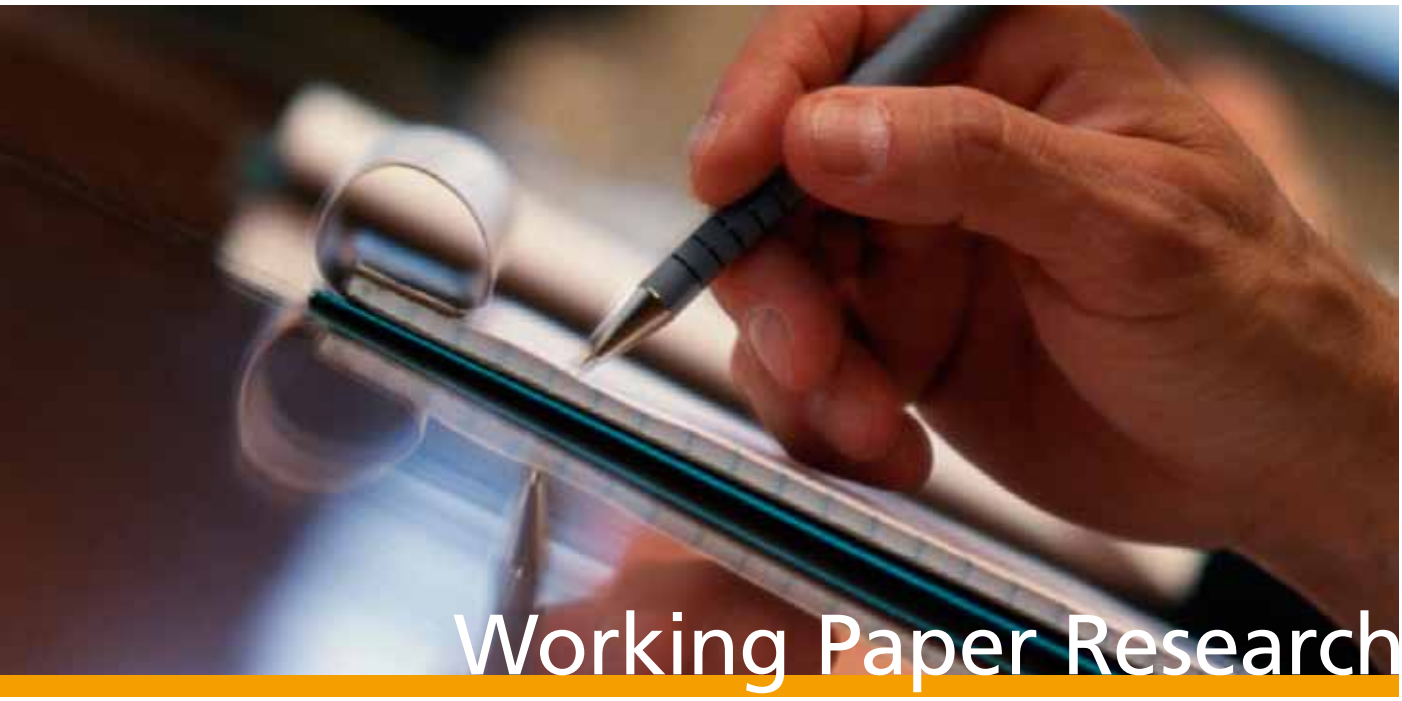
Understanding inflation dynamics : Where do we stand ?



Working Paper Research

by Maarten Dossche

June 2009 No 165

National Bank OF BELGIUM
Eurosystem

Editorial Director

Jan Smets, Member of the Board of Directors of the National Bank of Belgium

Statement of purpose:

The purpose of these working papers is to promote the circulation of research results (Research Series) and analytical studies (Documents Series) made within the National Bank of Belgium or presented by external economists in seminars, conferences and conventions organised by the Bank. The aim is therefore to provide a platform for discussion. The opinions expressed are strictly those of the authors and do not necessarily reflect the views of the National Bank of Belgium.

Orders

For orders and information on subscriptions and reductions: National Bank of Belgium,
Documentation - Publications service, boulevard de Berlaimont 14, 1000 Brussels.

Tel +32 2 221 20 33 - Fax +32 2 21 30 42

The Working Papers are available on the website of the Bank: http://www.nbb.be.

© National Bank of Belgium, Brussels

All rights reserved.
Reproduction for educational and non-commercial purposes is permitted provided that the source is acknowledged.

ISSN: 1375-680X (print)
ISSN: 1784-2476 (online)

Abstract

I summarize recent progress made in the literature on inflation dynamics. This has been a very productive area of research due to the development of the so-called New Keynesian model and the availability of new macroeconomic and microeconomic evidence. Nevertheless, a number of problems still subsist. In particular the importance of temporary price markdowns to inflation dynamics and the characteristics of the information set price-setters use for their price adjustment decision currently constitute unresolved issues.

Key Words: Inflation dynamics, New Keynesian model, sticky prices.
JEL Classification: E30, E50, E60.

Corresponding author:

Maarten Dossche, NBB Research Department and Ghent University,
e-mail: maarten.dossche@nbb.be.

I thank Freddy Heylen and Vivien Lewis for useful comments and suggestions.

The paper is forthcoming in the Review of Business and Economics.

The views expressed in this paper are my own, and do not necessarily reflect the views of the National Bank of Belgium. All errors are my own.

TABLE OF CONTENTS

1 Introduction

"Inflation is always and everywhere a monetary phenomenon." Milton Friedman

There are two reasons why understanding inflation dynamics is important. First, in the presence of price adjustment costs, inflation entails wasteful expenses for firms and generates changes in the distribution of relative prices that do not reflect changes in productivity. Second, inflation affects the real value of nominal assets, including money. In a market economy, the distribution of relative prices and the real value of nominal assets affect the allocation of the society's resources to consumption, leisure and investment. Through its effect on real goods prices and asset prices inflation ultimately determines economic welfare. Public policy that aims at maximizing economic welfare thus needs to understand what drives inflation and how it affects the allocation of resources.

During the last five to ten years we have seen an enormous research effort to better understand the inflation process, carried out by both the academic and central bank community. The reason why this area of research has been so productive is that during recent years there has been a fruitful interaction between the modeling of inflation and the search for a larger set of empirical characteristics of inflation.

I first briefly review the costs and benefits of with inflation. That part of the paper motivates why it is justified to allocate so much resources to a better understanding of the inflation process. As the motivation for a better understanding of the inflation process did not change recently, that part mixes somewhat older and more recent contributions to the literature. Then I give an overview of the features of the New Keynesian model that allow to assess the size of the costs and benefits of inflation. Subsequently, I present the features of the inflation and price adjustment data that the

model should ideally match. Finally, I conclude and discuss some unresolved issues.

2 Costs and Benefits of Inflation

Inflation and Costly Price Adjustment

Arguably price adjustment is not completely costless. There are many factors that contribute to the overall cost of price adjustment. There is for instance the labor cost of the people that decide on the price adjustment, the cost of printing new price tags, the labor cost of physically changing the price tag. Different goods have different costs of price adjustment. The costs for instance depend on the type of market where the good is sold. If the good is sold in an auction, the costs of price adjustment are likely to be lower than if the good is sold in a shop where each good carries a price tag. The literature often uses the term menu costs, referring to the printing costs restaurants incur when they change prices. But menu costs do not just comprise the costs of physically resetting prices, they also comprise the costs of reoptimizing the price. In the presence of menu costs, higher inflation will entail higher total costs (or a less efficient production) due to the more frequent adjustment of prices.

Due to menu costs, a lot of firms do not reset their price in response to every small change in costs and demand. There will be a range in which they keep their price unchanged and tolerate deviations of their actual price from its optimal level.[1] This generates a change in the distribution of relative prices that does not reflect changes in productivity, which entails efficiency and welfare losses. This cost is often referred to as a relative price distortion. In this way, small menu costs can entail large welfare losses. Lach and Tsiddon (1992) for instance find evidence for Israel that

[1] The mere fact that the prices of some goods continuously adjust does not imply that the cost of price adjustment is zero for these goods. The shocks to the optimal price of a good can be so large that the benefits of adjusting the good's price continuously outweigh the costs of price adjustment.

higher inflation pushes prices to both tails of the relative price distribution.

On the other hand, there can also exist benefits of higher inflation. In a world where nominal wages cannot adjust downwardly, higher inflation decreases the real value of nominal wages. If due to certain shocks optimal real wages need to decrease, small or zero changes in nominal wages still entail real wage decreases that are optimal. This effect is due to Tobin (1972) who stressed that in this context inflation can "grease the wheels of the economy". Fagan and Messina (2008), using a model with downward wage rigidity, conclude that for a number of European countries the optimal steady-state inflation rate varies between 0 and 2%. For the United States, the estimates for the optimal rate of inflation vary between 2% and 5%, depending on the data set they use.

Inflation and the Value of Nominal Assets

Inflation affects the real value of nominal assets. This includes the real value of outstanding money balances. Money is a special type of asset that on top of its function as a store of value, also has a transactions function. When inflation affects the real value of outstanding money balances, this can affect aggregate demand. In a model with perfect competition and costless price adjustment, Cooley and Hansen (1989) do not find significant effects of inflation on output. Blanchard and Kiyotaki (1987), however, assume imperfect competition and costly price adjustment and find that in combination with sticky prices there are significant effects of changes in the money supply on output. This illustrates how assumptions about inflation dynamics and price adjustment can determine the effects of monetary policy on output and welfare. It is therefore important to verify these assumptions with empirical facts, so that we can discriminate between different theories.

