EUROPEAN CENTRAL BANK

WORKING PAPER SERIES
NO. 496 / JUNE 2005

EUROSYSTEM INFLATION PERSISTENCE NETWORK

ESTIMATES OF THE OPEN ECONOMY NEW KEYNESIAN PHILLIPS CURVE FOR EURO AREA COUNTRIES

by Fabio Rumler

EUROPEAN CENTRAL BANK

WORKING PAPER SERIES

NO. 496 / JUNE 2005

EUROSYSTEM INFLATION PERSISTENCE NETWORK

ESTIMATES OF THE OPEN ECONOMY NEW KEYNESIAN PHILLIPS CURVE FOR EURO AREA COUNTRIES [1]

by Fabio Rumler [2]

In 2005 all ECB publications will feature a motif taken from the €50 banknote.

This paper can be downloaded without charge from http://www.ecb.int or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=726690.

1 This paper has been written in the context of the Eurosystem Inflation Persistence Network (IPN). I would like to thank Jordi Gali, Jim Malley, Hans Scharler, Lars Sondergaard, an anonymous referee of the ECB Working Paper series and the participants in the Eurosystem Inflation Persistence Network for valuable comments and discussions. The views expressed in this paper are those of the author and do not commit in any way the Oesterreichische Nationalbank or the ECB. All errors are my own responsibility.

2 Oesterreichische Nationalbank, Economic Analysis Division, Otto Wagner Platz 3, A-1090 Vienna, Austria; e-mail: Fabio.Rumler@oenb.at

The Eurosystem Inflation Persistence Network

This paper reflects research conducted within the Inflation Persistence Network (IPN), a team of Eurosystem economists undertaking joint research on inflation persistence in the euro area and in its member countries. The research of the IPN combines theoretical and empirical analyses using three data sources: individual consumer and producer prices; surveys on firms' price-setting practices; aggregated sectoral, national and area-wide price indices. Patterns, causes and policy implications of inflation persistence are addressed.

The IPN is chaired by Ignazio Angeloni; Stephen Cecchetti (Brandeis University), Jordi Galí (CREI, Universitat Pompeu Fabra) and Andrew Levin (Board of Governors of the Federal Reserve System) act as external consultants and Michael Ehrmann as Secretary.

The refereeing process is co-ordinated by a team composed of Vítor Gaspar (Chairman), Stephen Cecchetti, Silvia Fabiani, Jordi Galí, Andrew Levin, and Philip Vermeulen. The paper is released in order to make the results of IPN research generally available, in preliminary form, to encourage comments and suggestions prior to final publication. The views expressed in the paper are the author's own and do not necessarily reflect those of the Eurosystem.

Address
Kaiserstrasse 29
60311 Frankfurt am Main, Germany

Postal address
Postfach 16 03 19
60066 Frankfurt am Main, Germany

Telephone
+49 69 1344 0

Internet
http://www.ecb.int

Fax
+49 69 1344 6000

Telex
411 144 ecb d

ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

CONTENTS

Abstract 4

Non-technical summary 5

1 Introduction 7

2 The model 8

- 2.1 Product demand 9
- 2.2 Production technology 11
- 2.3 Price setting 11

3 Estimation and results 14

- 3.1 The data 14
- 3.2 Empirical specification 15
- 3.3 Results 18
  - 3.3.1 Comparison of results across countries 19
  - 3.3.2 Comparison of results across specifications 20
  - 3.3.3 Results related to the reduced form specification 22

4 Conclusions 23

References 25

A Appendix 27

European Central Bank working paper series 37

Abstract

This paper extends the existing literature on the open economy New Keynesian Phillips Curve by incorporating three different factors of production, domestic labor and imported as well as domestically produced intermediate goods, into a general model which nests existing closed economy and open economy models as special cases. The model is then estimated for 9 euro area countries and the euro area aggregate. We find that structural price rigidity is systematically lower in the open economy specification of the model than in the closed economy specification indicating that when firms face more variable input costs they tend to adjust their prices more frequently. However, when the model is estimated in its general specification including also domestic intermediate inputs, price rigidity increases again compared to the open economy specification without domestic intermediate inputs.

JEL codes: E31, C22, E12
Keywords: New Keynesian Phillips Curve, Open Economy, GMM

Non-technical summary

There is vast evidence in the literature that the baseline New Keynesian Phillips Curve model with the labor share proxying real marginal cost as the driving variable of inflation can explain inflation dynamics in many large industrial economies reasonably well. However, a number of studies have also shown that the baseline model is not always appropriate in tracking inflation dynamics in particular for open economies as reduced form estimates for the marginal cost term are often found to be insignificant in these studies.

