monetary policy. An understanding of how monetary policy works is crucial for successful policy-making in terms of whether monetary policy has the potential to stimulate and/or stabilize the economy. For decades, these debates have inspired a lot of thoughts. There seems to be a wide agreement that monetary policy influences inflation, but not all economists agree that monetary policy affects real economic activities. Essentially, there are three main schools of views.

The first school is Keynesian economics, arguing that monetary policy does not only affect inflation but also systematically affects investment, production, employment and real incomes (at least in the short run).<sup>1</sup> The non-neutrality of monetary policy arises from market frictions, imperfect information, nominal rigidities or asynchronized price- and wage-setting behaviour, or even different norms<sup>2</sup> of decision-makers.<sup>3</sup> Some Keynesians (though not all) argue that economic developments are path dependent<sup>4</sup> and thus, the demand shocks through monetary policy can lead to long-lasting effects on economic activities (see, e.g., Akerlof 2007; Ball 2009; Mankiw 2001). Despite this divergence in terms of short-run or long-run non-neutrality, all Keynesian economists believe that the short-run real effects matter. They argue that demand disturbances are the main source of economic fluctuations and activist demand management via monetary policy is strongly supported (see, e.g., de Long and Summers 1988; Romer and Romer 1989).

The second school is the monetarist argument that monetary policy affects the economy in the short run, but with uncertain lags and uncertain magnitudes. In the long run, it affects nominal variables only and inflation is a purely monetary phenomenon. Monetary policy is nevertheless important because inflation is costly and monetary policy determines the inflation

---

<sup>1</sup> The new development of the Keynesian school is known as New Keynesian economics, which emphasizes the provision of microeconomic foundations for traditional Keynesian macroeconomic models. As the main predictions about monetary policy of these two kin schools are essentially the same, I will not particularly distinguish between them in this thesis.

<sup>2</sup> Akerlof (2007) defines norms as how decision-makers think they and others should or should not behave.

<sup>3</sup> For surveys, see Blanchard (1990), Orphanides and Solow (1990) and Benjamin Friedman (1990).

<sup>4</sup> The theoretical foundations include inter alia the hysteresis theory and the endogenous growth theory (Aghion and Howitt 1998; Blanchard and Summers 1986).

rate, as argued by Milton Friedman (1968). Thus, the overriding objective of monetary policy should be price stability. This is the main contribution that monetary policy can provide. Monetary policy should be long-run oriented. Erratic monetary policy should be avoided. A rule of a fixed monetary growth rate is proposed by Milton Friedman (1968) – for example, 3 to 5 percent per year.

The third school is new classical economics, arguing for rational expectations and full-employment equilibrium. New classical economists believe that only unexpected monetary policy shocks have an impact on economic activities, while systematic monetary policy actions are expected by economic agents and thus have no effect on the economy (see, e.g., Lucas 1972, 1973, 1996; Sargent 1976). However, since policies cannot systematically fool all the people, monetary policy eventually merely plays a minor role in influencing economic developments. In the world of perfect markets, or the world with information imperfections but with rational expectations, monetary policy is simply neutral. Changes in the money stock induce proportional changes in prices only. Demand management with monetary policy is not desirable as these policy disturbances may amplify the economic fluctuations. Rather, supply-side policies (for example, fiscal reforms to mitigate tax distortions) should be given more attention (see Lucas 2003).

The Keynesian school differs from the other two in fundamentals. To Keynesians, the perfect market hypothesis does not hold: there are markets distortions, nominal rigidities and sluggish demand. Therefore, activist demand policy (for example, monetary policy) should be pursued to stimulate demand and impair distortions. In contrast, new classical and monetarist economists believe in the power of the “invisible hand”. Economic fluctuations are mainly driven by the supply side. Unemployment is largely structural (for example, due to a mismatch between job vacancies and the unemployed in skills, location, etc).<sup>5</sup> Activist demand policy is not wanted as it neither has an impact on the supply side nor on structural unemployment. Rather, monetary policy should more or less follow a fixed rule such that its unnecessary disturbances to the economy can be minimized. Once again, such debates are reflected in the current arguments among economists of different schools on how economies get out of the

---

<sup>5</sup> See, for example, Daly et al. (2012).



Great Recession and how high unemployment in the US can be reduced (for example, Paul Krugman against John Taylor).<sup>6</sup>

Possibly, we can test the views of different schools by checking their rationales. According to the Keynesian view, changes in nominal aggregate demand affect real output because of nominal wage and price rigidities, which might arise due to costs of price adjustment. More in particular, when inflation is high, the benefits from changing prices tend to exceed the adjustment costs such that prices are adjusted more often. As a result, nominal demand shocks induce faster and larger movements in prices and the fluctuations in the real economy are smaller. It follows that a higher trend inflation (measured, for example, by the average inflation rate) leads to a steeper short-run Phillips curve (i.e., the tradeoff between inflation and unemployment is smaller). That the average inflation rate affects the slope of the Phillips curve is the specific prediction of Keynesian theories based on nominal rigidities.

The new classical alternative explanation for the Phillips curve is the Lucas imperfect information model (1972, 1973). The short-run tradeoff between inflation and real output is observable only when firms misinterpret a change in the price level as a movement in relative prices and thereby adjust their production. The producers' expectations depend on the relative volatility of an individual price to the aggregate price level. The more volatile is the aggregate price level, the less likely it is that an observed price change is idiosyncratic. It follows that the more volatile is nominal aggregate demand, where the price level is nested, the less often a misperception occurs at the firm level. It implies that the curve relating real output to unanticipated inflation should be steeper for countries with highly variable nominal aggregate demand.

A large variation in trend inflation and nominal aggregate variability across countries thus provides a rationale for cross-country comparisons. Lucas (1973) tests his imperfect information hypothesis with data from 18 countries and finds supportive evidence: increased nominal aggregate variability is associated with a diminishing output-inflation tradeoff. Ball, Mankiw and Romer (BMR) (1988) provide empirical evidence based on a 43-country sample

---

<sup>6</sup> This debate shapes the way of thinking of policy-makers, which is reflected in this year's central banker meeting in Jackson Hole. One of the focuses at the meeting was how to disentangle the cyclical components from the structural ones of the US current high unemployment (Lazear and Spletzer 2012).

and confirm Lucas observation. However, their interpretation of this finding is different from that of Lucas: the uncertainty, arising from high nominal aggregate variability, increases nominal flexibility and thus reduces the real effects of nominal disturbances. They provide further evidence for the nominal rigidity hypothesis: they find that the cross-country differences in the output-inflation tradeoff are well explained by trend inflation even when nominal aggregate variability is controlled.

Following BMR (1988), a bundle of studies have emerged that examine the Keynesian theory on the output-inflation tradeoff, but vary in the estimation approaches applied. I summarize and evaluate these approaches in Chapter three “**Nominal Rigidity and the Output-Inflation Tradeoff**”. By doing so, I provide further evidence to see whether the Keynesian nominal rigidity hypothesis on the output-inflation tradeoff withstands new evidence. All my tests, using cross-country data and time series, discriminate between the two theoretical frameworks by disentangling the effects on the steepness of the Phillips curve that are attributable to the variance in nominal growth from those that can be attributed to the level of steady inflation. Consistent with BMR, my results from both cross-country and over-time analyses confirm the Keynesian theory that nominal rigidity is an important determinant of the output-inflation tradeoff. When inflation is higher, prices are less sticky; changes in nominal demand are transmitted more to fluctuations in prices; aggregate demand policy is thus less effective and the output-inflation tradeoff is smaller.

The cross-country comparison based on the extended sample constitutes evidence that the Keynesian theory is still relevant today. In higher-inflation countries, the output-inflation tradeoff that policy-makers face is smaller. However, in each individual country, the output-inflation tradeoff is not constant over time as the state of the economy changes and thus, the degree of nominal rigidity varies over time. Policy-makers should thus take a dynamic view towards the tradeoff.

The key prediction of the Keynesian school is that monetary policy is not neutral. Indeed, it is a well-established fact that in advanced economies, monetary policy is found to have a significant impact on output (at least in the short run), thanks to numerous contributions (Chapter two gives a detailed literature review). However, very few studies have addressed

this monetary non-neutrality issue for the case of China, and reported somewhat mixed findings (see, e.g., Dickinson and Liu 2007; Sun, Ford, and Dickinson 2010). On the other hand, it is not obvious that the conclusion drawn for advanced economies can simply be extended to the case of China, given the substantial differences between China and those economies in their central banking strategies and practices. The central bank of China, the People's Bank of China (PBC), is known to use several unconventional measures, including inter alia credit controls, to achieve various tasks. Furthermore, given under-developed financial markets and the fact that firms in China depend heavily on bank loans for external financing, the main effective monetary propagation mechanisms could differ from those in advanced economies. Hence, it is necessary to conduct an independent study to examine the effectiveness of Chinese monetary policy.

In Chapter four, **“Does Monetary Policy Matter in China? A Narrative Approach”**, I apply the narrative approach to the case of China. I read the documents of the PBC to obtain additional information about policy makers' intentions behind each policy movement. This narrative approach tackles two problems: the policy measurement problem and the identification problem. The first arises because the PBC applies multiple instruments, different from the standard one-instrument operating procedure that advanced economies adopt.<sup>7</sup> Under this operating procedure, all its frequently-used policy instruments contain information about its policy (see, e.g., Chen, Chen, and Gerlach 2011; He and Pauwels 2008; Shu and Ng 2010; Xiong 2011). It is thus impossible to represent the behavior of all PBC instrument variables with a single instrument, such as those conventional measures (the short-term interest rate or the money stock) that are widely used to measure monetary policy of other central banks. Using them will lead to odd estimates of the effects of monetary policy in China.

The second classical identification problem arises as the central bank also reacts to the state of the economy and the causal direction of the observed interaction between central bank actions and real activity needs to be identified. Changes in policy instruments reflect the influences more than monetary policy. For example, changes in the required reserve ratio and monetary

---

<sup>7</sup> That is, use open market operations with short-term money market rates as the operational target.

aggregates in China are strongly influenced by many non-monetary factors, including the trade balance, foreign exchange purchases and the subsequent sterilization interventions.<sup>8</sup>

Chapter four contributes to the literature with a careful examination of Chinese monetary policy by focusing on how and with what effects monetary policy is conducted in China. It hence gives outside observers some insights into the functioning of Chinese monetary policy.

Based on two sources of the PBC's documents for the period 2000-2011, I identify three exogenous monetary shocks as those movements that are driven by inflationary pressure. These shocks are uncorrelated with the current and future developments on the real side of the economy. Their impact on the economy should lead to an unbiased estimate of the effects of monetary policy. Estimates using these shocks indicate that monetary policy in China has strong and long-lasting effects on output. Following a monetary contraction, the maximum drop of output is found after 15 months: the level of output is about 6 percent lower than it would otherwise have been. This slowdown is perennial with the negative impact remaining at a substantial level even after five years. All these findings are robust to variations in the control variables and the specification.

My results confirm the narrative-approach findings based on the US data (see Romer and Romer 1989, 2004). However, the effects of Chinese monetary policy (with the use of various unconventional measures) are quicker and more persistent than those estimated for the US. For example, compared to Romer and Romer (2004), lags in the industrial production effects are smaller in China (with two months versus five months); the maximum depressing impact on output occurs earlier in China (with 15 months after the shock versus 24 months). This slowdown is more perennial in China: after five years, the effect on output is still substantially negative.

Different from Milton Friedman's proposal that unconventional direct instruments (for example, credit controls) should be abandoned because they lead to large distortions (Friedman 1960), the PBC still uses various direct instruments, partly due to institutional

---

<sup>8</sup> Sterilization refers to actions taken by the central bank to neutralize the impact of foreign exchange operations on domestic money supply. The PBC currently sterilizes the money supply through two instruments – open market operations by issuing central bank bills and increasing the required reserve ratio.

constraints. However, Chapter four, based on the study of the Chinese case, finds that monetary policy using combined indirect and unconventional direct policy instruments has strong and long-lasting effects on the real economy. This finding lends strong support to the current discussions on the effects of unconventional monetary measures that central banks around the world started to use after the outbreak of the financial crisis.

Given their different policy implications, competing schools of thoughts in macroeconomics have had strong influences on monetary policy adopted by different central banks. As expressed by Keynes, “the ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood. Indeed the world is ruled by little else. Practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist” (Keynes 1936: 383).

In Germany, the monetarist school has played an important role in shaping its monetary policy. For example, Otmar Issing, the former member of the board of the Deutsche Bundesbank and of the Executive Board of the European Central Bank (ECB), believes that: “other than by maintaining price stability and thereby reaping its benefits in terms of economic performance, there is no tradeoff at longer horizons between inflation, on the one hand, and economic growth or employment, on the other hand, that can be exploited by monetary policy makers” (Issing 2000: 4). This led to a broad consensus in Germany that the only appropriate objective of monetary policy was the maintenance of price stability. Thus, it is argued that monetary policy has nothing to do with the euro-sclerosis and the persistent high European unemployment rate in the last three decades (prior to the 2007 crisis).

However, de Grauwe and Polan (2005) test the monetarist claim that inflation is always and everywhere a monetary phenomenon and do not find the supportive evidence. They use panel data consisting of 160 countries over 30 years. They find that a positive long-run relationship between inflation and money growth is explained by the presence of high-inflation countries in the sample. In most of the low-inflation countries, there is no strong link between inflation and money growth. The effects of monetary policy do not end with the nominal magnitudes only.

Furthermore, the unemployment trend in Europe is hardly consistent with one specific rate of structural unemployment (or in Friedman's words, the "natural rate of unemployment") since unemployment rose with every recession and remained at levels substantially above the pre-recession rates. Neither could severe supply shocks per se explain the rising European unemployment for the period after 1980. Rather, this period is known as the Great Moderation for the US economy with the low unemployment rate and stable inflation, partly due to the relative absence of supply shocks.

Surprisingly, little attention was given to macroeconomic institutions although the institutional setup regarding monetary policy is very different across the Atlantic. The Deutsche Bundesbank differed from the Federal Reserve System (Fed) in its principles and practices. Rather than the dominance of price stability that was adopted by the Bundesbank (and later by the ECB), the Fed has a "dual mandate" and is required to use monetary policy to achieve price stability, but also "to promote effectively the goals of maximum employment, and stable prices." For the Bundesbank (and the ECB), price stability became the priority and other considerations should only be pursued conditional on the achievement of price stability.

These different doctrines are reflected in their policies. With a minor weight on growth, monetary policy of the Bundesbank might have been biased towards inflation fighting per se. A growing economy might already have triggered the fear of the Bank for inflation and shifted to contractionary policy. Indeed, in Chapter five, "**Monetary Policy and European Unemployment**" (co-authored with Ronald Schettkat), we find that the monetary policy of the Bundesbank is asymmetrical in the sense that the Bank did not actively fight against recessions, but that it dampened the recovery periods. Less constraint on growth would have kept German unemployment at lower levels. The interaction of negative external shocks and tight monetary policies may have been the major – although probably not the only – cause of unemployment in Europe remaining at ever higher levels after each recession.

This thesis examines rationales behind different economic schools and their policy application in a systematic way. Chapter two, "**Literature Review**", summarizes what we have known about monetary policy and, particularly, highlights problems faced by researchers in estimating the effects of monetary policy. Chapter three, "**Nominal Rigidity and the Output-**

**Inflation Tradeoff**”, takes a deep look into the rationales for two different schools – the new classical economics and the Keynesian economics. Chapter four, **“Does Monetary Policy Matter in China? A Narrative Approach”**, continues with the Chinese case and tests whether the prediction of the Keynesian non-neutrality of monetary policy holds there as well. Chapter five, **“Monetary Policy and European Unemployment”**, checks the policy implications of the monetarist school. We evaluate the impact of monetary policy in line with the monetarist doctrines on European unemployment.

## **2. Literature Review**

In this chapter, I review studies that have contributed to the understanding of how monetary policy influences output by following the evolution of methods that these studies have applied. The review begins with studies focusing on the money-income relationship in a simple regression, followed by the estimates based on a simultaneous-equation system. Throughout the review, I particularly highlight two problems in estimating the effects of monetary policy: the problem of how to measure monetary policy and the identification problem.

### **2.1 Money and Income: From Milton Friedman to the VAR Studies in the 1980s**

The empirical study of the money-income relationship can be traced back to Friedman and Schwartz (1963). In that study, they checked timing patterns of changes in the money growth rate in the US, and compared those to the reported peaks and troughs of the business cycles. They found that changes in the money growth rate led fluctuations in the business cycle, though those leads were varying over time. Thus, their conclusion was the short-run non-neutrality of monetary policy. Another empirical contribution in this line is made by Andersen and Jordan (1968) of the Federal Reserve Bank of St. Louis. They regressed changes in GNP on contemporary and three lagged values of changes in money stocks, and found that changes in money stock have significant impacts on output. Afterwards, this money-output regression became known as the St. Louis equation and has been widely applied by economists in the estimation of the effects of monetary policy.

Yet, the result based on this single equation provides information about the correlation between variables, but nothing about the direction of causation. Causation can run in both directions. The observed interaction of money and output could reflect the policy reaction to the state of the economy, or the effects of monetary policy on output, or very likely, the mixture of both. Hence, we need to identify the causal direction.



In 1980, Christopher Sims (1980b) proposed a new econometric methodology, vector autoregression (VAR), to solve this identification problem.<sup>1</sup> VAR is a kind of extension of the St. Louis equation through including several simultaneous equations in a system. We can thus run regressions of the variables of interest on their own lagged terms, and the lagged and *contemporaneous* terms of the other variables in the system. The reaction of monetary policy to the state of the economy is (implicitly) modelled in the equation for the policy indicator (for example, the money stock). Then, in an identified VAR model, the unexplained part of changes in the money stock (the error term or the so-called structural innovations in the VAR literature) is interpreted as exogenous policy shocks. The estimates of the impact of these structural innovations on output give the effects of monetary policy on the real economy.

Thus, in a standard VAR model, at least two equations are included: one is designed to identify the effects of monetary policy on output – represented by the equation with output regressed against a policy indicator; and other captures the reaction of policy to the state of the economy – represented by the equation with changes in the money stock depending on the output. With the regression results, it is possible to generate an impulse response analysis that traces out dynamic impacts of policy changes on the variables of interest.

However, special efforts have to be made to identify the policy shocks. In a VAR model, the true relationship between macroeconomic variables includes the contemporary interaction of those variables (structural equations in the VAR literature). That is, a vector of the current terms of these variables,  $X_t$ , appears on both sides of the equations. To run multi-regressions simultaneously, we need to transform equations to a reduced form: with  $X_t$  appearing only on the left-hand side of equations. However, the error terms of these regressions are different from structural errors and hard to interpret with economic meanings. Therefore, it is necessary to restore structural equations and derive structural errors that we can interpret, for example, as policy shocks. *Uniquely identifying* structural equations from the estimated reduced-form equations is a key issue and requires some additional structural restrictions on the system. Quite often used identification restrictions include recursive ordering, orthogonalization of contemporaneous errors, or the introduction of some neutrality constraints, either in terms of

---

<sup>1</sup> Sims won the Nobel Prize in Economics in 2011, largely due to this contribution.

the short run or the long run.<sup>2</sup> This kind of VAR is known as structural VAR (SVAR), as structural assumptions are made to identify policy shocks.

The VAR methodology was soon widely applied by monetary economists. In Bernanke's words, "identified VAR methods are currently the best available means of measuring effects of monetary policy changes on the economy" (Bernanke 1996: 73). Over the past three decades, large amounts of literature using VAR have emerged. The application of VAR methodology first appeared in the studies continuing to explore the money-income relationship in the 1980s. The conclusions concerning the predictability of money on income made by those studies are not robust and not consistent over time, in contrast to Friedman and Schwartz' (1963) claims that there exists a steady relationship between money and income. Table 2.1 shows four selected studies, which shed some light on the debates in monetary economics during that period.

**Table 2.1: Selected studies on the money-income relationship, using VAR**

Study	Period Sample	Variables	Conclusions
1 Sims (1980a)	Interwar 1920-41; Postwar 1948-78	Rs, M1, P, IP	With the interest rate added into the model, the predictability of M1 vanishes. The interest rate turns out to explain more of the variation in output, accounting for about 30 percent in the Postwar period.
2 Eichenbaum and Singleton (1986)	1949 -1983	$\Delta(M1)$ , $\Delta(IP)$ , $\pi$ , Rr	The monetary growth rate does not contribute to predict output growth.
3 Stock and Watson (1989)	1959 – 1985	IP, M1, P, Rs	M1 does not Granger-cause IP growth, but the deviation of money growth from a linear time trend does.
4 Spencer (1989)	1948-1978	M1, IP, P, Rs	The VAR estimates are not robust, but sensitive to the relative ordering of the variables, the detrending methods, the lags selection, and the data frequency.

Notes: M1 stands for the monetary aggregate M1; P for consumer price level index;  $\pi$  for inflation calculated based on CPI; IR for residential investment; Rs for three-month Treasury bill rate; Rr for real interest rate. All variables are in logarithm, with the exception of various interest rates and the inflation rate.  $\Delta(x)$  indicates that variable  $x$  is in first difference.

Source: Authors' summary based on the studies listed.

These studies use a monetary aggregate, M1<sup>3</sup>, to measure monetary policy and examine the effects of changes in M1 on industrial production for the US economy. Despite this similarity,

<sup>2</sup> For more, see Kennedy (2003) and Lütkepohl (2005).

they come to different conclusions. Sims (1980a) examines the forecast error variance decomposition of the VAR model at the time horizon of four years after a policy shock. In the first specification of the VAR model with M1, IP and price level, Sims shows that although money helps predict real income for both the interwar and the postwar period in the US, the predictability of money for the latter period is only half of that for the former period. When the short-term nominal interest rate is added to the VAR system, money ceases to predict real income. Based on this finding, Sims concludes that monetary policy does not explain post-war business cycles.

Eichenbaum and Singleton (1986) build their VAR model using postwar US data. They find that money growth does not help predict output growth and interpret this as the evidence for neutrality of monetary policy. Stock and Watson (1989) argue that this finding is sensitive to the detrending<sup>4</sup> methods applied to the data. They apply a different detrending method – introducing a linear time trend to money growth – and find that money growth itself does not explain the variations of output, but the deviation of money growth from its time trend is useful for forecasting real growth in industrial production. Spencer (1989) extends this argument. He confirms Stock and Watson’s finding. Moreover, he demonstrates that the VAR estimation results are not robust to the model specification: they vary with changes in the relative ordering of the policy and the macroeconomic variable, the lag length and the data frequency.<sup>5</sup>

The development of the literature on monetary policy in the 1980s showed that it was possible to use the VAR to trace out what happened in the “black box”<sup>6</sup> after changes in monetary policy. Yet, the estimate results based on VAR models are somehow mixed. Despite the sensitiveness to the model specification, in general they indicate less effectiveness (or even neutrality) of monetary policy in the postwar US.

---

<sup>3</sup> For the US data, M1 is the sum of currency held by public and demand deposits. This narrow money stock is more likely under the control of the central bank and is hence used as the indicator of monetary policy.

<sup>4</sup> Detrending refers to the process of transforming non-stationary time series into stationary ones. Different methods can be used, e.g., take first differences, which is widely used; introduce a time trend, either linear or time-varying; or, use some filtering techniques, such as the Hodrick-Prescott filter and the Kalman filter.

<sup>5</sup> Further evidence can be found in de Grauwe and Costa Storti (2004), where they conduct a meta-analysis with a sample of 43 studies using VAR. They find that the use of different identification assumptions helps explain a large variation in the estimated effects of monetary policies on output in those studies.

<sup>6</sup> “Black box” was used by Bernanke and Gertler (1995) to refer to the propagation process of how monetary policy affects the economy.

## **2.2 Is the Money Stock a Good Measure of Monetary Policy?**

The interpretation of those VAR estimates in the 1980s reflects the strong influence of monetarism on the economics profession at that time: the money stock was believed to be the good single indicator of monetary policy and the absence of the money-income relationship simply implied the neutrality of monetary policy. However, McCallum (1983) argues that the breaking-down of a money-income relationship says nothing about the neutrality of monetary policy. Rather, he pointed out that this result was due to the use of improper measures of monetary policy with monetary aggregates.

Bernanke and Blinder (1992) and Bernanke and Mihov (1997, 1998b) argue that the measurement of monetary policy is regime dependent – the indicator for monetary policy should be carefully studied in the framework of central banks' operating procedures. In the United States, the Fed's operating procedure experienced large changes after the War. During most of the postwar period, the Fed is better described as a federal-funds-rate targeter. That is, the Fed sets an implementing target for the federal funds rate (i.e., the overnight market price for the reserves), and then through open market operations keeps the target rate prevailing in the reserves market. In doing so, the Fed accommodates the fluctuations in money demand induced by income changes, which makes the money supply endogenous. A change in the money stock hence reflects factors more than policy changes. The endogenous nature of the money supply no longer makes the money stock a good policy indicator.

Changes in the operating procedures, which have also been seen in many other advanced economies, thus require economists to find another indicator to measure monetary policy. Studies turn to the short-term nominal interest rate and examine its potential for a policy indicator. Bernanke and Blinder (1992: 901) demonstrate that the federal funds rate is "extremely informative" and "sensitively records shocks to the supply of bank reserves". It stands well for the policy stance. Thus, they propose the federal funds rate as the policy indicator for the Fed. Extending this argument to Germany, Bernanke and Mihov (1997) argue that, analogous to the US case, policy instrument rates – the Lombard rate and the call rate (that is, the money market rate in Germany, analogous to the federal funds rate in the US) – performed as the optimal indicator of German monetary policy. Following these findings, it

has been a standard practice to measure monetary policy of those central banks in advanced economies with the short-term interest rate. Studies thus focus on the linkage from changes in the short-term interest rate to real GDP and put less or no emphasis on monetary aggregates, as in McCallum's (2001) words "monetary policy analysis in models without money".

### **2.3 Non-Neutrality of Monetary Policy Revisited**

Numerous studies have surged in the 1990s, modeling the interaction between changes in the short-term interest rate and economic developments with the VAR approach. The conclusions made in those studies are quite consistent across countries: shocks to monetary policy induce strong real effects, while price effects are sluggish and small (see, e.g., Bernanke, Gertler, and Waston 1997; Christiano, Eichenbaum, and Evans 1999; de Grauwe and Storti 2008).<sup>7</sup> The maximum impact on output is found about two years after a monetary policy shock.

Figures 2.1-2.3 represent the findings from four studies,<sup>8</sup> among many others. As shown in Figure 2.1, the impulse responses of real output to a contractionary policy shock, estimated by Leeper, Sims and Zha (1996) and Bernanke and Mihov (1997), are quite similar for two countries – the US and Germany. After about six to eight months, real output drops substantially and stays at the lower level over the reported time horizon (four years). Compared to real output, the unemployment rate, as reported by Bernanke and Blinder (1992) and displayed in Figure 2.2, needs a longer period of time to respond to a policy shock. Then, following a minor drop, it rises quickly and constantly, and peaks after about two years.<sup>9</sup> Figure 2.3 shows the impulse response of real GDP to an expansionary monetary policy shock, reported by Bernanke and Mihov (1998a). Symmetric to the impulse response of output to a contractionary policy shock, real GDP rises quickly and constantly after an initial small decline, and reaches the peak in about two years. Afterwards, it decreases slowly and stays at a higher level.

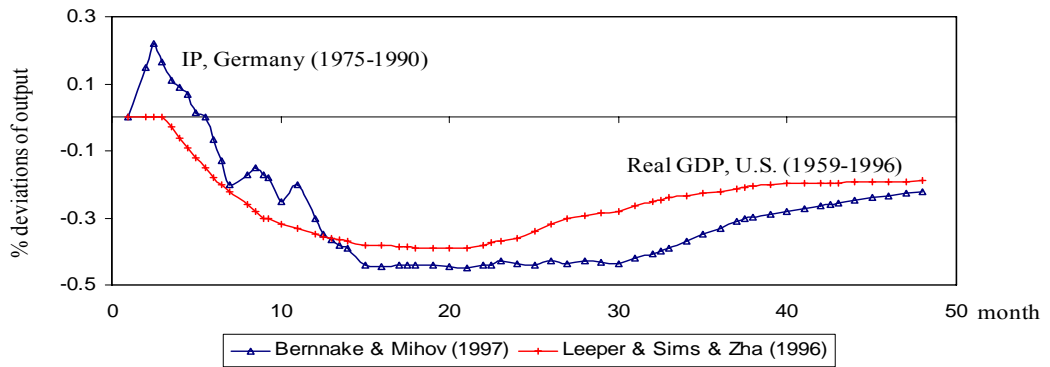
---

<sup>7</sup> In particular, de Grauwe and Costa Storti (2008) draw their conclusion from a meta-analysis with a sample of 86 published studies using VAR to estimate the effects of monetary policies on output.

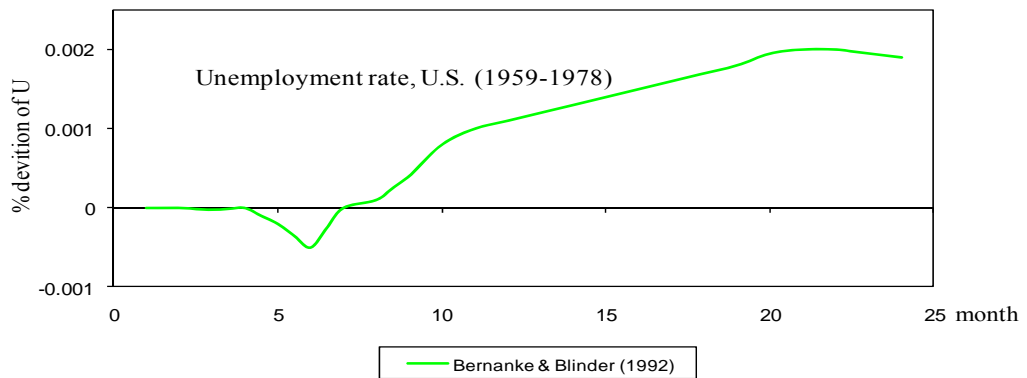
<sup>8</sup> To make the graph easier to read, I represent the spot estimates without confidence intervals.

<sup>9</sup> Though not shown in their graph, Bernanke and Blinder (1992: 919) point out that unemployment does not remain permanently high. Instead, it declines back to zero.

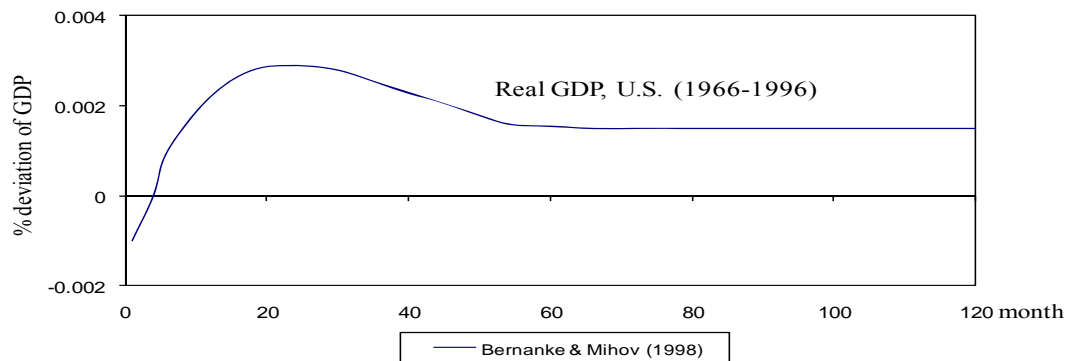
**Figure 2.1: Responses of output to a rise of the interest rate, US and Germany**



**Figure 2.2: Response of the unemployment rate to a rise of the federal funds rate, US**



**Figure 2.3: Response of real GDP to a decrease of the federal funds rate, US**



Notes: Figure 2.1 shows responses of output to a contractionary policy shock at the horizon of 48 months in two countries – the US and Germany. The policy shock is measured as a one-standard-deviation increase of the federal funds rate (in the US) or the call rate (in Germany). Figure 2.2 shows the response of unemployment rate to a one-standard-deviation increase of the federal funds rate in the US at the horizon of 24 months. Figure 2.3 shows the response of real GDP to a one-standard-deviation drop of the federal funds rate at the ten-year horizon.

Source: Data based on studies from Bernanke and Blinder (1992), Leeper, Sims and Zha (1996), Bernanke and Mihov (1997, 1998a).

## 2.4 Some Puzzles in the VAR Studies and an Alternative Approach

To identify the effects of monetary policy from policy reaction to the economy, we need to disentangle exogenous policy movements from passive policy reactions. The VAR approach attempts to model the reaction function of the central bank so as to proxy for exogenous monetary shocks with the structural innovations (see, e.g., Rudebusch 1998). However, an incorrectly specified VAR model would fail in identifying exogenous monetary policy shocks and lead to puzzling results, which contradict the theoretical predictions. A well-known example is that some VAR models estimate that prices rise with a monetary tightening. This is known as the price puzzle (see, e.g., Christiano, Eichenbaum, and Evans 1999; Sims 1992).

This puzzle arises because the expected inflation is not included that the central bank has had in mind when setting the policy (see, e.g., Bernanke, Boivin, and Elias 2005; Sims 1992). The forward-looking central banker decides on a policy shift to tightening, given an increase in the inflation expectations. When the policy action is not strong enough to sufficiently reduce inflation, the co-movement of a policy tightening and a rise in prices is observed. The solution to this problem is to include a variable that captures the central bank's inflation expectation – the common practice in the literature is to follow Sims (1992) and include a commodity price index – or include many information variables to possibly closely present the information set that the central banker has had at the decision-making, as modeled in a FAVAR (factor-augmented VAR) model.