Another cost of inflation comes from the combined role of the store of value and the transaction technology of money. As holding money is not remunerated, the effective nominal interest rate

is zero. With positive inflation, this creates an opportunity cost of holding money balances for transactions. On the other hand, money makes transactions easier. Therefore, inflation determines the number of times someone goes to the bank in order to withdraw money and in such a way tries to reduce money balances. With higher average inflation and nominal interest rates people will cut back money holdings as the opportunity cost increases, whereas the transaction benefits remain the same. This generates more trips to the bank, which explains the origin of the term shoe leather costs. In the literature this term covers all sorts of costs that are related to more cash management.

Another channel through which inflation can affect the aggregate economy and economic welfare is its role in generating real wealth redistributions across agents, in particular debtors and creditors. Doepke and Schneider (2006a) show that inflation surprises can entail a substantial redistribution of wealth among different groups of people. From an aggregate perspective it is not clear whether this redistribution is a cost or a benefit. This for instance depends on whether there is a wealth transfer from people that are unproductive to people that are productive and invest. Doepke and Schneider (2006b) find that for a zero sum redistribution shock through a surprise in inflation, households react asymmetrically, mostly because borrowers are younger on average than lenders. As a result, inflation generates a decrease in aggregate labor supply as well as an increase in savings. Even though inflation-induced redistribution has a persistent negative effect on output, it improves the weighted welfare of households.

In an economy with a role for the government and nominal government debt, surprises in inflation can also create a way to levy non-distortionary taxes. Because government debt is nominal the rate of inflation determines the real debt burden the government needs to finance. In the case of an inflation surprise real government debt decreases significantly without distorting economic activity

as is the case for labor and capital taxes. In effect inflation can be a non-distortionary lump sum tax.

However, higher inflation variability also increases risk premiums on nominal assets. See for instance De Graeve et al. (2008) and Rudebusch and Swanson (2008) for evidence and explanations of how higher inflation variability can increase the inflation risk premium that investors demand on nominal assets. One related issue is that for long-term nominal debt contracts inflation affects the profile of real debt repayments. This can for instance distort the allocation of investment in housing in a life-cycle model. Another related issue is that to hedge themselves against the risk of inflation people invest relatively more in real assets compared to nominal assets that entail inflation risk. This might not be welfare maximizing either.

In the case of negative inflation, or deflation, the real value of money increases. Holding money then gives a positive real return. This can become problematic if the optimal real interest rate should be lower than the rate of deflation. In that case the nominal interest rate hits the zero lower bound, so that the central bank loses control over the real interest rate. The experience of Japan in the nineties is a classic example of how detrimental a prolonged period of deflation - or of a suboptimally high real interest rate - can be for the economic performance of a country. Krugman (1998) analyzes the deflation episode in Japan during what has been called the Lost Decade.

Up to now I have listed the costs and benefits of inflation, and how the characteristics of inflation can affect economic welfare. I have not been able to perform a welfare analysis, so that we remain unsure about the net welfare effects of inflation. This can be done with the New Keynesian model. The main virtue of this model is that it links the microeconomic price setting decisions of economic agents to the behavior of inflation and other macroeconomic variables. In this way it allows us to

consider all the aspects of inflation and price adjustment in one coherent framework.

3 The New Keynesian Model

Today most of the questions raised in the previous section are studied in the New Keynesian model. This model has been developed starting from a real business cycle model, adding monopolistic competition, infrequent price adjustment, and a role for monetary policy. An overview of this model can be found in Woodford (2003) and Gali (2008).

The model is basically a real business cycle model with two additional frictions. This allows economists to benefit from the virtues of the real business cycle model and its methodology to address economic questions. The most important virtues are the explicit use of optimization of agents and rational expectations. This is much more appealing than the ad hoc behavioral relations that were posited in the older Keynesian literature. The first additional ingredient that is present in the New Keynesian model is monopolistic price setting. Prices are not determined in perfectly competitive markets, where the price equals the marginal cost of producing an additional unit. Instead the price will be higher than the marginal cost, due to the monopoly power of an infinite number of differentiated good producers. The differentiated good producers are mostly incorporated in the model using constant elasticity of substitution consumer preferences over an infinite range of goods as in Dixit and Stiglitz (1977). Nominal rigidities constitute a second ingredient that is often modeled using a price adjustment cost. This gives rise to nominal prices that are not adjusted continuously, which creates a constraint for firms when they reset their prices. The combination of imperfect competition and nominal rigidities generates the short run non-neutrality of monetary policy. Money has not necessarily an explicit role in this model; it is just a unit of account.

Nevertheless, inflation is a purely monetary phenomenon. It is ultimately the central bank that determines the price level and thus the inflation rate. Up to today people debate about whether they should include a more explicit role for money in the model or not.

The New Keynesian model can be used to evaluate different policies, but before we can start doing this we need to remove a number of remaining uncertainties about the extent to which different frictions are important or not. The success or failure of this framework needs to be evaluated against a number of properties of both macroeconomic and microeconomic data. Until a few years ago the model was most often evaluated against macroeconomic data. This approach creates a number of observational equivalences between different microeconomic models of price adjustment. Because the welfare effects crucially depend on the type of price adjustment the researcher assumes, we also need to evaluate the microeconomic implications of the model. Therefore, since the last five years people have increasingly studied the characteristics of microeconomic price adjustment using large micro price datasets. The next two sections give an overview of the macroeconomic and microeconomic statistical properties of the data and discuss which models are consistent with these statistical properties.

4 Post-War Inflation Dynamics

Most research on the time series properties of inflation has focused on (i) the real effects of monetary shocks and (ii) the degree of inflation persistence in the data. The real effects of monetary policy shocks are determined by the reaction of inflation to a monetary policy shock. If inflation reacts immediately and fully to a monetary shock, then there is little effect on output. Concerning the degree of inflation persistence, it has been quickly acknowledged that a simple version of the New

Keynesian model does not imply much persistence in inflation, even though at first sight that seems to be a key characteristic of inflation.[2] This spurred a lot of research on versions of the New Keynesian model with frictions (e.g. habit persistence in consumption) that can generate more inflation persistence. Today, there exists a widespread consensus about the existence of real effects of monetary policy shocks. The consensus view about the empirical degree of inflation persistence today seems to be that at the business cycle frequency it is relatively low.

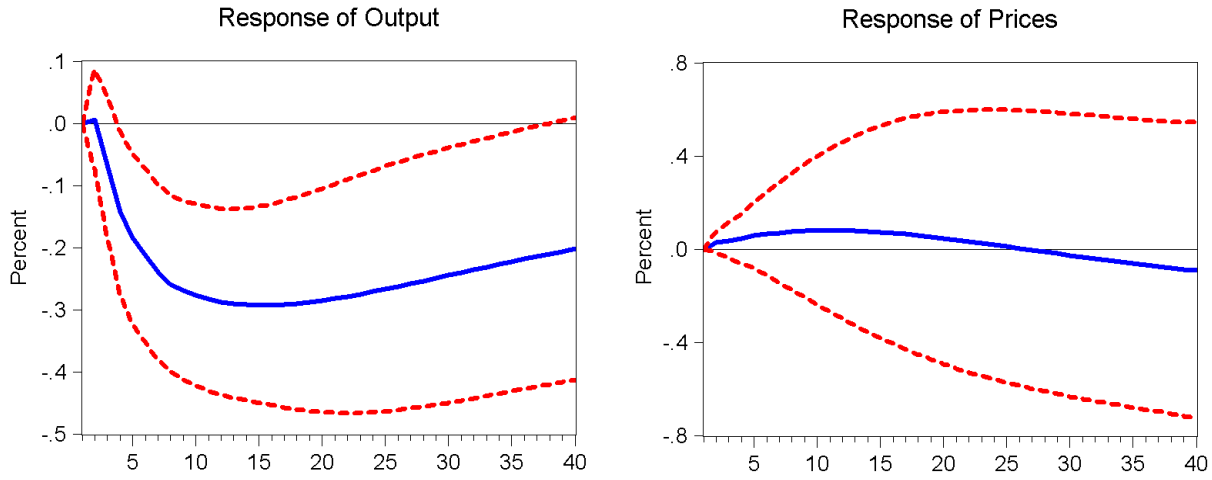
Evidence on the real effects of a monetary policy shock and inflation persistence is not the only source of evidence that researchers use to evaluate their monetary models. In addition, there exist well-developed maximum likelihood and Bayesian methods (e.g. Smets and Wouters, 2007) to confront our models with the data. These approaches compare the model at the same time to different statistical properties of the data. Discussing these approaches lies beyond the scope of this paper.

Evidence from VARs

One way to evaluate the New Keynesian model's performance in matching macroeconomic statistical properties is by comparing the model's reaction to a monetary policy shock with the reaction in the data. The response to a monetary policy shock in the data can be measured by a Vector Autoregression (VAR). Christiano et al. (1999) survey the literature on evidence on the transmission of monetary policy. They find that as the nominal interest rate increases, inflation, consumption, investment and output persistently fall. This literature delivers empirical evidence that structural models should try to match. Peersman and Smets (2003) use the same methodology for euro area data and find very similar results as for the United States.

[2]See for instance Fuhrer and Moore (1995) and Fuhrer (2000) who point out the lack of inflation persistence in the basic New Keynesian model.