One reason for this could be the fact that the labor share as a proxy for real marginal cost covers only part of the total cost of production of the firm. It ignores the costs of material inputs which especially in the manufacturing industry account for a large part of the total costs of firms. In addition, part of the intermediate inputs are imported from abroad, which consist of mainly raw materials and energy. Usually the prices of imported inputs are more variable than of domestic labor as well as domestically produced intermediate inputs. This should - other things equal - induce firms to change their prices more frequently and possibly also by a larger amount in response to more variable input costs. If this behavior can be detected also in aggregate data, i.e. if additionally taking into account the costs of intermediate inputs in the marginal cost term of the New Keynesian Phillips Curve can explain price dynamics in the euro area countries more appropriately, is examined in this paper.

To do so the baseline model is extended in order to account for open economy effects as well as effects of intermediate goods in the production technology of the firm: The open economy New Keynesian Phillips Curve is derived from an open economy model in which international trade takes place at two levels of production. Monopolistically competitive firms sell their products to consumers at home and abroad as well as to domestic and foreign firms for their use as intermediate input. The production technology of a firm includes domestic labor, foreign and domestically produced intermediate goods as factors of production such that the relative prices of these factors affect marginal costs of production. The inflation dynamics equation is derived from the maximization of discounted profits of the firm assuming a Calvo pricing rule. In addition, a group of price setters is assumed to follow a simple rule of thumb updating their prices with past inflation which gives rise to a hybrid form of the New Keynesian Phillips Curve. The formulation of our general model including imported as well as domestically produced intermediate inputs in production nests existing closed and open economy models of the New Keynesian Phillips Curve.

The model is then estimated for 9 euro area countries and the euro area aggregate with data from 1970 to 2003 Q2 in three different specifications: the closed economy specification with only the labor share as the driving variable of inflation, the open economy specification with imported intermediate goods in production, and the more general open economy specification which additionally includes also domestically produced intermediate inputs in production. Our general finding from these estimations is that open economy aspects matter for the performance and the fit of the NKPC. In particular, we find that the degree of structural price rigidity as measured by the Calvo probability of changing a price is systematically higher for the closed economy specification than in the open economy specification with only imported intermediate inputs in production. This could be explained by the fact that when firms face more variable input costs as they import from volatile international markets they tend to adjust their prices more frequently. When comparing the open economy specification with only imported intermediate inputs and the most general specification with imported and domestically produced intermediate inputs structural price rigidity is found to be systematically higher in the latter case. This could be due to substitution of imported by domestic intermediate goods when the relative price of the former increases, thus mitigating the need for the firm to adjust prices. The general open economy model including both imported as well as domestic intermediate inputs was also found to be the most appropriate specification to characterize the inflation process in most euro area countries as it could fit the data best in the reduced form estimations of the model.

1 Introduction

There is vast evidence in the literature that the baseline New Keynesian Phillips Curve model with the labor share proxying real marginal cost as the driving variable of inflation can explain inflation dynamics in many large industrial economies reasonably well; see Gali and Gertler [6] and Sbordone [18] for the US, and Gali, Gertler and Lopez-Salido [7], McAdam and Willman [14] for the euro area and Balakrishnan and Lopez-Salido [1] for the UK.

However, a number of studies have also shown that the baseline model is not always appropriate in tracking inflation dynamics in particular for open economies, see Balakrishnan and Lopez-Salido [1] for the UK, Bardsen et al. [2] for European countries, Freystätter [5] for Finland, Rubene and Guarda [17] for Luxembourg, and Sondergaard [20] for Germany, France and Spain. Reduced form estimates for the marginal cost term in the baseline model are often found to be insignificant in these studies.

The problem with the labor share as a proxy for real marginal cost is the fact that it covers only part of the total cost of production of the firm. It ignores the costs of material inputs which especially in the manufacturing industry account for a large part of the total costs of firms.[1] In addition, part of the intermediate inputs are imported from abroad, which consist of mainly raw materials and energy but also semi-manufactured inputs from other industrial economies. Usually the prices of imported inputs are more variable than of domestic labor as well as domestically produced intermediate inputs. This should - other things equal - induce firms to change their prices more frequently and possibly also by a larger amount in response to more variable input costs. If this behavior can be detected also in aggregate data, i.e. if additionally taking into account the costs of intermediate inputs in the marginal cost term of the New Keynesian Phillips Curve (NKPC) can explain price dynamics in the euro area countries more appropriately, will be examined in the second part of this paper.