However, even in the most sophisticated model (like FAVAR), it is impossible to proxy for all information that policymakers have had, particularly their numerical forecasts of future economic developments. In general, if any omitted variable is a determinant of both output and the policy reaction function, omitting it means that it appears in the error terms of both equations for output and the policy reaction function. Then, using the (structural) error term of the latter equation to measure exogenous monetary policy shocks will lead to biased estimates of the effects of monetary policy on output given the correlation of shocks with the error term in the output equation.<sup>10</sup> In particular, this omitted-variable bias could be a serious problem in

---

<sup>10</sup> Section 4.3 in this thesis presents a simple framework, showing the omitted-variable bias in the estimates.

the estimates of the effects of monetary policy with VAR models for emerging countries like China, where the availability of the data is an important issue.

An alternative approach, the narrative approach, can be used to solve the identification problem. This approach was pioneered by Friedman and Schwartz in their *Monetary History of the United States* (Friedman and Schwartz 1963) and has been applied by Romer and Romer in a series of studies (Romer and Romer 1989, 2004).<sup>11</sup> It “involves using the historical record, such as the descriptions of the process and reasoning that led to decisions by the monetary authority and accounts of the sources of monetary disturbances” (Romer and Romer 1989: 122). This information discloses the central bank’s intentions for each policy movement. Some of these intentions are neither linked directly to output nor indirectly to those factors that are likely to affect output growth. In this way, we can single out those policy movements that are exogenous to the current and future economic developments in the real side. A regression using these exogenous policy shocks will yield an unbiased estimate of the impact of monetary policy on output. Indeed, compared to what obtained using conventional indicators, Romer and Romer (2004) estimate quicker and stronger effects of monetary policy on output using their narrative-based exogenous monetary shocks.

## **2.5 Conclusion**

Thanks to numerical contributions, today we have a deeper understanding of monetary policy compared to half a century ago. It can be summed up into several findings. First, in advanced economies, the policy interest rate, rather than the money stock, reflects changes in monetary policy well. More specifically, the measurement of monetary policy is regime dependent and a policy indicator should be carefully studied in the framework of central banks’ operating procedures. Second, the proper measurement of monetary policy is essential for accurate estimates of the policy effect. The neutrality conclusions drawn from the studies in the 1980s that purely focus on the money-income relationship are biased due to the imprecise measurement of monetary policy. Third, monetary policy affects real economic activities and the maximum impact is found about two years after a policy shock. This finding is consistent

---

<sup>11</sup> The narrative approach has also been applied in studies on the effects of fiscal policy (see, e.g., Alesina, Favero, and Giavazzi 2012; Ramey 2011; Ramey and Shapiro 1998; Romer and Romer 2010).



with the evidence obtained for several industrial countries. Fourth, the accuracy of VAR estimates of the effects of monetary policy crucially depends on the validity of identified exogenous policy shocks. A misspecified VAR model could lead to an omitted-variable bias in its estimates. Alternatively, one can use the narrative approach to disentangle exogenous policy shocks from passive policy reactions based on the information inferred from the central bank's historical documents. A regression using exogenous policy shocks yields unbiased estimates of the effects of monetary policy on output.

Despite huge advances in methodology, two inherent problems – the choice of a good policy indicator and the identification problem – are still likely to impair the accuracy of the estimates of the effects of monetary policy on output. These two problems will be further elaborated in Chapter four, when the effectiveness of Chinese monetary policy is considered. To solve these problems, I will use the narrative approach to identify exogenous policy movements and use them to estimate the effects of monetary policy on output.

### 3. Nominal Rigidity and the Output-Inflation Tradeoff<sup>1</sup>

One of the key arguments of the Keynesian economics is that demand policy have an impact on real output and employment (at least in the short run). This non-neutrality arises because nominal prices (and wages) do not instantly adjust after changes in the nominal aggregate demand. Nominal rigidities play an important role in the propagation of nominal disturbances to real economic activities.

In a seminal paper elaborating the New Keynesian macroeconomics, Ball, Mankiw and Romer (1988) (BMR) argue that the degree of nominal rigidity, arising from costly price adjustment (“menu costs” in their model) and staggered price setting, is not fixed, but depends on trend inflation.<sup>2</sup> Following the New Keynesian approach, they (BMR) model nominal rigidity as an outcome of firms’ optimization decisions. After observing a change in the nominal aggregate demand, firms would not alter prices if the benefits from price adjustment are smaller than the associated costs. However, when inflation is high, to keep prices unchanged is becoming more costly and firms tend to adjust prices more frequently so that prices are less rigid. Consequently, nominal disturbances (originated from demand policy, for example) lead to quicker and larger movements in prices in high-inflation countries and smaller fluctuations in the real economy. Therefore, the slope of the Phillips curve, measuring the tradeoff between real output and inflation, is smaller. Hence, there exists a negative relationship between trend inflation and real effects of demand policy.

Along with this New Keynesian argument, there exists an alternative new classical view about the short-run output-inflation tradeoff. In two papers, Lucas (1972, 1973) models the formation of expectation given imperfect information. The short-run tradeoff between real output and inflation is observable only when firms misinterpret a change in the price level as a movement in relative prices and thereby adjust their production. When observing a price

---

<sup>1</sup>I would like to thank Katrin Heinrichs, Jan Klingelhöfer, Ronald Schettkat and the seminar (conference) participants at the Schumpeter School of Business and Economics, the DIW Macroeconometric Workshop 2009, the 2011 meeting of the Swiss Society of Economics and Statistics (SSES) and the 26th Annual Congress of European Economic Association (EEA), 2011 Oslo for their helpful comments. Any remaining errors are my own.

<sup>2</sup> This argument differs from the traditional Keynesian economics, which emphasizes rigidities in nominal wages and assumes that these rigidities are exogenous.

change of their own product, the producer does not know whether it is an idiosyncratic shock or an aggregate shock. And the producer's expectations depend on the relative volatility of an individual price to the aggregate price level. The more volatile is the aggregate price level, the less likely it is that an observed price change is idiosyncratic. It follows that the more volatile is nominal aggregate demand, where the price level is nested, the less often this misperception occurs. In his 1973's paper, Lucas (1973) tests this hypothesis with data from 18 countries and finds supportive evidence that increased nominal aggregate variability is associated with a deteriorating output-inflation tradeoff.<sup>3</sup> Thus, in countries with more volatile nominal GDP, demand policy is less effective on real output.

BMR (1988) provide empirical evidence based on a 43-country sample and confirm this observation. However, their interpretation of this finding is different from that of Lucas: more variable nominal demand implies higher uncertainty, which induces firms to follow a more flexible pricing strategy. Analogous to high trend inflation, the uncertainty (arising from high nominal aggregate variability) increases nominal flexibility, which results in diminishing effectiveness of demand policy. BMR provide further evidence for the nominal rigidity hypothesis: they find that the cross-country differences in the output-inflation tradeoff are well explained by trend inflation even when nominal aggregate variability is controlled.

As both the new classical and the New Keynesian theories are consistent with this finding, they cannot be distinguished by testing the hypothesis whether such an inverse relation exists between the tradeoff and the nominal aggregate variability (see Ball, Mankiw and Romer 1988; Akerlof, Rose and Yellen 1988). Instead, the predicted role of trend inflation for a smaller tradeoff can be used to validate the New Keynesian theory. By contrast, the new classical imperfect-information model argues that the expectation does not depend on average inflation and thus predicts no relationship between trend inflation and the output-inflation tradeoff. Therefore, in this chapter I test the New Keynesian theory on nominal rigidity by investigating whether trend inflation has impact on the size of real effects of demand policy.

---

<sup>3</sup> A few studies use extended samples and provide supportive evidence for Lucas's hypothesis (see, e.g., Alberro 1981; Jung 1985; Ram 1984), while some other do not (see, e.g., Froyen and Waud 1980; Katsimbris 1990, 1990). Besides the cross-country evidence, Kandil and Woods (1995) examine cross-industry data and do not find support for the imperfect-information model.

In this chapter, I extend the BMR (1988) analysis and many subsequent studies, e.g., Defina (1991), Katsimbris and Miller (1996) and Khan (2004), to test whether the New Keynesian economic nominal rigidity hypothesis on the output-inflation tradeoff withstands new evidence. In so doing, I summarize and evaluate four estimation approaches that have been used by those studies.<sup>4</sup>

The first approach is the baseline two-stage cross-country comparison, applied by BMR (1988). With this approach, the tradeoff for each country is estimated at the first stage and the cross-country variations in those tradeoffs are explained at the second stage. The New Keynesian hypothesis implies that demand policy is less effective in countries with high trend inflation, where prices are less rigid. A large variation in trend inflation across countries thus provides a rationale for cross-country comparisons.

Different from the base-line approach, the other three approaches allow the tradeoff to vary over time. The New Keynesian hypothesis implies that the output-inflation tradeoff in a country is not stable if trend inflation in this country changes over time. It is thus expected to have a smaller tradeoff during the period when inflation remains high. I consider this implication in my analysis. Approach two is the two-stage cross-country panel comparison. At the first stage, the time-varying tradeoffs are estimated for each country with the rolling regression, as done in Katsimbris and Miller (1996). At the second stage, those estimates are pooled together to create a cross-country panel dataset, which contains both cross-country and over-time variations in the tradeoffs. These variations are then explained. Approach three is the two-stage inter-temporal comparison. It continues to use those time-varying tradeoffs estimated with the rolling regression, but at the second stage focuses on the explanation of the over-time variations in the tradeoff in each country. Finally I follow Defina (1991) and Khan (2004) to examine the over-time variations in the tradeoffs in a framework of one-stage regression.

---

<sup>4</sup> De Grauwe and Costa Storti (2004) take another approach by using a meta-analysis based on 43 studies. They find that the large variation in these studies on the estimated effects of monetary policy can be explained by inflation. “In a low-inflation environment monetary policies are quite effective in influencing output, both in the short run and in the long run. These effects tend to disappear when inflation increases” (de Grauwe and Costa Storti 2004: 21).

The synthetic evaluation of all these estimation approaches is new in the literature and by doing so, this chapter provides a comprehensive corroboration for the existing evidence offered by other researchers. Methodologically, I find that the one-stage approach is preferred for analyzing the over-time changes in the tradeoff as it can avoid potential efficiency loss arising from two-stage estimation. Qualitatively, my results provide support for the New Keynesian theory on the output-inflation tradeoff. I extend BMR's analysis to the current great moderation period and find that nominal rigidity continues to explain both cross-country and over-time differences in the output-inflation tradeoff.

This chapter is extended as follows. In Section 1, I review the existing studies on nominal rigidity, both theoretically and empirically. Section 2 shortly describes the data. Section 3 offers a baseline cross-country analysis of differences in the output-inflation tradeoff. Section 4 presents an analysis based on pooled cross-country and over-time variations in the tradeoff. Section 5 checks the BMR's hypothesis with a country-by-country time-series comparison. Section 6 investigates the intra-country time variation of the tradeoff with one-stage regressions. Section 7 then concludes.

### **3.1 Literature Review on Nominal Rigidity**

#### **3.1.1 Why Are Wages or Prices Sticky?**

Nominal rigidity is crucial for understanding short-run economic fluctuations. Incomplete adjustment of prices implies that changes in aggregate demand are transmitted to output and employment. Nominal rigidity is the cornerstone for the Keynesian economists to explain the non-neutrality of aggregate demand policy (see, e.g., Christiano, Eichenbaum, and Evans 2005; Clarida, Galí, and Gertler 1999; Mankiw and Romer 1995; Roberts 1995). However, nominal rigidity was assumed *ad hoc* in the traditional Keynesian macroeconomic model. Only in response to the Keynesian economic theoretical crisis of the 1970s, studies emerged that provided solid microeconomic foundations of nominal rigidities (see Mankiw and Romer 1995).<sup>5</sup>

---

<sup>5</sup> For a good review on those studies, see Blanchard (1990).

Two lines are adopted to offer a micro-foundation of nominal rigidities. The first line focuses on price adjustment costs. It is argued that nominal rigidity can arise from costly price adjustment. Such adjustment costs can be as trivial as menu costs (see Mankiw 1985). At the micro-level, firms face physical costs or restrictions of changing a nominal price, which prevent firms from adjusting prices frequently.<sup>6</sup>

Surprisingly, these trivial menu costs can cause large business cycles (see Akerlof and Yellen 1985; Mankiw 1985). For an individual firm, the resulting profit loss is small as long as the deviation of the predetermined price from the profit-maximizing price is small. In this case, the private incentives to adjust prices are small, and these firms do not change prices continuously. Despite these small private costs, price rigidity can impose large costs on the economy in the presence of aggregate-demand externalities (see Blanchard and Kiyotaki 1987). That is, “rigidity in one firm’s price contributes to rigidity to the price level, which causes fluctuations in real aggregate demand and thus harms all firms” (Ball, Mankiw, and Romer 1988: 15).

The second line focuses on rigidity in the price level due to the wage- and price-setting behaviors. It is observed that in fact not all prices or wages are free to change every period. Much efforts are made to model asynchronized wage or price changes due to long-term, multi-period or staggered contracts (see, e.g., Blanchard 1982; Calvo 1983; Fischer 1977; Fuhrer and Moore 1995; Taylor 1979, 1980). This asynchronized timing of price changes by different firms leads to gradual adjustment of the price level after nominal disturbances. It implies that at the presence of staggering pricing, nominal disturbances can have large and long-lasting effects on output and employment even if there are no rigidities in individual prices.

Following these two lines, a series of studies have provided nominal rigidity with rich micro-foundations and laid solid theoretical foundation for the New Keynesian Phillips curve.<sup>7</sup>

---

<sup>6</sup> The term menu cost may be misleading, as Ball, Mankiw and Romer (1988) point out, “because the physical costs of printing menus and catalogs may not be the most important barriers to flexibility. Perhaps more important is the lost convenience of fixing prices in nominal terms – the cost of learning to think in real terms and of computing the nominal price changes corresponding to desired real price changes” (Ball, Mankiw and Romer 1988: 18).

<sup>7</sup> Besides the theoretical contributions on why prices are sticky, some economists try to answer this question directly. For example, Blinder (1994), based on surveying firms on their price adjustment decisions, finds that

“Menu costs cause prices to adjust infrequently. For a given frequency of individual adjustment, staggering slows the adjustment of the price level. Large aggregate rigidities can thus be explained by a combination of staggering and nominal frictions: the former magnifies the rigidities arising from the latter” (Ball, Mankiw, and Romer 1988: 12). Due to nominal rigidity arising from adjustment costs or staggered contracts, prices do not adjust fully to compensate shifts in nominal demand, and as a result changes in nominal demand have real effect.

It is also agreed that nominal rigidity by itself is not sufficient in accounting for the non-neutrality of aggregate demand shocks. Many studies focus on explaining the real effects of changes in nominal demand through combining nominal rigidity with real rigidity arising from efficiency wages, customer markets, implicit contracts, insider-outsider relationships, etc; or through combining nominal rigidities with information imperfections. In this way, nominal rigidities are further magnified and non-neutralities of demand policy increase greatly (see, e.g., Akerlof and Yellen 1986, 1988; Ball and Romer 1990; Mankiw and Reis 2002; Smets and Wouters 2007; Yellen 1984).

### **3.1.2 How Rigid Are Prices?**

The literature on the price stickiness can be traced back to studies using sectoral data on some specific products or markets – for example, scanner data on grocery products, newsstand prices of American magazines, catalog prices, and food products.<sup>8</sup> These studies examine how frequently sectoral prices change, and have showed the existence of price rigidities and the degree of rigidities varied across sectors.

Thanks to the openness of CPI and PPI micro-data to researchers in various countries, the last decade has seen an explosion of research on micro price-setting behavior based on large-scale data sets of individual prices. Baharad and Eden (2004) examine the Israeli CPI data set during 1991-1992 and find that on average 24 percent of stores changed their prices in each month, which implied an average price duration of about 4 months. Baumgartner et al. (2005) find

---

prices are indeed sticky and the reasons for that, however, are divergent across firms. It suggests that “price stickiness is a macroeconomic phenomenon without a single microeconomic explanation” (Mankiw 2006: 543).

<sup>8</sup> Dhyne et al. (2006) and Baumgartner et al. (2005) both give a good overview of this literature.

that prices are quite sticky by examining Austrian CPI data set and estimate the weighted average price duration between 10 to 14 months. Vilmunen and Laakkonen (2004) provide micro-level evidence from CPI on frequency of price changes in Finland and their estimate of average duration of consumer price spells ranges from 6 to 9 months. Bils and Klenow (2004), Klenow and Kryvtsov (2008) and Nakamura and Steinsson (2008) use CPI research data set provided by the Bureau of Labor Statistics and obtain different conclusions on the patterns of price changes in the United States. Bils and Klenow (2004) find that the median duration of prices is 4.3 months, while Klenow and Kryvtsov (2008) and Nakamura and Steinsson (2008) exclude temporary price changes due to sales and find that the median duration for regular prices is 7.2 months and between 8 and 11 months, respectively.<sup>9</sup> A series of studies look into the frequency of price changes in the Euro Area, including, e.g., Álvarez et al. (2006), Angeloni et al. (2006) and Dhyne et al (2006), find that prices in the euro area are sticky with the average price duration close to one year.<sup>10</sup>

A summary of those studies reveals that although price stickiness is common in many countries, the magnitude of price stickiness varies. Reviews contributed by Álvarez (2008) and Klenow and Malin (2010) provide good surveys of the recent micro-evidence found in various studies, which are represented in Table 3.1.<sup>11</sup> The listed studies investigate the monthly average frequency of price changes in various countries during the given periods. The variation of this frequency is huge across countries. The highest monthly frequency of price changes is found in Sierra Leone during the period from the end of 1999 to the early 2003, amounting to 51.5. That implies that on average, half of all prices change in each month. This frequency is more than five times higher than the minimum average frequency of price change

---

<sup>9</sup> As indicated in these three papers, the calculation of the median duration of prices is very sensitive to how the sales in the data are treated. For more discussion of this issue, see Klenow and Kryvtsov (2008), Nakamura and Steinsson (2008), Boivin, Giannoni, and Mihov (2009), Maćkowiak and Smets (2009) and Klenow and Malin (2010), among others.

An alternative way to deal with this problem is suggested by Eichenbaum, Jaimovich, and Rebelo (2011), in which they focus on reference prices – the most often quoted prices – and find that the duration of reference prices is about one year, and the nominal rigidities take form of inertia in reference prices.

<sup>10</sup> Some interpret the micro evidence (especially, the Bils and Klenow's (2004) findings) as a challenge of New Keynesian macroeconomic models, where prices are assumed to reset once per year (see, e.g., Christiano, Eichenbaum, and Evans 2005). However, studies argue that despite less rigidity of prices at the micro level, prices are stickier at the macro level, due to price asynchronization, real rigidities, information imperfections, and asymmetric responses of disaggregated prices to aggregate and idiosyncratic shocks (see, e.g., Ball and Romer 1990; Blanchard 1982; Boivin, Giannoni, and Mihov 2009; Mackowiak and Smets 2009).

<sup>11</sup> Klenow and Malin (2010) present a modified version of this table, in which three additional studies are included.



found in Italy during the period from 1996 to 2003. In general, prices are stickier in Euro Area countries. On the other hand, prices change much more often in Latin American countries, as in Brazil, Chile and Mexico.

To check whether the frequency of price changes depends positively on the average rate of inflation, I match the average inflation rate that those countries experienced during the given period with the price change frequency, as presented in Table 3.1. A close examination of the last two columns suggests that there is a positive relation between the average inflation rate and the monthly frequency of price changes – the correlation coefficient of these two is 0.35. That is, price changes are state-dependent – in high-inflation environments, consumer prices tend to change more often (see, e.g., Cecchetti 1986; Dias, Marques, and Santos Silva 2007; Kashyap 1995; Maćkowiak and Smets 2009; Taylor 1999).

**Table 3.1: Monthly average frequency of consumer price changes and average inflation (annualized) (both in %), various countries, selected period**

Country	Paper	Sample period	Average frequency of price changes	Mean inflation
Austria	Baumgartner et al. (2005)	1996:1 - 2003:12	15.1	1.44
Belgium	Aucremanne and Dhyne (2004)	1989:1 - 2001:1	16.9	2.18
Brazil	Gouvea (2007)	1996:1 - 2006:12	37.0	7.80
Canada	Harchanoui et al. (2008)	1995:1 - 2006:12	28.1	2.04
Chile	Medina et al. (2007)	1999:1 - 2005:7	46.1	2.88
Denmark	Hansen and Hansen (2006)	1997:1 - 2005:12	17.3	2.09
Euro Area	Dhyne et al. (2006)	1996:1 - 2001:1	15.1	1.58
Finland	Vilmunen and Laakkonen (2005)	1997:1 - 2003:12	16.5	1.83
France	Baudry et al. (2007)	1994:7 - 2003:2	18.9	1.51
Germany	Hoffmann and Kurz-Kim (2006)	1998:2 - 2004:1	11.3	1.15
Hungary	Gábel and Reiff (2008)	2001:12 - 2007:6	15.1	5.34
Israel	Baharad and Eden (2004)	1991:1 - 1992:12	24.5	15.50
Italy	Veronese et al. (2006)	1996:1 - 2003:12	10.0	2.48
Japan	Saita et al. (2006)	1999:1 - 2003:12	23.1	-0.59
Luxembourg	Lünnemann and Mathä (2005)	1999:1 - 2004:12	17.0	2.20
Mexico	Gagnon (2006)	1994:1 - 2004:12	22.6	14.51
Netherlands	Jonker et al. (2004)	1998:11 - 2003:4	16.5	3.11
Norway	Wulfsberg and Ballangrud (2008)	1975:1 - 2004:12	25.4	4.73
Portugal	Dias et al. (2004)	1992:1 - 2001:1	22.2	3.97
Sierra Leone	Kovanen (2006)	1999:11 - 2003:4	51.5	7.93
Slovakia	Coricelli and Horváth (2006)	1997:1 - 2001:12	34.0	8.50
South Africa	Creamer and Rankin (2007)	2001:12 - 2006:2	16.0	5.03
Spain	Álvarez and Hernando (2006)	1993:1 - 2001:12	15.0	3.31
United States	Bils and Klenow (2004)	1995:1 - 1997:12	26.1	2.69
United States	Klenow and Kryvtsov (2005)	1988:2 - 2003:12	23.3	3.06
United States	Nakamura and Steinsson (2008)	1998:1 - 2005:12	21.1	2.48

Source: Monthly average frequency of consumer price changes is taken from Álvarez (2008: 10), while average inflation is author's calculations based on the data from IMF *World Economic Outlook Database*.

### 3.2 Data and Sample Description

I follow the BMR criterion to include possibly many large, industrialized and free market economies (Ball, Mankiw and Romer 1988: 34). All together, 37 countries are included<sup>12</sup> and the sample period is extended to 2007.<sup>13</sup> All the data – nominal and real GDP, and GDP deflator – are annual, from IMF *International Financial Statistics*. The earliest available data start with 1948; the time series for some countries are shorter due to the unavailability of the data.

The sample countries are listed in Table 3.2 with the sample period for each country for which data are available. The table then presents the descriptive statistics of real growth, inflation, and nominal growth. The macroeconomic performance shows a large variation across countries. Southern American countries experienced high inflation – Colombia had an average annual inflation of 18 percent, Mexico 17 percent, Venezuela 16 percent. On the other hand, the newly industrialized country, Singapore showed a combination of fast real growth and low inflation: over nearly five decades, its average real growth rate was 7.6 percent with a low inflation rate of 2.6 percent.

---

<sup>12</sup> Compared to BMR (1988), I dropped off 6 countries from the sample of 43 countries: 2 African countries (Nicaragua and Zaire) with discontinuous data due to wars, 4 Latin American countries (Argentina, Bolivia, Brazil and Peru) that experienced hyperinflation around 1990.

<sup>13</sup> The sample does not include the current financial and macroeconomic crisis years. During the current crisis, financial-market disruptions appear to be central, which challenges the existing macroeconomic analysis and models (see Romer 2011). Exclusion of the crisis years avoids a big structural break at the end of the sample period.

**Table 3.2: Descriptive statistics on inflation and output, 37 countries, selected periods**

country	Sample period	Real growth		Inflation		Nominal growth	
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Australia	1959-2007	0.042	0.047	0.051	0.040	0.093	0.047
Austria	1964-2007	0.031	0.022	0.034	0.027	0.066	0.032
Belgium	1953-2007	0.035	0.025	0.029	0.019	0.065	0.030
Canada	1948-2007	0.037	0.023	0.040	0.031	0.077	0.038
Colombia	1968-2007	0.041	0.023	0.175	0.076	0.214	0.077
Costa Rica	1960-2007	0.048	0.033	0.132	0.116	0.178	0.099
Denmark	1966-2007	0.021	0.020	0.053	0.035	0.076	0.038
Dominican Republic	1962-2007	0.050	0.046	0.114	0.138	0.165	0.127
Ecuador	1965-2007	0.043	0.046	0.044	0.124	0.087	0.141
El Salvador	1951-2006	0.038	0.043	0.054	0.075	0.092	0.071
Finland	1960-2007	0.033	0.028	0.056	0.041	0.090	0.052
France	1950-2007	0.034	0.019	0.050	0.040	0.084	0.044
Germany	1960-2007	0.028	0.024	0.031	0.023	0.061	0.040
Greece	1948-2007	0.044	0.039	0.095	0.068	0.139	0.062
Guatemala	1951-2007	0.039	0.024	0.067	0.080	0.105	0.079
Iceland	1960-2007	0.042	0.037	0.163	0.137	0.203	0.141
Iran	1966-2007	0.041	0.088	0.170	0.110	0.208	0.115
Ireland	1948-2007	0.043	0.027	0.060	0.048	0.103	0.053
Israel	1968-2007	0.054	0.094	0.282	0.379	0.331	0.360
Italy	1970-2007	0.023	0.018	0.080	0.057	0.107	0.069
Jamaica	1960-2007	0.019	0.035	0.141	0.116	0.159	0.109
Japan	1955-2007	0.046	0.039	0.033	0.043	0.079	0.063
Mexico	1948-2007	0.047	0.033	0.170	0.185	0.217	0.171
Netherlands	1956-2007	0.031	0.022	0.040	0.028	0.072	0.041
Norway	1966-2007	0.034	0.016	0.057	0.044	0.088	0.050
Panama	1950-2007	0.049	0.041	0.027	0.043	0.076	0.058
Philippines	1958-2005	0.039	0.031	0.092	0.068	0.129	0.058
Portugal	1977-2007	0.026	0.022	0.106	0.080	0.137	0.086
Singapore	1960-2007	0.076	0.039	0.026	0.037	0.101	0.062
South Africa	1950-2007	0.034	0.023	0.082	0.052	0.117	0.045
Spain	1954-2007	0.040	0.041	0.075	0.055	0.118	0.049
Sweden	1950-2007	0.028	0.018	0.052	0.039	0.080	0.037
Switzerland	1948-2007	0.026	0.027	0.030	0.025	0.056	0.036
Tunisia	1961-2007	0.050	0.035	0.056	0.040	0.105	0.054
United Kingdom	1948-2007	0.025	0.017	0.056	0.044	0.081	0.039
United States	1948-2007	0.033	0.023	0.034	0.022	0.067	0.028
Venezuela	1957-2007	0.035	0.051	0.164	0.173	0.199	0.163
<i>Across-country values</i>							
Mean		0.038	0.034	0.082	0.075	0.120	0.077
Standard deviation		0.011	0.017	0.058	0.067	0.059	0.061

Notes: All data are annual. Growth rates are computed as differences in logarithms with the log of real output as  $y$  and the log of nominal output as  $x$ ; the log of the price level is  $p = x - y$ . The criterion for selecting sample countries follows BMR (1988).

Source: Author's calculations with data from International Monetary Fund, *International Financial Statistics*.

### 3.3 International Evidence (1): Two-Stage Cross-Country Results

BMR (1988) found that the output-inflation tradeoffs varied across countries for the sample period from 1948 to 1986. Since the publication of their paper (1988), major industrialized countries experienced a period of low fluctuation of real output and at the same time a relatively low inflation rate, which is referred as the great moderation in the literature. It might lead to changes in some empirical macroeconomic relationships. The natural question following this is whether such a tradeoff relation still exists and if so, what kind of changes this tradeoff illustrates. This section tries to clarify these questions by replicating Lucas (1973) and BMR (1988) empirical tests with the sample period extended to 2007.

#### 3.3.1 Estimating the Short-Run Output-Inflation Tradeoff

I follow Lucas (1973) and BMR (1988) to estimate the short-run output-inflation tradeoff by running the regression for each of these 37 countries:

$$y_{it} = \alpha_i + \tau_i \Delta x_{it} + \theta_i y_{i,t-1} + \gamma_i Time + \varepsilon_i, \text{ for } i = 1, 2, \dots, 41 \quad (3.1)$$

where  $y$  is real GDP in log;  $\Delta x$  is the first difference of the log nominal GDP;  $\gamma Time$  measures the time trend; subscript  $i$  is a country index; subscripts  $t$  and  $t-1$  are time indices. The residual,  $\varepsilon_i$ , reflects all the neglected factors that could affect output, including supply shocks. This residual will be discussed in the following section, when supply shocks are addressed.  $\Delta x$  measures the percentage change in nominal GDP. It is used as a proxy for a nominal disturbance. A monetary or fiscal expansion, such as an increase in the money supply or an increase in government purchases, is reflected in an increase in nominal GDP.

Equation 3.1 implies that output movements arise from two components – a long-run time trend and some short-run fluctuations due to aggregate demand disturbances, with the former approximated with  $\gamma Time$  and the latter with  $\tau \Delta x$ . This chapter focuses on the short-run fluctuations of the real output. The coefficient,  $\tau$ , is of our interest as it captures the short-run effects of nominal disturbance on the real output. A change in aggregate demand can be transmitted to the real output, or to prices, or affect *both*. The larger  $\tau$  is, the larger is the effect of a change in demand on the real economy. It results in a smaller  $1-\tau$ , the proportion of a

change in demand that is passed into prices. On the other hand, a smaller  $\tau$  corresponds to the situation that a nominal disturbance has more effects on prices. If  $\tau = 1$ , a change in nominal demand affects the real economy by one to one; while  $\tau = 0$ , a change in demand affects the price level only. For  $0 < \tau < 1$ , the effects of a change in demand fall partly on the real output and partly on the price level. The coefficient,  $\tau$ , measures the output-inflation tradeoff, a kind of variant of the slope of Phillips curve.

Table 3.3 reports the estimated values of the tradeoff parameters,  $\tau$ , and its estimated standard errors for the full sample period and two subsample periods with 1985 as a cutoff. The second subsample corresponds to the great-moderation period and with this split, it is possible to have a close look at the estimates of the tradeoff for the great-moderation period.

The estimated short-run tradeoff varies a lot across countries. For the full sample, the standard variation of  $\tau$  for the 37 countries is 0.25, which is close to its mean value. The estimated tradeoff is significant and large in many countries, such as Australia, Austria, Belgium, Canada, Denmark, Finland, Germany, Japan, Netherlands, Panama, Singapore, Switzerland, the United States, etc., ranging from 0.44 for to 0.74. However, in many other countries, the estimated tradeoff is small and close to zero. It indicates that the effect of demand policy on the real economy varies substantially across countries.

The last four columns present the estimated tradeoffs for two periods – the pre-great-moderation period and the great-moderation period – together with their estimated standard errors. A quick comparison of the estimation results suggests that the estimated tradeoff changes over time as well. On average, the estimated value of  $\tau$  for the great-moderation period is 0.4, higher than 0.32, the one estimated with the earlier data. Some countries exhibit a substantial increase of the output-inflation tradeoff for the post-1985 period. For example, the tradeoff for the United Kingdom increases considerably – from -0.02 (point estimate, insignificant) to 0.91, close to 1. The tradeoff for the United States increases from 0.68 to 0.82 for the great-moderation period. However, the tradeoff in some other countries declines. Across countries, the correlation between  $\tau$  estimated with the earlier data and  $\tau$  estimated with the later data is relatively low, about 0.4. It implies that over time there are changes of the tradeoff. The time variation of the tradeoff will be discussed further in Section 3.5.