Figure 1: Response to a One S.D. Monetary Policy Shock (Euro Area)



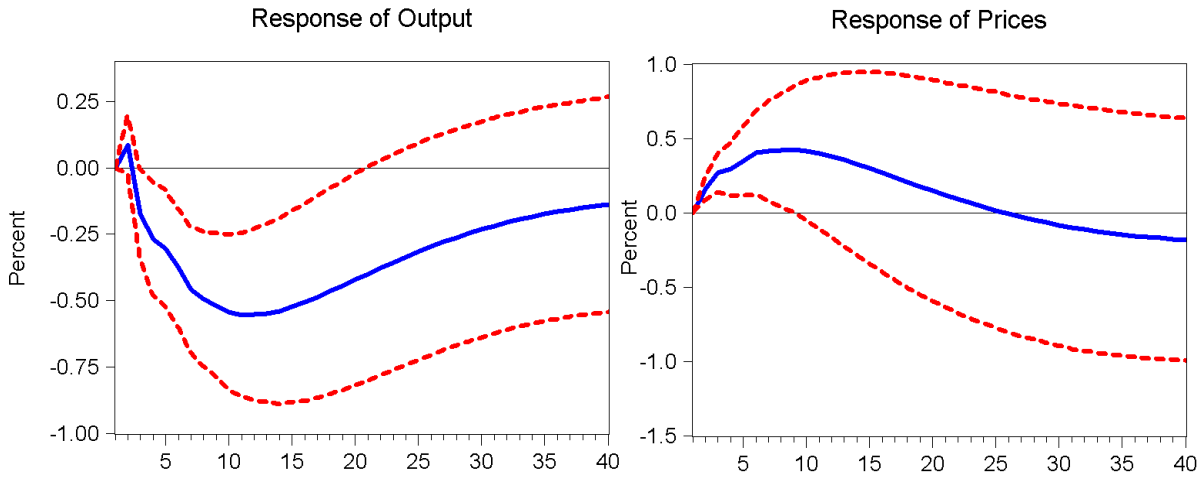
Note: The graph shows the responses of output and prices to a one standard deviation monetary policy shock +/- two standard error confidence bounds. The structural shocks are identified using a Choleski decomposition with ordering [output, consumer prices, policy interest rate]. This identification scheme is widely used and similar to the one of Christiano et al. (1999) and Peersman and Smets (2003). The data is quarterly, the sample is 1970:1-2007:4, and output and consumer prices are seasonally adjusted and expressed in log terms. Data sources: Datastream, ECB, OECD.

In Figures 1 and 2, I present the results of a simple VAR comprising output, consumer prices and the policy interest rate for the euro area and the United States. This exercise confirms what Christiano et al. (1999) and Peersman and Smets (2003) find for the United States and the euro area. Output decreases after a tightening of monetary policy. Prices do not react much, or even increase slightly in the short run.[3]

The evidence on the (persistent) effects of monetary policy on output and the small effects on prices can discriminate between the models of Cooley and Hansen (1989) and Blanchard and Kiyotaki (1987). The model of Cooley and Hansen (1989) is not able to replicate this evidence, so that it is not as good a description of reality as the model with imperfect competition and sticky

[3]This short run increase is called the "price puzzle" as we would a priori expect that prices decrease after a tightening of monetary policy. This phenomenon is widely documented for the United States. One conjecture is that policy shocks which are associated with substantial price puzzles are actually confounded with nonpolicy disturbances that signal future increases in prices, such as commodity price changes. Some authors therefore include a measure for commodity prices in their VAR. This lies beyond the scope of this paper.

Figure 2: Response to a One S.D. Monetary Policy Shock (United States)



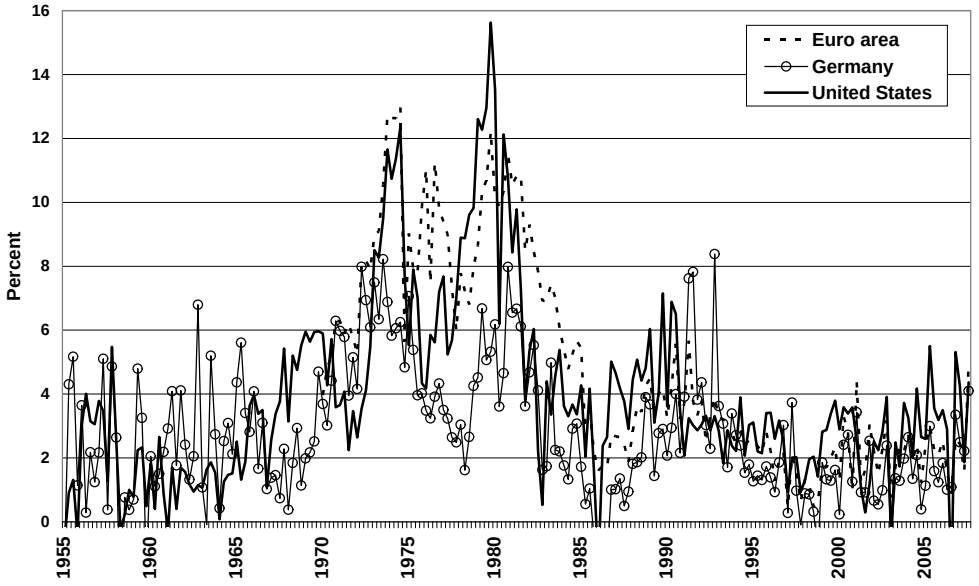
Note: See the note accompanying Figure 1.

prices of Blanchard and Kiyotaki (1987).

Evidence on Inflation Persistence

In Figure 3, I present inflation data for the euro area, Germany and the United States. From eyeballing this figure it appears that inflation in the euro area and the United States is a fairly persistent process. This is also confirmed when I compute the autocorrelation of inflation for the entire sample period 1955-2007 in Table 1. The autocorrelation coefficient of inflation in the United States and the euro area is above 0.8. A common practice is to estimate a univariate autoregressive time series model and to measure persistence as the sum of the autoregressive coefficients (e.g. Fuhrer and Moore, 1995; Pivetta and Reis, 2007). In most of these studies, inflation exhibits high to very high persistence during the post-war period, i.e. persistence is found to be close to that of a random walk. We can design models that generate high inflation persistence using a variety of frictions: backward-looking agents (Galí and Gertler, 1999), price indexation (Christiano et al., 2005), consumption habit persistence (Christiano et al, 2005), learning (Milani, 2007), real

Figure 3: Post-War Inflation



Note: The graph shows annualized log-differences of quarterly seasonally adjusted CPI. See Table 1 for the data sources.

wage rigidities (Blanchard and Galí, 2007). For a particular calibration these frictions are able to replicate the univariate reduced form inflation persistence. Importantly, this estimated persistence is a measure of unconditional inflation persistence.

Levin and Piger (2004) argue that the high persistence is not intrinsic. Instead, it is due to breaks in the mean of inflation due to changes in the monetary policy strategy. After all, such high persistence is not present in Germany, where the central bank was granted independence much before the central banks in the United States and the rest of the euro area. To test this hypothesis, in Table 1, I distinguish three periods: the Golden Sixties (1955-1964), the Great Inflation: 1965-1984, and the Great Moderation: 1985-2007. The first period was characterized by relatively low inflation with little persistence both in the United States and Germany. The second period is characterized by high, volatile and persistent inflation for both the euro area and the United States. In Germany,

however, this rise in average inflation and persistence was much more muted than in the euro area and the United States. The volatility of inflation in Germany even decreased during that period. In the third period inflation is again low and exhibits low persistence.

Table 1: Statistical Properties of Inflation

	United States	Euro area	Germany
		1955-2007*	
Std.	2.93	3.30	2.10
Mean	3.91	4.85	2.79
Autocorr.	0.81	0.92	0.58
		1955-1964	
Std.	1.32	-	2.09
Mean	1.56	-	2.15
Autocorr.	0.30	-	-0.12
		1965-1984*	
Std.	3.31	2.30	1.94
Mean	6.09	8.38	4.07
Autocorr.	0.82	0.74	0.71
		1985-2007	
Std.	1.51	1.16	1.66
Mean	3.00	2.59	1.94
Autocorr.	0.29	0.51	0.52

Note: the statistics are computed using the annualized quarterly log-differenced seasonally adjusted CPI. The source is OECD, except for the sample 1970-1998 for the euro area, which comes from the AWM dataset of the ECB. * The sample for the euro area only covers 1970-2007.

This observation is in line with evidence that the high persistence of inflation during the seventies was linked to the type of monetary policy regime in place (e.g. Benati, 2008).[4] The dynamics of inflation went through substantial changes during the last five decades. For this reason, Dossche and Everaert (2008) account for changes in the inflation target of the central bank when they measure the degree of inflation persistence in the euro area and the United States. Changes in

[4] An alternative explanation for the high empirical inflation persistence is that it is caused by the aggregation of microeconomic price paths that differ in their degree of persistence. See Altissimo et al. (2007) for how part of the aggregate inflation persistence in the euro area can be explained by aggregation.

the inflation target can be due to genuine mistakes (Gali and Gertler, 1999), misperceptions of the natural rates (Orphanides, 2002), or just ignorance about the natural rate principle that inflation cannot permanently increase economic activity (Sargent et al., 2006). To paraphrase Friedman, high inflation persistence is always and everywhere a monetary phenomenon.

5 The Role of Price Setting and Some Evidence

Two assumptions are key in the New Keynesian model. First, there is monopolistic competition in the goods market. This implies that firms are price setters, and not price takers as in perfectly competitive markets. The second assumption is costly price adjustment. This assumption always goes together with monopolistic competition as then the price setter can make a trade-off between adjusting his price or not. Here I give an overview of the different ways costly price adjustment is introduced in the model, and of the micro and macro implications. I also survey the empirical evidence.