In this paper the baseline model is extended in order to account for open economy effects as well as effects of intermediate goods in the production technology of the firm. Real marginal cost as a driving variable for inflation is decomposed into the relative prices of three different factors of production:

[1] In Germany, for instance, the proportion of the costs of intermediate inputs compared to the wage costs in the total economy amounted to about 60:40 on average from 1991 to 2003. According to the German input-output tables for 2000 the intermediate inputs and wage costs together accounted for about 80% of the total value of nominal output, while wage costs alone would only account for about 30% of the value of output. Similar figures can be cited for other countries.

real unit labor costs and the prices of imported and domestically produced intermediate goods. The formulation of our general model including imported as well as domestically produced intermediate inputs in production nests existing closed and open economy models of the hybrid NKPC.

The model is then estimated for the closed economy case, the case with only imported intermediate inputs and in the general formulation with imported and domestically produced intermediate inputs in different specifications for 9 euro area countries and the euro area aggregate with data from 1970 to 2003 Q2 (for some countries shorter or longer time series are available). Our general finding from these estimations is that open economy aspects matter for the performance and the fit of the NKPC. We find that the degree of structural price rigidity as measured by the Calvo probability of changing a price is systematically higher for the closed economy specification than in the open economy specification with only imported intermediate inputs in production. This could be explained by the fact that when firms face more variable input costs as they import from volatile international markets they tend to adjust their prices more frequently. When comparing the open economy specification with only imported intermediate inputs and the most general specification with imported and domestically produced intermediate inputs structural price rigidity is found to be systematically higher in the latter case. This could be due to substitution of imported by domestic intermediate goods when the relative price of the former increases, thus mitigating the need for the firm to adjust prices.

This paper is structured as follows. Section 2 introduces the theoretical model with monopolistically competitive firms employing three different input factors in the production of their output which is then used by consumers as final demand and by other firms as intermediate input. The open economy hybrid NKPC is derived from the profit maximization problem of the firm under the Calvo pricing assumption. The model is then put to the data of 9 euro area countries and the euro area aggregate. Issues on the empirical implementation of the model, in particular the different specifications for which the model is estimated, are discussed and the results of the estimations are presented and interpreted in section 3. Finally, section 4 concludes the paper.

2 The Model

The open economy New Keynesian Phillips Curve is derived from an open economy model in which international trade takes place at two levels of production. Monopolistically competitive firms sell their products to consumers at home and abroad as well as to domestic and foreign firms for their use as intermediate input. So, the representative firm's output is used partly for domestic and foreign final demand and partly as intermediate input in the production of domestic and foreign firms. The production technology of a firm includes domestic labor, foreign and domestically produced intermediate goods as factors of production such that the relative prices of these factors affect marginal costs of production. The firm's price setting behavior is derived from the maximization of future discounted profits assuming Calvo [4] type pricing, i.e. firms are allowed to reset their price after a random interval of time. In addition, we assume that within the group of Calvo price setters some follow a rule of thumb updating their prices with past inflation while the rest sets its price optimally which gives rise to a hybrid open economy NKPC. The model is based on the line of research started by Gali and Gertler [6] and Gali, Gertler and Lopez-Salido [7] on the hybrid specification of the NKPC. It draws heavily on the open economy NKPC model of Leith and Malley [13] extending their model by introducing a third factor of production, i.e. domestically produced intermediate goods, in order to allow firms to shift between domestic and foreign inputs in production. Related models also specifying a variant of the open economy NKPC can be found in Balakrishnan and Lopez-Salido [1], Razin and Yuen [16] and Gali and Lopez-Salido [8].

2.1 Product Demand

In our open economy model consumers derive their utility from a consumption bundle including domestic and foreign consumption goods:

$$C_t = \left[\chi^{\frac{1}{\eta}} \left(c_t^d \right)^{\frac{\eta-1}{\eta}} + (1-\chi)^{\frac{1}{\eta}} \left(c_t^f \right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \qquad (1)$$

where $c_t^d = \left[\int_0^1 c_t^d(z)^{\frac{\varepsilon-1}{\varepsilon}} dz \right]^{\frac{\varepsilon}{\varepsilon-1}}$ and $c_t^f = \left[\int_0^1 c_t^f(z)^{\frac{\varepsilon-1}{\varepsilon}} dz \right]^{\frac{\varepsilon}{\varepsilon-1}}$ are again CES indices of consumption goods produced in the home and foreign country, ε is the elasticity of substitution of goods within one country and η the elasticity of substitution of consumption bundles between countries and χ is the parameter representing the home bias in consumption. By assuming $\varepsilon \neq \eta$ we allow the substitutability of goods within countries to differ from the subsitutatbility of goods across countries.[2]

[2]see Tille [21]. Most other contributions like the well known paper by Obstfeld and Rogoff [15] focus on the case where $\varepsilon = \eta$. In our application, however, η appears only implicitly in the NKPC and does not feature as a structural paramter to be estimated or calibrated.