**Table 3.3: Estimates of the output-inflation tradeoff, 37 countries, selected periods**

country	Sample period	Full sample		Data through 1985		Data after 1985	
		Tradeoff parameter, $\tau$	Standard error	Tradeoff parameter, $\tau$	Standard error	Tradeoff parameter, $\tau$	Standard error
Australia	1959-2007	0.547*	0.056	0.659*	0.087	0.425*	0.068
Austria	1964-2007	0.651*	0.100	0.725*	0.104	0.487**	0.244
Belgium	1953-2007	0.737*	0.075	0.631*	0.129	0.327**	0.133
Canada	1948-2007	0.438*	0.062	0.396*	0.085	0.701*	0.074
Colombia	1968-2007	0.141*	0.053	0.19***	0.128	0.192**	0.082
Costa Rica	1960-2007	-0.119**	0.050	-0.246*	0.095	0.006	0.067
Denmark	1966-2007	0.495*	0.113	0.642*	0.227	0.629*	0.136
Dominican Republic	1962-2007	-0.021	0.056	0.387*	0.118	-0.138*	0.048
Ecuador	1965-2007	0.161*	0.041	0.304*	0.088	0.1**	0.051
El Salvador	1951-2006	0.152***	0.086	0.406*	0.090	-0.110	0.225
Finland	1960-2007	0.522*	0.061	0.48*	0.109	0.691*	0.056
France	1950-2007	0.039	0.069	-0.033	0.086	0.548*	0.135
Germany	1960-2007	0.649*	0.066	0.552*	0.104	0.776*	0.074
Greece	1948-2007	0.138***	0.077	0.279*	0.103	0.165***	0.102
Guatemala	1951-2007	0.07***	0.043	0.31*	0.078	-0.023	0.030
Iceland	1960-2007	0.209*	0.046	0.204**	0.089	0.463*	0.059
Iran	1966-2007	0.359*	0.107	0.408*	0.155	0.229**	0.102
Ireland	1948-2007	0.161*	0.059	0.24*	0.073	0.638*	0.070
Israel	1968-2007	0.031	0.045	-0.192	0.201	0.179***	0.104
Italy	1970-2007	0.202*	0.067	0.403*	0.069	0.421*	0.149
Jamaica	1960-2007	0.027	0.048	0.082	0.149	0.048	0.039
Japan	1955-2007	0.481*	0.116	0.644*	0.180	0.742*	0.078
Mexico	1948-2007	-0.053***	0.027	-0.09***	0.051	-0.043	0.035
Netherlands	1956-2007	0.538*	0.047	0.599*	0.055	0.682*	0.091
Norway	1966-2007	0.103***	0.056	0.135	0.110	0.086	0.082
Panama	1950-2007	0.531*	0.065	0.328*	0.105	0.738*	0.077
Philippines	1958-2005	-0.023	0.090	-0.029	0.095	0.364**	0.170
Portugal	1977-2007	0.058	0.113			0.046	0.106
Singapore	1960-2007	0.524*	0.048	0.542*	0.073	0.573*	0.059
South Africa	1950-2007	0.155***	0.082	0.241*	0.085	0.618*	0.146
Spain	1954-2007	0.288***	0.156	0.201	0.228	0.674*	0.102
Sweden	1950-2007	0.083	0.078	0.011	0.095	0.571*	0.120
Switzerland	1948-2007	0.696*	0.066	0.714*	0.091	0.68*	0.050
Tunisia	1961-2007	0.534*	0.065	0.476*	0.101	0.609*	0.097
United Kingdom	1948-2007	-0.004	0.066	-0.024	0.104	0.911*	0.142
United States	1948-2007	0.605*	0.067	0.685*	0.090	0.818*	0.147
Venezuela	1957-2007	0.036	0.055	0.096***	0.063	0.019	0.095
<i>Across-country values</i>							
Mean		0.274	0.070	0.315	0.108	0.401	0.098
Standard deviation		0.254	0.026	0.270	0.043	0.305	0.049

Note: Regression results based on Equation 3.1. The output-inflation tradeoff,  $\tau$ , is the estimated coefficient of  $\Delta x_{it}$ . \*, \*\* and \*\*\* indicate that a null hypothesis of zero is rejected at the 1 percent, 5 percent and 10 percent levels, respectively.

Source: Author's estimates based on the data from IMF, *International Financial Statistics*.

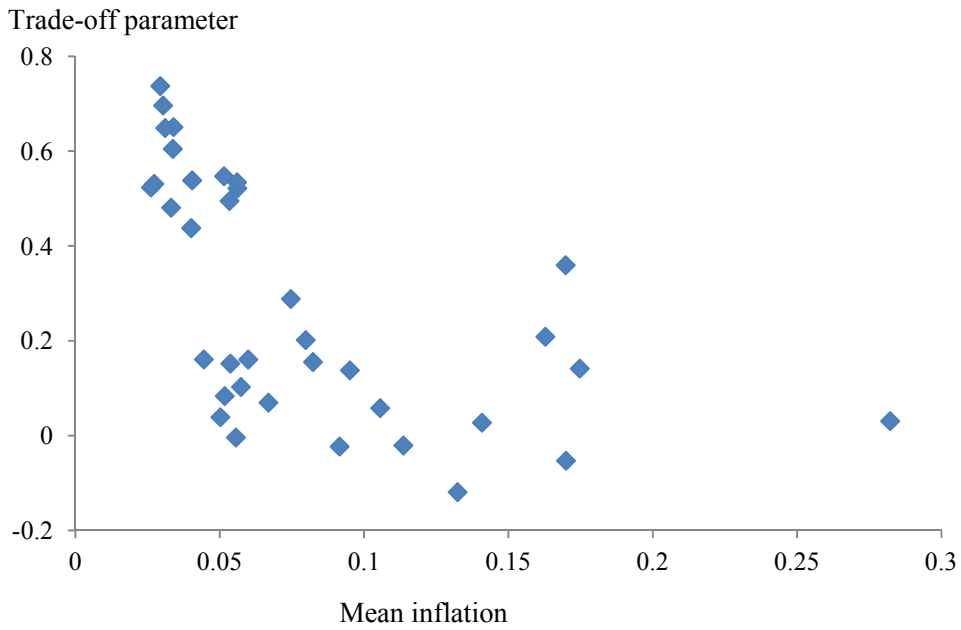
### 3.3.2 Determinants of the Tradeoff: Cross-Country Results

The new classical and New Keynesian economists both agree that the short-run output-inflation tradeoff varies across countries. The controversy exists in how to explain these cross-country differences. The new classical economics claims that it is due to imperfect information, while the New Keynesian economists argue that the true cause is nominal rigidity. While both schools predict a negative relationship between the volatility of nominal demand and the effects of demand policy, the test of this relationship cannot distinguish two arguments. However, two theories differ in the predicting role of trend inflation for the tradeoff. It is hence possible to distinguish them by testing whether there is a reverse relationship between the trend inflation and the tradeoff.

Figure 3.1 and Figure 3.2 show a scatter plot of the output-inflation tradeoff estimated for the full sample against the two candidate determinants – trend inflation and aggregate variability, respectively. Aggregate variability is measured with the standard deviation of nominal GDP growth and trend inflation with an average inflation rate. Figure 3.1 suggests that there is a negative relationship between the tradeoff and trend inflation. The tradeoff appears to be significant and large in countries with low inflation rates while in those countries with high inflation rates, the tradeoff is small. Figure 3.2 indicates that a negative nonlinear relationship exists between the tradeoff and the standard deviation of nominal GDP growth as well. Meanwhile, the negative relationship between the tradeoff and these two explanatory variables both appear to be nonlinear: the negative impact of trend inflation (or aggregate variability) on the tradeoff fades away with a rising value of trend inflation (or aggregate variability).

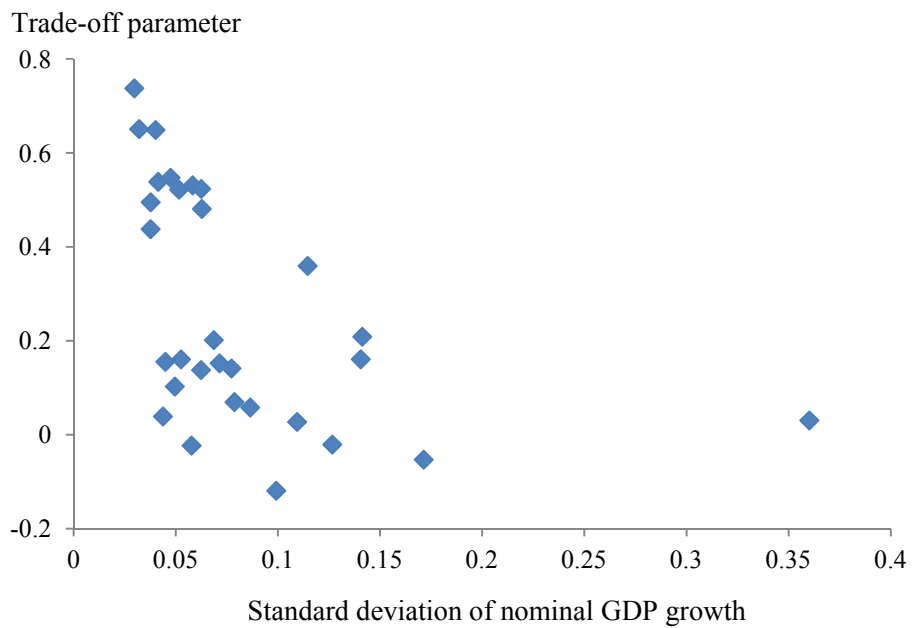


**Figure 3.1: The output-inflation tradeoff and average inflation**



Source: The output-inflation tradeoff,  $\tau$ , is from Table 3.3. Average inflation is from Table 3.2.

**Figure 3.2: The output-inflation tradeoff and standard deviation of nominal growth**



Source: The output-inflation tradeoff,  $\tau$ , is from Table 3.3. Standard deviation of nominal GDP growth is from Table 3.2.

One way to capture the nonlinearity is to include the terms of squared explanatory variables, as BMR (1988) specified  $\tau_i = con + \alpha_1\pi_i + \alpha_2\pi_i^2 + \beta_1\sigma_{xi} + \beta_2\sigma_{xi}^2 + e$ . However, with this quadratic functional form the relationship between the tradeoff and trend inflation can be ambiguous. As Akerlof, Rose and Yellen (1988: 71) pointed out, when BMK estimate this quadratic equation for only OECD countries (without Iceland), the relationship between  $\tau$  and  $\pi$  changes to be positive at a 7.2 percent inflation rate, which is close to the midpoint of inflation for the sample. Yet, the theory suggests an unambiguous negative relation between the tradeoff and trend inflation. The quadratic functional form is thus not optimal in describing a negative monotonic relationship between  $\tau$  and  $\pi$ .

In this chapter, I use an alternative nonlinear specification. A simple nonlinear form consistent with an unambiguous relationship between the tradeoff and explanatory variables would be:

$$\tau_i = c + \alpha / \pi_i + \beta / \sigma_{xi} + u, \quad (3.2)$$

where  $\tau$  is estimated tradeoff obtained from the regression of Equation 3.1;  $i$  is a country index;  $\pi$  is average inflation rate over the sample period and  $\sigma_x$  is the standard deviation of nominal GDP growth rate over the sample period. The key feature of the functional form in Equation 3.2 is that the nonlinear negative relation is modeled by including the inverse term of two explanatory variables. If the theory is right, the estimated  $\alpha$  and  $\beta$  should be positive. In this way, the relationship between  $\tau$  and  $\pi$  is monotonically negative and so is the relationship between  $\tau$  and  $\sigma_x$ . This negative impact dies away when trend inflation (or/and aggregate variability) is getting bigger.

Table 3.4 presents the regression results based on three variants.<sup>14</sup> The estimated coefficients,  $\alpha$ 's and  $\beta$ 's, are all positive, as the theory predicts. The regression result based on the general specification, listed in column 4.3, suggests that trend inflation is a significant determinant of the output-inflation tradeoff, while aggregate variability is not when both explanatory variables are included.

---

<sup>14</sup> BMR's quadratic functional form is tested with the data as well and the results are consistent with the BMR's findings (Ball, Mankiw and Romer 1988).

**Table 3.4: Determinants of the tradeoff, 37 countries, selected periods**

Independent variable	4.1	4.2	4.3
Constant	-0.08 (0.04)	-0.06 (0.06)	-0.1** (0.05)
Inverse of mean inflation	0.02* (0.002)		0.016* (0.003)
Inverse of standard deviation of nominal GDP growth		0.02* (0.003)	0.005 (0.004)
<i>Summary statistic</i>			
Adj. <i>R</i> -squared	0.645	0.46	0.653
Standard error	0.153	0.187	0.151

Note: The dependent variable is the output-inflation tradeoff,  $\tau_i$  (estimated in Table 3.3) based on the data for the full sample period. Numbers in parentheses are standard errors. \* and \*\* indicate that a null hypothesis of zero is rejected at the 1 percent and 5 percent levels, respectively.

Source: Author's calculations.

However, aggregate variability turns to be a statistically significant determinant of the tradeoff when trend inflation is left out of the regression. This might be due to the fact that the two explanatory variables are highly correlated with the correlation coefficient of 0.75. With such a high correlation, omitting either of these two variables from the regression could lead to a biased estimate.<sup>15</sup> The theory suggests that both variables could explain the cross-country variations in the tradeoff. Thus, the specification with both of them included is preferred. The regression result presented in column 4.3 suggests that trend inflation matters after accounting for aggregate variability, which provides strong evidence for the New Keynesian nominal rigidity hypothesis.<sup>16</sup>

The baseline cross-country comparison results show that the New Keynesian nominal rigidity hypothesis is robust with the extended sample and an alternative nonlinear specification. The

<sup>15</sup> A high correlation coefficient of variables,  $1/\pi$  and  $1/\sigma_x$ , implies that they move together. Thus it is possible that the results in column 4.1 with  $1/\sigma_x$  omitted arise not because  $1/\pi$  directly affects the tradeoff, but because it co-moves with the  $1/\sigma_x$ , a true determinant of  $\tau$ . The same caveat exists with the results in column 4.2.

<sup>16</sup> Note that the goodness-of-fit has not been improved much when the inverse of aggregate variability is included in the regression, compared with the regression with only the inverse of trend inflation included. The *F*-test of the hypothesis that the inverse of aggregate variability does not enter the regression when the inverse of trend inflation is included also indicates that aggregate variability does not determine  $\tau$  in the case of  $F(1, 38) = 1.85$ .

inverse relationship between trend inflation and effectiveness of demand policy persists in the low-inflation great-moderation period.

### 3.3.3 Robustness Test: Supply Shocks

The key assumption of Equation 3.1 is that  $\Delta x$  reflects only aggregate demand changes. Short-run output movements are mainly due to demand changes, while supply shocks are incorporated into the residual of Equation 3.1 as some left-out variable. One can argue, however, that supply shocks – for example, oil price shocks – are correlated with changes in nominal GDP. If it were the case, the estimates of the tradeoff,  $\tau_i$ , could be biased.

A simple approach to avoid this bias is to add the omitted variable by including the supply shocks in Equation 3.1. Oil price shocks are major negative supply shocks in consideration. Altogether, there are five oil price shocks over the sample period – 1973, 1978, 1980, 1990 and 2002 (see Hamilton 2011). I discard these five years from the sample, which is equivalent to introducing an oil price shock dummy variable. Equation 3.1 is re-estimated. The regression results are similar to the ones obtained above. The correlation between the  $\tau$ 's estimated with and without the oil price shock years is 0.97. And the regression of the tradeoff estimated without oil price shock years on explanatory variables leads to the following result:

$$\tau_i = -0.1 + 0.018 / \pi_i + 0.005 / \sigma_{xi} + u$$

(0.05) (0.003)      (0.04)

$$\overline{R^2} = 0.69; \text{ standard error} = 0.17$$

This result is very similar to that presented in Table 3.4: the coefficient on the inverse of trend inflation is statistically significant and quantitatively slightly larger; the coefficient on the inverse of aggregate variability is insignificant and small. It suggests that the omission of supply shocks in the baseline cross-country analysis does not cause severe bias in the estimates of the tradeoff.

### 3.4 International Evidence (2): Two-Stage Cross-Country Panel Results<sup>17</sup>

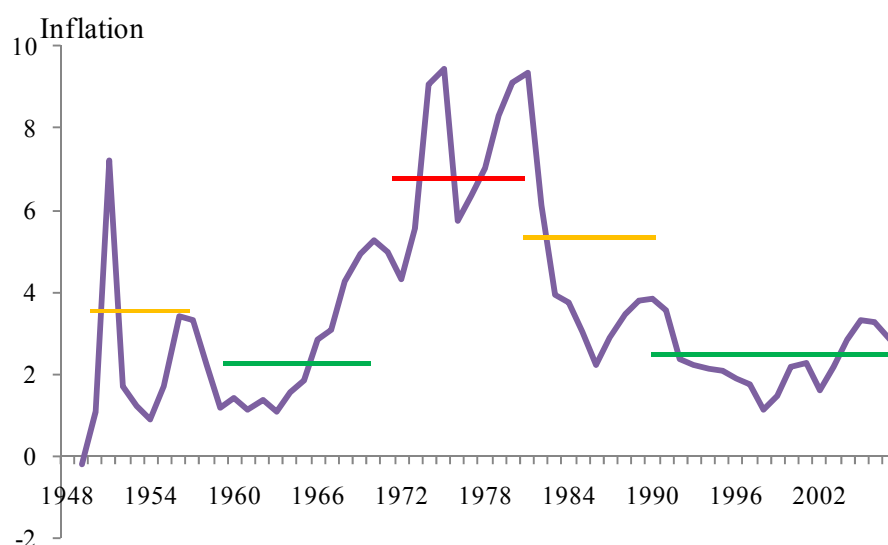
The nominal rigidity theory argues that a higher average inflation rate (or more volatile aggregate demand) increases nominal flexibility and as a consequence changes in demand are largely transmitted to price changes and leave real variables little changed. In other words, a higher trend inflation is associated with a lower value of the output-inflation tradeoff. In the preceding part it is recognized that the output-inflation tradeoff varies across countries due to the persistent inflation differentials among those countries. Yet, trend inflation and aggregate variability are assumed to be constant for each country throughout the sample period; consequently, the output-inflation tradeoff for each country,  $\tau_i$ , is treated to be constant over time for each country.

However, it is more likely that trend inflation and aggregate variability are not constant over time in most countries. The descriptive statistics on inflation in Table 3.2 suggests that this is the case. Inflation in many high-inflation countries is very volatile – the standard deviation of inflation is as high as 0.19 in Mexico, for example. In other low-inflation countries, a simple plot of inflation suggests high fluctuation of inflation over the past six decades within individual countries as well. For example, Figure 3.3 presents a movement of the annual inflation rate in the United States from 1948 to 2007. The inflation rate in the US is far from constant, showing several trends over time; it is high in the 1970s – with the average rate of 6.6 percent – compared to that in the 1960s and 1990s.

---

<sup>17</sup> For example, Katsimbris and Miller (1996) apply this approach.

**Figure 3.3: Inflation in the United States, 1948-2007**



Note: Inflation is computed as a percentage change of annual GDP deflator.  
Source: Author's calculations with data from International Monetary Fund, *International Financial Statistics*.

If trend inflation and aggregate variability are not constant over time in most countries, the optimal frequency to adjust prices should also change over time within individual countries. We should thus expect the tradeoff to change over time as well. Table 3.3 shows that with a simple split of the whole period into two, in many countries the tradeoff estimated with the earlier data appears to be different from the one estimated with the later data. A Wald-test suggests that in about 30 percent of countries<sup>18</sup>, the null hypothesis that there is no change between these two  $\tau$ 's estimated with the earlier and later data can be rejected at the 5 percent significance level.<sup>19</sup>

### 3.4.1 Estimating the Output-Inflation Tradeoff with Rolling Regressions

A simple split of the sample period into two sheds lights on the fact that the tradeoff changes over time as well. Hence I relax the assumption that  $\tau$  is constant over the six decades and re-estimate the first-stage regression. To estimate  $\tau$  for each country, Equation 3.1 is estimated for each country using a rolling regression with a rolling window of 15 years.<sup>20</sup> That is,

<sup>18</sup> They are Costa Rica, Dominican Republic, Ecuador, El Salvador, France, Guatemala, Ireland, Panama, Sweden and the United Kingdom.

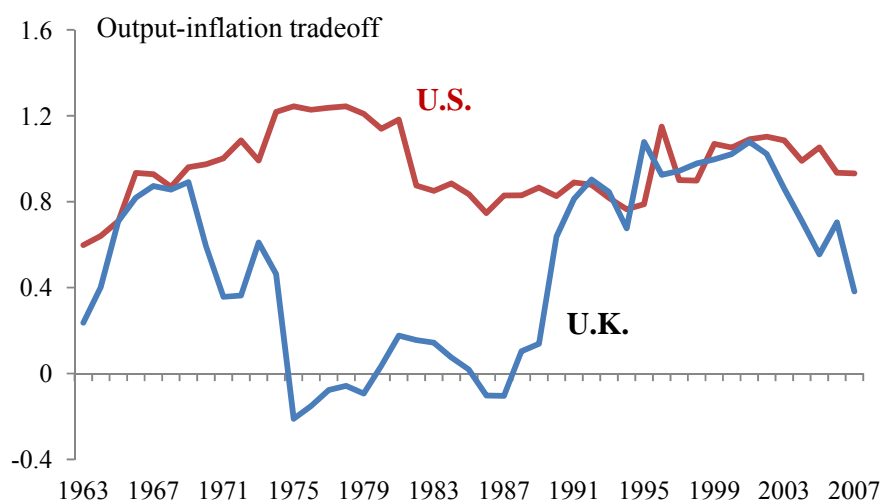
<sup>19</sup> This null hypothesis is rejected at the 10 percent significance level in 40 percent of countries.

<sup>20</sup> The rolling window is specified as 15 years to ensure the sufficient degrees of freedom for each regression.

Equation 3.1 is first estimated using the data from 1949 to 1963, next using the data from 1950 to 1964, ..., finally using the data from 1993 to 2007. In this way, for each country the tradeoff estimated with the first rolling regression is allowed to be different from those estimated with other rolling regressions. Thus, a series of  $\tau_t$  estimates are obtained for each country. The length of such a series depends on the data availability and varies across countries, ranging from 17 to 45.

The rolling regression results show that in most countries,  $\tau_t$  displays a distinct movement over time. Two series of  $\tau_t$  estimated for the United Kingdom and the United States are, for example, illustrated in Figure 3.4. The tradeoff in the United States appears more stable while the tradeoff estimated for the United Kingdom shows more fluctuation; in the 1960s and 1990s, the Phillips curve in the U.K. is much steeper than that in the 1970s.

**Figure 3.4: The Output-Inflation Tradeoff, the UK and the US, 1948-2007**



Note: The estimates of  $\tau_{it}$  are obtained from running rolling regressions of Equation 3.1 with a rolling window of 15 years. The year on the horizontal line marks the end year for each rolling period.  
 Source: Author's estimates. The data used in the estimation are from IMF, *International Financial Statistics*.

### 3.4.2 Determinants of the Tradeoff: Cross-Country Panel Results

The series of  $\tau_t$  for each country are then pooled together such that I obtain a pooled dataset, containing both cross-country and over-time estimates of the tradeoff. Such a pooled dataset is

rich in observations – here, altogether 1444 observations – and thus ensures a large gain in degrees of freedom and would in principle result in more precise estimates. For the second-stage regression, trend inflation is now approximated by a fifteen-year average inflation rate for each rolling period; and aggregate variability is approximated by the standard deviation of the nominal growth for the same rolling fifteen-year periods.

Table 3.5 presents the regression results of cross-country time series of the tradeoff on the inverses of average inflation and standard deviation of nominal GDP growth. Both explanatory variables appear to be statistically significant in the general specification as listed in column 5.3. And the inverse of aggregate variability turns out to be a substantively important determinant, compared to the cross-country regression results presented in Table 3.4. Like high inflation, uncertainty leads to less nominal rigidity and thus nominal disturbances have less effect on the real economy.

**Table 3.5: Determinants of the tradeoff, panel data, 37 countries, selected periods**

Independent variable	5.1	5.2	5.3
Constant	0.34* (0.009)	0.07* (0.01)	0.07* (0.01)
Inverse of mean inflation	0.0007* (0.0001)		0.0003* (0.00009)
Inverse of standard deviation of nominal GDP growth		0.01* (0.0003)	0.01* (0.0003)
<i>Summary statistic</i>			
Adj. R-squared	0.023	0.390	0.394
Standard error	0.328	0.259	0.258

Note: The dependent variable is the pooled estimates of output-inflation tradeoff,  $\tau_{it}$ , which is estimated by running rolling regressions based on Equation 3.1 with a rolling window of 15 years. The regression is based on the pooled dataset. Numbers in parentheses are standard errors. \* indicates that a null hypothesis of zero is rejected at the 1 percent level.

Source: Author's calculations.



### 3.4.3 Robustness Test: Cross-Country Heterogeneity

In the regression using the pooled dataset, I treat the cross-country variation in  $\tau$  and intra-country over-time variation in  $\tau$  indiscriminately. However, such a regression is based on the strong assumption of the absence of cross-country heterogeneity. In reality, it is more likely that heterogeneity exists among countries. For example, countries are different in institutional frameworks, such as the laws governing labor market flexibility, trade union strength, etc., which, like trend inflation, have impacts on the extent of wage and price rigidity and consequently the output-inflation tradeoff. These differences in institutions might lead to country-specific levels of the tradeoff. If it were true, we would expect different intercepts for different countries and thus the assumption that the regression has a single common constant for all countries was improper.

Besides, these differences in institutions might affect the sensitivity of the tradeoff to two focal explanatory variables – trend inflation and aggregate variability – as well. If it were the case, the assumption in the pooled model that the slope coefficients,  $\alpha$  and  $\beta$ , are equal across countries would not be suitable, either.

To check the pooling restriction that all countries share a common intercept, the pooled regression is amended to include separate dummy variables for forty-one countries (the constant is thus dropped out). Those country dummies capture individual country-fixed effects. Table 3.6 presents the regression results of slope coefficients,  $\alpha$  and  $\beta$ , and country dummies. Most of the country-fixed effects are statistically significant. The  $F$ -test for the restriction that all country dummies are equal to each other yields an  $F(40, 1401) = 26.65$ . This pooling restriction is thus rejected at the 99 percent level.

If only country-fixed effects mattered, i.e., those institutional differences affected only the level of the output-inflation tradeoff and had no effects on the sensitivity of the tradeoff to the two explanatory variables, the estimation results with the correction of country-fixed effects, presented in Table 3.6, would be sufficient for a conclusion. Yet, as pointed out above, very likely those country-specific institutions affect the sensitivity of the tradeoff to trend inflation and aggregate variability as well.

To check it, I amend the pooled regression again by including interactions between forty-one country dummies and each of the explanatory variables –  $\alpha * Dummy_i$  and  $\beta * Dummy_i$  – while a common constant is assumed. The pooling restriction of the equalities of slope coefficients across country is rejected at the 99 percent level with an  $F(80, 1361) = 12.6$ .

Due to the presence of the cross-country heterogeneity, both pooling restrictions are rejected. It suggests that it is improper to pool the cross-country and over-time changes in the tradeoffs together. An alternative approach is to focus on the over-time changes in the tradeoff within each individual country, which will be done in the ensuing two sections.

**Table 3.6: Determinants of the tradeoff with fixed effects, panel data, 37 countries, selected periods**

Country-specific effects	Coefficient	Standard Error
Australia	0.2*	0.037
Austria	0.46*	0.043
Belgium	0.15*	0.037
Canada	0.41*	0.033
Colombia	0.07***	0.040
Costa Rica	-0.16*	0.035
Denmark	0.46*	0.043
Dominican Republic	-0.06***	0.036
Ecuador	0.1*	0.037
El Salvador	0.14*	0.032
Finland	0.44*	0.036
France	0.13*	0.036
Germany	0.54*	0.038
Greece	0.18*	0.031
Guatemala	0.05	0.032
Iceland	0.13*	0.035
Iran	0.38*	0.038
Ireland	0.24*	0.031
Israel	0.1*	0.04
Italy	0.23*	0.043
Jamaica	-0.015	0.035
Japan	0.43*	0.036
Mexico	-0.067**	0.03
Netherlands	0.43*	0.037
Norway	-0.016	0.04
Panama	0.35*	0.032
Philippines	-0.058***	0.035
Portugal	0.12**	0.05
Singapore	0.41*	0.035
South Africa	0.24*	0.033
Spain	0.23*	0.034
Sweden	0.17*	0.035
Switzerland	0.45*	0.033
Tunisia	0.38*	0.037
United Kingdom	0.22*	0.036
United States	0.66*	0.037
Venezuela	-0.023	0.033

Notes: The dependent variable is the pooled estimates of output-inflation tradeoff,  $\tau_{it}$  (see note of Table 3.5). The regression is run with Equation 3.2 and the constant is replaced with a set of 37 country dummies. Numbers in the third column are standard errors. \*, \*\* and \*\*\* indicate that a null hypothesis of zero is rejected at the 1 percent, 5 percent and 10 percent levels, respectively.

Source: Author's calculations.

### 3.5 International Evidence (3): Two-Stage Country-by-Country Time-Series Results

In this section and the one following, I relax the assumption made in the cross-country analysis that countries are homogenous in other factors that affect the extent of nominal rigidity and examine the over-time changes in the tradeoff within each individual country. In so doing, I offer a disaggregate analysis by answering the same question how the output-inflation tradeoff is determined in a country-by-country inter-temporal framework.<sup>21</sup> The regression in such a framework has the advantage of correcting fixed country effects. If the New Keynesian theory holds true, evidence that trend inflation matters should arise in a significant fraction of countries.

The estimates of  $\tau_t$  obtained from the rolling regressions in the preceding part consist of time series of the tradeoff for each country, displaying over-time changes in the tradeoff in these countries. They will be used in this part.

***The determinants of the tradeoff: Country-by-country time-series results.*** For each country, Equation 3.2 is regressed with a series of over-time changes in the tradeoff as a regressand over a constant and inverses of average inflation and standard deviation of nominal GDP growth. These regressions test New Keynesian theory by examining intra-country time variations of the tradeoff country by country.

Table 3.7 presents the regression results of two slope coefficients for each country, together with their estimation standard errors and the adjusted-*R*-squared.<sup>22</sup> The results suggest that in about 40 percent of the countries under study, there exists a nonlinear significant negative relationship between the tradeoff and average inflation. And in about another 40 percent of the countries, aggregate variability is significant in explaining the over-time changes in the tradeoff. In those countries, aggregate demand policy is less effective on output during the periods with high inflation or/and high uncertainty.

---

<sup>21</sup> This inter-temporal framework is applied in several studies as well (see, e.g., Defina 1991; Froyen and Waud 1980; Khan 2004).

<sup>22</sup> The estimation results of the constant in each regression are not reported as it is not of our interest.

**Table 3.7: Determinants of over-time variations in the tradeoff, 37 countries, selected periods, two-step procedure**

country	Observations	Inverse of mean inflation	Standard error	Inverse of standard deviation of nominal GDP growth	Standard error	Adj. R-squared
Australia	34	0.0066	0.003	-0.006**	0.002	0.18
Austria	29	-0.00001	0.002	0.0002	0.002	-0.08
Belgium	40	-0.007*	0.003	-0.003	0.002	0.44
Canada	45	0.006*	0.002	-0.001	0.004	0.16
Colombia	25	0.09*	0.008	0.007*	0.001	0.86
Costa Rica	33	-0.0004	0.007	0.041*	0.006	0.68
Denmark	27	-0.005	0.005	0.003	0.006	-0.03
Dominican Republic	31	0.045*	0.004	-0.005	0.005	0.83
Ecuador	28	-0.0007*	0.000	0.1*	0.013	0.72
El Salvador	41	-0.0004	0.000	0.016**	0.007	0.27
Finland	33	0.0037*	0.001	-0.01*	0.003	0.38
France	43	0.009*	0.004	0.001	0.003	0.34
Germany	33	-0.001	0.002	0.004	0.003	-0.004
Greece	45	0.003	0.003	0.008**	0.004	0.08
Guatemala	42	0.00007	0.000	0.016*	0.002	0.80
Iceland	33	0.033*	0.011	-0.012	0.012	0.49
Iran	27	0.22*	0.091	0.002	0.034	0.22
Ireland	45	0.015*	0.005	0.015	0.007	0.62
Israel	25	0.009	0.011	0.034*	0.010	0.84
Italy	23	-0.008	0.012	0.008	0.007	0.13
Jamaica	33	-0.05*	0.014	0.026*	0.007	0.29
Japan	38	0.00013	0.000	0.01*	0.003	0.22
Mexico	45	0.05*	0.007	-0.02*	0.006	0.79
Netherlands	37	-0.007	0.005	0.007	0.003	0.06
Norway	27	0.001	0.001	0.011*	0.002	0.55
Panama	43	0.002*	0.000	-0.007**	0.003	0.37
Philippines	33	0.048*	0.017	0.015*	0.003	0.77
Portugal	16	0.022	0.011	0.001	0.009	0.72
Singapore	33	0.002*	0.001	-0.019*	0.007	0.47
South Africa	43	-0.003	0.002	0.009*	0.002	0.27
Spain	39	0.010	0.014	0.016**	0.008	0.35
Sweden	43	0.004**	0.002	-0.001	0.002	0.11
Switzerland	45	0.0005	0.002	0.003	0.004	0.05
Tunisia	32	0.005	0.008	0.014582	0.004	0.68
United Kingdom	45	0.05*	0.012	-0.007**	0.003	0.38
United States	45	-0.004	0.002	0.004*	0.001	0.20
Venezuela	36	-0.004	0.004	0.036**	0.014	0.78
<i>Across-country values</i>						
Mean		0.014	0.008	0.010	0.006	0.43
Standard deviation		0.040	0.015	0.021	0.006	0.302

Notes: The dependent variable is the estimates of output-inflation tradeoff,  $\tau_t$ 's, obtained from rolling regressions (see note of Table 3.5). The regression is run for each country:  $\tau_t = c + \alpha / \pi_t + \beta / \sigma_{x,t} + u$ , with only slope coefficients reported in the table. \* and \*\* indicate that a null hypothesis of zero is rejected at the 1 percent and 5 percent levels, respectively.

Source: Author's calculations.

Yet in some countries, the estimated effects of average inflation and aggregate variability on the tradeoff are positive, not negative as predicted by theory. In most of those countries with wrong-sign coefficients, these coefficients are not statistically significant. But there are a few exceptions with significant wrong-sign coefficients. This is puzzling and will be addressed in the next section.

### **3.6 International Evidence (4): One-Stage Country-by-Country Time-Series Results**

Till now, all the analyses in the preceding parts are done in a two-stage procedure. At the first stage, the output-inflation tradeoff,  $\tau_i$ , was estimated by running regressions on Equation 3.1 for each country. At the second stage, to explain the differences of the output-inflation tradeoff,  $\tau_i$ , obtained at the first stage across country or over time, they are regressed on two explanatory factors. Such a procedure was originally applied in Lucas (1973) and BMR (1988), and many subsequent studies (see also Alberro 1981; Froyen and Waud 1980; Jung 1985; Katsimbris 1990).