Theoretical Assumptions

There are two main ways of introducing costly price adjustment in the New Keynesian model. First, there is time dependent price setting. Under this assumption some prices in the economy can adjust in the current period, whereas other prices cannot adjust. Which prices can adjust and which cannot is exogenously determined; it is not chosen by the firms or price setters. One very popular model is the Calvo (1983) model, which assumes that a randomly chosen fraction of prices, drawn from a uniform distribution, can adjust. The model is popular because it gives rise to very simple optimality conditions. This model implies, however, that some prices do not adjust for a very long period. Even though there is some evidence of very long-lasting prices (Young and Levy, 2005), it

seems unlikely that prices do not adjust when the firm makes losses and has to meet demand. Ascari (2004) also shows that in the Calvo (1983) model the steady state output level is very sensitive to the steady state money growth rate. Low levels of inflation imply large, and unrealistic, changes in the steady state output level. Another popular time-dependent price setting model is the Taylor (1980) price adjustment model. This model assumes that every period there is a certain cohort of firms that can adjust their prices. In this case the fraction of prices that can adjust is not random. It is always the same cohort of prices that can adjust after, for instance, four quarters. This model does not suffer from the problems of the Calvo model under positive steady state inflation (Ascari, 2004).

A second way of introducing costly price adjustment is through explicitly assuming a cost of price adjustment that the firm needs to pay every time it changes its price. A popular model is the menu cost model where there is a fixed cost to be paid every time the firm adjusts its price. Because of the non-linearity this implies that it is more difficult to solve the model using perturbation methods. See, however, Dotsey et al. (1999) for an example of a menu-cost model that can be solved with a perturbation method. In this model the frequency of price adjustment is endogenous. The firms that need the price adjustment most urgently adjust their prices first. This feature is also called the selection effect (Golosov and Lucas, 2007). It implies that the response of inflation to a monetary shock is much faster than if the selection effect were absent.

The model of Rotemberg (1982) assumes that the price adjustment cost is quadratic in the size of the price adjustment. In this model the frequency of price adjustment is 100%; there is no staggering of price adjustment. This is at odds with the micro data as I show below. However, in a first order approximation the model delivers the same Phillips curve as under the Calvo price

adjustment. Lombardo and Vestin (2008) show how the choice for Calvo or Rotemberg pricing can affect the policy prescriptions of different models.

Another theory is the one proposed by Mankiw and Reis (2002). This theory assumes that prices can be reset every period, but that the firm can only infrequently choose the optimal rate of price adjustment. Thus, information about the state of the economy is not immediately reflected in price adjustment decisions. This creates a short-run impact of money on output.

All the previous models assume that agents are perfectly rational and (at least after some time) perfectly informed. This implies that the natural rate hypothesis is respected. Output cannot be increased forever by increasing the rate of inflation. One paper that proposes an alternative to the natural rate hypothesis is the paper of Akerlof et al (2000). It argues that under low inflation, price and wage setters do not fully update their decisions to their expectations. Therefore, slightly higher inflation will push activity higher. As inflation gets higher they argue that then agents will start updating their decisions again with inflation expectations. Therefore, small deviations from the natural rate hypothesis are possible and efficient in that model.

Empirical Evidence and Implications for the Theory

The body of empirical research on costly price adjustment has been growing exponentially during the last years. Usually the fact that goods prices do not change is taken as indirect evidence for costs of price adjustment. This might be true under the assumption that the optimal price changes continuously due to continuously changing costs and demand. However, it could as well be that some goods prices do not change simply because costs and demand do not change. To alleviate this identification problem, there exists direct evidence on costly price adjustment. Levy et al. (1997) and Zbaracki et al. (2004) find direct evidence for the costs of price adjustment from a supermarket

and an industrial firm, respectively. They find that price adjustment costs amount to 0.7% or 1.23% of revenues. Zbaracki et al. (2004) document that the direct cost of changing prices is very low. However, the managerial and customer costs are quite substantial. So to implement a price change a firm needs to spend a lot of resources on organizing the price change within the firm, and informing and explaining the price change to the customers of the firm.

Mills (1920) and Means (1927) are the earliest empirical studies of price adjustment. Between then and the early 2000s there exist a large number of empirical studies of price adjustment. The main characteristic of these studies is, however, that they only cover a subset of goods traded in the economy. Some examples are Kashyap (1995) for retail catalogues and Cecchetti (1986) for magazines. It took until Bils and Klenow (2004) and Nakamura and Steinsson (2008) before a large scale study on US consumer prices was done. At about the same time, the central banks of the euro area started a research project within the Inflation Persistence Network (IPN). They study the stickiness of consumer (Dhyne et al., 2006) and producer prices (Vermeulen et al, 2007) using micro data underlying the CPI and PPI. In addition they survey (Fabiani et al., 2007) firms about the way they adjust prices. This study was similar in approach to the study of Blinder et al. (1998). Angeloni et al. (2006) summarize some implications of this work for macroeconomic modeling. All these studies allow us to calibrate macroeconomic models that cover almost the entire set of goods traded in the economy.

The main statistic that these studies compute is the frequency of price adjustment, which ranges between 10% and 30% depending on the sample period and country. They also study the size of price adjustment and a number of other features of the price change distribution. The studies find infrequent price adjustment compared to perfectly competitive markets. However, prices adjust too

fast to be able to match evidence from VARs on the output and inflation effects of a monetary policy shock in a New Keynesian model. This gives rise to yet another puzzle.

To solve this puzzle a series of papers have proposed real price rigidities (Ball and Romer, 1990). Real rigidities refer to strategic complementarity in the price setting decision of firms. A firm is more reluctant to adjust its price in response to changes in the state of the economy the less other firms adjust their prices. Different frictions can generate this strategic complementarity. One way to introduce strategic complementarity is through the preference specification of Kimball (1995). In contrast to the traditional Dixit and Stiglitz (1977) aggregator, Kimball (1995) does not assume a constant elasticity of demand. The price elasticity of demand becomes a function of the relative price. A key concept is the curvature of the demand curve, which measures the price elasticity of the price elasticity. When the curvature is positive, Kimball's preferences generate a concave or "kinked" demand curve in a log price/log quantity space. A price above the level of the firm's competitors increases the elasticity of demand for its product, so that the firm progressively loses profits from relative price increases. Conversely, a price below the level of the firm's competitors reduces the elasticity of demand for its product, so that the firm again progressively loses profits from relative price decreases. In this way the combination of small costs to nominal price adjustment and a concave demand curve generates slow adjustment to changes in the state of the economy. Despite its attractiveness, the literature suffers from a lack of empirical evidence on the curvature of a typical demand curve. Calibrations of the curvature using macroeconomic data range from below 2 to above 400. The results in Dossche et al. (2008) using scanner data support the introduction of a kinked (concave) demand curve in a representative firm economy, but the median degree of curvature is much lower than currently calibrated.

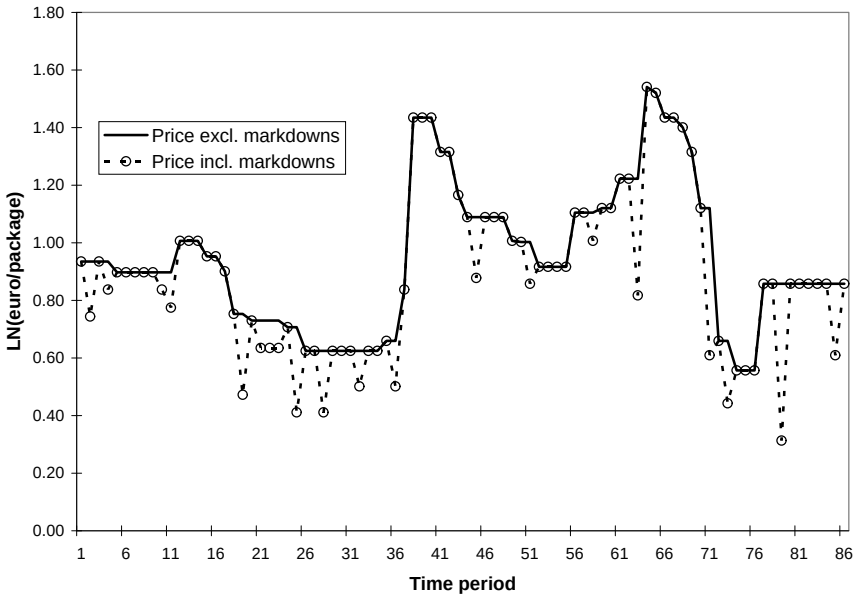
Another way to introduce real rigidities is by assuming a production chain. In industrialized countries, 40% of the value of a consumption good is typically generated in the distribution stage, whereas 60% of its value is generated in the production stage (Burstein et al., 2003). This slows down aggregate price adjustment as price changes pass through the production chain. Cornille and Dossche (2008) contribute to understanding the way producer prices adjust. They document producer price adjustment using a Belgian micro price dataset. On average, 24% of prices adjust each month, with an average increase/decrease of 6%. Producer prices adjust more frequently than consumer prices, but their size of adjustment is typically smaller.

A particular feature of the micro data is that the size of price adjustment is large compared to inflation. This implies that there must be large changes in relative prices. To match this fact, one needs idiosyncratic shocks to be able to generate such big price changes (Golosov and Lucas, 2007). Mackowiak and Wiederholt (2009) argue that when idiosyncratic conditions are more variable or more important than aggregate conditions, firms should pay more attention to idiosyncratic conditions than to aggregate conditions. In that case, prices react fast and by large amounts to idiosyncratic shocks, but only slowly and by small amounts to nominal shocks.