The associated consumption price index which minimizes the cost of purchasing one unit of the composite consumption bundle C_t is given by

$$P_t = \left[\chi \left(p_t^d\right)^{1-\eta} + (1-\chi)\left(p_t^f\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}, \tag{2}$$

where also $p_t^d = \left[\int_0^1 p_t^d(z)^{1-\varepsilon} dz\right]^{\frac{1}{1-\varepsilon}}$ and $p_t^f = e_t \left[\int_0^1 p_t^{*f}(z)^{1-\varepsilon} dz\right]^{\frac{1}{1-\varepsilon}}$ are the price indices associated with domestic and foreign production (in domestic currency), e_t being the nominal exchange rate (where foreign variables are denoted with an asterisk).

In addition to domestic and foreign consumers, the product of each individual firm is also demanded by domestic and foreign producers as intermediate input in their production. So, the output of each firm is partly used for final consumption and partly as intermediate inputs by other firms. Accordingly, the bundles of domestically produced goods used in domestic and foreign production as intermediate inputs are defined by $m_t^d = \left[\int_0^1 m_t^d(z)^{\frac{\varepsilon-1}{\varepsilon}} dz\right]^{\frac{\varepsilon}{\varepsilon-1}}$ and $m_t^{*d} = \left[\int_0^1 m_t^{*d}(z)^{\frac{\varepsilon-1}{\varepsilon}} dz\right]^{\frac{\varepsilon}{\varepsilon-1}}$ where the degree of substitutability between intermediate goods is assumed to be the same as between consumption goods.

Given that domestic and foreign consumers and domestic and foreign producers all demand the product of each individual firm and allocate their demands for consumption and intermediate goods across countries and products with the same pattern, the global demand for the output of firm z is given by[3]

$$y_t^d(z) = \left(\frac{p_t^d(z)}{p_t^d}\right)^{-\varepsilon}\left(c_t^d + c_t^{*d} + m_t^d + m_t^{*d}\right). \tag{3}$$

The demand for the firm's product depends on the price charged by the firm relative to the other domestically produced goods and the total demand

[3]Implicitly consumers and input demanding firms pursue a 2-step optimization by first allocating their demand across countries, which in the case of the domestic demand for domestically produced consumption goods yields $c_t^d = (p_t^d/P_t)^{-\eta}\chi C_t$, and in a second step within a country, which in the case of the demand for a specific domestic firm's consumption good yields $c_t^d(z) = (p_t^d(z)/p_t^d)^{-\varepsilon} c_t^d$ with c_t^d being given by the above expression. The total demand for a domestic firm's output is then the sum of the demand for its consumption good at home and abroad, c_t^d and c_t^{*d} (for which an equivalent expression can be found), as well as for its output employed as intermediate input by domestic and foreign firms, m_t^d and m_t^{*d}, which leads to expression (3).

of domestic and foreign consumers as well as producers allocated to domestic goods.

2.2 Production Technology

Each individual firm produces its output employing labor and domestic as well as foreign intermediate goods as variable factors of production and a fixed amount of capital

$$y_t(z) = \left(\alpha_N N_t(z)^{\frac{\rho-1}{\rho}} + \alpha_d m_t^d(z)^{\frac{\rho-1}{\rho}} + \alpha_f m_t^f(z)^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{(\rho-1)\phi}} \overline{K}^{1-\frac{1}{\phi}}, \qquad (4)$$

where $N_t(z)$, $m_t^d(z)$ and $m_t^f(z)$ are domestic labor, domestically produced and imported intermediate inputs used in production by firm z and α_N, α_d and α_f are the weights of these factors in the production function. The inputs enter the production function as imperfect substitutes where ρ is the constant elasticity of substitution between them and $1 - \frac{1}{\phi}$ represents the weight of fixed capital in production.