However, as Akerlof, Rose and Yellen (1988) pointed out, this two-stage procedure might result in an efficiency loss as the precision with which  $\tau$  is estimated in the first-stage procedure varies from country to country. The tradeoff,  $\tau$ , is measured with errors. Especially, as shown in Table 3.3, some estimates of  $\tau$  are statistically significant while others are not. However, all these tradeoffs estimated at the first stage are treated equally in the second-stage analysis. “The resulting heteroskedasticity in equation (3.2) leads to inefficient estimates, and also could lead one to conclude, for example, that (the inflation coefficient) is significant in equation (3.2), when in fact it is not” (Akerlof, Rose and Yellen 1988: 72).

This might shed light on the possible reasons why the puzzling results were obtained in Section 5. There the tradeoff is estimated with the rolling regression at the first stage, which might endanger the accuracy of the estimates of the tradeoff as the rolling window is specified as 15 years and thus the degree of freedom is low. Therefore, the results reported in Section 4 and 5 should be interpreted cautiously.

**The determinants of the real effect of changes in aggregate demand: One-stage country-by-country time-series result.** In this part, I apply an alternative approach to answer what determines the real effect of changes in aggregate demand in a one-stage analysis. The dependency of the tradeoff on two explanatory variables is nested directly within Equation 3.1. In so doing, I get:

$$y_{it} = con_i + f(\pi_{it}, \sigma_{x,it})\Delta x_{it} + \theta_i y_{i,t-1} + \gamma_i Time + \omega_{it}, \text{ for } i = 1, 2, \dots, 41 \quad (3.3)$$

Most of notations are as given in Equation 3.1. The residual is measured with  $\omega_{it}$ . The function,  $f(\pi_{it}, \sigma_{x,it})$ , specifies the relationship between the magnitude of real effects of nominal disturbances and two explanatory factors – trend inflation and aggregate variability. As shown in the preceding parts, this relationship is negative and nonlinear. Following Equation 3.2, the  $f$  function is thus specified as:

$$f(\pi_{it}, \sigma_{x,it}) = c_i + \alpha_i / \pi_{it} + \beta_i / \sigma_{x,it}. \quad (3.4)$$

Substituting Equation 3.4 into Equation 3.3, we get:

$$y_{it} = con_i + c_i \Delta x_{it} + \alpha_i \Delta x_{it} / \pi_{it} + \beta_i \Delta x_{it} / \sigma_{x,it} + \theta_i y_{i,t-1} + \gamma_i Time + \omega_{it}. \quad (3.5)$$

With a one-stage regression based on Equation 3.5, we can directly derive how trend inflation and aggregate variability impact the size of real effects of nominal disturbances (see, e.g., Defina 1991; Khan 2004). The impact effects of nominal demand changes on output in country  $i$  are thus the first derivative of real output with respect to the nominal demand change. It results in the  $f$  function:  $\partial y_{it} / \partial \Delta x_{it} = c_i + \alpha_i / \pi_{it} + \beta_i / \sigma_{x,it}$ . And the effects of the inverse of average inflation and nominal demand volatility on the impact effect are the cross-partials.

$$\frac{\partial^2 y_{it}}{\partial \Delta x_{it} \partial (1 / \pi_{it})} = \alpha_i, \quad (3.6)$$

$$\frac{\partial^2 y_{it}}{\partial \Delta x_{it} \partial (1 / \sigma_{x,it})} = \beta_i. \quad (3.7)$$

The two coefficients,  $\alpha_i$  and  $\beta_i$ , measure sensitivity of the slope of Phillips curve to the inverse of average inflation and the inverse of aggregate demand variability, respectively. These coefficients to be estimated appear to be the same as those estimated in the preceding analysis. However, the method to be applied to estimate  $\alpha_i$  and  $\beta_i$  is different; they are to be

estimated directly from a one-stage procedure. In this way, the loss of efficiency will be avoided.

Another advantage of this one-stage procedure is that it allows more degrees of fluctuation of two explanatory variables and consequently the tradeoff. In the preceding two parts, the estimation using a rolling regression is an attempt to permit some variations of these two variables. However, the permitted degree of variations in the rolling regression is still limited due to the fact that a sufficient degree of freedom is required for running a regression at the first stage. For a rolling window of 15 years, average inflation and nominal demand volatility are assumed to be constant during each of these rolling 15 years. Realistically, inflation and nominal demand volatility have fluctuated more in most countries.<sup>23</sup> As one-stage procedure applied in this part is not constrained with a degree of freedom, the period can be shortened during which these two explanatory variables are assumed to be constant. They are hence allowed to take different values each three years. In this way, average inflation and nominal demand volatility are computed as a three-year moving average of the current and two past values.<sup>24</sup>

Table 3.8 presents the part of regression results based on Equation 3.5 for each of these countries. Only the estimates of two coefficients,  $\alpha_i$  and  $\beta_i$ , are presented as they are of our interest and they explain how the over-time variations in the real effect of nominal disturbances are influenced by two explanatory factors for each sample country. Together, the number of observations, the estimated standard errors and the adjusted  $R$ -squared are reported as well.

The statistics of the adjusted  $R$ -squared listed in the last column of Table 3.8 are high and indicate a goodness-of-fit for the regressions. The standard errors of the estimated coefficients, both  $\alpha_i$  and  $\beta_i$ , in the one-stage framework appear to be smaller on average compared to those in the two-stage framework, as listed in Table 3.7. It suggests that the estimates obtained

---

<sup>23</sup> For example, Figure 3.3 shows the movements of inflation in the United States, which suggests that inflation is more volatile than it was otherwise assumed in the rolling regression models.

<sup>24</sup> Defina (1991) uses five-year moving averages. By using three-year moving averages in this chapter, I allow more movement in these two explanatory variables. Another advantage is that it ensures more degrees of freedom, particularly for those countries with relatively short time series available. Despite this difference, I obtain qualitatively the same results as he did.



with a one-stage procedure are more accurate on average. Another comparison with Table 3.7 reveals that one-stage estimates also result in much fewer wrong-sign coefficients.

Table 3.8 suggests that in around 60 percent of the countries, a higher-inflation period is accompanied by less effective demand policy, while only in 17 percent of the countries, such a negative relationship between aggregate variability and the tradeoff is significant. These estimation results thus provide further support for the New Keynesian hypothesis – during a period of high inflation, demand policy is found to be less effective in a large fraction of countries.

**Table 3.8: Determinants of over-time variations of the tradeoff, 37 countries, selected periods, one-stage procedure**

country	Observations	$\alpha$	Standard error	$\beta$	Standard error	Adj. R-squared
Australia	46	0.0023**	0.001	0.00027	0.0002	0.999
Austria	41	-0.002	0.001	-0.00019	0.0004	0.998
Belgium	51	0.001	0.001	0.00005	0.0003	0.999
Canada	57	0.0048*	0.001	0.00117	0.0006	0.9996
Colombia	37	0.029*	0.010	0.00118	0.0006	0.998
Costa Rica	45	0.001	0.003	0.00042	0.0007	0.997
Denmark	39	0.0078*	0.003	0.00031	0.0003	0.996
Dominican Republic	43	0.0063*	0.002	0.0033	0.0031	0.995
Ecuador	40	-0.0035*	0.001	0.0011	0.0012	0.995
El Salvador	53	0.0001	0.000	-0.00035	0.0011	0.99
Finland	45	0.0003	0.000	0.00056	0.0003	0.998
France	55	0.0054*	0.002	0.00004	0.0003	0.999
Germany	45	0.001	0.000	-0.0001	0.0003	0.999
Greece	57	0.011*	0.003	0.0002	0.0003	0.998
Guatemala	54	0.0005	0.000	0.0026**	0.0011	0.999
Iceland	45	0.014**	0.006	0.0016**	0.0007	0.997
Iran	39	0.01	0.008	0.011**	0.0052	0.94
Ireland	57	0.012*	0.002	0.0007	0.0003	0.999
Israel	37	-0.0006	0.002	0.0036	0.0031	0.98
Italy	35	0.019*	0.005	0.0010	0.0007	0.997
Jamaica	45	0.02*	0.005	0.0004	0.0008	0.98
Japan	50	0.0006	0.001	0.0005	0.0003	0.998
Mexico	57	0.011*	0.004	-0.00001	0.0009	0.999
Netherlands	49	0.003*	0.001	0.0003	0.0003	0.999
Norway	39	0.002	0.001	0.0015*	0.0005	0.999
Panama	55	0.0005	0.001	0.0015	0.0010	0.999
Philippines	45	0.03*	0.009	-0.0005	0.0005	0.997
Portugal	28	0.019**	0.009	0.0001	0.0003	0.99
Singapore	45	0.0002	0.000	0.0013**	0.0006	0.9996
South Africa	55	0.006*	0.002	-0.0003	0.0005	0.998
Spain	51	0.01*	0.003	0.0004	0.0005	0.997
Sweden	55	0.0076*	0.002	0.0004	0.0003	0.999
Switzerland	57	0.0009	0.001	0.00078**	0.0004	0.999
Tunisia	44	0.015*	0.005	0.000005	0.0008	0.999
United Kingdom	57	0.016*	0.003	0.0002	0.0004	0.999
United States	57	0.007*	0.001	0.0003	0.0005	0.9996
Venezuela	48	0.002	0.003	-0.0007	0.0027	0.98
<i>Across-country values</i>						
Mean		0.0015	0.0033	0.0005	0.0009	0.99
Standard deviation		0.0029	0.0033	0.0010	0.0010	0.011

Note: The regression is run with Equation 3.5 for each country. Only the results for the coefficients of interest,  $\alpha$  and  $\beta$ , are reported here. \* and \*\* indicate that a null hypothesis of zero is rejected at the 1 percent and 5 percent significance level, respectively.

Source: Author's calculations

### 3.7 Conclusion

This chapter studies the sources of the observed variation in the output-inflation tradeoff – is it because of nominal rigidities according to the New Keynesian theory or is it due to imperfect information according to the new classical theory? The distinction between these two competing theories on the tradeoff has important policy implications. The former suggests that the tradeoff arising from nominal rigidities is a fairly stable economic relationship and it thus can be explored by policy makers, while the latter predicts that the tradeoff due to misperception is not stable and policy makers can do nothing with it. The chapter conducts a series of tests and finds that a higher degree of nominal rigidity<sup>25</sup> leads to a higher output-inflation tradeoff. This relationship is not only a cross-country observation but also an over-time observation.

Given a large variety of estimation approaches applied in the literature when examining the New Keynesian theory on the output-inflation tradeoff, in this chapter I summarize and evaluate these approaches – a baseline two-stage BMR cross-country comparison, a two-stage analysis based on a cross-country panel dataset, a two-stage and finally one-stage country-by-country time-series comparison. In the latter three setups, the tradeoff is allowed to change over time, which is more consistent with what the theory predicts as trend inflation is far from constant over time. To make an over-time comparison, the one-stage analysis is preferred to the two-stage procedure, as the latter suffers a potential efficiency loss due to a limited degree of freedom in the rolling regression.

The cross-country comparison based on the extended sample suggests that the New Keynesian theory is still relevant today. In higher-inflation countries, the output-inflation tradeoff that policy-makers face is smaller. However, in each individual country, the output-inflation tradeoff is not constant over time as the state of the economy changes and thus the extent of nominal rigidity varies over time – higher inflation reduces nominal rigidity and thus reduces

---

<sup>25</sup> In this chapter, I focus mainly on nominal price rigidity. Certainly, rigidities arise also from sticky wages or other forms of nominal frictions (see Christiano, Eichenbaum, and Evans 1997; Rotemberg 1984). The species of rigidities are, nevertheless, relatively unimportant for the discussion of the real impacts of nominal disturbances, as the conclusion would not be altered so long as the degree of these rigidities is inflation-dependent.

the size of non-neutralities. Policy makers thus should take a dynamic view towards the tradeoff.

#### 4. Does Monetary Policy Matter in China? A Narrative Approach<sup>1</sup>

Does monetary policy matter in China? Very few studies have addressed this issue, but reported somewhat mixed findings (see, e.g., Dickinson and Liu 2007; Sun, Ford, and Dickinson 2010). On the other hand, it is a well-established fact that in advanced economies, monetary policy has a significant impact on output (at least in the short run), thanks to numerous contributions (see, e.g., Bernanke and Blinder 1992; Bernanke and Gertler 1995; Blanchard 1990; Friedman 1995; Romer and Romer 1989). Yet, it is unclear that we can simply extend this conclusion to the case of China, given the substantial differences between China and those economies in their central banking strategies and practices. For example, the central bank of China, the People's Bank of China (PBC<sup>2</sup>), does not follow the standard one-instrument operating procedure that advanced economies adopt.<sup>3</sup> Rather, it uses multiple instruments, including unconventional administrative measures, to achieve various tasks. Second, compared to many advanced economies, financial markets in China are underdeveloped and that fact that firms depend still heavily on bank loans for external financing. It follows that the main effective monetary propagation mechanisms in China could be different as well. Hence, it is necessary to conduct an independent study to examine the effectiveness of monetary policy in China.

In order to estimate the effect of monetary policy, first we should be able to measure monetary policy changes (i.e., to describe monetary policy in a quantitative way). The validity of this measure is the premise of an accurate estimate of the effects of monetary policy (see, e.g., Bernanke and Mihov 1998b; Romer and Romer 1989, 2004). However, the study of China's monetary policy faces two measurement problems. The first is which policy instrument should be used as a policy indicator. The PBC's current operating procedure suggests that all of its frequently-applied policy instruments contain information about its policy (see, e.g., Chen,

---

<sup>1</sup> I thank Rüdiger Bachmann, Katrin Heinrichs, Jan Klingelhöfer, Ronald Schettkat, Paul Welfens and seminar participants at the University of Wuppertal and the RWTH Aachen University for their helpful comments. Any remaining errors are my own.

<sup>2</sup> In the literature, two short forms of the People's Bank of China are used: PBoC and PBC, although the People's Bank of China tags itself with PBC only. In this chapter, I follow the Bank's routine and use PBC.

<sup>3</sup> That is, use open market operations with short-term money market rates as the operational target. This is the case in normal times. Central banks, such as the Fed and the ECB, use primarily open market operations on a regular basis; and other tools play only a minor role in monetary policy. Yet, in crisis times, central banks in advanced economies started to apply many other tools such as balance sheet tools and communication tools.

Chen, and Gerlach 2011; He and Pauwels 2008; Shu and Ng 2010; Xiong 2011). On the other hand, these instruments are different in nature and their changes are not necessarily identical in terms of the frequency and magnitude. None of them per se can represent the behavior of all others and hereby adequately reflect changes in the PBC's policy stance.

The second problem is known as the identification problem in the literature. That is, the causation direction of the observed interaction between monetary policy and economic fluctuations needs to be identified. A simple regression of output on changes in monetary policy is very likely to result in biased estimates of the effect of monetary policy. For example, if the central bank takes counter-cyclical actions and stabilizes the level of economic activity absolutely, "then an observer ... would see (changes in the interest rate) accompanied by a steady level of aggregate activity. He would presumably conclude that monetary policy has no effects at all, which would be precisely the opposite of the truth" (Kareken and Solow 1963: 16). By contrast, economic fluctuations in consequence of exogenous policy movements should reflect the impact of monetary policy, but not other influences (see Romer and Romer 2004). Hence, it is necessary to isolate exogenous components of policy changes from endogenous policy responses.

One approach to overcome these two challenges is the narrative approach, which was pioneered by Friedman and Schwartz in their *Monetary History of the United States* (Friedman and Schwartz 1963) and has been applied by Romer and Romer in a series of studies (Romer and Romer 1989, 2004).<sup>4</sup> This approach relies on the reading of the central bank's documents to infer additional information on policy-makers' intentions. The policy stance is identified and in addition, the driving force of each policy movement is detected. Only those policy shifts are defined as exogenous that are not driven by *current and future* developments on the real side of economy. These shocks are exogenous with respect to the state of the real economy.

---

<sup>4</sup> The narrative approach has also been applied in studies on the effect of fiscal policy (see, e.g., Alesina, Favero, and Giavazzi 2012; Ramey 2011; Ramey and Shapiro 1998; Romer and Romer 2010).

One study by Shu and Ng (2010) has applied the narrative approach to examine monetary policy of the PBC.<sup>5</sup> They study *China Monetary Policy Report*, a quarterly executive report of monetary policy of China, and construct a time series of the PBC's policy stance index (tight, neutral or ease, for example). The Shu-Ng index is useful as it can be used as a monetary policy indicator to solve the first measurement problem. However, the Shu-Ng index does not address the identification problem and their paper does not isolate exogenous shifts in policy. This chapter complements Shu and Ng's study with another independent reading of the PBC's historical records and singles out those policy movements that are exogenous.

This chapter uses two sources of the PBC's documents: short summaries of quarterly Monetary Policy Committee's meeting and *China Monetary Policy Report*. Both documents include explicit statements of the PBC's monetary policy stance for the next period and reasoning of changes in policy. Based on this information, three exogenous shocks are identified as episodes, in which the PBC shifted policy to contraction to rein in inflation. Estimates using these shocks and various robustness tests indicate that monetary policy has large and persistent effects on output in China.

This Chapter proceeds as follows. Section 1 provides institutional backgrounds of Chinese monetary policy and highlights the monetary policy indicator problem. Section 2 presents a brief introduction to developments of financial markets in China and thus addresses the functioning of monetary transmission channels. Section 3 presents a simple framework, explaining why a policy measure with endogenous components is likely to lead to biased estimates. Section 4 identifies three exogenous policy shifts of the PBC through reading its documents. Section 5 examines the impacts of these shocks on output and inflation. Section 6 concludes.

#### **4.1 What Measures China's Monetary Policy**

Since the mid-1980s, the PBC has experienced a series of changes in its institutional framework and its operating procedure. Currently, it targets the broad money (M2) and uses

---

<sup>5</sup> Xiong (2011) applies the narrative approach by reading *China Monetary Policy Report* as well to abstract the information on the PBC's views of macroeconomic conditions.

multiple monetary instruments to achieve various tasks. Is it possible to measure the PBC's monetary policy with the money stock or one of its policy instruments? In this section, I address the monetary policy indicator problem.

#### **4.1.1 Institutional Background**

The PBC was established on December 1<sup>st</sup>, 1948 and was the only bank in China before the economic reforms. It combined the functions of a central bank and commercial banks.<sup>6</sup> In the 1984 central bank reform, the regular commercial banking activities were separated from the PBC and passed to four newly established (or reorganized) state-owned commercial banks.<sup>7</sup> The PBC was designated exclusively as a central bank. The objectives of its monetary policy are defined in the People's Bank of China Act (promulgated in 1995) as "to maintain the stability of the value of the currency and thereby promote economic growth". The first mandate of the PBC is thus price stability. Meanwhile, the PBC has attached great importance to economic growth. The GDP growth target is set each year by the central government of China to guarantee high-level job creation so as to absorb the consistent labor surplus, either freed from the agricultural sector or as a result of workers being laid-off from state-owned enterprises. One of the major tasks of the PBC is to implement monetary policy in line with this growth target. Along with this mandate, the PBC is actively engaged in foreign exchange interventions to keep the renminbi (RMB) exchange rate within its floating range (it will be elaborated in the next subsection). Thus, the PBC appears to pursue monetary policy with multiple objectives – price stability, economic growth and exchange rate stability.

Until 1997, the PBC implemented monetary policy through the credit plan. The PBC set the quantitative bank-specific loan quotas, which were precise lending ceilings for individual financial institutions,<sup>8</sup> and provided liquidity to those banks, which then allocated credit to government-preferred subsectors and projects (see Montes-Negret 1995). Banks adjusted their

---

<sup>6</sup> Such a banking system was typical for planned economies, where the central bank functioned mainly as a fiscal agent of the central government in fulfilling the state production plan. The function of financial intermediation remained limited – the investment was financed through budget and on the other hand, private savings were low.

<sup>7</sup> They are the Agriculture Bank of China (ABC), the Bank of China (BOC), the China Construction Bank (CCB), and the Industrial and Commercial Bank of China (ICBC), often referred to as the Big Four.

<sup>8</sup> Such direct lending controls were used by other central banks in the post-World-War-II era as well. For example, from 1965 to 1971, the Bank of England employed them as the main monetary policy tool.



lending activities to meet the loan quotas. In this way, the PBC, together with banks, worked as fiscal agents to implement the credit plan and thus achieve economic goals.<sup>9</sup>

However, this direct control over the lending quantity of individual banks led to a mismatch between credit supply and demand, hindering the efficient allocation of credits. Furthermore, with the new development of financing sources other than bank credits, the relationship between the credit plan and real GDP became less predictable (see Montes-Negret 1995). In 1996, the PBC introduced the growth rates of monetary aggregates (M1 and M2)<sup>10</sup> as nominal anchors and adopted them, together with the credit quotas, as its intermediate targets. Two years later, in January 1998, bank-specific credit quotas were formally abolished.<sup>11</sup> Instead, the PBC started to set the target for the total bank lending and use it as one of its intermediate targets as well. In May 1998, the PBC resumed the open market operations. There is thus a consensus in the literature that the year 1998 is a turning point of the PBC's monetary policy regime from direct to more indirect control (see, e.g., Cao 2001; OECD 2010; Xie 2004), although to some degree, direct monetary control methods still exist. This chapter focuses on the post-1998 monetary policy regime.

#### **4.1.2 Measuring Monetary Policy with M2?**

Some studies use the broad money to measure the PBC's monetary policy, based on the argument that the PBC is targeting M2. Table 4.1 presents the targeted and actually realized growth rates of monetary aggregates M1 and M2 for the period 1998-2011.<sup>12</sup> During this period, the broad money, M2, grew consistently at a double-digit rate while the growth rate of M1 showed a higher volatility. In 2009, the growth rates of both M1 and M2 reached a historically high level: 33 percent and 28 percent, respectively, when the PBC injected a huge amount of liquidity into the banking system as a part of stimulus programs.

---

<sup>9</sup> Dickinson and Liu (2007) present an in-depth discussion on how monetary policy affects the real economy in China during this transition period.

<sup>10</sup> According to the PBC, monetary aggregates are M0 (currency in circulation), M1 (sum of M0 plus demand deposits) and M2 (the sum of M1 plus savings and time deposits) (see *PBC's Annual Report 2007*).

<sup>11</sup> It does not imply, though, that the credit policy has disappeared from the PBC's practices. Today, the PBC still routinely employs specific credit policy tools to control the quantity of credit and affect the structure of credit.

<sup>12</sup> The PBC stopped announcing a target for M1 in 2007 but continued to set targets for M2.

**Table 4.1: Targeted and actual growth rates of monetary aggregates, 1998-2011**

Year	M1 Growth (%)		M2 Growth (%)	
	Target	Actual	Target	Actual
1998	17	11.9	16-18	14.8
1999	14	17.7	14-15	14.7
2000	15-17	15.9	14-15	12.3
2001	15-16	12.7	13-14	17.6
2002	13	18.4	13	16.9
2003	16	18.7	16	19.6
2004	17	14.1	17	14.9
2005	15	11.8	15	17.6
2006	14	17.5	16	15.7
2007	No Target	21	16	16.7
2008	No Target	9	16	17.8
2009	No Target	33.2	17	28.4
2010	No Target	20.4	17	18.9
2011	No Target	8.7	16	17.3
<i>Descriptive Statistics</i>				
Mean	15.1	16.5	16.7	17.4
Standard deviation	1.4	6.2	1.3	3.7

Note: The actual growth rates are computed as percentage changes of the stocks of monetary aggregates at the year end.

Source: The targeted money growth rates over the post-2000 period are the author's compilation (based on various issues of *China Monetary Policy Report*), while those over the period of 1998-2000 are adopted from Geiger (2006). The actual money growth rates are the author's calculations based on the data from Datastream.

A simple comparison of the target and the realized growth rate of M2 indicates that quite often the PBC missed the targets – in most cases, the actual growth exceeded the targets. Can we simply conclude that the PBC has in those cases implemented expansionary monetary policy? The answer is no. For example, in 2008 and 2011, the PBC explicitly announced contractionary monetary policy and undertook a series of tightening measures (by raising interest rates and the required reserve ratio, for example) to rein in inflation. Yet, M2 grew at a higher-than-target growth rate in both years.

Changes in the money stock thus appear to reflect not only changes in the stance of monetary policy, but other factors. Particularly in China, rises in the money stock could be due to the PBC's foreign exchange purchases. The current managed floating exchange rate regime in

China allows a daily movement up to +/- 1 percent in bilateral exchange rates.<sup>13</sup> Under this regime, the PBC is thus committed to stepping in the foreign exchange market to buy or sell foreign currencies whenever the exchange rate hits the bound. Given the current account surplus and the expectation of the RMB appreciation, quite often the exchange rate hit the upper bound and the PBC had to buy foreign currencies. These operations result in increases in the money supply. To drain the resultant excess liquidity, the PBC used to take offsetting operations to sterilize the monetary base, though often only partially. The observed changes in the money stock are thus strongly influenced by the strength and magnitude of these interventions. An increase in the money stock cannot be interpreted as monetary easing.

Money demand is another factor that drives changes in the supply of money. A rich literature finds that money demand is far from stable because of technological, institutional, and regulatory changes in the retail banking sector (see, e.g., Friedman and Kuttner 1992, 1996; Goldfeld and Sichel 1990). Central banks in turn accommodate changes in the demand for money. This endogeneity makes it impossible to use the money stock as a proper policy indicator.

#### **4.1.3 Measuring Monetary Policy with One Policy Instrument?**

Another practice in the literature is to measure monetary policy with a policy instrument.<sup>14</sup> In normal times, central banks in advanced economies (for example, the Fed and the ECB) use primarily open market operations on a regular basis to fine-tune movements in short-term interest rates. Other tools play only a minor role in monetary policy.<sup>15</sup> Thus, there is a consensus to measure monetary policy of the Fed and the ECB with a short-term interest rate. Some studies indeed follow this practice and measure the PBC's monetary policy with a short-term interest rate. However, there is no way to describe the PBC's operating regime as a one-

---

<sup>13</sup> In July 2005, China announced to give up its decade-long dollar peg and switch to a managed floating exchange rate regime. The exchange rate is thus set "with reference to a basket of currencies", allowing a daily movement up to +/- 0.3 percent in bilateral exchange rates. In May 2007, this daily band was extended to +/- 0.5 percent, and on April 16, 2012 it was further extended to +/- 1 percent.

<sup>14</sup> For example, Kareken and Solow (1963: 76) suggested that "(t)o denote the policy of a particular moment, it is enough to give the values for that moment of the monetary authority's instrument variables".

<sup>15</sup> The 2007 financial crisis has reverted the attention of those central banks to "unconventional" monetary policy instruments, among which quantitative easing has been the most widely used.

instrument procedure. Rather, the PBC uses various policy instruments to achieve its multiple objectives. Among them, quantity and administrative policy measures play an important role. Table 4.2 summarizes policy instruments that the PBC applies, including both monetary and specific credit policy instruments. Monetary policy instruments are presented in the upper panel of the table. They are a mix of quantity and price measures, mainly including open market operations, changes in the required reserve ratios and interest rates.

Many of these monetary policy tools do appear in the list of policy instruments in advanced countries. However, in normal times their central banks in practice mainly use open market operations per se. They seldom change the required reserve ratio and the central bank lending is small in quantity.

By contrast, all these tools play different important roles in China. Quantity measures, open market operations and changes in the required reserve, are used extensively by the PBC to absorb the excess liquidity in the banking sector through issuing central bank bills and/or raising the required reserve ratio, rather than to meet the operational target of a money market rate (as the Fed and the ECB do). The PBC relies less on the money market interest rate to affect economic activities. Rather, it exerts direct influences on private saving and bank lending by setting the benchmark deposit rates and lending rates (of various maturities), while commercial banks are allowed to adjust interest rates around the benchmark within a limited band.<sup>16</sup> Recently, the PBC uses the price tool less intensively. Instead, it influences economic activities essentially through quantity tools, by controlling the quantity of money and hence the supply of bank loans.

---

<sup>16</sup> At the moment, the band for the lending rate is  $[0.9, \infty)$  and that for the deposit rate is  $(-\infty, 1]$ . Only in 2004, the PBC abolished the lending-rate ceiling and the deposit-rate floor.

**Table 4.2: Policy instruments applied by the PBC**

<b>Monetary policy instruments</b>	
Open market operations	Quantity-based indirect tool, including repurchases transactions, outright transactions <sup>a</sup> and the issuance of central bank bills <sup>b</sup> .
Required reserve ratio	Discretionary and more direct tool.
Interest rates	Price-based tool, including various central bank base interest rates <sup>c</sup> . The deposit rate and lending rate of commercial banks are highly regulated.
<b>Specific credit policy instruments</b>	
Specific central bank lending schemes	Discretionary tool. Under certain specific eligibility requirements, the PBC provides special funds at a lower cost for a particular group of industries or regions.
Window guidance <sup>d</sup>	Administrative tool in a form of "moral suasion" or "indirect pressure" through regular meetings with commercial banks so as to influence the quantity and the structure of bank lending.

Notes: a. Outright transactions include outright purchase and outright sale, by which the PBC buys/sells securities directly from/to the secondary market to increase/decrease base money. b. Central bank bills are short-term securities issued by the PBC, which were introduced in 2002 to deal with the inadequate supply problem of government bonds. Through issuing central bank bills, the PBC can effectively reduce the money supply. The PBC has used them extensively to offset rises in liquidity in the banking system as a result of the PBC's foreign exchange purchases. Therefore, central bank bills are often referred as sterilization bonds. c. They include the central bank lending rate, the rediscount rate, the interest rates paid on the required and excess reserves. d. The Bank of Japan exercised this practice as well in the post-War era until the early 1990s.

Source: Author's summary.

Monetary policy instruments are supplemented by specific credit policy tools, as listed in the lower panel of Table 4.2. The PBC believes that the development and implementation of credit policy is one of its important duties (see People's Bank of China 2012). Quite often, the PBC launches specific central bank lending schemes, under which it provides special funds at a lower cost for a particular group of industries or regions, and holds regular meetings with commercial banks in a form of "indirect pressure" so as to window-guide "financial institutions to strengthen the extension of supporting loans for central government-invested projects" (*China Monetary Policy Report 2009 QuarterIV*: 16).<sup>17</sup> Bank loans are shifted toward policy-oriented sectors and regions, such as agriculture, small- and medium-sized enterprises, job creation, western less-developed regions, etc. Such efforts are more obvious in recent years in an attempt to mitigate structural imbalances in the economy of China – for example, unbalanced economic growth with the coexistence of overheating and under-

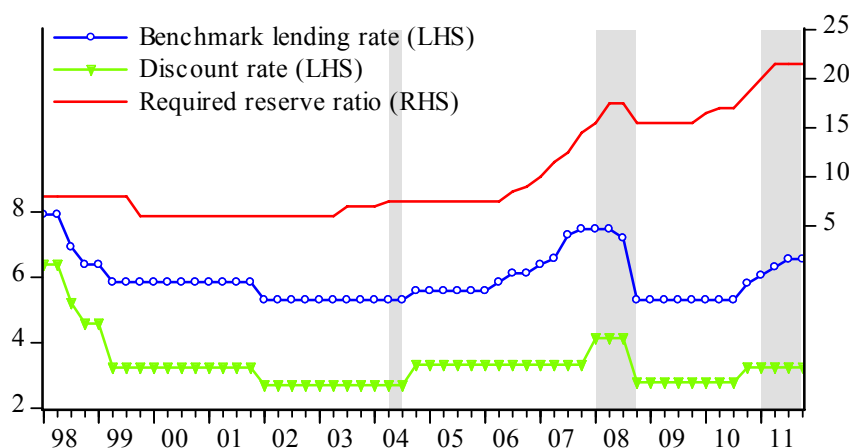
<sup>17</sup> According to Geiger (2006), window guidance has been effective in China given that the PBC can influence appointments of the senior personnel at commercial banks.

developed sectors; the rising regional disparity, mainly between coastal and interior regions; the soaring income inequality, especially between rural and urban residents. Through credit policy tools, the PBC is actively engaged in directing bank lending and affecting the structure of bank loans. In general, these credit tools are more direct, yet administrative and discretionary. Most of central banks in advanced economies abolished them in the 1970s and 1980s.

Under the current operating procedure, both monetary policy tools and credit policy tools are informative about the stance of monetary policy. Thus, changes in the PBC's policy stance should be predicted through monitoring all policy tools (see also Chen, Chen, and Gerlach 2011; He and Pauwels 2008; Shu and Ng 2010; Xiong 2011). However, "explicit mention of all instrument variables is not in all circumstances the best possible description of monetary policy" (Kareken and Solow 1963: 76). Moreover, these policy instruments are so different in nature that it is impossible to summarize them into a single indicator.

Yet, if all the policy instruments move simultaneously in a comparable magnitude, it is nevertheless possible to use one instrument to represent the behavior of all others. Figure 4.1 shows the development of three selected policy instruments for the post-1998 period: the discount rate, the benchmark lending rate and the required reserve ratio. A close examination of these three instruments indicates that they did not always move together. Two interest rates initially showed a simultaneous movement, which however impaired after 2006. Changes in the required reserve ratio displayed divergences from the change pattern of interest rates: the correlation coefficient of the reserve ratio with the benchmark lending rate is 0.24 and that with the discount rate is even slightly negative, -0.03. In particular, over the post-2006 period the PBC tended to use changes in reserve requirements more extensively, in terms of both the frequency and the magnitude. For example, in eighteen months throughout June 2008, the PBC almost doubled the required reserve ratio to 17.5 percent in 16 steps while the benchmark lending rate was raised only modestly by 1.2 percentage points in 6 adjustments.

**Figure 4.1: Three selected monetary policy instruments in China: the required reserve ratio, the benchmark lending rate and the discount rate (in %), 1998-2011<sup>a, b</sup>**



Notes: a. Starting from September 25, 2008, the reserve ratio for the small- and medium-sized financial institutions is set 1-2 percentage points lower than that for the big financial institutions. In the figure, the ratio for the big financial institutions is reported. b. The discount rate is an interest rate at which the PBC lends to commercial banks with a maturity of 20 days; the benchmark lending rate (with a maturity of 1 year) is an interest rates set by the PBC as a benchmark for banks to follow.