Another source of large price changes are price markdowns that are mainly present in micro consumer price data and not in producer price data (Cornille and Dossche, 2008; Vermeulen et al., 2007). Nakamura and Steinsson (2008) argue that it is important to distinguish price changes due to temporary price markdowns and regular price changes because they are fundamentally different. Temporary price changes are much more transient than regular price changes, and after a temporary price decrease prices often return to the initial regular price level. Kehoe and Midrigan (2007) argue that if one explicitly accounts for price markdowns in a macro model, the implications of the model

are significantly different from those of a model without price markdowns. The difference between a price path that excludes the markdowns, and one that includes them, is shown in Figure 4.

Figure 4: Example of a Price Trajectory: Potatoes



Source: Dossche et al. (2008)

The details of price setting models raise a lot of issues because they determine the welfare costs of different policies. So it is very important to be able to compare the microeconomic implications of these models with microeconomic data. The macroeconomic data cannot deliver a firm conclusion. With respect to time- versus state-dependent price setting, evidence from Klenow and Kryvtsov (2008) and Gagnon (2008) suggests that a time-dependent model is consistent with an economy with low inflation such as the United States today. However, for an economy with high inflation such as Mexico during the Peso crisis of 1994, a state dependent model seems to be more useful. A time-dependent model fails to match the increased frequency of price adjustment as inflation reaches higher levels. However, Mackowiak and Smets (2008) argue that the microeconomic data

can narrow the range of models that match the data, but that even with the microeconomic data there remains uncertainty about what price setting frictions are more realistic. One way out of this could be to further exploit survey evidence as in Blinder et al (1998) and Fabiani et al. (2004) to shed more light on how price setters process information and at what stage of the price adjustment process they incur significant costs.

6 Conclusion and Some Unresolved Issues

During the last five years there has been much interest in understanding inflation and price dynamics. First, this is due to the emergence of a microfounded modeling framework with explicit optimization of agents and rational expectations. This implies that questions of central bank commitment and discretion can be analyzed in these models. Second, there is now access to new databases that significantly increases the microeconomic evidence on price adjustment. In addition, there is the macroeconomic evidence from VARs (e.g. Christiano et al., 1999) and Bayesian model evaluations (Smets and Wouters, 2007) and evidence on inflation persistence.

Whereas during the eighties and nineties central banks had turned away from formal analysis[5], they are now investing more and more resources in improving the New Keynesian model as well as using it for policy analysis and forecasting (see e.g. Smets and Wouters, 2003, 2007). Today the Swedish central bank even publishes optimal macroeconomic forecasts based on a version of the New Keynesian model (Adolfson et al., 2008). This type of analysis is currently becoming an important tool in many other central banks.

However, there remain a number of unresolved issues. Even though the microeconomic evidence

[5] In the 1980s and 1990s, many central banks continued to use reduced-form statistical models to produce forecasts of the economy that presumed no structural change, but they did so knowing that these models could not be used with any degree of confidence to predict the outcome of policy changes.

has substantially narrowed the range of models that can explain the macroeconomic facts, there remains substantial uncertainty about the right model. There is for instance the issue of how to interpret relatively frequent price adjustment in the microeconomic data and the persistent output effects of a monetary policy shock. There are a number of theories that can generate real rigidity in response to a nominal shock. Some rely on strategic complementarity in the price setting decision (Kimball, 1995; Burstein and Hellwig, 2008), other theories rely on staggered information flows (Mankiw and Reis, 2002), or optimal information processing of an idiosyncratic or aggregate source (Mackowiak and Wiederholt, 2009). A second issue is whether we need to take into account temporary price markdowns explicitly in our macroeconomic models. It is not yet clear how this affects the aggregate dynamics and welfare. More evidence from surveying price setters might improve our understanding of price and inflation dynamics, so that we can converge on one model that matches both the macroeconomic and microeconomic evidence on inflation and prices.

References

[1] Adolfson M., Laséen S., Lindé J. and L. Svensson, 2008, Optimal Monetary Policy in an Operational Medium-Sized DSGE Model, Sveriges Riksbank, *mimeo*

[2] Akerlof G., Dickens W. and G. Perry, 2000, Near Rational Wage and Price Setting and the Long-Run Phillips Curve, *Brookings Papers on Economic Activity*

[3] Altissimo f., Mojon B. and P Zaffaroni, 2007, Fast Micro and Slow Macro. Can Aggregation Explain the Persistence of Inflation?, *ECB Working Paper Series*, N° 729

[4] Angeloni I, Aucremanne L;, Ehrmann M., Gali J., Levin A. and F. 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, 562-574

[5] Ascari G., 2004, Staggered Prices and Trend Inflation: Some Nuisances, *Review of Economic Dynamics*, 7, 642-667

[6] Benati L., 2008, Investigating Inflation Persistence across Monetary Regimes, *Quarterly Journal of Economics*, 123, 1005-1060

[7] Bils M. and P. Klenow, 2004, Some Evidence on the Importance of Sticky Prices, *Journal of Political Economy*, 112, 947-985

[8] Blanchard O.J. and J. Galí, 2007, Real Wage Rigidities and the New Keynesian Model, *Journal of Money Credit and Banking*, 39, 35-65

[9] Blanchard O. and N. Kiyotaki, 1987, Monopolistic Competition and the Effects of Aggregate Demand, *American Economic Review*, 77, 647-666

[10] Blinder A., Canetti E., Lebow D. and J. Rudd, 1998, *Asking About Prices: A New Approach to Understanding Price Stickiness*, Russell Sage Foundation, New York

[11] Burstein A. and C. Hellwig, 2008, Prices and Market Shares in a Menu Cost Model, UCLA, *mimeo*

[12] Burstein A., Neves J. and S. Rebelo, 2003, Distribution Costs and Real Exchange Rate Dynamics During Exchange-Rate-Based Stabilizations, *Journal of Monetary Economics*, 1189-1214

[13] Calvo G., 1983, Staggered Prices in a Utility-Maximizing Framework, *Journal of Monetary Economics*, 12, 383-398

[14] Cecchetti S., 1986, The Frequency of Price Adjustment: A Study of the Newsstand Prices of Magazines, *Journal of Econometrics*, 31, 255-274

[15] Christiano L., Eichenbaum M. and C. Evans, 1999, Monetary Policy Shocks: What Have We Learned and to What End?, in J. Taylor & M. Woodford (eds) *Handbook of Macroeconomics*, 65-148

[16] Christiano L., Eichenbaum M. and Evans C., 2005, Nominal Rigidities and the Dynamic Effects of Shock to Monetary Policy, *Journal of Political Economy*, 113, 1-45

[17] Cooley T. and G. Hansen, 1989, In‡ation Tax in a Real Business Cycle Model, *American Economic Review*, 79, 733-748

[18] Cornille, D. and M. Dossche, 2008, Some Evidence on the Adjustment of Producer Prices, *Scandinavian Journal of Economics*, 110, 489-518

[19] De Graeve F., Dossche M., Emiris M. Sneessens H. and R. Wouters, 2008, Risk Premiums and Macroeconomic Dynamics in a Heterogeneous Agents Model, *National Bank of Belgium Working Paper Series*, n° 150

[20] Dhyne E., Álvarez L., Le Bihan H., Veronese G., Dias D., Hoffmann J., Jonker N., Lunnemann P., Rumler F., and J. Vilmunen, 2006, Price Changes in the Euro Area and the United States: Some Facts from Individual Consumer Price Data, *Journal of Economic Perspectives*, 20, 171-192

[21] Dixit A. and J. Stiglitz, 1977, Monopolistic Competition and Optimum Product Diversity, *American Economic Review*, 67, 297-308

[22] Doepke M. and M. Schneider, 2006a, Inflation and the Redistribution of Nominal Wealth, *Journal of Political Economy*, 114, 1069-1097

[23] Doepke M. and M. Schneider, 2006b, Inflation as a Redistribution Shock: Effects on Aggregates and Welfare, *mimeo*

[24] Dossche M. and G. Everaert, 2008, Disentangling the Sources of Inflation Persistence, Ghent University, *mimeo*

[25] Dossche M., Heylen F. and D. Van den Poel, 2008, The Kinked Demand Curve and Price Rigidity: Evidence from Scanner Data, Ghent University, *mimeo*

[26] Dotsey M., King R. and A. Wolman, 1999, State Dependent Pricing and the General Equilibrium Dynamics of Money and Output, *Quarterly Journal of Economics*, 114, 655–690

[27] Fabiani S., Druant M., Hernando I., Kwapil C., Landau B., Loupias C., Martins F., Mathä t. and R. Sabbatini, 2006, What Firms Surveys Tell Us About Price-setting Behaviour in the Euro Area, *International Journal of Central Banking*, 3-47

[28] Fagan G. and J Messina, 2008, Downward Wage Rigidity and Optimal Steady State Inflation, European Central Bank, *mimeo*

[29] Fuhrer, J. and G. Moore, 1995, Inflation Persistence, *Quarterly Journal of Economics*, 110, 127-159.