To derive marginal costs from this production function we note that the variable factors of production when combined with fixed capital display decreasing marginal returns which induces an increasing marginal cost function and thus a dependence of marginal costs on firm specific output. Firm specific real marginal costs of firm z can then shown to be

$$MC_t(z) = \phi \left[\frac{W_t N_t(z) + p_t^d m_t^d(z) + p_t^f m_t^f(z)}{P_t y_t(z)}\right]. \qquad (5)$$

2.3 Price Setting

Firms set their prices by maximizing real variable profits facing the constraints implied by Calvo contracts in that they can only change their prices after a random interval of time. Specifically, firms are allowed to change their price with a fixed probability $1 - \theta$ in a given period while they keep their price constant with probability θ. Thus, when deriving the profit maximizing price firms take into account that the price may be in effect for a long period of time and therefore discount future profits with the probability θ. The optimization problem of the firm in period t can then be written as

$$\frac{\Pi_t(z)}{P_t} = E_t \sum_{s=0}^{\infty} \frac{\theta^s \left[\frac{x_t}{P_{t+s}} \left(\frac{x_t}{p_{t+s}^d} \right)^{-\varepsilon} \widetilde{y}_{t+s} - MC_t \left(\frac{x_t}{p_{t+s}^d} \right)^{-\varepsilon\phi} \widetilde{y}_{t+s}^{\phi} \right]}{\prod_{j=1}^{s} r_{t+j-1}}, \tag{6}$$

where $\Pi_t(z)$ denotes variable profit of the firm, x_t is the newly set optimal price, $\widetilde{y}_{t+s}$ summarizes total demand for domestic goods $(c_{t+s}^d + c_{t+s}^{*d} + m_{t+s}^d + m_{t+s}^{*d})$ from the demand function (3), MC_t is the part of real marginal cost that is not firm specific[4] and r_t is the stochastic discount rate.

Since under the Calvo pricing assumption only a fraction of firms are allowed to reset their price every period, the index of output prices can be shown - by making use of the Law of Large Numbers - to be a weighted average of prices reset in period t and the previous period's price index

$$\left(p_t^d\right)^{1-\varepsilon} = \theta \left(p_{t-1}^d\right)^{1-\varepsilon} + (1-\theta)\left(p_t^r\right)^{1-\varepsilon}, \tag{7}$$

where p_t^r is the reset price in period t. In addition to pure Calvo pricing we also assume that within the group of firms who are allowed to reset its price in a given period a fraction of firms do not set their prices based on the optimization but instead follow a simple rule of thumb. This deviation from optimality by part of the firms is common in the literature and can be rationalized by costs of price adjustment (not modeled here) which become severe especially for firms which receive the random signal of price adjustment within short intervals. With the fraction ω of firms who use the rule of thumb the average reset price in period t is given by

$$p_t^r = \omega p_t^b + (1-\omega)\, x_t, \tag{8}$$

where p_t^b is the price set according to the rule of thumb which is assumed to be the average reset price of the previous period updated with last period's inflation rate

$$p_t^b = p_{t-1}^r \left(1 + \pi_{t-1}^d\right). \tag{9}$$

The assumption of part of the firms following a backward-looking rule of thumb gives rise to the hybrid formulation of the New Keynesian Phillips Curve which has been introduced by Gali and Gertler [6] and widely used in the literature since then.

[4] $MC_t(z)$ can be shown to equal $\phi y_t(z)^{\phi-1} MC_t$ where MC_t is a function of the prices of the factors of production and the parameters in the production function that are common to all firms.

Maximizing the firm's real profits given in (6) with respect to x_t and applying the Calvo pricing assumptions just outlined and after log-linearizing the system around a zero-inflation steady state gives rise to an open economy hybrid New Keynesian Phillips Curve

$$\widehat{\pi}_t^d = E_t \frac{\theta\beta}{\Delta} \widehat{\pi}_{t+1}^d + \frac{\omega}{\Delta} \widehat{\pi}_{t-1}^d + \frac{(1-\theta)(1-\omega)(1-\theta\beta)}{[\varepsilon(\phi-1)+1]\Delta} \left[\widehat{MC}_t + \widehat{P}_t - \widehat{p}_t^d + (\phi-1)\,\widehat{\widetilde{y}}_t \right], \tag{10}$$

where $\widehat{\pi}_t^d = \widehat{p}_t^d - \widehat{p}_{t-1}^d$ and $\Delta = \theta + \omega[1-\theta(1-\beta)]$ and $\beta = \frac{1}{\overline{r}}$ is the steady-state discount rate of future profits. Hatted variables denote deviations from steady state and barred variables represent steady state values.