Grey shaded areas are marked as contractionary episodes, which will be elaborated in the following section.

Source: The minimum required reserve ratios are author's compilation based on the "Chronology" of various issues of the PBC's *Annual Report*. The interest rates are from IMF *International Financial Statistics*.

This shift is due to concerns that a rise in interest rates would be followed by capital inflows, which would elicit undesired increases in appreciation pressures on the RMB. Furthermore, keeping the domestic interest rate above the American one implies sterilization costs for the PBC. After foreign exchange purchases, the PBC used to take offsetting operations by issuing central bank bills to sterilize the monetary base. It buys foreign assets (mostly in the form of US government bonds) and sells central bank bills. The sterilization costs arise when the returns on US government bonds is smaller than the domestic interest rates on central bank bills. But sterilization could result in profits as long as the differential between two bond yields is positive. Indeed, there had been virtually no sterilization costs until October 2007 (see, e.g., Capiello and Ferrucci 2008; Xie 2009). However, since November 2007 the domestic yields have exceeded the US bond yields<sup>18</sup>, sterilization has turned to be costly. These costs would be exacerbated if the appreciation of the RMB is taken into consideration. Eventually, the PBC has been more reluctant to use the interest rate tool.

<sup>18</sup> The Crisis has led to increasing demand for US government bonds (safe-haven effect) and a fall of their yields.

On the other hand, the use of central bank bills for the sterilization purpose was “partly constrained by weaker purchasing willingness on the part of commercial banks” (*China Monetary Policy Report 2006 Quarter II*). In 2006, the PBC shifted to more extensive use of the required reserve ratio. It is direct and effective in influencing the money supply.<sup>19</sup>

The current exchange rate regime predicates that as long as there are foreign exchange purchases, the PBC has to conduct large-scale open market operations, supplemented with raising reserve requirements, to sterilize the monetary base. The frequent changes in reserve requirements have drawn a lot of attention – they were publicly announced and newsworthy. Nevertheless, these changes are “not necessarily indicative of monetary easing or tightening, but are more related to the management of foreign exchange reserves”, as the PBC’s Governor, Zhou, Xiaochuan, pointed out (Caixin 2012). This suggests that a part of changes in policy instruments is systematic response of the PBC to the state of the economy. To isolate exogenous components of monetary policy changes from systematic policy responses requires more information on driving forces of policy movements.

#### **4.2 Financial Markets and the Functioning of Monetary Transmission Channels**

Since the beginning of reforms, China’s financial markets have seen huge progress. However, they are still under-developed and regarded as the Achilles’ heel of China’s economic developments (see, e.g., Dobson and Kashyap 2006; Forssback and Oxelheim 2007; Lardy 2004, 2008; OECD 2010). At the moment, bank loans are the main source of the external financing in China.

Figure 4.2 presents financial markets components in China at the end of 2004 and 2010, as compared to those in the United States. The financial depth in China (calculated with the total outstanding debts and equities divided by the GDP) was around half of that in the United States. Among the total outstanding debts and equities, bank loans in China used to account for 72 percent in 2004, playing a dominating role in external financing. This share declined below 50 percent in 2010, due to fast developments of stock markets. Yet, it was still very

---

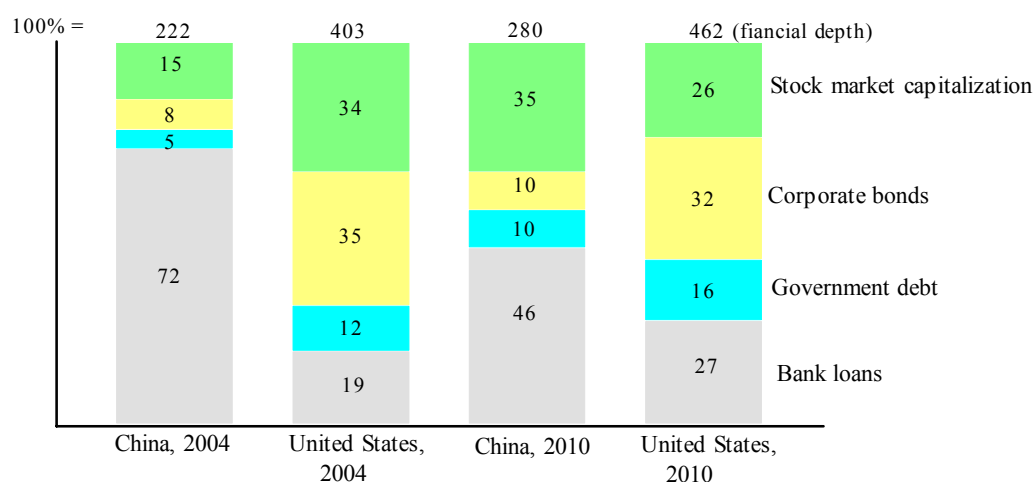
<sup>19</sup> It is unclear whether the PBC fully neutralizes excess liquidity through these two operations. However, a quick look at China’s persistently “anomalously high” (with respect to what the quantity theory predicts) M2-to-GDP ratio suggests that the money base is not fully sterilized.



high – about twice larger than that in the United States – indicating a high degree of bank dependency of Chinese firms. Meanwhile, bond markets saw very limited progress in China during this period and continued to play only a minor role in external financing. In China, the share of corporate bonds accounted for only 10 percent of the total external financing in 2010, compared to 32 percent in the United States, where direct financing through bond markets has been a much more important financing source.

In China, firms rely on bank loans as the main source of external financing on the one hand and on the other hand, the PBC applies various tools to control liquidity in the banking system and thereby the credit supply, which implies that China’s monetary policy could have strong effects on the real economy via the bank lending channel and the interest rate channel. However, concerns about the functioning of these monetary transmission channels arise due to the high concentration of state-owned commercial banks<sup>20</sup> in the banking system, which are blamed to make policy loans and thus be less sensitive to changes in monetary policy.

**Figure 4.2: Components of external financing<sup>a</sup>, China and the USA, 2004 and 2010**  
Financial depth (% of GDP)<sup>b</sup>



Notes: a. Calculated as a percentage share of each component relative to the total outstanding national debts and equities.  
b. Calculated with the total outstanding national debts and equities divided by GDP.  
Source: MGI (2006: 13; 2011: 25).

<sup>20</sup> They are mainly the Big Four. Some studies use the Big Five as they include the fifth, a rapid growing bank, the Bank of Communications (BoCom), in this group.

Indeed, until the mid-1990s Chinese state-owned commercial banks used to serve as government financial intermediaries to make policy loans to government-approved projects. In 1994 bank reforms, three policy banks were established to take over policy lending from state-owned commercial banks.<sup>21</sup>

However, studies find that state-owned commercial banks continue to show a strong bias toward lending to SOEs, including some unprofitable SOEs, in order to maintain high employment growth and thereby the social stability, as long as these SOEs offer plenty of jobs (see, e.g., Dobson and Kashyap 2006). It thus follows that state-owned commercial banks are less profit-oriented and less sensitive to changes in monetary policy, which might result in malfunction of the monetary transmission mechanism.

Yet, this bias is found to be less harmful due to two recent developments. First, the Big Four went public in 2005, 2006 and 2010, respectively. As showed in interviews conducted by Dobson and Kashyap with bank managers, the banking management of the listed companies is thus under market pressure to improve efficiency and profitability (Dobson and Kashyap 2006). Bank loans are more transparent and profit-oriented. Second, the market share of state-owned commercial banks has steadily declined, for example, from 55 percent in 2003 to about 46 percent in 2011, according to the data from China Banking Regulatory Commission. Meanwhile, the market share of non-state-owned banks, including joint-stock commercial banks and city commercial banks, which are profit-oriented and immune to the bias toward lending to SOEs, increased from 19 percent in 2003 to 25 percent in 2011. A rising share of private banks would thus improve efficiency of the banking system as a whole.

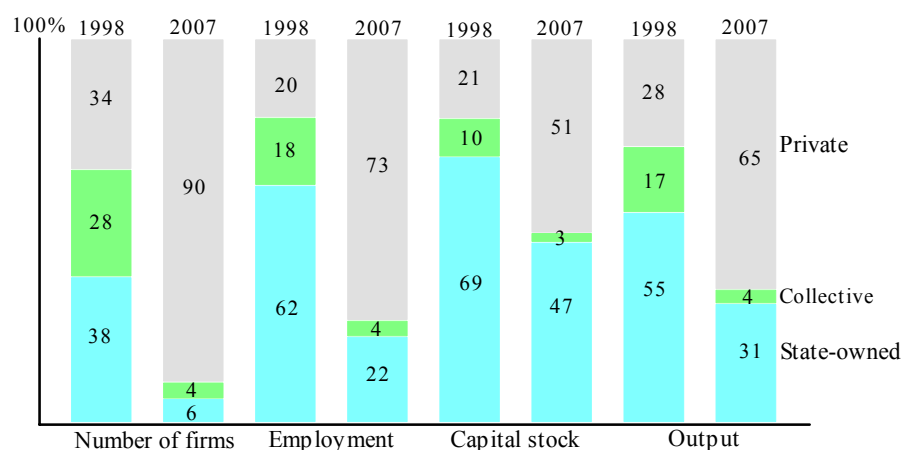
On the other hand, with the rapidly growing private-owned sector, state-owned commercial banks are under less pressure to make loans to SOEs, as those private companies are at the moment the biggest job creators in China. Figure 4.3 shows developments of the private sector in China between 1998 and 2007. The number of private-owned firms increased dramatically, more people worked in the private-owned companies and produced more. By 2007, 73 percent of the employed worked in the private sector, contributing to 65 percent of GDP. However,

---

<sup>21</sup> They are the China Development Bank, the Agricultural Development Bank of China, and the Export-Import Bank of China. Different from commercial banks, policy banks are less profit-oriented. They make policy lending to finance government-directed and state-invested projects.

SOEs still owned about half of the capital stock. They are large in size and have higher capital intensity.

**Figure 4.3: Fast developments of the private sector in China, 1998 and 2007<sup>a, b</sup>**



Notes: a. Calculated as a percentage share. b. State-owned enterprises include those both wholly and partly (for example, the state as the main share holder) owned by the state. Collective enterprises are owned by some community.  
Source: OECD (2010: 106).

Those private-owned companies are mainly small- and medium-sized enterprises (SMEs). Most of them have no access to capital market (bond and stock markets) for external financing and are thus more bank-dependent. When a contractionary monetary policy shock is accompanied with a fall of liquidity in the banking system, a decline of credit supply would squeeze many SMEs out of bank lending as these firms are less able to evidence high value of collaterals. Only a small part of them will be able to find other external financing sources, while others have to cut investments and employment.<sup>22</sup> Hence we would expect to see a decline in economic activity in this sector. Since the private sector takes up a rising share in GDP, this will account for more fluctuations in aggregate output.

With the progress in the banking system, including a rising share of private-owned banks and increased profit orientation of state-owned commercial banks, banks are more sensitive to changes in monetary policy. It thus contributes to improving the functioning of monetary

<sup>22</sup> For example, the PBC 2011 monetary contraction resulted in substantial financing problems of many private-owned small companies, which led to payment arrears and rising bankruptcy in southern China. It has already aroused wide attention in China.

policy transmission channels. On the other hand, with a rising share of the private sector in GDP, we would expect to see increasing fluctuations in GDP as a result of a monetary stimulus. All these factors would thus lead to more influences of monetary policy on the real economy in China.<sup>23</sup>

### 4.3 The Identification Problem

The movements of the PBC's policy variables reflect more than policy changes. They incorporate large endogenous responses of monetary policy to current and expected economic developments. This section presents a simple framework to illustrate the identification problem inherent in the estimation of the effects of monetary policy. It further shows why estimates with conventional measures of monetary policy are likely to give rise to omitted variable bias.

Suppose output is affected by the monetary policy variable  $\Delta m$  (for example, conventional monetary policy measures such as a monetary aggregate, the money market rate, or other policy indicator) and some other factors:

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta m_t + \alpha_2 Z_t + \alpha_3 E_t + \epsilon_t, \quad (4.1)$$

where  $\Delta Y_t$  is the first difference of logarithm of real GDP. The vector,  $Z$ , summarizes many other factors that affect real growth, such as government spending, supply shocks and foreign demand shocks, while the vector,  $E$ , includes expectations about future developments. For simplicity, the lagged terms of variables are ignored.

The PBC reacts to output and sets policy to achieve economic goals. When doing so, it watches a range of variables, including output growth and variables in the  $Z$  and  $E$  vector. Its policy reaction function can be written as:

$$\Delta m_t = \beta_0 + \beta_1 \Delta Y_t + \beta_2 Z_t + \beta_3 E_t + \delta_t, \quad (4.2)$$

---

<sup>23</sup> Some studies, using vector autoregressions, suggest that the transmission channels of monetary policy, similar to those found for advanced economies, exist in China. For example, Sun, Ford, and Dickinson (2010) trace effects of a monetary policy shock on variables of banks' balance sheets and macroeconomic variables. They conclude that in China there exists the bank lending channel, the interest rate channel and the asset price channel.

Rewriting Equation 4.2 yields:

$$\Delta Y_t = \left( -\frac{\beta_0}{\beta_1} \right) + \frac{1}{\beta_1} \Delta m_t - \frac{\beta_2}{\beta_1} Z_t - \frac{\beta_3}{\beta_1} E_t - \frac{1}{\beta_1} \delta_t, \quad (4.3)$$

The rearranged policy reaction function, Equation 4.3, appears to have the same list of right-hand variables as Equation 4.1. We hence do not know what a simple regression of output on those variables tells us. Is it the effect of monetary policy on output, or the PBC's reaction function? It is most likely the mixture of these two. This is known as the identification problem. Only exogenous shocks to the monetary policy variable –  $\delta_t$  in Equation 4.2, the monetary policy movements that are independent of output growth and other factors in the vector  $Z$  and  $E$  that affect output growth – can be used to identify the true effects of monetary policy on output.

However, even in the most sophisticated model, it is impossible to proxy for all information about future output movements that policymakers have had. Suppose that the true relationships between  $\Delta Y$  and  $\Delta m$  are represented in the system of Equation 4.1 and 4.2. Yet, the PBC's expectations about the future output movements are not observed. Thus, the vector  $E$  is left out of the system:

$$\Delta Y_t = \gamma_0 + \gamma_1 \Delta m_t + \gamma_2 Z_t + \vartheta_t, \quad (4.4)$$

$$\Delta m_t = \theta_0 + \theta_1 \Delta Y_t + \theta_2 Z_t + \varphi_t, \quad (4.5)$$

The error terms in Equation 4.4 and 4.5 are  $\vartheta_t = \alpha_3 E_t + \epsilon_t$  and  $\varphi_t = \beta_3 E_t + \delta_t$ , respectively. They are correlated. Clearly, the proxy for exogenous monetary policy shocks with the error term  $\varphi_t$  will lead to biased estimates of monetary policy on output.

Obviously, this omitted-variable bias can be narrowed to some limit by including more control variables. However, the analysis of the PBC's operating procedure and history suggests that the PBC watches an enormous number of economic variables when setting policy. Many original macroeconomic data are not publicly available in China, neither are the PBC's numerical forecasts of future economic developments. Thus, left-out variables are a serious problem in the estimates of the PBC's monetary policy effects with simple regressions.

Another concern is that the PBC's operating procedures have evolved over time. Thus, its monetary policy reaction function cannot be well described with time-invariant Equation 4.2. Rather, the coefficients in its reaction function should vary from episode to episode. This suggests that a simple inclusion of more control variables into the system is unlikely to eliminate the bias.

Estimates of the effects of monetary policy with conventional measures rely crucially on the correct modeling of the interrelationship between economic variables and monetary policy measures. An alternative approach, the narrative approach, can be used to solve both the indicator and identification problems. This approach "involves using the historical record, such as the descriptions of the process and reasoning that led to decisions by the monetary authority and accounts of the sources of monetary disturbances" (Romer and Romer 1989: 122). This information discloses the central bank's intentions for each policy movement. Some of these intentions are neither linked directly to output nor indirectly to those factors that are likely to affect output growth. In this way, I can single out those policy movements that are exogenous to the current and future economic developments in the real side.

Let us define the exogenous monetary policy movements as  $\Delta m_t^u$  such that we have:

$$\Delta Y_t = \rho_0 + \rho_1 \Delta m_t^u + \omega_t, \quad (4.6)$$

where the error term,  $\omega_t$ , includes the impact of all other factors on output growth. This regression appears to be simple. But it should yield an unbiased estimate of the impact of monetary policy on output given that with the narrative approach,  $\Delta m_t^{u'}$ s are identified as those monetary policy movements that are orthogonal to any other shocks in  $\omega_t$  that might influence output growth. Hence, in the subsequent sections I will use this regression and some of its extension to estimate the effects of the PBC's monetary policy on output. On the other hand, unbiased estimates with a simple regression as Equation 4.6 relies crucially on the validity of its underlying identifying assumption that the identified shocks,  $\Delta m_t^{u'}$ s, are uncorrelated with other determinants of output growth. I thus complement my empirical analysis with various robustness tests in the last section to check this identifying assumption.

#### 4.4 Narrative Identification of Monetary Shocks

In this section, I apply the narrative approach to identify monetary policy shocks. An exogenous shock is precisely defined as a monetary movement driven by inflation, rather than by the state of the real economy. In this way, only those contractionary anti-inflationary policy movements are considered. The reason for using this narrow definition of monetary shock is that the concern about inflation appears to be the only driving force that fulfils the premise of being independent of the *current and future* developments of real output. First, inflation is mainly due to past shocks. And second, trend inflation by itself does not cause large short-run fluctuations in real output. On the contrary, monetary expansions are largely associated with real economic developments (for example, weak economic growth) and thus we can barely isolate exogenous policy changes from those endogenous policy responses to the state of the economy.

##### 4.4.1 Identification of Monetary Shocks

I use two sources of documents from the PBC – “Press Release” on quarterly meetings of the Monetary Policy Committee (MPC) and *China Monetary Policy Report*. The MPC was established in July 1997. According to the PBC’s Law, the Committee “shall play an important role in macroeconomic management and in the making and adjustment of monetary policy” (Article 12 of the PBC’s Law). At the moment, it is composed of 15 members.<sup>24</sup> Since 1999, it holds quarterly meetings to discuss current policy issues. After each meeting, the PBC discloses main contents of discussion by issuing a short press release. The press release covers the MPC’s reviews of current economic developments and challenges ahead, its assessments of current monetary policy and in particular, its suggestion for the future monetary policy is clearly stated and explained.<sup>25</sup> Based on this information, I single out those policy shifts when the MPC held the view that policy should shift to contraction to rein in inflation for the forthcoming quarter. These releases are made online on the PBC’s homepage, though incomplete (only those from 2000 on are available).

---

<sup>24</sup> They include the PBC’s Governor, two Deputy Governors; officials from government departments, such as the State Council, the State Development and Reform Commission, Finance Ministry; officials from banking, securities, and insurance regulatory authorities; and experts from the academia.

<sup>25</sup> More detailed notes of the MPC meeting are recorded in the form of “meeting minutes”. Yet, they are not made publicly available.

As a cross check, I control my findings from “Press Release” with a comparison to *China Monetary Policy Report*, which is an executive summary of monetary policy and published each quarter by the PBC since 2001. This Report covers analysis of the macroeconomic and financial situation and explains the monetary policy operations. One chapter addresses the PBC’s policy intentions for the next period and policy changes are well explained. Throughout the overlapping sample period of 2001-2011, I did not find contradictory statements between two sources. Altogether, I identify three exogenous shocks when the PBC shifted to an anti-inflationary tightening. They are 2004 Q2; 2008 Q1-2008 Q3; and 2011 Q1-2011 Q4.

The end of contraction is defined when the PBC stopped showing concerns about inflation and announced a shift back to normal.<sup>26</sup> In this way, the duration of each shock is specified, which is new compared to Romer and Romer (1989). One criticism on narrative-based monetary policy shocks is that these shocks contain no information about the magnitude of contraction and they are treated homogeneously. Certainly, identifying the duration of each shock weakens this critique as the length of the episode sheds light on the degree of contraction. The longer the episode, the more severe the contraction is. Thus, contractions can be evaluated on a heterogeneous basis.

**2004 Q2.** The steadily rapid growth of money stock and bank lending in 2002 and 2003 made inflation a real risk in 2004. Inflation in the first quarter of 2004 grew at a rate of 3 percent, after being negative for years. At its meeting in March 2004, the MPC held the view that it was time to take actions to prevent inflation. “Money and credit growth should be properly controlled.... No negligence should be tolerated in preventing inflation and financial risks” (“Press Release” on the First Quarter 2004 MPC Meeting). For the next period, monetary policy should be “appropriately tight” and the PBC “will closely monitor the price changes” (*China Monetary Policy Report 2004 Quarter I*).

The contractionary episode lasted only one quarter as at the end of the second quarter, “the strong growth momentum of money supply and loans had been reined in, and the macro

---

<sup>26</sup> Quite often, the PBC describes its normal policy as “the prudent monetary policy” (it was originally translated as “sound monetary policy”, yet starting from 2009 the PBC translated it as “prudent monetary policy”). The “prudent” monetary policy is an activist policy with the PBC maintaining an appropriate money growth rate so as to support the sustainable, steady and healthy growth of GDP (*China Monetary Policy Report*, Quarter 4 2010).



financial control measures had produced expected result” (“Press Release” on the Second Quarter 2004 MPC Meeting). The MPC agreed that the prudent monetary policy should be adopted in the coming period.

**2008 Q1-2008 Q3.** Starting from 2007, the PBC got concerned about the build-up of inflationary pressure on the grounds of the more-than-expected growth of money and bank lending. In the second half of 2007, prices grew at a rate of 6 - 8 percent, mainly due to rapid rises in food and oil prices. At two MPC meetings in the fourth quarter of 2007 and the first quarter of 2008, the Committee repeatedly emphasized that “efforts should be made to ... prevent shifts ... from structural price rise to full-scale inflation.” For the coming periods, “the Committee held the view that a tight monetary policy should be implemented” (“Press Release” on the Fourth Quarter 2007 and on the First Quarter 2008 MPC Meeting). By June 2008, the PBC still held the view that “the inflationary pressure was noticeable”; “curbing excessive price increase” and “containing inflation” should be taken as top priorities (“Press Release” on the Second Quarter 2008 MPC Meeting).

From July 2008, inflation showed a decelerating trend: from 7 percent in June to 4.6 percent in September. In September 2008, Lehman Brothers went bankruptcy and the US subprime mortgage crisis spilled over to the real economy. At its September’s meeting, the MPC agreed to end the tightening.

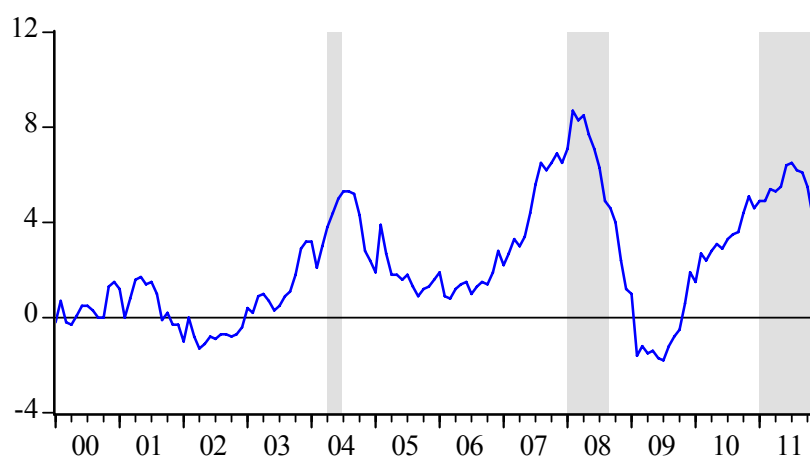
**2011 Q1-2011 Q4.** In 2010, inflation crept up from 1.5 percent to 5.1 percent. At its December 2010 meeting, the MPC held the view that the PBC was facing tough tasks in controlling money, credit and liquidity growth. The MPC agreed that for the next year, monetary policy should “give more priority to stabilizing the general price level” and “efforts should be made to control liquidity and bring the monetary and credit conditions back to a normal state” (“Press Release” on the Fourth Quarter 2010 MPC Meeting). Inflation continued in 2011 and reached 6.5 percent in July. At its first three meetings in 2011, the MPC reemphasized that monetary policy should attach top priority to inflation control and various measures should be taken to effectively manage the liquidity and keep credit and money aggregates at reasonable levels.

Inflation started to slow down in August 2011 and reached 4.1 percent in December. At its December 2011 meeting, the MPC agreed that the Chinese economy faced complex domestic and external situation due to the European debt crisis and for the coming period, a prudent monetary policy should be taken.

#### 4.4.2 Were Shocks Predictable?

Figure 4.4 plots the dynamic of inflation from 2000 to 2011, together with three identified episodes, which are marked in grey shaded areas. In each case, inflation went up gradually. All these contractionary shifts always happened around the local peaks of inflation. Yet, the PBC's response to inflation does not appear to be deterministic. The "unacceptable" inflation rates varied largely across three identified episodes: they were 3 percent, 6.5 percent and 4.6 percent, respectively, at the PBC's decision for 2004 QII, 2008 QI and 2011 QI contraction.

**Figure 4.4: Inflation (in %, annualized), 2000-2011**



Notes: The inflation rate is calculated as a percentage change of the consumer price index (CPI). Grey shaded areas are marked as identified contractionary episodes.

Source: Monthly data from Datastream.

The exogeneity of policy shocks suggests that shocks are not predictable. Yet, Leeper (1997) found that in a logit model, the Romer and Romer (1989)'s dates were highly predicted by lagged economic variables.<sup>27</sup> He concluded that these shocks were not exogenous. However, this finding should be interpreted with caution because the predictability was largely due to overfitting of the model, as pointed out by Romer and Romer (1997).<sup>28</sup> Nevertheless, it sheds the light on the importance to examine the predictability of the narrative monetary policy shocks.

I test the Leeper critique with my identified policy shocks in a logistic model, which is parallel to the Leeper's specification, but more parsimonious. This logit model says that when the PBC's tolerance of inflation exceeded a certain threshold, it stopped accommodative policy and shifted to monetary tightening. It is given as follows:

$$E(D_t^s | \Omega_t) = F(\alpha, \bar{X}), \quad (4.7)$$

where  $E(\cdot)$  is an expectation term;  $D_t^s$  is a policy shift dummy variable, which takes value of 1 in the month, when the PBC decided to shift policy to anti-inflationary; and 0 otherwise;<sup>29</sup>  $\Omega_t$  stands for the PBC's information set, which includes the most recent developments of two macroeconomic variables – output and inflation.<sup>30</sup> These two variables reflect costs and benefits that the PBC considers in determining whether to move to anti-inflationary policy. On the right-hand side of the equation,  $F(\cdot)$  is a logistic function and  $\alpha$  is a constant term;  $\bar{X} = (\bar{g}_{IP}, \bar{\pi})'$  is the list of macroeconomic variables in the information set, with  $\bar{g}_{IP} = \frac{\sum_{i=1}^3 g_{IP,t-i}}{3}$  standing for the average growth rate of industrial production for the previous three months and  $\bar{\pi} = \frac{\sum_{i=1}^3 \pi_{t-i}}{3}$  for that average inflation rate. In doing so, I try to avoid overfitting by limiting

---

<sup>27</sup> Shapiro (1994) made another test, finding that future inflation and unemployment did not highly predict the Romer and Romer dates.

<sup>28</sup> Overfitting arose as the Leeper's logistic model was too complex with too many parameters (37 parameters altogether) relative to the limited variation in the dataset (a time series of the Romer and Romer dummy with only 7 observations equal to one).

<sup>29</sup> That is,  $D_t^s = 1$ , when  $t =$  April 2004, February 2008 and February 2011. Note that the 2008 and 2011 contractionary shifts are defined in February because the January observations on industrial production growth are not available due to Spring Festival effects (more discussion about the data follows in the subsequent section).

<sup>30</sup> Four other variables in Leeper (1997) are not included in the information set: one is commodity prices and the other three are indicators of monetary policy. However, including those variables does not change the results. For example, including the producer price index leads to the same  $R^2$  of 0.13 and the largest implied probability of 0.1 for 2008 policy shift; including one lag of the dummy leads to essentially the same results.

the number of coefficients that need to be estimated.<sup>31</sup> On the other hand, I use the average values of the past three months to proxy for a possibly large information set of the PBC.

The time series data of industrial production growth are available on a monthly basis, but discontinuous, with January data since 2005 missing. The reason for that is the unconventional method that the Chinese National Bureau of Statistics uses in solving the seasonality problem inherent in time series. The growth rate of industrial production is calculated by comparing industrial production over the same period last year.<sup>32</sup> For example, the growth rate for 2011  $M_j$  is calculated as  $g_{IP,2011M_j} = \left( \frac{IP_{2011M_j}}{IP_{2010M_j}} - 1 \right) * 100$ , with  $j = 1, 2, \dots, 12$ , giving a percentage change of industrial production in month  $M_j$  over year. In so doing, the time series of industrial production growth should not contain any seasonal variations.<sup>33</sup> However, there are still abnormal fluctuations in the beginning of some years due to Chinese New Year effects.

The Chinese New Year, the most important family festival in China, based on the Chinese lunar calendar, takes place either at the end of January or in February. Officially, it is a three-day public holiday. Yet, many migrant workers from the rural area quit shortly before the Chinese New Year to travel home, or take a weeks-long holiday. Therefore, the holiday effects on the output level in the corresponding month could be even larger. This leads to large fluctuations in industrial production growth for the years that are adjacent, but have the Holiday in different months.<sup>34</sup> In 2005, the Chinese authorities stopped publishing industrial production growth for January. Instead, industrial production in January and February was added up and the growth rate for such an aggregate was calculated. I correct the data before 2005 in the same way to keep it consistent and eliminate Holiday effects. In this way, the time series of industrial production growth has only 11 observations for each year.

---

<sup>31</sup> Rather than averages of three lags of industrial production growth and inflation, I examine two variants of Equation 4.7 by defining the PBC's information set to either only one lag or three lags of IP growth and inflation, and obtain quite similar results.

<sup>32</sup> The original data are not publicly available.

<sup>33</sup> That is, March of this year, for example, typically has the same number of working days, weather, and other variables that might affect output as March of last year.

<sup>34</sup> For example, the industrial production growth rate was 2.3 percent in January and 19 percent in February 2001, respectively, as the Chinese New Year fell in January for the year 2001 but in February for the year 2000.

The data used in this chapter are mainly from Datastream, except those specifically indicated. The sample period hereafter is from January 2000 to December 2011. Yet, when industrial production is included in the estimates, I adjust other time series by dropping out January observations to accommodate the industrial production data. In those cases, the sample period starts with February 2000.

Table 4.3 presents the estimation results of three variants of Equation 4.7, which differ in the regressands included.<sup>35</sup> In all three specifications, the coefficients before the lagged inflation and the lagged industrial production growth both have the right sign as the theory predicts: higher inflation and higher output growth raise the probability of a policy shift to contraction. Yet, none of them is statistically significant. In the most general specification, 3.c, the joint null hypothesis that coefficients before both explanatory variables are zero cannot be rejected at the high significance level (19 percent). All three regressions have a low  $R^2$ , indicating poor fit of the prediction equation.

**Table 4.3: Decision to shift to contraction: logistic estimates<sup>a</sup>**

	3.a	3.b	3.c
Constant	-5.01* (1.23)	-8.09 (4.44)	-8.35 (5.05)
Inflation ( $\bar{\pi}$ )	0.37 (0.23)		0.33 (0.24)
Output Growth ( $\bar{g}_{IP}$ )		0.28 (0.27)	0.22 (0.31)
<i>Summary statistic</i>			
McFadden (Pseudo) R-squared	0.09	0.05	0.12
Probability(LR statistic) <sup>b</sup>	0.10	0.23	0.19

Notes: a. The logistic estimates are based on Equation 4.7. For more details, see the text. b. Probability (LR test) is the p-value of the LR test statistic, which tests the joint null hypothesis that all slope coefficients except the constant are zero.

Month data are used. Standard errors are in parentheses. \* indicates that a null hypothesis of zero is rejected at the 1 percent level.

Source: Author's estimations.

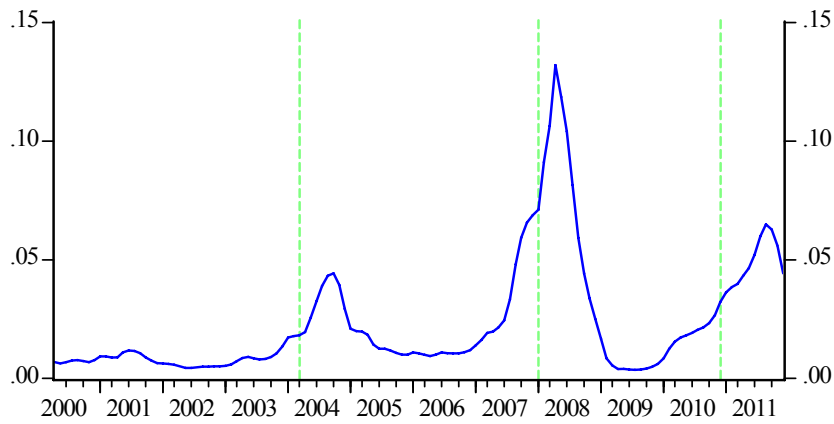
<sup>35</sup> Given the limited variation of the data, this logistic model is still on the borderline of overfitting despite all the efforts to model in a parsimonious way. In fact, using it to test the predictability of policy shifts tends to overstate the degree of endogeneity of policy movements.