[30] Gagnon E., 2008, Price Setting during Low and High Inflation: Evidence from Mexico, *Quarterly Journal of Economics*, forthcoming

[31] Gali, J., 2008, *Monetary Policy, Inflation and the Business Cycle*, Princeton University Press

[32] Galí J. and M. Gertler, 1999, Inflation Dynamics: A Structural Econometric Analysis, *Journal of Monetary Economics*, 44, 195-222

[33] Golosov M. and R. Lucas, 2007, Menu Costs and Phillips Curves, *Journal of Political Economy*, 115, 171-199

[34] Kashyap A., 1995, Sticky Prices: New Evidence from Retail Catalogs, *Quarterly Journal of Economics*, 245-74

[35] Kehoe P. and V. Midrigan, 2007, Sales and the Real Effects of Monetary Policy, *Federal Reserve Bank of Minneapolis Working Papers*, N° 652

[36] Kimball M., 1995, The Quantitative Analytics of the Basic Neomonetarist Model, *Journal of Money, Credit and Banking*, 27, 1241-1277

[37] Klenow P. and O. Kryvtsov, 2008, State-Dependent or Time-Dependent Pricing: Does It Matter for Recent U.S. Inflation?, *Quarterly Journal of Economics*, 123, 863-904

[38] Krugman P., 1998, It's Baaack: Japan's Slump and the Return of the Liquidity Trap, *Brookings Papers on Economic Activity*, 49, 137-205

[39] Lach S. and D. Tsiddon, 1992, The Behavior of Prices and Inflation: An Empirical Analysis of Disaggregate Price Data, *Journal of Political Economy*, 100, 349-389

[40] Levin A. and J. Piger, 2004, Is Inflation Persistence Intrinsic in Industrialized Countries?, *ECB Working Paper Series*, n° 334

[41] Levy D., Bergen M., Dutta S. and R. Venable, 1997, The Magnitude of Menu Costs: Direct Evidence from Large US Supermarket Chains, *Quarterly Journal of Economics*, 112, 791–825

[42] Lombardo G. and D. Vestin, 2008, Welfare Implications of Calvo vs. Rotemberg-Pricing Assumptions, *Economics Letters*, 100, 275-279

[43] Mackowiak B. and F. Smets, 2008, On Implications of Micro Data for Macro Models, *European Central Bank Working Papers Series*, n° 960

[44] Mackowiak B. and M. Wiederholt, 2009, Optimal Sticky Prices under Rational Inattention, forthcoming in *American Economic Review*

[45] Mankiw G. and R. Reis, 2002, Sticky Information versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve, *Quarterly Journal of Economics*, 117, 1295-1328

[46] Means G., 1936, Notes on Inflexible Prices, *American Economic Review*, 23-35

[47] Milani F., 2007, Expectations, Learning and Macroeconomic Persistence, *Journal of Monetary Economics*, 54, 2065-2082

[48] Mills F., 1927, *The Behaviour of Prices*, New York, NBER

[49] Nakamura E. and J. Steinsson, 2008, Five Facts about Prices: A Reevaluation of Menu Cost Models, *Quarterly Journal of Economics*, 123, 1415-1464

[50] Orphanides A., 2002, Monetary-Policy Rules and the Great Inflation, *American Economic Review*, 92, 115-120

[51] Peersman G. and F. Smets, 2003, The Monetary Transmission Mechanism in the Euro Area: More Evidence From VAR Analysis, in *Monetary Policy Transmission in the Euro Area*, Angeloni, Kashyap and Mojon (eds), Cambridge University Press

[52] Pivetta, F. and R. Reis, 2007, The persistence of inflation in the United States, *Journal of Economic Dynamics and Control*, 31, 1326-1358

[53] Rotemberg J., 1982, Sticky Prices in the United States, *Journal of Political Economy*, 90, 1187-1211

[54] Rudebusch G. and E. Swanson, 2008, The Bond Premium in a DSGE Model with Long-Run Real and Nominal Risks, Federal Reserve Bank of San Francisco Working Paper, N° 31

[55] Sargent T., Williams N. and T. Zha, 2006, Shocks and Government Beliefs: The Rise and Fall of American Inflation, *American Economic Review*, 96, 1193-1224

[56] Smets F. and R. Wouters, 2003, An Estimated Dynamic Stochastic General Equilibrium Model for the Euro Area, *Journal of the European Economic Association*, 1, 1123-1175

[57] Smets F. and R. Wouters, 2007, Shocks and Frictions in US Business Cycles: A Bayesian DGSE Approach, *American Economic Review,* 97, 586-606

[58] Taylor J., 1980, Aggregate Dynamics and Staggered Contracts, *Journal of Political Economy*, 88, 1-23

[59] Tobin J., 1972, Inflation and Unemployment, *American Economic Review*, 62, 1-18

[60] Vermeulen P., Dias D., Dossche M., Gautier E., Hernando I., Sabbatini R. and H Stahl, 2007, Price Setting in the Euro Area: Some Stylised Facts from Individual Producer Price Data, *ECB Working Papers*, N° 727

[61] Woodford M., 2003, *Interest and Prices*, Princetion University Press.

[62] Young A. and D. Levy, 2005, Explicit Evidence on an Implicit Contract,*Emory Economics Working Paper*, 0519, Emory University

[63] Zbaracki M., Ritson M., Levy D., Dutta S. and M. Bergen, 2004, The Managerial and Customer Costs of Price Adjustment: Direct Evidence from Industrial Markets, *Review of Economics and Statistics*, 514–533

NATIONAL BANK OF BELGIUM - WORKING PAPERS SERIES

1. "Model-based inflation forecasts and monetary policy rules" by M. Dombrecht and R. Wouters, *Research Series*, February 2000.
2. "The use of robust estimators as measures of core inflation" by L. Aucremanne, *Research Series*, February 2000.
3. "Performances économiques des Etats-Unis dans les années nonante" by A. Nyssens, P. Butzen, P. Bisciari, *Document Series*, March 2000.
4. "A model with explicit expectations for Belgium" by P. Jeanfils, *Research Series*, March 2000.
5. "Growth in an open economy: some recent developments" by S. Turnovsky, *Research Series*, May 2000.
6. "Knowledge, technology and economic growth: an OECD perspective" by I. Visco, A. Bassanini, S. Scarpetta, *Research Series*, May 2000.
7. "Fiscal policy and growth in the context of European integration" by P. Masson, *Research Series*, May 2000.
8. "Economic growth and the labour market: Europe's challenge" by C. Wyplosz, *Research Series*, May 2000.
9. "The role of the exchange rate in economic growth: a euro-zone perspective" by R. MacDonald, *Research Series*, May 2000.
10. "Monetary union and economic growth" by J. Vickers, *Research Series*, May 2000.
11. "Politique monétaire et prix des actifs: le cas des Etats-Unis" by Q. Wibaut, *Document Series*, August 2000.
12. "The Belgian industrial confidence indicator: leading indicator of economic activity in the euro area?" by J.-J. Vanhaelen, L. Dresse, J. De Mulder, *Document Series*, November 2000.
13. "Le financement des entreprises par capital-risque" by C. Rigo, *Document Series,* February 2001.
14. "La nouvelle économie" by P. Bisciari, *Document Series*, March 2001.
15. "De kostprijs van bankkredieten" by A. Bruggeman and R. Wouters, *Document Series*, April 2001.
16. "A guided tour of the world of rational expectations models and optimal policies" by Ph. Jeanfils, *Research Series*, May 2001.
17. "Attractive Prices and Euro - Rounding effects on inflation" by L. Aucremanne and D. Cornille, *Documents Series*, November 2001.
18. "The interest rate and credit channels in Belgium: an investigation with micro-level firm data" by P. Butzen, C. Fuss and Ph. Vermeulen, *Research series*, December 2001.
19. "Openness, imperfect exchange rate pass-through and monetary policy" by F. Smets and R. Wouters, *Research series*, March 2002.
20. "Inflation, relative prices and nominal rigidities" by L. Aucremanne, G. Brys, M. Hubert, P. J. Rousseeuw and A. Struyf, *Research series*, April 2002.
21. "Lifting the burden: fundamental tax reform and economic growth" by D. Jorgenson, *Research series*, May 2002.
22. "What do we know about investment under uncertainty?" by L. Trigeorgis, *Research series*, May 2002.
23. "Investment, uncertainty and irreversibility: evidence from Belgian accounting data" by D. Cassimon, P.-J. Engelen, H. Meersman, M. Van Wouwe, *Research series*, May 2002.
24. "The impact of uncertainty on investment plans" by P. Butzen, C. Fuss, Ph. Vermeulen, *Research series*, May 2002.
25. "Investment, protection, ownership, and the cost of capital" by Ch. P. Himmelberg, R. G. Hubbard, I. Love, *Research series*, May 2002.
26. "Finance, uncertainty and investment: assessing the gains and losses of a generalised non-linear structural approach using Belgian panel data", by M. Gérard, F. Verschueren, *Research series*, May 2002.
27. "Capital structure, firm liquidity and growth" by R. Anderson, *Research series*, May 2002.
28. "Structural modelling of investment and financial constraints: where do we stand?" by J.- B. Chatelain, *Research series*, May 2002.
29. "Financing and investment interdependencies in unquoted Belgian companies: the role of venture capital" by S. Manigart, K. Baeyens, I. Verschueren, *Research series*, May 2002.
30. "Development path and capital structure of Belgian biotechnology firms" by V. Bastin, A. Corhay, G. Hübner, P.-A. Michel, *Research series*, May 2002.
31. "Governance as a source of managerial discipline" by J. Franks, *Research series*, May 2002.