In order to transform the open economy NKPC in (10) into a form appropriate for estimation we first note that the marginal cost term that is not firm specific can be decomposed in terms of the prices of all factors of production, namely wages and domestic and foreign intermediate input prices (in log-linearized form)

$$\widehat{MC}_t = \frac{\frac{\overline{w}}{\overline{P}}\widehat{w}_t + \frac{\overline{p}^d}{\overline{P}}\left(\frac{\overline{w}}{\overline{p}^d}\frac{\alpha_d}{\alpha_N}\right)^{\rho}\widehat{p}_t^d + \frac{\overline{p}^f}{\overline{P}}\left(\frac{\overline{w}}{\overline{p}^f}\frac{\alpha_f}{\alpha_N}\right)^{\rho}\widehat{p}_t^f}{\frac{\overline{w}}{\overline{P}} + \frac{\overline{p}^d}{\overline{P}}\left(\frac{\overline{w}}{\overline{p}^d}\frac{\alpha_d}{\alpha_N}\right)^{\rho} + \frac{\overline{p}^f}{\overline{P}}\left(\frac{\overline{w}}{\overline{p}^f}\frac{\alpha_f}{\alpha_N}\right)^{\rho}} - \widehat{P}_t. \tag{11}$$

Plugging this expression into (10) and applying some further substitutions,[5] the term in square brackets in equation (10) can be expressed in terms of the relative prices of the factors of production and the labor share

$$[\ldots] = \begin{array}{l} \widehat{s}_{nt} - (\phi-1)\frac{\overline{s}_{m^d}+\overline{s}_{mf}}{1+(1-\phi)\left(\overline{s}_{m^d}+\overline{s}_{mf}\right)}\widehat{y}_t + \frac{\overline{s}_{mf}}{1+(1-\phi)\left(\overline{s}_{m^d}+\overline{s}_{mf}\right)}\left(\widehat{p}_t^d - \widehat{p}_t^f\right) - \\ \left[(1-\rho)\frac{\overline{s}_{m^d}}{\overline{s}_n+\overline{s}_{m^d}+\overline{s}_{mf}} + \rho\frac{\overline{s}_{m^d}}{1+(1-\phi)\left(\overline{s}_{m^d}+\overline{s}_{mf}\right)}\frac{\overline{s}_n}{\overline{s}_n+\overline{s}_{m^d}+\overline{s}_{mf}}\right]\left(\widehat{w}_t - \widehat{p}_t^d\right) - \\ \left[(1-\rho)\frac{\overline{s}_{mf}}{\overline{s}_n+\overline{s}_{m^d}+\overline{s}_{mf}} + \rho\frac{\overline{s}_{mf}}{1+(1-\phi)\left(\overline{s}_{m^d}+\overline{s}_{mf}\right)}\frac{\overline{s}_n}{\overline{s}_n+\overline{s}_{m^d}+\overline{s}_{mf}}\right]\left(\widehat{w}_t - \widehat{p}_t^f\right) \end{array}, \tag{12}$$

where $s_n = \frac{wN}{p^d y}$, $s_{m^d} = \frac{p^d m^d}{p^d y}$ and $s_{mf} = \frac{p^f m^f}{p^d y}$ are the shares of labor, domestic intermediate goods and imported intermediate goods in GDP and $\phi = \frac{(\varepsilon-1)\left(1+\overline{s}_{m^d}+\overline{s}_{mf}\right)}{\varepsilon\left(\overline{s}_n+\overline{s}_{m^d}+\overline{s}_{mf}\right)}$ can be derived from the steady-state markup and the steady-state labor and intermediate goods shares in production.

[5]In the case of intermediate goods in production the definition of aggregate firm output appearing in our model differs from the definition of GDP (value added) which is normally used in empirical applications of the NKPC. Therefore, we need to reformulate (10) by substituting aggregate firm output, $\widetilde{y}_t$, with GDP, y_t. The derivations are available on request.

From (12) we see that the driving variable of inflation in the open economy case with intermediate goods depends on the log deviation of the labor share, $\widehat{s}_{nt}$ (as in the closed economy case), the domestic real labor costs, $\widehat{w}_t - \widehat{p}_t^d$, representing the relative costs of domestic labor and domestically produced intermediate goods, the relative price of domestic labor and imported intermediate goods, $\widehat{w}_t - \widehat{p}_t^f$, the terms of trade, $\widehat{p}_t^d - \widehat{p}_t^f$, representing the relative price of domestically produced and imported intermediate goods, and a term reflecting the decreasing marginal return to production (second term). The weights with which these relative prices enter the expression are determined by the steady state shares of the three factors of production in GDP and the elasticity of substitution between them.

This general specification of the open economy hybrid NKPC nests other open and closed economy models of the NKPC. With the share of domestically produced intermediate goods, s_m^d, set to 0 it reduces to the open economy NKPC model of Leith and Malley [13] and additionally setting the share of imported intermediate goods, s_m^f, to 0 yields the standard closed economy specification of the NKPC as for instance in Sbordone [18] or Gali et al. [7]. Gali and Lopez-Salido [8] and Balakrishnan and Lopez-Salido [1] derive an open economy NKPC for Spain and the UK only taking into account imported intermediate goods in production but not trade in final consumption goods which is thus also nested in our general model.