The probability of an anti-inflationary policy shift implied by these logistic estimates is presented in Figure 4.5. Vertical green dotted lines mark the dates of the actual policy shift. A comparison of Panel A and Panel B suggests that inflation plays more important role in predicting a policy shift, though the fitted probability of the 2004 April contraction is mainly associated with the output variable. Throughout all three specifications, the predictability is low. For example, according to the most-generally-specified model, as shown in Panel C, the predicted probability of three contractions is 0.03, 0.09 and 0.02, respectively. Evidently, the PBC's shift to contraction is not predictable, suggesting that my narrative-based shocks are exogenous.

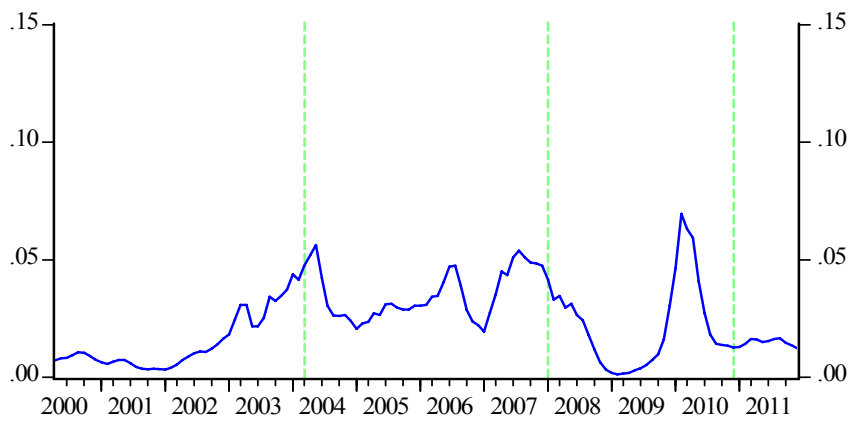
I extend this predictability test further by considering an alternative specification. Given that the exchange rate stability is one of the PBC's policy objectives, I include the trade balance, which is likely to influence the exchange rate, into the logistic model. Accounting for the trade balance (as a ratio of GDP) does not change the results. The  $R^2$  is 0.19, slightly higher. The coefficient before the lagged trade balance is negative, as expected, but not statistically significant (neither are the other two coefficients). The predicted probability is eventually the same for the 2008 and 2011 contractions as that in Panel C of Figure 4.5. Yet, the predicted probability for 2004 contraction is increased to 0.16. It suggests that the trade balance plays some limited role in predicting 2004 contraction only.

**Figure 4.5: Implied probability of an anti-inflationary policy shift**

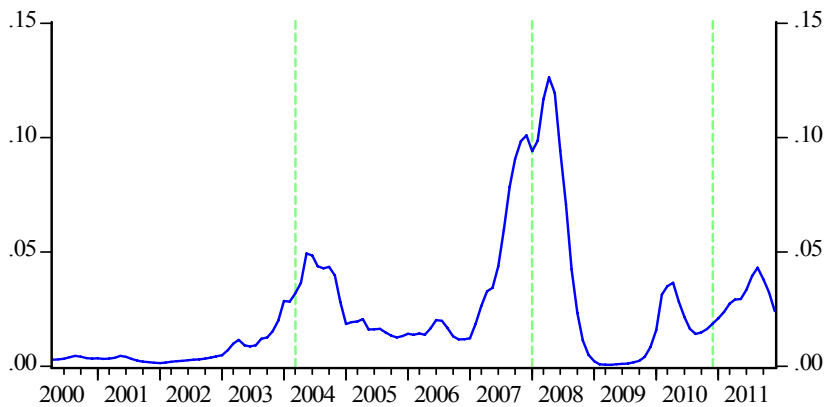
Panel A: Estimates with the lagged inflation only



Panel B: Estimates with the lagged industrial production growth rate only



Panel C: Estimates with both the lagged inflation and the industrial production growth rate



Notes: See notes of Table 4.3. Vertical green dotted lines mark identified actual policy shift dates.  
Source: Author's estimations.

### 4.4.3 Intensions versus Actions

Three policy shock episodes are identified when the PBC made a clear statement that monetary policy should shift to contraction to rein in inflation. However, one can argue that intensions are not necessarily followed by actions. A quick check of the PBC's policy actions indicates that after each anti-inflationary decision, the PBC indeed took various tightening measures in those episodes. Figure 4.1, presented in the previous section, shows the evolution of three selected policy tools, the required reserve ratio and two interest rates, together with the identified episodes, marked in grey shaded areas. In each episode, the PBC used all these three tools to lower inflation. In April 2004, the PBC raised both the interest rates and the required reserve ratio; in the first half of 2008, the PBC raised the required reserve ratio to 17.5 percent in seven continuous adjustments, together with increases in the interest rates; again in 2011, the reserve ratio was hiked to 21.5 percent, a record-high level, and interest rates were increased as well.

## 4.5 How Do Monetary Shocks Affect the Economy?

To quantitatively estimate effects of monetary policy on the economy, I introduce a monetary contraction dummy variable that equals 1 in the episodes when monetary policy is identified to be anti-inflationary, and 0 otherwise. This time series for the monetary contraction dummy thus has  $D_t = 1$  if  $t = 2004:4-2004:6$ ,  $2008:1-2008:9$  and  $2011:1-2011:12$ , and  $D_t = 0$  otherwise.

### 4.5.1 Baseline Results

*The impact on output.* The contraction dummy series reflects changes in monetary policy exogenous to the real economic developments. With these exogenous shocks, I thus can use the simple specification for the basic estimation, similar to Equation 4.6, but including the lagged terms, which considers dynamics of output growth and at the same time allows monetary policy to affect output beyond the current period:

$$g_{IP,t} = a_0 + \sum_{j=1}^{11} b_j g_{IP,t-j} + \sum_{k=0}^{11} c_k D_{t-k} + e_t, \quad (4.8)$$



where  $g_{IP}$  is growth of industrial production and  $D$  is the monetary contraction dummy. I include 11 lags of industrial production growth.<sup>36</sup> This autoregression part accounts for some inherent boom-and-bust cyclical movements of output. The current and 11 lags of monetary policy measure are included,<sup>37</sup> which captures the impact of monetary policy on output.

With the regression results of Equation 4.8 (see Table B-4.1 in the appendix), the implied impact of exogenous monetary restrictions on output is computed. For example, following a one-unit rise in  $D$ , the estimated response of industrial production growth in the contemporaneous month is simply the coefficient on the contemporary term of  $D$ ,  $c_0$ ; the estimated response after one month is  $c_0 + (c_1 + b_1c_0)$ ; and so on so forth (see Romer and Romer 2004). This response combines the direct effect of a monetary contraction on output and the feedback effect through lagged output.

These responses are then cumulated.<sup>38</sup> Figure 4.6 presents implied impact of a shift to a monetary contraction on industrial production growth, together with one-standard-error bands.<sup>39</sup> This hump-shaped pattern of the impact is very similar to those estimates obtained in the literature for other countries (see, e.g., Christiano, Eichenbaum, and Evans 1999; Romer and Romer 2004; Sims 1992). After the PBC shifts to contraction, industrial production starts to fall with a two-month delay. Then it declines quickly after 6 months. The maximum impact is found after 15 months: the anti-inflationary shift reduces industrial production by about 5.9 percent, compared to what it would otherwise be. After hitting the trough, industrial production rebounds slightly, but remains at a substantially negative level: about -4.8 percent after three years,<sup>40</sup> although the precision of the estimation deteriorates with a rising horizon. Monetary policy has strong and persistent effects on output.

---

<sup>36</sup> This is because the monthly data of industrial production growth contain only 11 observations.

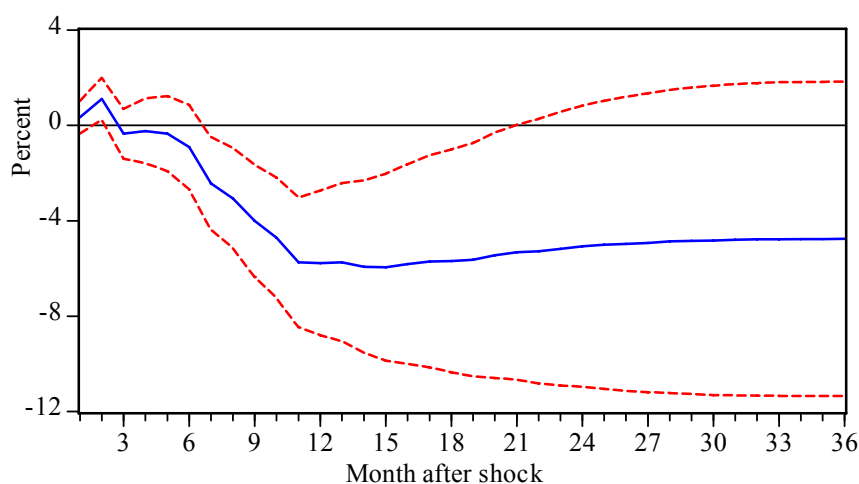
<sup>37</sup> With an inclusion of the current term of the monetary contraction dummy, monetary disturbances are allowed to have contemporaneous effects on real output.

<sup>38</sup> This cumulative response provides an estimate of the total effect of a policy shock on output after some horizon.

<sup>39</sup> The asymptotic standard errors of the impulse response function are computed according to the formula specified by Poterba, Rotemberg and Summers (1986: 668).

<sup>40</sup> It remains at this level even after five years.

**Figure 4.6: Estimated impact of monetary tightening on industrial production**  
(baseline simple regression)



Notes: The implied effects are computed cumulative responses of industrial production growth to a one-unit rise of the contraction dummy, based on the estimation of Equation 4.8 (see Table B-4.1 in the appendix). The dotted lines are one-standard-error bands.

Source: Author's estimation.

**The impact on inflation.** The PBC shifted to contraction with the intention to control inflation. The natural question is thus whether this tightening has effects on the price level. The baseline regression is as follows:

$$\pi_t = a_0 + \sum_{j=1}^{24} b_j \pi_{t-j} + \sum_{k=0}^{24} c_k D_{t-k} + e_t, \quad (4.9)$$

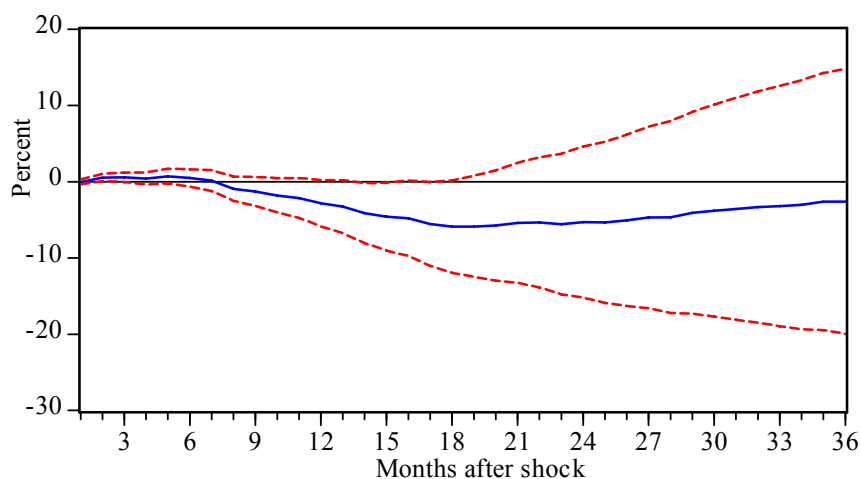
where  $\pi$  is inflation rate, calculated as a percentage change of the consumer price index over years, similar to the method used in computing industrial production growth. Given that monetary policy is likely to affect rigid prices with larger delay, I include more lags, altogether 24.

Table B-4.2 in the appendix summarizes the regression results of Equation 4.9. Its implied impact of a monetary contraction on inflation is reported in Figure 4.7, together with one-standard-error bands. The point estimates suggest that following a tightening, prices do fall, though with a substantial delay. Prices first rise, small and insignificantly. Starting from the eighth month, they drop steadily. After one and a half year, the price level is about 5.9 percent lower than what it would otherwise have been.<sup>41</sup> Afterwards, prices start to rise and the impact

<sup>41</sup> The implied sacrifice ratio (the ratio of the total industrial production loss to the change in inflation) of the PBC's disinflation policy is about 5.9 percent / 5.9 percent = 1 after one year and a half.

remains negative (-2.6 percent) after 36 months. Yet, statistical uncertainty about this result is large.

**Figure 4.7: Estimated impact of monetary tightening on the price level**  
(baseline simple regression)



Notes: The impulse response is computed based on the estimation of Equation 4.9 (see Table B-4.2 in the appendix). For more explanations, see notes of Figure 4.6.  
Source: Author's estimation.

#### 4.5.2 VAR Results

I consider another specification by extending the baseline regressions to a bivariate vector autoregression (VAR) which allows for effects of both lagged output (inflation) and past policy changes on the monetary contraction dummy. This extension can be viewed as a robustness check.<sup>42</sup> My test of the exogeneity of identified policy shifts in Section 4.2 indicated that the past developments of output and inflation do not have any significant effects on the policy shifts. Hence, we expect to get similar results from the VAR approach.

To be consistent with the baseline regression, I allow monetary policy to affect the economy contemporaneously in the VAR. Thus, the equation for the monetary contraction dummy is ordered first and industrial production growth (inflation) second in the VAR system.

<sup>42</sup> Leeper (1997) provides such a robustness test for the Romer and Romer (1989)'s results by contrasting the VAR results with the ones that the Romers obtained.

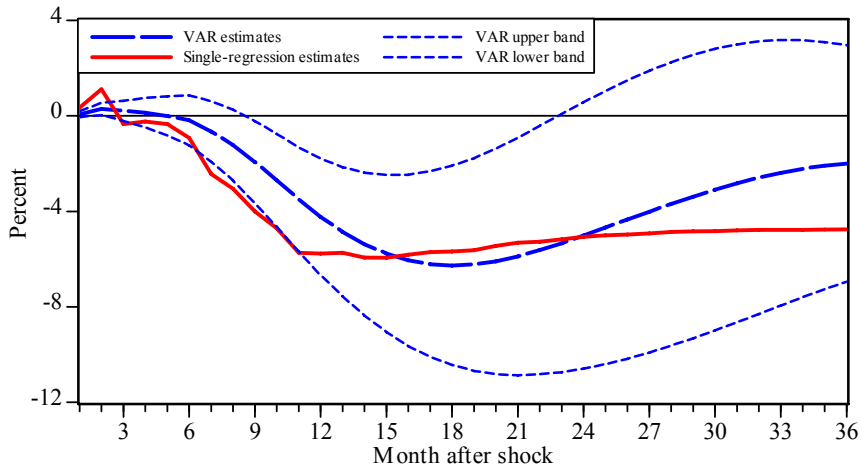
Two bivariate VARs are run. Figure 4.8 shows the results. Panel A presents the responses of industrial production growth to a contractionary monetary shift, together with one-standard-error bands. Panel B shows the impact on inflation. The VAR results are compared with the implied impacts of monetary policy estimated from the baseline single-equation regression, which are repeated in both panels. The VAR estimation, allowing for the endogeneity of the monetary contraction dummy, does not change the main results.

Again in the VAR estimates, the responses of industrial production to a monetary tightening follow the hump-shaped pattern, with a slightly larger delay. The estimated maximum decline of industrial production occurs at the end of 18 months and is actually slightly larger (-6.3 percent compared to -5.9 percent). Yet, the VAR suggests that this decline is less severe with output rebounding more quickly. The negative impact falls to about -2 percent after 3 years.

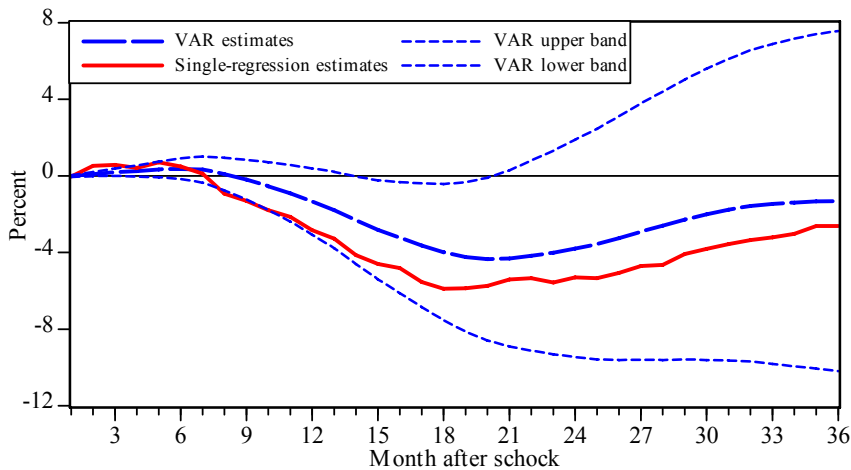
The VAR estimation for prices yields the same sluggish response pattern of prices to monetary tightening. Prices are first sticky and start to decline after the eighth month. Then, the two sets of estimates show a parallel co-movement at all horizons. Yet, the effects estimated in the VAR framework are in general 1.5 percent smaller than those from the simple regression. The VAR estimated maximum effect is a decline of prices of 4.4 percent. Yet, this estimate is not highly precise and the confidence interval is nevertheless substantial.

**Figure 4.8: Estimated impact of monetary tightening (bivariate VAR)**

Panel A. Impact on industrial production



Panel B. Impact on the price level



Notes: The cumulated impulse responses of industrial growth (Panel A) and prices (Panel B) are estimated separately in two bivariate VARs with the monetary contraction dummy and industrial production growth (or inflation).  
Source: Author's estimation.

### 4.5.3 Comparison with Other Measures

The motivation for this chapter to use the narrative approach is due to two concerns about how to measure Chinese monetary policy. First, the conventional measures that are widely used to measure monetary policy of other central banks may not be able to sufficiently reflect the PBC's policy changes given that the PBC applies a wide range of policy instruments and does not necessarily change all of them simultaneously. The second one is that the conventional

measures contain reaction components of the central banks to the current and expected economic developments. As shown in Section 4.3, using these endogenous conventional measures to estimate the real effect of monetary policy may lead to an omitted-variable bias. It is therefore useful to compare my results based on the narrative exogenous measure with those using the conventional measures to see if this bias indeed exists.

In this section, we consider four other measures. The first one is the Shu-Ng narrative index. As mentioned in the introduction, Shu and Ng (2010) read the PBC's documents and build an index time series to indicate the stance of the PBC's monetary policy. I consider their five-value index, ranging from -2 (very easy) to 2 (very tight), available over the sample period from January 2001 to June 2009. Another two measures are the growth rate of the broad money stock (the year-over-year growth rate of M2) and the interest rate (I consider the prime lending rate with the maturity of one year or less), both of which are widely used to measure monetary policy of other central banks. The fourth measure that I consider is the required reserve ratio given the fact that the PBC has been extensively using this policy tool.

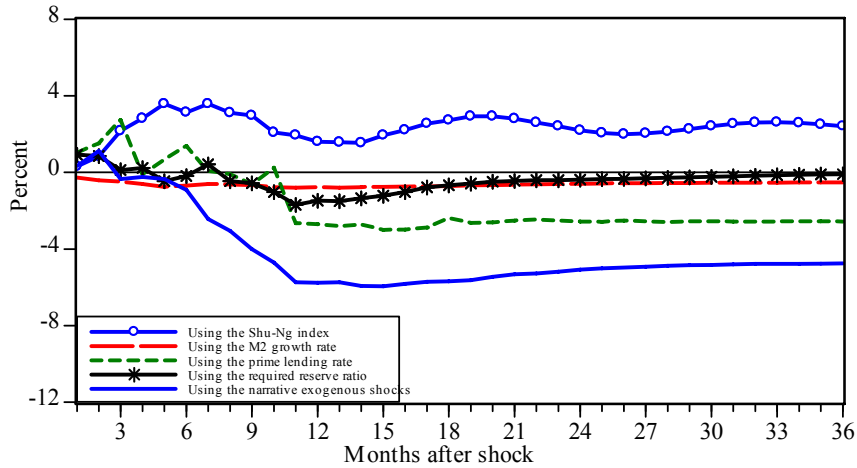
Panel A of Figure 4.9 shows the implied impact of monetary tightening on industrial production estimated with the regressions (parallel to Equation 4.8) using these four measures as the policy indicator each in turn. Panel B shows the impact on the price level based on the regressions (parallel to Equation 4.9). For comparison, the results using my narrative exogenous policy measure are repeated in both panels.<sup>43</sup> The comparison focuses mainly on the response patterns given that the impulses based on different measures are not comparable. Overall, the results suggest that the estimates based on other measures are either puzzling or biased with slow and transient responses.

---

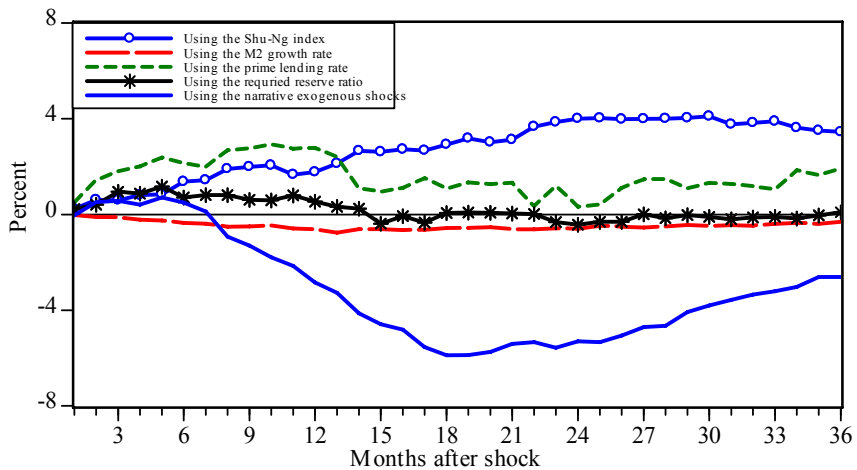
<sup>43</sup> The confidence intervals of all the estimates are not reported to keep the figures readable.

**Figure 4.9: Estimated impact of monetary tightening using other measures**

Panel A. Impact on industrial production



Panel B. Impact on the price level



Notes: The figures present the implied impact of monetary tightening on industrial production (Panel A) and the price level (Panel B), based on the regression specification similar to Equation 4.8 and 4.9, respectively, but using different monetary policy measures each time.

Source: Author's estimation.

Surprisingly, the Shu-Ng index performs the worst. The results by using this index show that monetary tightening induces a rise in both output and the price level, which is inconsistent with what the theory predicts. It implies that although the Shu-Ng index precisely measures the policy stance of the PBC by summarizing all records information, it still contains many policy response components. Special efforts are required to search for a right model to disentangle those endogenous components if one attempts to use it in estimating the impact of monetary policy.

The estimates by using the interest rate show that after a rise in the interest rate, output falls, but after eight months. This output response is slower compared to the results using my narrative exogenous shocks. The maximum impact of a one-percentage-point rise in the interest rate on output is around -3 percent after about one and half years. However, the estimates predict that after a rise in the interest rate, prices increase. This result is puzzling (known as the price puzzle in the literature) as the theory suggests the opposite.

The results based on the required reserve ratio suggest that output starts to decline with a larger delay. Then, this effect dies out quickly after about one and half years. Correspondingly, a rise in the reserve ratio has virtually null impact on inflation. Prices first rise moderately and fall to slightly negative after fifteen months. Thereafter, prices fluctuate around the zero line.

The estimates by using the M2 growth rate show that following a monetary contraction with a one-percentage-point reduction of the money supply, both output and the price level fall immediately and remain moderately negative at all horizons.

The results by using these four measures indicate that the endogeneity of these measures is a severe problem and using them is very likely to lead to puzzling or biased estimates of the policy impact. The puzzle and bias are not easily dealt with. My attempt to control for the endogeneity of these policy measures in a bivariate (VAR) with output (or inflation) and the policy measure ends in vein. The price puzzle still exists in the estimates based on the Shu-Ng index, the interest rate and the required reserve ratio. Neither is the prediction based on the Shu-Ng index for output corrected: industrial production increases following monetary tightening. Obviously, a simple VAR model cannot sufficiently disentangle exogenous policy changes from endogenous response components. This is a particular challenge for the study of China's monetary policy as the PBC's reaction cannot be simply described with a time-invariant response function over the period when the PBC's operation procedures experienced evolutionary changes.



#### 4.5.4 Robustness

So far, monetary policy appears to have strong and persistent impact on real output in China. In this section, I clarify several concerns about the robustness of these results.

*Was inflation different across episodes?* Inflation was the main factor that explained the PBC's contractionary policy shift. The first concern is hence whether the inflation that I identified was driven by some common factors. If it is the case, then these factors could account for fluctuations in real output that I found. Yet, my reading of the PBC's analysis about inflation did not suggest that there was such a common driving force. Rather, inflation was different across episodes. In 2003/2004, it was the build-up of liquidity in the banking system that drove up prices. In 2007/2008, high inflation was triggered by rapid rises in food prices, including cereal, pork and poultry, and oil prices. In 2010/2011, several factors led to rises in prices: first, expansionary monetary policy in major industrialized countries has caused capital inflows into emerging markets, driving up asset prices there; second, the depreciation of the reference currency (the US dollar) contributed to rises in commodity prices; third, domestically, the unit production cost stepped up as a result of rising labor costs (see *China Monetary Policy Report 2010 Quarter IV*). In sum, inflation in three identified episodes was largely caused by past shocks, with the specific driving forces varying across episodes.

*Is a slowdown due to inflation?* Given that inflation is clearly visible during all shock episodes, the concern arises whether the identified economic slowdown was due to inflation. In fact, there is neither theory nor evidence showing that inflation by itself (independent of supply shocks) has direct impact on real output. Nonetheless, I test whether controlling for inflation will change the results by including the current and 11 lags of inflation (based on the producer price index) into Equation 4.8.<sup>44</sup> The regression results suggest that accounting for a direct effect of inflation on output has little impact on the timing and the persistence of the response of industrial production to a monetary shock. The maximum impact is found at the end of the first year, but somehow smaller (about -4 percent). This negative impact of monetary contraction on output is persistent and remains at the substantial level (around -3.7 percent even after five years).

---

<sup>44</sup> The data are adjusted with the January observations omitted.

*Is a slowdown due to adverse supply shocks?* I extend the robustness test further and ask whether adverse supply shocks around the times of the policy shifts were the true driving force of the economic slowdown.<sup>45</sup> Energy price changes based on the purchasing price index for fuel and power, published by National Bureau of Statistics of China,<sup>46</sup> are used as a proxy to measure adverse supply shocks. I include the current and 11 lags of energy price changes into Equation 4.8. Controlling for energy price shocks does not change the implied impact of monetary tightening on output. Industrial production declines with a small delay and after about one year, it is about 6 percent lower than what it would otherwise have been. Again, this substantial negative impact is perennial.

*Controlling for fiscal policy.* Another concern is that the identified effects on output may not purely stem from anti-inflationary monetary policy. For example, the central government of China might implement all kinds of policies to fight inflation. I test this argument by controlling for fiscal policy in my simple regression. I extend Equation 4.8 by including the current and 11 lags of the ratio of budget surplus/deficit to nominal GDP.<sup>47</sup> Accounting for fiscal policy does not mitigate the estimated effects of monetary policy on output. Industrial production falls quickly after a four-month delay. After about one year, the negative impact of monetary tightening on output is about -6 percent. Similar to my results using my narrative exogenous measure, this impact remains substantial and persistent.

## 4.6 Conclusion

As a fast growing emerging economy, China has attracted the world's attention. Yet, its institutions and functioning framework remain distinctive from those in advanced economies. Studies are thus needed that dig into those institutional details and give some insight of the functioning of the Chinese economy. This chapter enriches the literature with a careful examination of China's monetary policy by focusing on how and with what effects monetary policy is implemented in China.

---

<sup>45</sup> Indeed, Hoover and Perez (1994) and Romer and Romer (1994a) argue on whether the estimated monetary policy impact on the output, found by Romer and Romer (1989), is due to oil shocks.

<sup>46</sup> The data are available only since January 2003.

<sup>47</sup> Alternatively, one can use government spending to measure fiscal policy, which is not possible given that the monthly data on Chinese government expenditures are available only over a shorter sample period (since June 2007). Nonetheless, the high correlation between budget surplus/deficit and government spending over this sample period (-0.9) suggests that budget surplus/deficit can well proxy for fiscal policy.

At the moment, the PBC uses many policy instruments and none of them can be described as its principal tool. Its operational procedures still vary over time. Its reaction function can hardly be described with a time-invariant equation. All the PBC's institutional specifics suggest that the conventional monetary policy measures can neither sufficiently reflect its policy changes nor can estimates using those conventional measures be free of bias. To overcome these measurement challenges, I use the narrative approach in this chapter to disentangle the PBC's exogenous policy changes from its endogenous components. Based on the reading of the PBC's documents for the period of 2000-2011, I identify three exogenous policy changes as those driven by inflationary pressure. These exogenous policy shocks are uncorrelated with developments on the real side of economy. Their impact on the economy gives an unbiased estimate of the effects of monetary policy.

Estimates using the shocks that I have identified indicate that monetary policy in China has strong effects on output. My baseline regression suggests that a shift to fight inflation lowers industrial production by almost 6 percent. This is further confirmed by most of my robustness tests. Another important finding is that this suppression appears to be perennial with the negative impact remaining at a substantial level even after five years, though the estimates are becoming less precise with an increase in the time horizon. The persistence of the effects is robust to variations in control variables and specification.

## **Appendix A: Data Appendix**

### **A.1: Institutional background of the PBC from 1998 to 2011**

*Targeted money growth rates for M1 and M2:* Targets announced by the PBC on the annual basis, partly adopted from Geiger (2006) and partly the author's compilation;

*Actual growth rates of M1 and M2:* Annual growth rates calculated as yearly percentage changes of M1 and M2, Datastream;

*Minimum required reserve ratio:* On the quarterly basis, the author's compilation based on the "Chronology" of various issues of the PBC's *Annual Report*;

*Discount rate:* The interest rate at which the PBC lends to commercial banks with a maturity of 20 days, on the quarterly basis, IMF *International Financial Statistics*;

*Benchmark lending rate:* The interest rate (with a maturity of one year or less) set by the PBC as a benchmark for commercial banks to follow, on the quarterly basis, IMF *International Financial Statistics*.

### **A.2: Macroeconomic data**

All data series are monthly from January 2000 to December 2011 (except those specifically mentioned).

*D:* The exogenous monetary contraction dummy, identified by the author through reading the PBC's documents;

*g<sub>IP</sub>:* The annualized growth rate of industrial production, Datastream;

*π:* The annualized inflation rate based on the consumer price index, Datastream;

*Trade balance:* Its ratio to nominal GDP is used, Datastream;

*Shu-Ng narrative index:* The index to indicate the PBC's policy stance, Shu and Ng (2010);

*g<sub>M2</sub>:* The annualized growth rate of M2 on the monthly basis, Datastream;

*Prime lending rate:* The benchmark lending rate set by the PBC with the maturity of one year or less, Datastream;

*Energy price shocks:* The changes in the purchasing price index for fuel and power, available only from January 2003 on, National Bureau of Statistics of China;

*Ratio of budget surplus/deficit to nominal GDP:* Datastream.

## Appendix B: Baseline Regression Results

**Table B-4.1: Baseline regression results for industrial production**

Monetary policy shock			Change in industrial production		
Lag	Coefficient	Standard error	Lag	Coefficient	Standard error
0	0.35	0.68	1	0.77*	0.10
1	0.49	0.93	2	0.18	0.13
2	-2.12**	0.91	3	0.12	0.13
3	1.06	0.94	4	-0.14	0.13
4	0.02	0.93	5	-0.05	0.13
5	-0.20	0.92	6	-0.10	0.13
6	-1.21	0.92	7	0.12	0.13
7	0.65	0.93	8	0.11	0.13
8	-0.42	0.94	9	-0.13	0.13
9	0.39	0.94	10	-0.04	0.13
10	-0.23	0.94	11	0.04	0.10
11	0.61	0.75			

*Summary statistic*

Number of observations	121 after adjustment
Adj. R-squared	0.84
Standard error of regression	1.35
DW statistic	2.03

Notes: The regression is based on the estimation of Equation 4.8. The estimates of the constant term are not reported. \* and \*\* indicate that a null hypothesis of zero is rejected at the 1 percent and 5 percent level, respectively.

Source: Author's estimation.

**Table B-4.2: Baseline regression results for inflation**

Monetary policy shock			Change in CPI		
Lag	Coefficient	Standard error	Lag	Coefficient	Standard error
0	-0.03	0.32	1	0.99*	0.12
1	0.59	0.44	2	0.04	0.17
2	-0.50	0.43	3	-0.05	0.17
3	-0.24	0.45	4	0.00	0.17
4	0.49	0.45	5	0.07	0.18
5	-0.51	0.45	6	-0.06	0.19
6	-0.21	0.46	7	0.13	0.19
7	-0.62	0.45	8	0.16	0.19
8	0.61	0.45	9	-0.27	0.19
9	-0.22	0.46	10	-0.06	0.19
10	0.29	0.48	11	0.16	0.19
11	-0.28	0.48	12	-0.57	0.17
12	0.13	0.53	13	0.39**	0.17
13	0.04	0.55	14	0.08	0.18
14	0.40	0.55	15	-0.16	0.18
15	0.14	0.54	16	-0.06	0.18
16	-0.33	0.52	17	0.04	0.18
17	0.20	0.52	18	0.09	0.18
18	0.39	0.51	19	0.04	0.18
19	-0.28	0.50	20	0.10	0.18
20	0.44	0.51	21	-0.12	0.17
21	-0.33	0.51	22	0.12	0.17
22	-0.49	0.50	23	-0.23	0.18
23	0.15	0.50	24	0.08	0.11
24	0.01	0.42			

*Summary statistic*

Number of observations	120 after adjustment
Adj. R-squared	0.96
Standard error of regression	0.51
DW statistic	2.08

Notes: The regression is based on the estimation of Equation 4.9. The estimates of the constant term are not reported. \* and \*\* indicate that a null hypothesis of zero is rejected at the 1 percent and 5 percent level, respectively.