32. "Financing constraints, fixed capital and R&D investment decisions of Belgian firms" by M. Cincera, *Research series*, May 2002.
33. "Investment, R&D and liquidity constraints: a corporate governance approach to the Belgian evidence" by P. Van Cayseele, *Research series*, May 2002.
34. "On the Origins of the Franco-German EMU Controversies" by I. Maes, *Research series*, July 2002.
35. "An estimated dynamic stochastic general equilibrium model of the Euro Area", by F. Smets and R. Wouters, *Research series*, October 2002.
36. "The labour market and fiscal impact of labour tax reductions: The case of reduction of employers' social security contributions under a wage norm regime with automatic price indexing of wages", by K. Burggraeve and Ph. Du Caju, *Research series*, March 2003.
37. "Scope of asymmetries in the Euro Area", by S. Ide and Ph. Moës, *Document series*, March 2003.
38. "De autonijverheid in België: Het belang van het toeleveringsnetwerk rond de assemblage van personenauto's", by F. Coppens and G. van Gastel, *Document series*, June 2003.
39. "La consommation privée en Belgique", by B. Eugène, Ph. Jeanfils and B. Robert, *Document series*, June 2003.
40. "The process of European monetary integration: a comparison of the Belgian and Italian approaches", by I. Maes and L. Quaglia, *Research series*, August 2003.
41. "Stock market valuation in the United States", by P. Bisciari, A. Durré and A. Nyssens, *Document series*, November 2003.
42. "Modeling the Term Structure of Interest Rates: Where Do We Stand?, by K. Maes, *Research series*, February 2004.
43. "Interbank Exposures: An Empirical Examination of System Risk in the Belgian Banking System", by H. Degryse and G. Nguyen, *Research series*, March 2004.
44. "How Frequently do Prices change? Evidence Based on the Micro Data Underlying the Belgian CPI", by L. Aucremanne and E. Dhyne, *Research series*, April 2004.
45. "Firms' investment decisions in response to demand and price uncertainty", by C. Fuss and Ph. Vermeulen, *Research series*, April 2004.
46. "SMEs and Bank Lending Relationships: the Impact of Mergers", by H. Degryse, N. Masschelein and J. Mitchell, *Research series*, May 2004.
47. "The Determinants of Pass-Through of Market Conditions to Bank Retail Interest Rates in Belgium", by F. De Graeve, O. De Jonghe and R. Vander Vennet, *Research series*, May 2004.
48. "Sectoral vs. country diversification benefits and downside risk", by M. Emiris, *Research series*, May 2004.
49. "How does liquidity react to stress periods in a limit order market?", by H. Beltran, A. Durré and P. Giot, *Research series*, May 2004.
50. "Financial consolidation and liquidity: prudential regulation and/or competition policy?", by P. Van Cayseele, *Research series*, May 2004.
51. "Basel II and Operational Risk: Implications for risk measurement and management in the financial sector", by A. Chapelle, Y. Crama, G. Hübner and J.-P. Peters, *Research series,* May 2004.
52. "The Efficiency and Stability of Banks and Markets", by F. Allen, *Research series*, May 2004.
53. "Does Financial Liberalization Spur Growth?" by G. Bekaert, C.R. Harvey and C. Lundblad, *Research series*, May 2004.
54. "Regulating Financial Conglomerates", by X. Freixas, G. Lóránth, A.D. Morrison and H.S. Shin, *Research series*, May 2004.
55. "Liquidity and Financial Market Stability", by M. O'Hara, *Research series*, May 2004.
56. "Economisch belang van de Vlaamse zeehavens: verslag 2002", by F. Lagneaux, *Document series*, June 2004.
57. "Determinants of Euro Term Structure of Credit Spreads", by A. Van Landschoot, *Research series*, July 2004.
58. "Macroeconomic and Monetary Policy-Making at the European Commission, from the Rome Treaties to the Hague Summit", by I. Maes, *Research series*, July 2004.
59. "Liberalisation of Network Industries: Is Electricity an Exception to the Rule?", by F. Coppens and D. Vivet, *Document series*, September 2004.
60. "Forecasting with a Bayesian DSGE model: an application to the euro area", by F. Smets and R. Wouters, *Research series*, September 2004.
61. "Comparing shocks and frictions in US and Euro Area Business Cycle: a Bayesian DSGE approach", by F. Smets and R. Wouters, *Research series*, October 2004.

62. "Voting on Pensions: A Survey", by G. de Walque, *Research series*, October 2004.
63. "Asymmetric Growth and Inflation Developments in the Acceding Countries: A New Assessment", by S. Ide and P. Moës, *Research series*, October 2004.
64. "Importance économique du Port Autonome de Liège: rapport 2002", by F. Lagneaux, *Document series*, November 2004.
65. "Price-setting behaviour in Belgium: what can be learned from an ad hoc survey", by L. Aucremanne and M. Druant, *Research series,* March 2005.
66. "Time-dependent versus State-dependent Pricing: A Panel Data Approach to the Determinants of Belgian Consumer Price Changes", by L. Aucremanne and E. Dhyne, *Research series*, April 2005.
67. "Indirect effects – A formal definition and degrees of dependency as an alternative to technical coefficients", by F. Coppens, *Research series,* May 2005.
68. "Noname – A new quarterly model for Belgium", by Ph. Jeanfils and K. Burggraeve, *Research series*, May 2005.
69. "Economic importance of the Flemish maritime ports: report 2003", F. Lagneaux, *Document series*, May 2005.
70. "Measuring inflation persistence: a structural time series approach", M. Dossche and G. Everaert, *Research series*, June 2005.
71. "Financial intermediation theory and implications for the sources of value in structured finance markets", J. Mitchell, *Document series*, July 2005.
72. "Liquidity risk in securities settlement", J. Devriese and J. Mitchell, *Research series*, July 2005.
73. "An international analysis of earnings, stock prices and bond yields", A. Durré and P. Giot, *Research series*, September 2005.
74. "Price setting in the euro area: Some stylized facts from Individual Consumer Price Data", E. Dhyne, L. J. Álvarez, H. Le Bihan, G. Veronese, D. Dias, J. Hoffmann, N. Jonker, P. Lünnemann, F. Rumler and J. Vilmunen, *Research series*, September 2005.
75. "Importance économique du Port Autonome de Liège: rapport 2003", by F. Lagneaux, *Document series,* October 2005.
76. "The pricing behaviour of firms in the euro area: new survey evidence, by S. Fabiani, M. Druant, I. Hernando, C. Kwapil, B. Landau, C. Loupias, F. Martins, T. Mathä, R. Sabbatini, H. Stahl and A. Stokman, *Research series*, November 2005.
77. "Income uncertainty and aggregate consumption, by L. Pozzi, *Research series*, November 2005.
78. "Crédits aux particuliers - Analyse des données de la Centrale des Crédits aux Particuliers", by H. De Doncker, *Document series*, January 2006.
79. "Is there a difference between solicited and unsolicited bank ratings and, if so, why?" by P. Van Roy, *Research series*, February 2006.
80. "A generalised dynamic factor model for the Belgian economy - Useful business cycle indicators and GDP growth forecasts", by Ch. Van Nieuwenhuyze, *Research series*, February 2006.
81. "Réduction linéaire de cotisations patronales à la sécurité sociale et financement alternatif" by Ph. Jeanfils, L. Van Meensel, Ph. Du Caju, Y. Saks, K. Buysse and K. Van Cauter, *Document series*, March 2006.
82. "The patterns and determinants of price setting in the Belgian industry" by D. Cornille and M. Dossche, *Research series*, May 2006.
83. "A multi-factor model for the valuation and risk management of demand deposits" by H. Dewachter, M. Lyrio and K. Maes, *Research series*, May 2006.
84. "The single European electricity market: A long road to convergence", by F. Coppens and D. Vivet, *Document series*, May 2006.
85. "Firm-specific production factors in a DSGE model with Taylor price setting", by G. de Walque, F. Smets and R. Wouters, *Research series*, June 2006.
86. "Economic importance of the Belgian ports: Flemish maritime ports and Liège port complex - report 2004", by F. Lagneaux, *Document series*, June 2006.
87. "The response of firms' investment and financing to adverse cash flow shocks: the role of bank relationships", by C. Fuss and Ph. Vermeulen, *Research series*, July 2006.
88. "The term structure of interest rates in a DSGE model", by M. Emiris, *Research series,* July 2006.
89. "The production function approach to the Belgian output gap, Estimation of a Multivariate Structural Time Series Model", by Ph. Moës, *Research series*, September 2006.
90. "Industry Wage Differentials, Unobserved Ability, and Rent-Sharing: Evidence from Matched Worker-Firm Data, 1995-2002", by R. Plasman, F. Rycx and I. Tojerow, *Research series,* October 2006.