3 Estimation and Results

3.1 The Data

The open economy New Keynesian Phillips Curve is estimated for 9 euro area countries and the euro area aggregate. For Luxembourg, Ireland and Portugal the NKPC could not be estimated either due to the lack of appropriate data or too short time series. The data for the estimation of the country NKPCs have been obtained from two sources, the database of macroeconomic time series compiled for the Inflation Persistence Network and from the New Chronos database provided by Eurostat. The data for real and nominal GDP, the GDP deflator, compensation to employees, employment, real and nominal imports and the import deflator have been taken from the IPN database and the data on intermediate inputs have been downloaded from the national accounts database on New Chronos. Information on the share of imported intermediate goods in total imports have been calculated from input-output tables when available on the New Chronos database. In case the input-output tables for some countries have been available for more years (New Chronos reports input-output tables for 1995, 1997 and 2000) the imported intermediate goods share has been averaged over the available years. The data on intermediate inputs which are available only at annual frequency have been disaggregated to quarterly frequency with the help of Ecotrim, a software for temporal disaggregation supplied by Eurostat. The shares of domestically produced and imported intermediate inputs, s_m^d and s_m^f, have been calculated as nominal intermediate inputs - decomposed into domestic and imported shares - divided by nominal GDP and the labor share, s_n, is total compensation to employees divided by GDP.

3.2 Empirical Specification

We estimate the structural parameters of the model outlined in the previous section employing a single equation approach. Equation (10) "including" (12) is estimated employing the generalized method of moments (GMM) estimator proposed by Hansen [11] which has been widely used in solving the orthogonality conditions implied by forward-looking rational expectations models - as in our model, see Verbeek [22]. There is, however, a debate in the literature on the appropriate estimation method for the hybrid specification of inflation dynamics equations like the NKPC. A widely used alternative to the instrumental variables approach adopted in this paper is the estimation of the structural parameters of the NKPC by maximum likelihood (ML). As Gali et al. [9] note, the debate which approach is most appropriate is completely open. There exists a trade-off of the form that GMM estimates are sensitive to the choice of instruments while ML relies on normality of the error term and on appropriate assumptions on the structure of the economy. Jondeau and Le Bihan [12] have shown that estimated coefficients under both methods are biased in small samples and in case of misspecified model dynamics, but they are biased in opposite directions, thus not indicating the dominance of one approach over the other. In a recent note Gali et al. [9] convincingly demonstrate that their GMM estimates of the hybrid NKPC obtained in Gali and Gertler [6] and Gali et al. [7] are robust to a variety of different estimation procedures - including also ML. Thus, we believe that the GMM estimator based on an appropriately chosen instrument set entails only a relatively small finite sample bias and delivers quite reliable parameter estimates of the NKPC. Apart from that, the GMM approach was also chosen for comparison with most existing studies on the NKPC which adopted this approach.

The structural parameters which are estimated in our empirical specifications include θ, the probability that a firm keeps a fixed price in a given period, β, the steady-state discount factor of firms, ω, the fraction of firms following the rule of thumb and ρ, the elasticity of substitution between labor, domestic and imported intermediate inputs in production. However, the elasticity of demand of the firm's product, ε, cannot be estimated econometrically, as it does not appear in the estimation equation, but has to be calibrated in order to derive an empirical value for the elasticity of substitution between capital and the variable factors of production, ϕ. In calibrating ε we follow the literature (see Gali et al. [7], Leith and Malley [13]) and adopt a value of 11 as a baseline implying a steady-state markup of prices over marginal costs $\mu = \frac{\varepsilon}{\varepsilon-1}$ of 1.1.

One important point concerning the empirical implementation of our open economy NKPC is the choice of the price index for the dependent variable domestic output inflation, π_t^d. In the model the price set by a firm is its output price. The output is then used for final consumption demand and intermediate inputs of other forms at home or abroad. Empirically, the appropriate index that measures aggregate output prices is the output deflator. However, output deflators are not available from current accounts statistics for the euro area countries. Another candidate as the empirical counterpart of aggregate output prices is the producer price index (PPI). There are, however, two considerations that limit the use of the producer price index for our estimations: First, also the producer price index for many euro area countries is available only for too short time periods (e.g. for Austria only since 2000) and, second, it does not exactly measure output prices as defined in our model since it only measures prices at the industrial producer level but not at the final demand level. Given this and in order for our results to be comparable to other studies the value added (GDP) deflator has been chosen as the dependent variable of our empirical model. While on conceptual grounds it is clear that the value added deflator is not the appropriate index to measure output prices, empirically, given the principle of double-deflation employed by statistical agencies in national accounts statistics, the output deflator and the value added deflator are not too different from each other if a rapid pass-through from input to output prices is assumed.[6] A rapid pass-through is not an unrealistic assumption at the annual frequency for which the output deflator is usually measured and given the fact that the output deflator and the value added deflator display the same seasonal pattern as they are converted from annual to quarterly frequency with the