Source: Author's estimation.

## 5. Monetary Policy and European Unemployment<sup>1</sup>

The analysis of European unemployment trends has been dominated by hypotheses claiming rising equilibrium unemployment (rising NAIRUs) caused by European labor market institutions, standing alone or in interaction with external shocks. If monetary policy is included in the analysis at all, it is used as a “control” or only as a short-run disturbance, very much in line with the neutrality of money hypothesis. Differences in welfare state arrangements between the US and Europe, together with stable unemployment in the US but an upward trend in unemployment in Europe, have been widely used as support for the diagnosis and the consequent proposal of the deregulation of European labor markets and reductions of welfare state programs in general. This diagnosis had been deduced from natural rate theory but the empirical evidence for the theory was weak. However, Europe’s unemployment trend (see Figures 5.1) is hardly consistent with one specific “natural rate of unemployment” since unemployment rose with every recession and remained at levels substantially above the pre-recession rates. “The only interpretation of this experience that is consistent with the accelerationist model (the Friedman/ Phelps model, RS/ RS) is that the neutral<sup>2</sup> rate of unemployment must have gone from around three percent to something of 10 percent in much of Europe, without doubt a bit higher in some countries and a bit lower in others. This rather remarkable hypothesis seems to have been accepted without a qualm” (Solow 1998: 9). Most remarkably, empirical evidence against the “consensus” (see Baker et al. 2004; Glyn, Howell, and Schmitt 2006) went largely unnoticed.

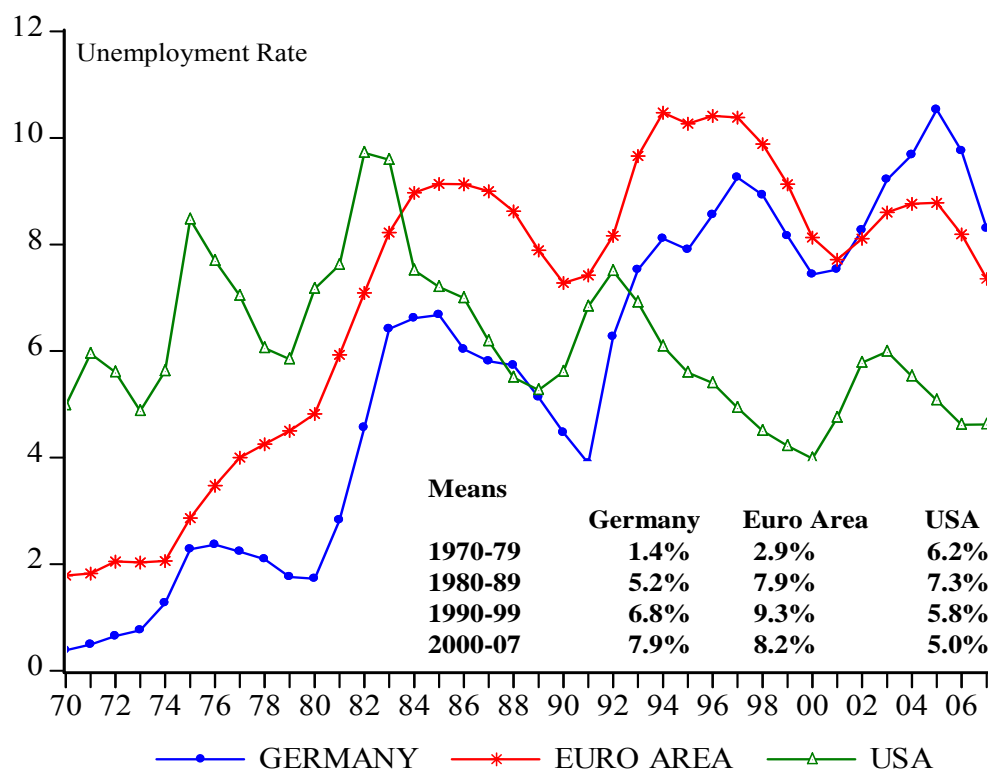
---

<sup>1</sup> This chapter is a joint work with Ronald Schettkat. Earlier versions of this chapter have been discussed at the LoWER conference (Institutions, Markets and European Unemployment Revisited: What have we learned? in Amsterdam on April 18/19, 2008), seminars at the University of Hagen, University of Wuppertal and IAB, Nuremberg. We are indebted to Frank den Butter, Friedrich Kißmer, Joachim Möller, Robert Solow, Heinz-Peter Spahn, Helmut Wagner and an anonymous referee for their invaluable comments. Susanne Hochscherf provided excellent research assistance. All remaining errors are ours.

This chapter was published in *Oxford Review of Economic Policy* (see Schettkat and Sun 2009). The long version of this chapter was published as *Schumpeter Discussion Papers* No. SDP 2008-002 (see Schettkat and Sun 2008).

<sup>2</sup> Solow refers to the “natural” rate of unemployment as the “neutral” rate of unemployment because “natural” is a misnomer since the level of unemployment, neutral to inflation, is influenced by institutions rather than naturally given. We use “natural”, “neutral”, “NAIRU” and “equilibrium rate of unemployment” as synonyms in this chapter.

**Figure 5.1: Unemployment trends in Germany, Euro Area and the USA**



Source: Computations are based on OECD Economic Outlook database.

Surprisingly little attention was given to macroeconomic institutions although substantial differences between the US and Europe exist here as well and could have been used to investigate differences in labor market performance. Also, the role of monetary policy changed substantially after 1973 when the Bretton Woods system of fixed exchange rates was substituted by flexible exchange rates. The impact of flexible exchange rates on trade, raising the risk for international transactions, has been widely recognized, but very little attention has been given to the fundamentally different role that monetary policy has in a flexible exchange rate system compared to that in a fixed exchange rate system.

With their “interaction of shocks and institutions hypothesis”, Blanchard and Wolfers (2000) argue that changes in welfare state institutions cannot explain the jumps in European unemployment rates but that institutions slowed growth after the economy was hit by negative external shocks. This had the effect that the economy and employment could not fully recover



to their initial growth path. Thus, the economy remained with higher levels of unemployment. Surely this hypothesis fits the rise of European unemployment and the long-run decline in growth rates after 1970 and it is certainly more plausible than the hypothesis blaming welfare-state institutions alone. However, this pattern is also consistent with an asymmetric monetary policy overemphasizing price stability and thus precautionarily dampening growth in the recovery period.

According to the dominant and widely accepted view, monetary policy is neutral at least in the middle and long-run and does not affect real output or the growth path. “Output is a real magnitude, not a monetary magnitude” (Friedman 2006: 4). Thus, monetary policy is innocent: It does not affect growth and unemployment directly but only indirectly through its effects on expectations. In the words of Central Bankers: “Other than by maintaining price stability and thereby reaping its benefits in terms of economic performance there is no trade-off at longer horizons between inflation, on the one hand, and economic growth or employment, on the other hand, that can be exploited by monetary policy makers” (Issing 2000: 4). This led to a broad consensus that the only appropriate objective of monetary policy is the maintenance of price stability, full stop. “Potential oriented” monetary policy will reduce the fluctuations around the trend but not the trend itself (as illustrated by the straight lines around the linear trend in Figure 5.2), which was the message of the Bundesbank and the ECB. Hence, potential oriented policy contributes to the stability of expectations, from which the economy can only benefit.

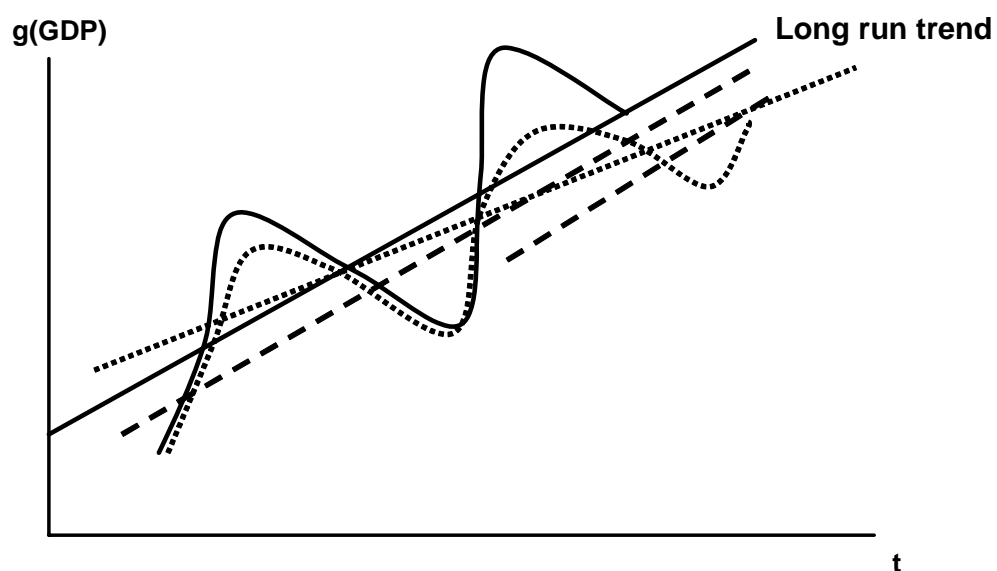
However, a whole battery of recent research suggests that monetary policy is not neutral to output, employment and unemployment but that it leaves scars identifiable in the data even after 5 and 10 years. Applying vector autoregressions (VARs), Bernanke and Gertler (1995) show that the effect of a rise of the funds rate on real GDP only dies out after 48 months. Using similar methodology (VAR), Bernanke and Mihov (1998a) find that the impulse response function does not dampen to zero even after 10 years.<sup>3</sup> Alexius and Holmlund (2007) – also applying VARs – find that monetary shocks can have very long-run effects on

---

<sup>3</sup> Mankiw (2001: C48) classifies the finding of non-neutrality by Bernanke and Mihov (1998a) “surprising”, because the “the paper purports to provide evidence for the opposite conclusion – long-run monetary neutrality. ... But if one does not approach the data with a prior view favouring long-run neutrality, ... (t)he data’s best guess is that monetary shocks leave permanent scars on the economy.”

unemployment in Sweden. Taylor (1980) argues that contracts lasting for some period predict a tradeoff between output and price stability. Hysteresis theories of unemployment, of course, predict long lasting effects even of otherwise short run impacts of monetary policy (see Ball 1997). Romer and Romer (1994b) conclude in their empirical analysis of every US business cycle since 1950 that monetary policies acted early can counter recessions. Blinder and Reis (2005) give monetary policy credit for the long US growth period in the 1990s. Theoretically, due to short-run wage or price rigidities, changes in the money supply might induce a short-run tradeoff between inflation and unemployment. Alternatively, some economists explore another approach – real rigidities- to explain the non-neutralities of money (see Solow 1985; Ball and Romer 1990).

**Figure 5.2: Business cycles and long-run growth trends**



In their meta analysis of 86 studies, de Grauwe and Costa Storti (2008) find that monetary policy affects real economic variables even after 5 years. They argue that studies using structural VARs often impose the restriction that the long-run output effect of monetary policy is zero, but this restriction is based on the neutrality of money assumption. “Put differently, in those econometric studies that do not impose long-run neutrality, the long-run neutrality of money is rejected” (de Grauwe and Costa Storti 2008: 75).

How do we evaluate price stability if monetary policy is not neutral? Once one accepts real effects of monetary policy, as many recent studies suggest, a restrictive monetary policy will reduce growth and will not allow the economy to return to its initial growth path. This is especially true if it is asymmetric, i.e., overly concerned with price stability and fears that expansionary periods create price pressure. If, in addition, investment depends on expected growth as many studies have shown (Carpenter, Fazzari, and Petersen 1994; Solow 2008), an asymmetric monetary policy will also reduce investment and thus potential output. Hysteresis in labor markets may cause similar effects with respect to labor inputs.

Figure 5.2 illustrates the impact of slow growth in upswings either caused by welfare state institutions (Blanchard and Wolfers 2000) or asymmetric monetary policy. The most popular view of tight monetary policy under the (long-run) neutrality of money hypothesis is that the volatility is reduced but that the growth path is unaffected. However, with asymmetric monetary policy the recoveries are slowed and recessions are not fully counteracted. We define asymmetric monetary policy as not (not fully) accommodating upswings and only reluctantly reacting to downswings. Asymmetric monetary policy in interaction with negative external shocks may be working in the following way:

- 1) A negative external shock pushes the economy into a recession which is not (fully) counteracted by monetary policy;
- 2) The upswing is not fully accommodated because the central bank fears inflationary pressure;
- 3) As a result the economy will not swing back to the initial growth path but remains below;
- 4) With the next downswing the process will be reiterated;
- 5) In consequence asymmetric monetary policy will lower the long-run growth trend.

All the ingredients needed to establish such a scenario are negative demand shocks and asymmetric policy reaction functions of central banks.

This chapter first analyzes the yardsticks for policy evaluations, potential output (growth) and “NAIRUs” in Section 1. We then investigate the asymmetry of the monetary policy of the Bundesbank in Section 2. The last section concludes.

## 5.1 Neutral Output and NAIRUs

Whatever the wording - “natural employment”, “full employment”, “natural unemployment”, “equilibrium unemployment”, “neutral unemployment”, “NAIRU”, “equilibrium output” “potential output”, “natural growth” - it seems to be generally accepted among economists that productive resources may be overused and that this may create inflationary pressure<sup>4</sup>. However, since the “potential” (to use a shortcut for the different wordings) cannot be observed directly but needs to be estimated, the measurement (in a theoretical sense as well as with respect to econometric methods) is under debate. When do economies depart from the natural rate of unemployment (from full employment)?

The late James Tobin (1995: 33) emphasizes that for Friedman and Lucas the departure from “full employment” describes an equilibrium (market clearing) which thus can be changed only through adjustments of the institutional framework. Reducing unemployment requires a shift of the equilibrium. For Keynes and Keynesians, unemployment (deviations from full employment) is not the result of market clearing but on the contrary a non-clearing or a slow adjustment phenomenon. Take the extreme assumption that “markets are always cleared”. Under this assumption the economy always operates at full employment and the “potential” can actually be observed because it is always equal to actual output. Introducing some stochastic disturbances but quick adjustments preserves the core of the story, however, once slow adjustments are allowed for, it is less clear what “full employment” or “potential output” actually is. For sure, it is not always the observed output or employment, but more often economies will deviate from full employment and thus the estimation procedure is crucial.

The pioneer of estimating potentials, Arthur Okun, used a simple linear trend between two peaks to estimate potential output (see Okun 1970). The simplicity of the method is an obvious advantage, but it requires the peaks to result from policies allowing the potential to develop. A bit more complicated but still very modest with respect to data requirements are so called filter techniques, such as the widely used Hodrick-Prescott filter or the Kalman filter. All that is needed is the data series itself. Filter techniques, of course, assume that actual values fluctuate

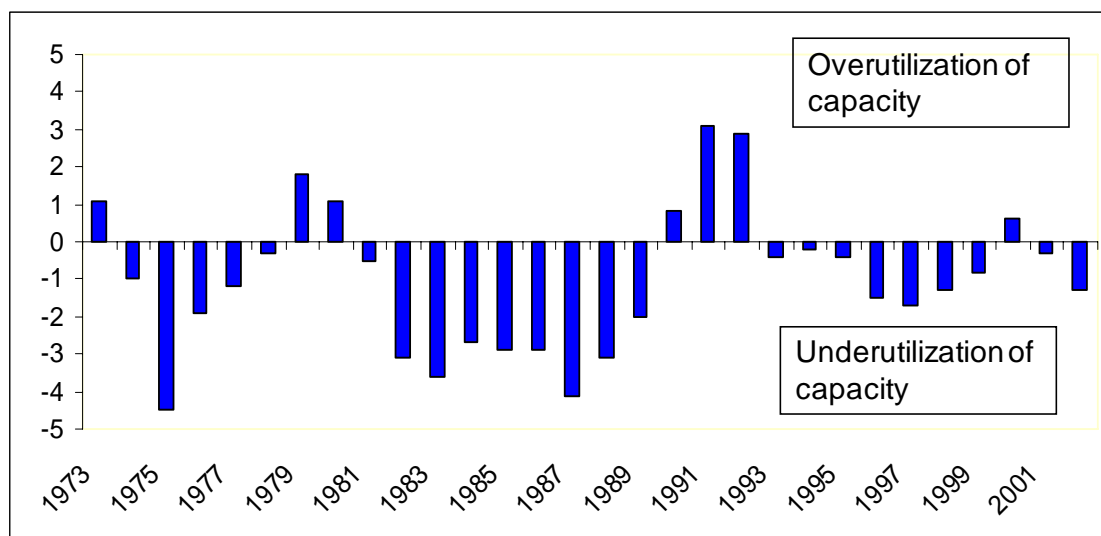
---

<sup>4</sup> In the economic policy debate, usually NAIRUs (or natural rates) and/or potential output are used as proxies. Which one is used is largely a matter of taste because both are close relatives although not identical twins. Blinder and Reis (2005), for example, analyze the Greenspan legend in terms of NAIRUs.

around the potential (or that actual unemployment fluctuates around “neutral” unemployment). The method, however, does not allow for prolonged periods of capacity underutilization (which may be due to underused labor or capital). That distinguishes smoothing methods from structural estimates using aggregate or disaggregated production functions. Therefore, the difference between methods is fundamental: Smoothing of time series – filtering – assumes more or less quick adjustments if the economy deviates from the equilibrium whereas structural models are potentially immune against such a bias. Although theoretically preferable, structural models are facing data problems ranging from the availability of data to substantial measurement error and volatility of the data which often requires some smoothing of the underlying data series. Estimates of potential output influence monetary and fiscal policy as well as social, tax and labor market policies because they are at least one indicator which directs policy (see, e.g., Hargreaves Heap 1980). An underestimated potential output may, for example, lead to a budget deficit identified as structural although it may in fact be not. It may lead to overly restrictive monetary policy because an underestimated potential feeds the fear of price pressure. Thus, being cautious against potential output (or NAIRU) estimations may turn out to be very “beneficial as the Greenspan legend” suggests (Blinder and Reis 2005).

The Bundesbank published a paper which propagates new Bundesbank estimates and provides an impression of differences in the estimated output gap for different estimation methods, which are astonishingly big (Deutsche Bundesbank 2003). The difference in the output gap between potentials estimated with different methods can be as big as six percentage points. For example, in the mid 1980s some methods would suggest over-utilization of capacity whereas others predicted severe under-utilization, i.e., the upper bound estimates would make Central Bankers already nervous, whereas the lower estimates would probably keep them more relaxed.

**Figure 5.3: Output gap for Germany according to the Bundesbank (2003)**



Source: Deutsche Bundesbank (2003).

Astonishingly enough, the Bundesbank's estimates with the new (but also with the former) method suggest that the German economy was underutilizing its capacity over long periods. If the Bundesbank's re-estimation of the German production potential is close to the true potential, the recent economic history of Germany is characterized by an almost continuous underutilization of capacity (see Figure 5.3). In 16 out of 30 years shown in Figure 5.3 the underutilization was at least 1 percent or more of the potential output, and in only 7 years the economy was operating above its potential. At the same time actual inflation declined substantially from 5.6 percent in 1975 to less than 1 percent in 1998, very much in line with targeted inflation.

Also, the NAIRU estimations are suffering from great insecurity. Analyzing US NAIRUs, Staiger et al. (1997) conclude: "However, the most striking feature of these estimates is their lack of precision. For example, the 95 percent confidence interval for the current value of the NAIRU based on the GDP deflator is 4.3 percent to 7.3 percent. In fact, our 95 percent confidence intervals for the NAIRU are commonly so wide that the unemployment rate has only been below them for a few brief periods over the last 20 years."<sup>5</sup> The data for Germany from Richardson et al. (2000: 16), who carefully analyzed different

<sup>5</sup> Staiger et al. (1997: 40), however, mention that the slope of the Phillips curve (the Phillips coefficient) seems to be quite stable but that the intercept with the x-axis is imprecisely estimated.

NAIRU estimates for OECD countries, show substantial deviations between NAIRUs estimated with Kalman and HP filters and both differ substantially from NAWRUs (Non-Accelerating Wage Rates of Unemployment), originally favored by the OECD. OECD's NAWRUs followed actual unemployment closely, i.e. they suggested a high degree of structural unemployment in Germany. The "Kalman NAIRU", however, suggests severe underutilization of resources in most years<sup>6</sup> implying that actual unemployment was substantially above structural unemployment. Thus, NAWRUs seem to have severely overestimated structural unemployment in Germany or in other words, these estimates may have caused an unnecessarily cautious monetary policy.

In the 1990s almost all US economists believed that the US NAIRU was about 6.5 percent and thus a fall of actual unemployment below the NAIRU should have alarmed central bankers. However, as we know now, the US unemployment rate could fall as far as 4 percent without accelerating inflation. We only know this because the FED allowed the unemployment rate to fall below the level which so many believed would lead to accelerating inflation. Greenspan, however, concluded that US productivity must have risen and his NAIRU estimates must have been substantially lower than the commonly believed 6.5 percent. Blinder and Reis (2005) argue that sophisticated econometricians (Blinder and Reis refer to Staiger et al. 2001) were only years after the event able to trace the downward NAIRU-path Alan Greenspan must have identified in the mid 1990s. Therefore, we should probably be very cautious before applying restrictive policies, which are extremely costly. "I want to argue that there can be an economically meaningful margin of uncertainty of the whereabouts of the neutral rate at any particular time, and, even further, that it may not be the sort of stable parameter that the underlying theory needs it to be" (Solow 1998: 8).

---

<sup>6</sup> In addition, the confidence-band around the Kalman filtered NAIRU is according to OECD (Richardson et al. 2000: 67) about 0.7 percentage points in both directions (one standard error), i.e., the unemployment gap could be around 5 percentage points or two thirds of the actual unemployment rate in 1982. Using the Okun gap formula (The Okun Gap describes the difference between the actual and the "neutral" unemployment rate as a difference in unemployment rates as a function of GDP growth rates.) We estimate that

- 1 percent difference in the unemployment rate results in about 2.5 percent loss in GDP in Germany before 1989;
- 1 percent difference in the unemployment rate results in about 2.0 percent loss in GDP in the US before 1989.

This translates into a 10 – 12.5 percent loss in GDP. No peanuts!

## 5.2 Asymmetric Monetary Policy

The Deutsche Bundesbank enjoyed high independence as mandated by the Bundesbank Act of 1957. However, fixed exchange rates under the Bretton Woods system were limiting the Bank's room for manoeuvre substantially (see Mundell 1963) until 1973 when fixed exchange rates gave way to flexible exchange rates. This increased the degree of freedom for monetary policy and the Bundesbank used the new option to target price stability (see Baltensperger 1998; von Hagen 1998). The Bundesbank became de facto Europe's central bank in about three decades before the setup of the European Central Bank because some countries pegged their currencies directly to the DM and others were influenced by Bundesbank policies through the European Exchange Rate Mechanism (ERM). For the Bundesbank (and later, the ECB) price stability became priority and other considerations should only be pursued conditional on the achievement of price stability!<sup>7</sup> This is in contrast to the principles of the Federal Reserve System (Fed). The Fed has a "dual mandate" and is required to use monetary policy to achieve price stability, but also to promote maximum employment (see the Federal Reserve Act).

In the post-Bretton-Woods era, the Bundesbank adopted a policy of targeting monetary aggregates. Each year since 1975, the Bundesbank announced targets for the increase in Central Bank Money (CBM), and later in M3 (from 1988). In practice, these targets had been quite flexible: they were often missed, especially when hitting monetary targets might conflict with the control of inflation (see Bernanke and Mihov 1997; von Hagen 1995). This practice made the Bundesbank's monetary targeting differ from a strictly monetarist doctrine. Instead, the Bundesbank viewed its monetary targets as a nominal anchor for the coordination of price expectations. With the monetary targets as an intermediate goal, the Bundesbank, like the Fed relied on short-term interest rates as a monetary instrument (see Clarida and Gertler 1997). We apply an interest rate monetary response function<sup>8</sup> to analyze the Bundesbank's monetary

---

<sup>7</sup> It could be evidenced by the citation of the former president of the Bundesbank, Otmar Emminger, "price stability is not everything, but without price stability everything is nothing" (Deutsche Bundesbank 2008).

<sup>8</sup> Such a monetary response function is a simple interest rate rule proposed by John Taylor (1993), which states that the central bank should set the short-term interest rate considering the variability of inflation and output. Taylor (1993) specifies a monetary response function that fits the US data pretty well for the period from 1987 to 1992:

$$i = 5 + 1.5(\pi - 2) + 0.5(y - y^*),$$



policy for the post-Bretton-Woods era. We do not, however, intend to argue that the Bundesbank applied an inflation-target rule in the strict sense, but we rather use it as an empirical instrument to detect possible asymmetries in monetary policy. Clearly, the Bundesbank argued that it followed a median or long term strategy of price stability.

**Table 5.1: The Bundesbank’s money growth and implicit inflation targets for 1975-1998**

Year	Money Growth		Inflation	
	Target	Actual	Implicit target	Actual
1975	8	10.1	4.5	5.6
1980	5 - 8	4.9	4.0	5.3
1985	3 - 5	4.5	2.5	1.6
1990	4 - 6	5.6	2.0	2.7
1995	4 - 6	2.1	2.0	1.8
1998	3 - 6	4.9	1.5 – 2.0	0.9

Note: From 1975-1985, the inflation targets are announced “unavoidable rate of price increase”, and since 1986, are announced the rate of being consistent with “price stability”.

Source: Bernanke and Mihov (1997), Deutsche Bundesbank *Monthly Report* (1997, 1998).

Using quarterly data<sup>9</sup>, we run OLS-regression of the overnight money market interest rates on the variation of inflation and output, while allowing for interest rate smoothing by introducing two lags interest rate terms in the specification<sup>10</sup>, and get the following monetary response function for the Bundesbank for the period 1975:1 to 1998:4:

$$i_t = (0.11)[5.36 + 1.09(\pi_t - \pi_t^*) + 0.09(y_t - y_t^*)] + 1.41i_{t-1} - 0.52i_{t-2} + \varepsilon_t \quad (5.1)$$

where the adjusted R-squared is 0.94, S.E. = 0.56, and DW = 2.21.

The constant 5.36 can be interpreted as the equilibrium nominal interest rate, close to the sample mean: 5.79. The coefficient before the Taylor rule reaction function (the part in

---

where the inflation target is assumed to be 2 percent,  $i$  is the federal funds rate,  $\pi$  is inflation rate and  $(y-y^*)$  is the percentage deviation of the real output from its target.

<sup>9</sup> The data sources are Bundesbank’s Statistics and OECD Economic Outlook: West German data for 1975-1990 and German data for 1991-1998. Inflation,  $\pi$ , is calculated based on CPI. The implicit inflation targets by the Bundesbank are used as  $\pi^*$ , as shown in Table 5.1. The real GDP trend is created with the Hodrick-Prescott filter (with  $\lambda$  equal 1600). Then  $(y-y^*)$  is calculated as percentage deviation of real GDP from its trend.

<sup>10</sup> Introducing two lags is sufficient to reduce the serial correlation in the residuals of an OLS regression and it reflects the fact that central banks care about financial market stability and thus hesitate to make overly abrupt changes in interest rates.

brackets), is  $0.11 = 1 - (1.41 - 0.52)$ , which captures the impact of the current variables on interest setting. The response function shows that on average the Bundesbank followed a gradual adjustment strategy, while taking the inflation deviation from its targets into account. Nevertheless, the Bundesbank barely responded to output gaps. However, output itself is an important factor in determining inflation. An upward deviation of output from its potential could raise inflationary pressure, which might have triggered the Bundesbank's inflation expectations, while a downward output deviation might have been simply ignored by the Bundesbank. That is, the Bundesbank might have reacted asymmetrically to output fluctuations: ignoring underutilization of potential capacity but fearing the price pressure from the overutilization of the potential.

To investigate asymmetry in the Bundesbank's monetary policy, we split the sample into two periods: Underutilization period, in which actual output is below potential output, and overutilization period, in which actual output is above potential output. We thus estimate the monetary reaction function to allow the response to differ according to the state of the economy. We get:

for  $(y - y^*)_t > 0$  (overutilization):

$$i_t = (0.13)[4.46 + 1.08(\pi_t - \pi_t^*) + 0.46(y_t - y_t^*)] + 1.31i_{t-1} - 0.44i_{t-2} + \varepsilon_t \quad (5.2a)$$

for  $(y - y^*)_t < 0$  (underutilization):

$$i_t = (0.13)[4.46 + 0.23(\pi_t - \pi_t^*) - 0.38(y_t - y_t^*)] + 1.31i_{t-1} - 0.44i_{t-2} + \varepsilon_t \quad (5.2b)$$

where the adjusted R-squared is 0.95, S.E. = 0.55, and DW = 2.12.

Indeed, when the actual was above potential output, the Bundesbank raised the interest rate as a precautionary measure, and thus deviated from the long orientation. When actual output was below potential output, the Bundesbank kept the long-run orientation and did not lower the interest rate.<sup>11</sup> The regression results support our hypothesis that the Bundesbank responded to

---

<sup>11</sup> The negative coefficient for  $(y - y^*)_t$  is not significant. Otherwise it would indicate a pro-cyclical monetary policy, i.e., rising interest rates when the production potential is underused. We find this coefficient to be significant when we use generalized method of moments (GMM) rather than OLS. Other considerations (such as exchange-rate stabilization, or an underestimation of the potential (see the discussion in Section 5.1)) may rationalize that result. Adverse supply shocks may be another explanation for the negative coefficient but, in all three recessions analyzed, both inflation and output declined, although inflation rates were – especially in the 1970s and 1980s – above their (implicit) targets.

output gaps asymmetrically.<sup>12</sup> Positive output gaps enhance the fear of higher inflation and the Bundesbank reacted by raising the interest rate, as evidenced by the larger coefficients for both inflation deviation and output gap. Thus, the Bundesbank slowed economic expansions. In contrast, when the output gap is negative, the Bundesbank does not reduce the interest rate significantly, i.e., it does not counter recessions.

To investigate the impact of asymmetric monetary policy on the real economy, we display the cumulative growth rates of GDP and its components – investment, private and public consumption – for recoveries for Germany and the US in Table 5.2. The data show roughly similar cumulative GDP growth rates for the 1975 recession in both countries but in the following cycles, cumulative GDP growth rates for Germany were substantially lower than the US rates, which is probably most severe in the recovery of the early 1990s (this recession was later in Germany than in the US), i.e., in a situation where growth was most needed, just after German unification. For investment as well as consumption growth was always much stronger in the US than in Germany. The biggest difference occurs in investment, where the differential after 12 quarters was as high as 24.5 percentage points in the 1982 recovery. Also private consumption grew at substantially higher rates in the US. However, with public consumption the picture was mixed. Investment is the classical textbook case for the illustration of monetary policy effects but a non-accommodating monetary policy may also dampen investment through the expected lower demand growth.

---

<sup>12</sup> Wald-test under the null hypothesis of equality of the coefficients for (i) inflation deviations and (ii) output gaps in Equation 5.2a and 5.2b:

	<b>Test Statistic</b>	<b>Value</b>	<b>df</b>	<b>Probability</b>
(i)	F-statistic	1.26	(1, 89)	0.265
	Chi-square	1.26	1	0.262
(ii)	F-statistic	6.04	(1, 89)	0.016
	Chi-square	6.04	1	0.014

**Table 5.2: Three recoveries in Germany and the USA (cumulative growth rates of GDP, investment and consumption, and differences between GDP and TFP growth rates for ..... quarters after the trough\*)**

Trough	GDP			Investment			Consumption						GDP growth minus TFP growth					
	after...quarters			after...quarters			private			public			Export (%)			after...quarters		
	4	8	12	4	8	12	4	8	12	4	8	12	4	8	12	4	8	12
<b>Germany</b>																		
<b>1975 II</b>	5.4	8.7	11.2	7.1	10.3	14.2	4.0	8.8	11.4	2.3	3.2	7.6	8.3	14.0	14.7	-	-	-
<b>1982 III</b>	2.0	5.8	8.3	4.2	5.9	6.3	1.8	4.9	7.1	-0.3	1.0	2.4	0.7	11.8	18.8	0.9	1.9	2.8
<b>1992 III</b>	-0.2	2.4	4.5	-2.6	1.6	2.1	1.9	3.8	6.4	-1.0	1.7	4.5	4.3	12.7	17.7	0.2	0.3	0.3
<b>USA</b>																		
<b>1975 I</b>	5.9	9.1	13.1	7.2	14.4	21.3	6.0	10.5	14.0	0.8	1.9	4.2	0.1	3.4	5.9	-	-	-
<b>1982 III</b>	5.5	12.1	16.3	11.4	25.3	30.8	6.5	11.1	16.9	3.9	4.6	10.8	-1.3	7.4	7.6	3.3	7.9	11.7
<b>1991 I</b>	2.6	5.8	9.1	2.1	7.9	14.9	2.9	5.9	9.9	-0.7	0.0	-0.4	3.5	13.5	16.3	3.1	3.7	6.9

Note:\* A trough is defined as at least two consecutive quarters with negative growth in GDP.  
Source: Calculations are based on OECD Economic Outlook Database.