91. "The dynamics of trade and competition", by N. Chen, J. Imbs and A. Scott, *Research series,* October 2006.
92. "A New Keynesian Model with Unemployment", by O. Blanchard and J. Gali, *Research series,* October 2006.
93. "Price and Wage Setting in an Integrating Europe: Firm Level Evidence", by F. Abraham, J. Konings and S. Vanormelingen, *Research series,* October 2006.
94. "Simulation, estimation and welfare implications of monetary policies in a 3-country NOEM model", by J. Plasmans, T. Michalak and J. Fornero, *Research series,* October 2006.
95. "Inflation persistence and price-setting behaviour in the euro area: a summary of the Inflation Persistence Network evidence ", by F. Altissimo, M. Ehrmann and F. Smets, *Research series*, October 2006.
96. "How Wages Change: Micro Evidence from the International Wage Flexibility Project", by W.T. Dickens, L. Goette, E.L. Groshen, S. Holden, J. Messina, M.E. Schweitzer, J. Turunen and M. Ward, *Research series*, October 2006.
97. "Nominal wage rigidities in a new Keynesian model with frictional unemployment", by V. Bodart, G. de Walque, O. Pierrard, H.R. Sneessens and R. Wouters, *Research series*, October 2006.
98. "Dynamics on monetary policy in a fair wage model of the business cycle", by D. De la Croix, G. de Walque and R. Wouters, *Research series*, October 2006.
99. "The kinked demand curve and price rigidity: evidence from scanner data", by M. Dossche, F. Heylen and D. Van den Poel, *Research series*, October 2006.
100. "Lumpy price adjustments: a microeconometric analysis", by E. Dhyne, C. Fuss, H. Peseran and P. Sevestre, *Research series*, October 2006.
101. "Reasons for wage rigidity in Germany", by W. Franz and F. Pfeiffer, *Research series*, October 2006.
102. "Fiscal sustainability indicators and policy design in the face of ageing", by G. Langenus, *Research series*, October 2006.
103. "Macroeconomic fluctuations and firm entry: theory and evidence", by V. Lewis, *Research series*, October 2006.
104. "Exploring the CDS-Bond Basis" by J. De Wit, *Research series*, November 2006.
105. "Sector Concentration in Loan Portfolios and Economic Capital", by K. Düllmann and N. Masschelein, *Research series*, November 2006.
106. "R&D in the Belgian Pharmaceutical Sector", by H. De Doncker, *Document series*, December 2006.
107. "Importance et évolution des investissements directs en Belgique", by Ch. Piette, *Document series*, January 2007.
108. "Investment-Specific Technology Shocks and Labor Market Frictions", by R. De Bock, *Research series*, February 2007.
109. "Shocks and frictions in US Business cycles: a Bayesian DSGE Approach", by F. Smets and R. Wouters, *Research series*, February 2007.
110. "Economic impact of port activity: a disaggregate analysis. The case of Antwerp", by F. Coppens, F. Lagneaux, H. Meersman, N. Sellekaerts, E. Van de Voorde, G. van Gastel, Th. Vanelslander, A. Verhetsel, *Document series,* February 2007.
111. "Price setting in the euro area: some stylised facts from individual producer price data", by Ph. Vermeulen, D. Dias, M. Dossche, E. Gautier, I. Hernando, R. Sabbatini, H. Stahl, *Research series,* March 2007.
112. "Assessing the Gap between Observed and Perceived Inflation in the Euro Area: Is the Credibility of the HICP at Stake?", by L. Aucremanne, M. Collin, Th. Stragier, *Research series,* April 2007.
113. "The spread of Keynesian economics: a comparison of the Belgian and Italian experiences", by I. Maes, *Research series,* April 2007.
114. "Imports and Exports at the Level of the Firm: Evidence from Belgium", by M. Muûls and M. Pisu, *Research series,* May 2007.
115. "Economic importance of the Belgian ports: Flemish maritime ports and Liège port complex - report 2005", by F. Lagneaux, *Document series*, May 2007.
116. "Temporal Distribution of Price Changes: Staggering in the Large and Synchronization in the Small", by E. Dhyne and J. Konieczny, *Research series,* June 2007.
117. "Can excess liquidity signal an asset price boom?", by A. Bruggeman, *Research series,* August 2007.
118. "The performance of credit rating systems in the assessment of collateral used in Eurosystem monetary policy operations", by F. Coppens, F. González and G. Winkler, *Research series*, September 2007.
119. "The determinants of stock and bond return comovements", by L. Baele, G. Bekaert and K. Inghelbrecht, *Research series*, October 2007.

120. "Monitoring pro-cyclicality under the capital requirements directive: preliminary concepts for developing a framework", by N. Masschelein, *Document series*, October 2007.
121. "Dynamic order submission strategies with competition between a dealer market and a crossing network", by H. Degryse, M. Van Achter and G. Wuyts, *Research series*, November 2007.
122. "The gas chain: influence of its specificities on the liberalisation process", by C. Swartenbroekx, *Document series*, November 2007.
123. "Failure prediction models: performance, disagreements, and internal rating systems", by J. Mitchell and P. Van Roy, *Research series*, December 2007.
124. "Downward wage rigidity for different workers and firms: an evaluation for Belgium using the IWFP procedure", by Ph. Du Caju, C. Fuss and L. Wintr, *Research series*, December 2007.
125. "Economic importance of Belgian transport logistics", by F. Lagneaux, *Document series*, January 2008.
126. "Some evidence on late bidding in eBay auctions", by L. Wintr, *Research series*, January 2008.
127. "How do firms adjust their wage bill in Belgium? A decomposition along the intensive and extensive margins", by C. Fuss, *Research series*, January 2008.
128. "Exports and productivity – comparable evidence for 14 countries", by The International Study Group on Exports and Productivity, *Research series*, February 2008.
129. "Estimation of monetary policy preferences in a forward-looking model: a Bayesian approach", by P. Ilbas, *Research series*, March 2008.
130. "Job creation, job destruction and firms' international trade involvement", by M. Pisu, *Research series*, March 2008.
131. "Do survey indicators let us see the business cycle? A frequency decomposition", by L. Dresse and Ch. Van Nieuwenhuyze, *Research series*, March 2008.
132. "Searching for additional sources of inflation persistence: the micro-price panel data approach", by R. Raciborski, *Research series,* April 2008.
133. "Short-term forecasting of GDP using large monthly datasets - A pseudo real-time forecast evaluation exercise", by K. Barhoumi, S. Benk, R. Cristadoro, A. Den Reijer, A. Jakaitiene, P. Jelonek, A. Rua, G. Rünstler, K. Ruth and Ch. Van Nieuwenhuyze, *Research series*, June 2008.
134. "Economic importance of the Belgian ports: Flemish maritime ports, Liège port complex and the port of Brussels - report 2006" by S. Vennix, *Document series*, June 2008.
135. "Imperfect exchange rate pass-through: the role of distribution services and variable demand elasticity", by Ph. Jeanfils, *Research series*, August 2008.
136. "Multivariate structural time series models with dual cycles: Implications for measurement of output gap and potential growth", by Ph. Moës, *Research series*, August 2008.
137. "Agency problems in structured finance - a case study of European CLOs", by J. Keller, *Document series*, August 2008.
138. "The efficiency frontier as a method for gauging the performance of public expenditure: a Belgian case study", by B. Eugène, *Research series*, September 2008.
139. "Exporters and credit constraints. A firm-level approach", by M. Muûls, *Research series*, September 2008.
140. "Export destinations and learning-by-exporting: Evidence from Belgium", by M. Pisu, *Research series*, September 2008.
141. "Monetary aggregates and liquidity in a neo-Wicksellian framework", by M. Canzoneri, R. Cumby, B. Diba and D. López-Salido, *Research series*, October 2008.
142 "Liquidity, inflation and asset prices in a time-varying framework for the euro area, by Ch. Baumeister, E. Durinck and G. Peersman, *Research series*, October 2008.
143. "The bond premium in a DSGE model with long-run real and nominal risks", by Glenn D. Rudebusch and Eric T. Swanson, *Research series*, October 2008.
144. "Imperfect information, macroeconomic dynamics and the yield curve: an encompassing macro-finance model", by H. Dewachter, *Research series*, October 2008.
145. "Housing market spillovers: evidence from an estimated DSGE model", by M. Iacoviello and S. Neri, *Research series*, October 2008.
146. "Credit frictions and optimal monetary policy", by V. Cúrdia and M. Woodford, *Research series*, October 2008.
147. "Central Bank misperceptions and the role of money in interest rate rules", by G. Beck and V. Wieland, *Research series*, October 2008.
148. "Financial (in)stability, supervision and liquidity injections: a dynamic general equilibrium approach", by G. de Walque, O. Pierrard and A. Rouabah, *Research series*, October 2008.

149. "Monetary policy, asset prices and macroeconomic conditions: a panel-VAR study", by K. Assenmacher-Wesche and S. Gerlach, *Research series*, October 2008.
150. "Risk premiums and macroeconomic dynamics in a heterogeneous agent model", by F. De Graeve, M. Dossche, M. Emiris, H. Sneessens and R. Wouters, *Research series*, October 2008.
151. "Financial factors in economic fluctuations", by L. J. Christiano, R. Motto and M. Rotagno, *Research series*, to be published.
152. "Rent-sharing under different bargaining regimes: Evidence from linked employer-employee data", by M. Rusinek and F. Rycx, *Research series*, December 2008.
153. "Forecast with judgment and models", by F. Monti, *Research series*, December 2008.
154. "Institutional features of wage bargaining in 23 European countries, the US and Japan", by Ph. Du Caju, E. Gautier, D. Momferatou and M. Ward-Warmedinger, *Research series*, December 2008.
155. "Fiscal sustainability and policy implications for the euro area", by F. Balassone, J. Cunha, G. Langenus, B. Manzke, J Pavot, D. Prammer and P. Tommasino, *Research series*, January 2009.
156. "Understanding sectoral differences in downward real wage rigidity: workforce composition, institutions, technology and competition", by Ph. Du Caju, C. Fuss and L. Wintr, *Research series*, February 2009.
157. "Sequential bargaining in a New Keynesian model with frictional unemployment and staggered wage negotiation", by G. de Walque, O. Pierrard, H. Sneessens and R. Wouters, *Research series*, February 2009.
158. "Economic Importance of Air Transport and Airport Activities in Belgium", by F. Kupfer and F. Lagneaux, *Document series*, March 2009.
159. "Rigid labour compensation and flexible employment? Firm-Level evidence with regard to productivity for Belgium", by C. Fuss and L. Wintr, *Research series*, March 2009.
160. "The Belgian Iron and Steel Industry in the International Context", by F. Lagneaux and D. Vivet, *Document series*, March 2009.
161. "Trade, wages and productivity", by K. Behrens, G. Mion, Y. Murata and J. Südekum, *Research series*, March 2009.
162. "Labour flows in Belgium", by P. Heuse and Y. Saks, *Research series*, April 2009.
163. "The young Lamfalussy: an empirical and policy-oriented growth theorist", by I. Maes, *Research series*, April 2009.
164. "Inflation dynamics with labour market matching: assessing alternative specifications", by K. Christoffel, J. Costain, G. de Walque, K. Kuester, T. Linzert, S. Millard and O. Pierrard, *Research series*, May 2009.
165. "Understanding inflation dynamics: Where do we stand?", by M. Dossche, *Research series*, June 2009.