The comparison of GDP growth rates in the first three columns of Table 5.2 underestimates the restrictiveness of the Bundesbank policy because Germany operated at substantially higher productivity growth rates than the US until the mid 1990s, i.e., higher productivity growth in Germany should have allowed for higher GDP growth in Germany without creating inflationary pressure. To return to the initial growth path and initial employment levels, GDP growth needs to be higher than productivity growth. The cumulative differences of GDP growth rates and productivity growth rates are shown in the fourth column of Table 5.2 for the 3 recoveries in Germany and the US. In every recovery, the values for the US were clearly higher than those for Germany and reached substantial levels, which enabled the employment expansion in the US. In contrast, the cumulative differences of GDP growth rates minus the productivity growth rates in Germany hardly moved above zero: it was -1.0 percent even for 12 quarters after the trough for the 1992 recovery in Germany. This is in stark contrast to the US values, which were 9.7 percent for the 1975 recovery, 8.1 percent for the 1982 recovery and 3.5 percent for the 1991 recovery.

### 5.3 Conclusions

This chapter establishes evidence that the German economy was, with the exception of a few years, operating continuously below its potential since the early 1970s, and furthermore, that growth in expansionary periods was too low. This is in stark contrast to the US economy, where the growth rates were clearly higher after recessions, both in absolute terms and relative to the growth of the potential. We emphasized the measurement problems related to the estimation of potential output but the patterns seem to be very stable and different methods applied show consistent results: Germany could have been more prosperous if the potential had been fully used.

Is the relative underperformance of the German economy related to monetary policy or did other variables cause the underperformance? We show that the Bundesbank applied an asymmetric interest reaction function, i.e., the bank emphasized price stability and thus reacted strongly to rising inflation – which is the basis of the widely celebrated Bundesbank legend – and raised interest when potential output was reached or passed. But the Bundesbank did not react when actual output was falling short of potential output. It is sufficient that monetary policy affects the real economy in the short run to establish the link between asymmetric monetary policy reaction and the growth path of the economy. If economic growth after a recession is dampened, the economy cannot return to the initial growth path and this way, the long-run growth trend will be reduced as well.

Could the Bundesbank have done better? Was it the over-commitment to price stability in the bank's objective function or was the information at the time when decisions had to be made, just not sufficient to draw different conclusions? This issue is discussed in the “real time” literature, where it is argued, for example, that the US inflation of the 1970s was the result of an overestimated potential because the productivity slowdown was not recognized at that time (Orphanides 2001). Clearly, if the estimates of the potential are biased, policies based on these estimates may be biased as well. But the bias can go in both directions and although inflation may be harming the economy, so do underused capacity and unemployment. If one assumes neutrality of monetary policy, the decision is easily made: pushing for high price stability is a free good. If, however, monetary policy has short-run or long-run effects – as endogenous

investments or hysteresis processes suggest - overly emphasizing price stability is extremely costly for society, as Okun's law suggests.

Monetary policy is not the only macro policy and the Bundesbank may not be responsible for the entire underperformance of the German economy. Aside from monetary policy, fiscal policy is surely important as well – with the ECB, fiscal policy should have gained importance if it were not restricted by the “Maastricht criteria” (see Allsopp and Vines 2005). Dolado et al. (2003) argue that rigid European labor markets did not allow the central banks in Europe to follow a more “flexible inflation targeting” as the Fed did because wage rigidities in Europe would have caused inflationary pressure in expansionary periods. However, as the OECD (2004) states, microeconomic studies comparing the US with European economies fail to establish evidence for the wage-rigidity hypothesis. And wage flexibility also has two sides and coordinated market economies seem to create stronger wage restraint in expansionary periods than “liberal market economies”. Empirical evidence for Germany in comparison to the US does not seem to support the labor market rigidity hypothesis (see Carlin and Soskice 2008; Schettkat 1992).

True, unemployment turned into long-term unemployment and became more and more concentrated among the low skilled. But what caused this structuring of unemployment? Once path-dependence is allowed for (through sorting, skill depreciation and other mechanisms) unemployment may be difficult to reduce after high unemployment has persisted for a certain period. This process, however, is not an argument against a more expansionary policy but it is in favor of it because inactivity will cause high, long-lasting costs. A monetary policy less constraining economic growth in recoveries could have brought German unemployment rates back to pre-recession levels and prevented the structuring of unemployment.

## Bibliography

- Aghion, Philippe, and Peter Howitt. 1998. *Endogenous Growth Theory*: The MIT Press.
- Akerlof, George A. 2007. The Missing Motivation in Macroeconomics. *American Economic Review* 97 (1):5-36.
- Akerlof, George A., Andrew Rose, and Janet L. Yellen. 1988. The New Keynesian Economics and the Output-Inflation Trade-Off: Comment. *Brookings Papers on Economic Activity* 1988 (1):66-75.
- Akerlof, George A., and Janet L. Yellen. 1985. A Near-Rational Model of the Business Cycle with Wage and Price Inertia. *Quarterly Journal of Economics* 100 (Supplement):823-838.
- . 1986. *Efficiency Wage Models of the Labor Market*: Cambridge Univ Pr.
- . 1988. Fairness and Unemployment. *The American Economic Review* 78 (2):44-49.
- Alberro, Jose. 1981. The Lucas Hypothesis on the Phillips Curve: Further International Evidence. *Journal of Monetary Economics* 7 (2):239-250.
- Alesina, Alberto, Carlo Favero, and Francesco Giavazzi. 2012. The Output Effect of Fiscal Consolidations. *NBER Working Paper Series* No. 18336.
- Alexius, Annika, and Bertil Holmlund. 2007. Monetary Policy and Swedish Unemployment Fluctuations. *IZA Discussion Paper* No. 2933.
- Allsopp, Christopher, and David Vines. 2005. The Macroeconomic Role of Fiscal Policy. *Oxford Review of Economic Policy* 21 (4):485-508.
- Álvarez, Luis J. 2008. What Do Micro Price Data Tell Us on the Validity of the New Keynesian Phillips Curve? *Economics: The Open-Access, Open-Assessment E-Journal* 2 (2008-19).
- Álvarez, Luis J., E. Dhyne, M. Hoerberichts, C. Kwapil, H. Le Bihan, P. Lünemann, F. Martins, R. Sabbatini, H. Stahl, and P. Vermeulen. 2006. Sticky Prices in the Euro Area: A Summary of New Micro-Evidence. *Journal of the European Economic Association* 4 (2-3):575-584.
- Andersen, Leonall C., and Jerry L. Jordan. 1968. Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization. *Federal Reserve Bank of St. Louis Review* 50 (11):11-24.
- Angeloni, Ignazio, Luc Aucremanne, Michael Ehrmann, Jordi Galí, Andrew Levin, and Frank Smets. 2006. New Evidence on Inflation Persistence and Price Stickiness in the Euro Area: Implications for Macro Modeling. *Journal of the European Economic Association* 4 (2-3):562-574.
- Baharad, Eyal, and Benjamin Eden. 2004. Price Rigidity and Price Dispersion: Evidence from Micro Data. *Review of Economic Dynamics* 7 (3):613-641.
- Baker, Dean, Andrew Glyn, David Howell, and John Schmitt. 2004. Labor Market Institutions and Unemployment: A Critical Assessment of the Cross-Country Evidence. In *Fighting Unemployment: The Limits of Free Market Orthodoxy*, edited by D. Howell. New York: Oxford University Press.
- Ball, Laurence. 1997. Disinflation and the NAIRU. In *Reducing Inflation*, edited by C. Romer. Chicago.
- . 2009. Hysteresis in Unemployment: Old and New Evidence. In *NBER Working Paper No. 14818*.

- Ball, Laurence, Gregory Mankiw, and David Romer. 1988. The New Keynesian Economics and the Output-Inflation Trade-Off. *Brookings Papers on Economic Activity* (1988 (1)):1-82.
- Ball, Laurence, and David Romer. 1990. Real Rigidities and the Non-Neutrality of Money. *Review of Economic Studies* 57 (2):183-203.
- Ball, Laurence, and David Romer. 1990. Real Rigidities and Non-Neutrality of Money. *Review of Economic Studies* 57 (190):183-203.
- Baltensperger, Ernst. 1998. Geldpolitik bei wachsender Integration (1979-1996). In *Fünfzig Jahre Deutsche Mark: Notenbank und Währung in Deutschland seit 1948*, edited by D. Bundesbank. München: Beck.
- Baumgartner, Josef, Ernst Glatzer, Fabio Rumler, and Alfred M. Stiglbauer. 2005. How Frequently Do Consumer Prices Change in Austria? Evidence from Micro CPI Data. In *European Central Bank Working Paper No. 523*.
- Bernanke, Ben, and Ilian Mihov. 1998. The Liquidity Effect and Long-Run Neutrality. NBER Working Paper 6608.
- Bernanke, Ben S. 1996. Comment on "What Does Monetary Policy Do". *Brookings Papers on Economic Activity* 1996 (2):69-73.
- Bernanke, Ben S., and Alan Blinder. 1992. The Federal Funds Rate and the Channels of Monetary Transmission. *American Economic Review* 82(4) (Sep.):901-921.
- Bernanke, Ben S., Jean Boivin, and Piotr Eliasch. 2005. Measuring the Effects of Monetary Policy: A Factor-Augmented Vector Autoregressive (FAVAR) Approach. *Quarterly Journal of Economics* 120 (1):387-422.
- Bernanke, Ben S., and Mark Gertler. 1995. Inside the Black Box: The Credit Channel of Monetary Policy Transmission. *The Journal of Economic Perspectives*:27-48.
- Bernanke, Ben S., Mark Gertler, and Mark W. Waston. 1997. Systematic Monetary Policy and the Effects of Oil Price Shocks. *Brookings Papers on Economic Activity* 1997 (1):91-157.
- Bernanke, Ben S., and Ilian Mihov. 1997. What Does the Bundesbank Target? *European Economic Review* 41 (6):1025-1053.
- . 1998a. The Liquidity Effect and Long-Run Neutrality. *Carnegie-Rochester Conference Series on Public Policy* 49:149-194.
- . 1998b. Measuring Monetary Policy. *Quarterly Journal of Economics* 113 (3):869-902.
- Bils, Mark, and Peter J. Klenow. 2004. Some Evidence on the Importance of Sticky Prices. *Journal of Political Economy* 112 (5):947-985.
- Blanchard, Olivier J. 1997. The Medium Run. *Brookings Papers on Economic Activity* 1997 (2):89-158.
- Blanchard, Olivier J., and Lawrence H. Summers. 1986. Hysteresis and the European Unemployment Problem. *NBER Macroeconomics Annual* 1:15-78.
- Blanchard, Olivier J. 1982. Price Asynchronization and Price Level Inertia. *NBER Working Paper* No. 900.
- . 1990. Why Does Money Affect Output? A Survey. In *Handbook of Monetary Economics*, edited by B. M. Friedman and F. H. Hahn: Elsevier.
- Blanchard, Olivier J., and Nobuhiro Kiyotaki. 1987. Monopolistic Competition and the Effects of Aggregate Demand. *American Economic Review* 77 (Sep.):647-666.
- Blanchard, Olivier J., and Justin Wolfers. 2000. The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence. *The Economic Journal* 110 (462):C1-C33.



- Blinder, Alan S. 1994. On Sticky Prices: Academic Theories Meet the Real World. In *Monetary Policy*, edited by N. G. Mankiw: The University of Chicago Press.
- Blinder, Alan S., and Ricardo Reis. 2005. Understanding the Greenspan Standard. In *The Greenspan Era: Lessons for the Future* Jackson Hole, Wyoming: Federal Reserve Bank of Kansas City Symposium.
- Boivin, Jean, Marc P. Giannoni, and Ilian Mihov. 2009. Sticky Prices and Monetary Policy: Evidence from Disaggregated US Data. *The American Economic Review* 99 (1):350-384.
- Caixin. 2012. Central Banker Says Monetary Policy Rests on Forex Flows. <http://english.caixin.com/2012-03-12/100367241.html>.
- Calvo, Guillermo A. 1983. Staggered Prices in a Utility-Maximizing Framework. *Journal of Monetary Economics* 12 (3):383-398.
- Cao, Tinggui. 2001. The People's Bank of China and its Monetary Policy. *Business Institute Berlin at the Fachhochschule für Wirtschaft Berlin, Working Paper* No. 14.
- Cappiello, Lorenzo, and Gianluigi Ferrucci. 2008. The Sustainability of China's Exchange Rate Policy and Capital Account Liberalisation. *ECB Occasional Paper Series* No. 82.
- Carlin, Wendy, and David Soskice. 2008. Reforms, Macroeconomic Policy and Economic Performance in Germany. In *Economic Policy Proposals for Germany and Europe*, edited by R. Schettkat and J. Langkau. London and New York: Routledge Taylor & Francis Group.
- Carpenter, Robert E. , Steven M. Fazzari, and Bruce C. Petersen. 1994. Inventory Investment, Internal-Finance Fluctuations, and the Business Cycle. *Brookings Papers on Economic Activity* 1994 (2):75-138.
- Cecchetti, Stephen G. 1986. The Frequency of Price Adjustment: A Study of the Newsstand Prices of Magazines. *Journal of Econometrics* 31 (3):255-274.
- Chen, Hongyi, Qianying Chen, and Stefan Gerlach. 2011. The Implementation of Monetary Policy in China: The Interbank Market and Bank Lending. *HKIMR Working Paper* No. 26/2011.
- Christiano, Lawrence J. , Martin Eichenbaum, and Charles L. Evans. 1997. Sticky Price and Limited Participation Models of Money: A Comparison. *European Economic Review* 41:1201-1249.
- . 1999. Monetary Policy Shocks: What Have We Learned and to What End? In *Handbook of Macroeconomics*, edited by J. B. Taylor and M. Woodford: Elsevier.
- Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans. 2005. Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy. *Journal of Political Economy* 113 (1):1-45.
- Clarida, Richard, Jordi Galí, and Mark Gertler. 1999. The Science of Monetary Policy: A New Keynesian Perspective. *Journal of Economic Literature* XXXVII (Dec. 1999):1661-1707.
- Clarida, Richard, and Mark Gertler. 1997. How the Bundesbank Conducts Monetary Policy. In *Reducing Inflation: Motivation and Strategy*, edited by C. Romer and D. Romer. Chicago: NBER.
- Daly, Mary C., Bart Hobijn, Aysegül Sahin, and Robert G. Valletta. 2012. A Search and Matching Approach to Labor Markets: Did the Natural Rate of Unemployment Rise? *Journal of Economic Perspectives* 26 (3):3-26.
- de Grauwe, Paul, and Magdalena Polan. 2005. Is Inflation Always and Everywhere a Monetary Phenomenon? *Scandinavian Journal of Economics* 107 (2):239-259.

- de Grauwe, Paul, and Cláudia Costa Storti. 2004. The Effect of Monetary Policy: A Meta-Analysis. *CESifo Working Paper* No. 1224.
- . 2008. Monetary Policy and the Real Economy. In *Economic Policy Proposals for Germany and Europe*, edited by R. Schettkat and J. Langkau. London and New York: Routledge Taylor & Francis Group.
- de Long, J. Bradford, and Lawrence H. Summers. 1988. How Does Macroeconomic Policy Affect Output? *Brookings Papers on Economic Activity*:433-494.
- Defina, Robert H. 1991. International Evidence on a New Keynesian Theory of the Output-Inflation Trade-Off. *Journal of Money, Credit and Banking* 23 (3):410-422.
- Deutsche Bundesbank. 1997. Strategy of Monetary Targeting in 1997-8. *Deutsche Bundesbank Monthly Report* January 1997:17-25.
- . 1998. Review of Monetary Targeting in 1997-8 and of the 1998 Monetary Target. *Deutsche Bundesbank Monthly Report* August 1998:17-26.
- . 2003. Zur Entwicklung des Produktionspotenzials in Deutschland. *Monatsbericht* März 2003:43-54.
- . 2008. <http://www.bundesbank.de/50jahre/50jahre.en.php>.
- Dhyne, Emmanuel, Luis J. Álvarez, Hervé Le Bihan, Giovanni Veronese, Daniel Dias, Johannes Hoffmann, Nicole Jonker, Patrick Lünemann, Fabio Rumler, and Jouko Vilmunen. 2006. Price Changes in the Euro Area and the United States: Some Facts from Individual Consumer Price Data. *Journal of Economic Perspectives* 20 (2):171-192.
- Dias, Daniel A., Carlos Robalo Marques, and João M. C. Santos Silva. 2007. Time- or State-Dependent Price Setting Rules? Evidence from Micro Data. *European Economic Review* 51 (7):1589-1613.
- Dickinson, David, and Jia Liu. 2007. The Real Effects of Monetary Policy in China: An Empirical Analysis. *China Economic Review* 18 (1):87-111.
- Dobson, Wendy, and Anil K. Kashyap. 2006. The Contradiction in China's Gradualist Banking Reforms. *Brookings Papers on Economic Activity* 2006 (2):103-148.
- Dolado, Juan J., Ramón María-Dolores, and Manuel Naveira. 2003. Are Monetary-Policy Reaction Functions Asymmetric? The Role of Nonlinearity in the Phillips Curve. *European Economic Review* 49 (2):485-503.
- Eichenbaum, Martin, Nir Jaimovich, and Sergio Rebelo. 2011. Reference Prices, Costs, and Nominal Rigidities. *The American Economic Review* 101 (1):234-262.
- Eichenbaum, Martin, and Kenneth J. Singleton. 1986. Do Equilibrium Real Business Cycle Theories Explain Post-War U.S. Business Cycles? *NBER Macroeconomics Annual* 1986 (1):91-145.
- Federal Reserve Act. <http://www.federalreserve.gov/GeneralInfo/fract/sect02a.htm>.
- Fischer, Stanley. 1977. Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule. *Journal of Political Economy* 85:191-205.
- Forsback, Jens, and Lars Oxelheim. 2007. The Transition to Market-Based Monetary Policy: What Can China Learn from the European Experience? *Journal of Asian Economics* 18 (2):257-283.
- Friedman, Benjamin M. 1990. Changing Effects of Monetary Policy on Real Economic Activity. *NBER Working Paper* No. 3278.
- . 1995. Does Monetary Policy Affect Real Economic Activity?: Why Do We Still Ask This Question? *NBER Working Paper* No. 5212.
- Friedman, Benjamin M., and Kenneth N. Kuttner. 1992. Money, Income, Prices, and Interest Rates. *The American Economic Review*: 472-492.

- . 1996. A Price Target for US Monetary Policy? Lessons from the Experience with Money Growth Targets. *Brookings Papers on Economic Activity*:77-146.
- Friedman, Milton. 1960. *A Program for Monetary Stability*. New York: Fordham Univ. Press.
- . 1968. The Role of Monetary Policy. *American Economic Review* 58 (1):1-17.
- . 2006. Tradeoffs in Monetary Policy. In *Daniel Laidler's Festschrift*.
- Friedman, Milton, and Anna J. Schwartz. 1963. *A Monetary History of the United States 1867-1960*. Princeton: Princeton University Press.
- Froyen, Richard T., and Roger N. Waud. 1980. Further International Evidence on Output-Inflation Tradeoffs. *The American Economic Review* 70 (3):409-421.
- Fuhrer, Jeffrey C., and George Moore. 1995. Inflation Persistence. *The Quarterly Journal of Economics* 110 (1):127.
- Geiger, Michael. 2006. Monetary Policy in China (1994-2004): Targets, Instruments and Their Effectiveness *Wuerzburg Economic Working Paper* No. 68.
- Glyn, Andrew, David Howell, and John Schmitt. 2006. Labor Market Reforms: The Evidence Does Not Tell the Orthodox Tale. *Challenge* 49 (2):5-22.
- Goldfeld, Stephen M., and Daniel E. Sichel. 1990. The Demand for Money. *Handbook of Monetary Economics* 1:299-356.
- Hamilton, James D. 2011. Historical Oil Shocks. *NBER Working Paper* No. 16790.
- Hargreaves Heap, S. P. 1980. Choosing the Wrong 'Natural' Rate: Accelerating Inflation or Decelerating Employment and Growth? *The Economic Journal* 90:611-620.
- He, Dong, and Laurent L. Pauwels. 2008. What Prompts the People's Bank of China to Change Its Monetary Policy Stance? Evidence from a Discrete Choice Model. *China & World Economy* 16 (6):1-21.
- Hoover, Kevin D., and Stephen J. Perez. 1994. Post Hoc Ergo Propter Once More: An Evaluation of 'Does Monetary Policy Matter?' in the Spirit of James Tobin. *Journal of Monetary Economics* 34 (1):47-74.
- Issing, Otmar. 2000. The Monetary Policy of the European Central Bank: Strategy and Implementation. Paper read at CESifo Forum.
- Jung, W. S. 1985. Output-Inflation Tradeoffs in Industrial and Developing Countries. *Journal of Macroeconomics* 7 (1):101-113.
- Kandil, Magda, and Jeffrey G. Woods. 1995. A Cross-Industry Examination of the Lucas Misperceptions Model. *Journal of Macroeconomics* 17 (1):55-76.
- Kareken, John, and Robert M. Solow. 1963. Lags in Monetary Policy. In *Stabilization Policies*. Englewood Cliffs, N.J.: Prentice-Hall.
- Kashyap, Anil K. 1995. Sticky Prices: New Evidence from Retail Catalogs. *The Quarterly Journal of Economics* 110 (1):245-274.
- Katsimbris, George M. 1990a. "Input-Inflation Trade-Off in Industrial and Developing Countries": A Comment and Additional Evidence. *Journal of Macroeconomics* 12 (3):483-499.
- . 1990b. Intracountry Evidence on the Lucas Variance Hypothesis. *Economic Inquiry* 28 (4):756-773.
- Katsimbris, George M., and Stephen Miller. 1996. The New Keynesian Economics and the Output-Inflation Trade-Off. *Applied Economics Letters* 3 (9):599-602.
- Kennedy, Peter E. 2003. *A Guide to Econometrics*: The MIT Press.
- Keynes, John Maynard. 1936. *The General Theory of Employment, Interest and Money*. London: Macmillan.
- Khan, Hashmat. 2004. Price Stickiness, Trend Inflation, and Output Dynamics: A Cross-Country Analysis. *Canadian Journal of Economics* 37 (4):999-1020.

- Klenow, Peter J., and Oleksiy Kryvtsov. 2008. State-Dependent or Time-Dependent Pricing: Does It Matter for Recent US Inflation? *Quarterly Journal of Economics* 123 (3):863-904.
- Klenow, Peter J., and Benjamin A. Malin. 2010. Microeconomic Evidence on Price-Setting. *NBER Working Paper* No. 15826.
- Lardy, Nicholas R. 2004. State-Owned Banks in China. In *The Future of State-Owned Financial Institutions*, edited by G. Capito and e. al.: Brookings.
- . 2008. Financial Repression in China. *Peterson Institute for International Economics Policy Brief* 08-8.
- Lazear, Edward P., and James R. Spletzer. 2012. Labor Markets and Monetary Policy. In *2012 Jackson Hole Symposium*. Jackson Hole.
- Leeper, Eric M. 1997. Narrative and VAR Approaches to Monetary Policy: Common Identification Problems. *Journal of Monetary Economics* 40 (3):641-657.
- Leeper, Eric M. , Christopher A. Sims, and Tao Zha. 1996. What Does Monetary Policy Do? *Brookings Papers on Economic Activity* 27 (1996-2):1-78.
- Lucas, Robert E. Jr. 1972. Expectations and the Neutrality of Money. *Journal of Economic Theory* 4 (2):103-124.
- . 1973. Some International Evidence on Output-Inflation Tradeoffs. *American Economic Review* 63 (3):326-34.
- . 1996. Nobel Lecture: Monetary Neutrality. *Journal of Political Economy* 104 (4):661-82.
- . 2003. Macroeconomic priorities. *American Economic Review* 93 (1):1-14.
- Lütkepohl, Helmut. 2005. *New Introduction to Multiple Time Series Analysis*. Berlin, Heidelberg, New York: Springer.
- Mackowiak, Bartosz, and Frank Smets. 2009. Evidence on Price Determinants: Implications of Microeconomic Price Data for Macroeconomic Models. In *Understanding Inflation and the Implications for Monetary Policy: A Phillips Curve Retrospective*, edited by J. Fuhrer, Y. K. Kodrzycki, J. S. Little and G. P. Olivei: The MIT Press.
- Mankiw, N. Gregory. 1985. Small Menu Costs and Large Business Cycles: A Macroeconomic Model of Monopoly. *Quarterly Journal of Economics* 100 (May):529-537.
- . 2001. The Inexorable and Mysterious Tradeoff between Inflation and Unemployment. *The Economic Journal* 111 (May):C45-C61.
- . 2006. *Macroeconomics*. 6th edition ed: Worth Publishers.
- Mankiw, N. Gregory, and Ricardo Reis. 2002. Sticky Information versus Sticky prices: A Proposal to Replace the New Keynesian Phillips Curve. *The Quarterly Journal of Economics* 117 (4):1295-1328.
- Mankiw, N. Gregory, and David H. Romer. 1995. *New Keynesian Economics*: MIT Press.
- McCallum, Bennett T. 1983. A Reconsideration of Sims' Evidence Concerning Monetarism. *Economics Letters* 13 (2-3):167-71.
- McCallum, Bennett T. 2001. Monetary Policy Analysis in Models without Money. *NBER Working Paper* No. 8174.
- MGI. 2006. Putting China's Capital to Work: The Value of Financial System Reform. Washington DC.: McKinsey Global Institute.
- . 2011. Mapping Global Financial Markets 2011 Washington DC.: McKinsey Global Institute.
- Montes-Negret, Fernando. 1995. China's Credit Plan: An Overview. *Oxford Review of Economic Policy* 11 (4):25-42.

- Mundell, Robert A. 1963. Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates. *The Canadian Journal of Economics and Political Science* 29 (4):475-485.
- Nakamura, Emi, and Jon Steinsson. 2008. Five Facts about Prices: A Reevaluation of Menu Cost Models. *The Quarterly Journal of Economics* 123 (4):1415-1464.
- OECD. 2004. Wage-Setting Institutions and Outcomes. In *Employment Outlook 2004*. Paris: OECD.
- . 2010. *OECD Economic Surveys: China 2010* Paris: OECD Publishing.
- Okun, Arthur. 1970. *The Political Economy of Prosperity*. New York: Norton & Company.
- Orphanides, Athanasios. 2001. Monetary Policy Rules Based on Real-Time Data. *The American Economic Review* 91 (September):964-985.
- Orphanides, Athanasios, and Robert M. Solow. 1990. Money, Inflation and Growth. In *Handbook of Monetary Economics*, edited by B. M. Friedman and F. H. Hahn. : Elsevier Science Publishers B. V.
- People's Bank of China. *Annual Reports*, various issues.
- People's Bank of China. *China Monetary Policy Report*, various issues.
- People's Bank of China. “Press Release” (on Quarterly Meetings of Monetary Policy Committee), various issues.
- People's Bank of China. 2012.  
[http://www.pbc.gov.cn/publish/jinrongshichangsi/1023/2010/20100915164335804922955/20100915164335804922955\\_.html](http://www.pbc.gov.cn/publish/jinrongshichangsi/1023/2010/20100915164335804922955/20100915164335804922955_.html).
- Poterba, James M., Julio J. Rotemberg, and Lawrence H. Summers. 1986. A Tax-Based Test for Nominal Rigidities. *The American Economic Review*: 659-675.
- Ram, Rati. 1984. Further International Evidence on Inflation-Output Trade-Offs. *Canadian Journal of Economics* 17 (3):523-540.
- Ramey, Valerie A. 2011. Identifying Government Spending Shocks: It's all in the Timing. *The Quarterly Journal of Economics* 126 (1):1-50.
- Ramey, Valerie A., and Matthew D. Shapiro. 1998. Costly Capital Reallocation and the Effects of Government Spending. *Carnegie-Rochester Conference Series on Public Policy* 48:145-194.
- Richardson, Pete, Laurence Boone, Claude Giorno, Mara Meacci, David Rae, and David Turner. 2000. The Concept, Policy Use and Measurement of Structural Unemployment: Estimating a Time Varying NAIRU across 21 OECD Countries. *OECD Working Paper* No. 250.
- Roberts, John M. 1995. New Keynesian Economics and the Phillips Curve. *Journal of Money, Credit and Banking* 27 (4):975-984.
- Romer, Christina D., and David H. Romer. 1989. Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz. *NBER Macroeconomics Annual*:121-170.
- . 1994a. Monetary Policy Matters. *Journal of Monetary Economics* 34 (1):75-88.
- . 1994b. What Ends Recessions? *NBER Macroeconomics Annual* 9:13-57.
- . 1997. Identification and the Narrative Approach: A Reply to Leeper. *Journal of Monetary Economics* 40 (3):659-665.
- . 2004. A New Measure of Monetary Shocks: Derivation and Implications. *The American Economic Review* 94 (4):1055-1084.
- . 2010. The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks. *The American Economic Review* 100 (3):763-801.
- Romer, David H. 2011. *Advanced Macroeconomics*. 4th edition ed: McGraw-Hill/Irwin.

- Rotemberg, Julio J. 1984. A Monetary Equilibrium Model with Transactions Costs. *The Journal of Political Economy* 92 (1):40.
- Rudebusch, Glenn D. 1998. Do Measures of Monetary Policy in a Var Make Sense? *International Economic Review* 39 (4):907-931.
- Sargent, Thomas J. 1976. A Classical Macroeconometric Model for the United States. *The Journal of Political Economy*:207-237.
- Schettkat, R., and R. Sun. 2009. Monetary policy and European unemployment. *Oxford Review of Economic Policy* 25 (1):94-108.
- Schettkat, Ronald. 1992. *The Labor Market Dynamics of Economic Restructuring: The United States and Germany in Transition*. New York: Praeger.
- Schettkat, Ronald, and Rongrong Sun. 2008. Monetary Policy and European Unemployment. *Schumpeter Discussion Papers* No. SDP 2008-002.
- Shapiro, Matthew D. 1994. Federal Reserve Policy: Cause and Effect. In *Monetary Policy*, edited by N. G. Mankiw. Chicago and London: University Of Chicago Press.
- Shu, Chang, and Brian Ng. 2010. Monetary Stance and Policy Objectives in China: A Narrative Approach. *Hong Kong Monetary Authority China Economic Issues* 1/10.
- Sims, Christopher A. 1980a. Comparison of Interwar and Postwar Business Cycles: Monetarism Reconsidered. *The American Economic Review* 70 (2):250-257.
- . 1980b. Macroeconomics and Reality. *Econometrica* 48 (Jan.):1-48.
- . 1992. Interpreting the Macroeconomic Time Series Facts: the Effects of Monetary Policy. *European Economic Review* 36(5) (Jun.):975-1000.
- Smets, Frank, and Rafael Wouters. 2007. Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach. *The American Economic Review* 97 (3):586-606.
- Solow, Robert. 1985. Another Possible Source of Wage Stickiness. *Journal of Macroeconomics* 1 (1):79-82.
- Solow, Robert M. 1998. How Cautious Must the Fed Be? In *Inflation, Unemployment, and Monetary Policy*, edited by B. M. Friedman. Cambridge, Massachusetts, London, England: The MIT Press.
- . 2008. Broadening the Discussion of Macroeconomic Policy. In *Economic Policy Proposals for Germany and Europe*, edited by R. Schettkat and J. Langkau. London and New York: Routledge Taylor & Francis Group.
- Spencer, David E. 1989. Does Money Matter? The Robustness of Evidence from Vector Autoregressions. *Journal of Money, Credit and Banking* 21 (4):442-54.
- Staiger, Douglas, James H. Stock, and Mark W. Watson. 1997. The NAIRU, Unemployment and Monetary Policy. *The Journal of Economic Perspectives* 11 (1):33-49.
- Stock, James H., and Mark W. Watson. 1989. Interpreting the Evidence on Money-Income Causality. *Journal of Econometrics* 40:161-181.
- Sun, Lixin, Jim L. Ford, and David G. Dickinson. 2010. Bank Loans and the Effects of Monetary Policy in China: VAR/VECM Approach. *China Economic Review* 21 (1):65-97.
- Taylor, John B. 1979. Staggered Wage Setting in a Macro Model. *The American Economic Review* 69 (2):108-113.
- . 1980. Aggregate Dynamics and Staggered Contracts. *Journal of Political Economy* 88:1-22.
- . 1993. Discretion versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy* 39:195-214.
- . 1999. Staggered Price and Wage Setting in Macroeconomics. In *Handbook of Macroeconomics*, edited by J. B. Taylor and M. Woodford: Elsevier.

- Tobin, James. 1995. The Natural Rate as New Classical Macroeconomics. In *The Natural Rate of Unemployment: Reflections on 25 Years of the Hypothesis*, edited by R. Cross. Cambridge: Cambridge University Press.
- Vilmunen, Jouko, and Helina Laakkonen. 2004. How Often Do Prices Change in Finland? Micro-Level Evidence from the CPI. *Bank of Finland, Mimeo*.
- von Hagen, Jürgen. 1995. Inflation and Monetary Targeting in Germany. In *Inflation Targets*, edited by L. Leiderman and L. Svensson. London: Centre for Economic Policy Research.
- . 1998. Geldpolitik auf neuen Wegen (1971-1978). In *Fünfzig Jahre Deutsche Mark: Notenbank und Währung in Deutschland seit 1948*, edited by Deutsche Bundesbank. München: Beck.
- Xie, Hailin. 2009. A Study on the Sterilization Costs of the PBC's Central Bank Bills: A Study Based on the Monthly Data for the Period from March 2006 to December 2008 (in Chinese). *Development Study* (005):35-38.
- Xie, Ping. 2004. The Analysis of China's Monetary Policy in 1998-2002. *Journal of Finance* 2004-08.
- Xiong, Weibo. 2011. Measuring the Monetary Policy Stance of the People's Bank of China: An Ordered Probit Analysis. *China Economic Review*.
- Yellen, Janet L. 1984. Efficiency Wage Models of Unemployment. *The American Economic Review* 74 (2):200-205.