[6]This has been verified for the Austrian case where the output deflator was directly available.

help of the same indicator variables (e.g. wholesale prices, producer prices, CPI components) considering the GDP deflator in our estimations at the quarterly frequency should not make any significant difference as compared to the output deflator. Moreover, given that in our model the firm charges the same price for its output regardless if it is used for final demand or intermediate inputs by other firms, the empirical price index used for the price of domestically produced intermediate goods is also the GDP deflator.[7]

For each country a number of different specifications of equation (10) are estimated by GMM and displayed in the tables below. Following Gali et al. [7] two alternative specifications of the orthogonality conditions are considered. In the first specification 10 is estimated directly imposing the orthogonality conditions while in the second specification the nonlinearities are minimized by pre-multiplying the equation with Δ:[8]

$$E_t\left(\left[\pi_t^d - \frac{\theta\beta}{\Delta}\pi_{t+1}^d - \frac{\omega}{\Delta}\pi_{t-1}^d - \frac{(1-\theta)(1-\omega)(1-\theta\beta)}{[\varepsilon(\phi-1)+1]\Delta}(.....)\right]z_t\right) = 0 \quad (13)$$

$$E_t\left(\left[\Delta\pi_t^d - \theta\beta\pi_{t+1}^d - \omega\pi_{t-1}^d - \frac{(1-\theta)(1-\omega)(1-\theta\beta)}{[\varepsilon(\phi-1)+1]}(.....)\right]z_t\right) = 0 \quad (14)$$

where z_t is a vector of instruments. The set of instruments has been selected for each country individually based on the criteria that they should display a high correlation with the regressors and they satisfy the overidentifying restrictions of Hansen's J-test: From a matrix showing the correlations of a large number of potential instruments with all regressors the variables (and the lags) with the highest correlation have been selected as instruments. The results on the J-test of overidentifying restrictions has not been reported in the tables below because they turned out to be far from rejecting the validity of the overidentifying restrictions for any of the presented estimations (the lowest p-value was 0.4; the results are available on request). The hatted variables are calculated as deviations from a quadratic trend in order to in-

[7]The validity of this choice has also been checked for Austrian data. It turned out that the deflator of total intermediate inputs can be approximated by a weighted average of the GDP deflator and the import deflator with the share of imported and domestically produced intermediate goods being the weights.

[8]In case of a zero inflation steady state which is assumed in this model $\widehat{\pi}_t^d$ and π_t^d are equivalent.

duce stationarity.[9] Newey-West corrected standard errors which are robust to heteroskedasticity and autocorrelation of unknown form are employed in the coefficient's significance tests. This correction is especially important when the variance of the dependent variable (inflation) changes over time, which for instance could be due to one or more regime shifts of monetary or exchange rate policy in the sample period. The number of lags considered for the computation of the coviarance matrix was based on a rule proposed by Newey-West depending on the sample length (e.g. 4 lags for a sample of 120 quarters).

3.3 Results

The estimation results are summarized in tables 1 to 10 in the appendix. All tables give the estimates of the structural parameters θ, β, ω and ρ along with the significance levels and report the expected duration of prices in months in the last column which has been derived from θ by the formula $\frac{3}{1-\theta}$. The estimation results of the different model specifications are listed in the rows of the tables: In model M1 we estimate the specification for the closed economy without intermediate inputs in production, i.e. the standard specification of closed economy hybrid New Keynesian Phillips curve models widely used in the literature, e.g. in Gali et al. [7] and others. Model M2 includes imported intermediate goods in production but no domestically produced inputs which is the specification adopted in the previous literature on open economy NKPCs, as in Leith and Malley [13]. Model M3 is the most general formulation of the open economy NKPC as developed in this paper, as it includes domestic and imported intermediate inputs in production. Furthermore, the models with extension A are estimated according to the first specification mentioned above (equation (13)) and the models with extension B are based on the second specification (equation (14)). In addition to the baseline models of each class where the elasticity of substitution between the variable factors of production, ρ, is freely estimated, a second specification is displayed where ρ is restricted to 1, implying a Cobb-Douglas production function. In the lower part of the tables the estimates of the reduced form coefficients are reported for those specifications (M1, M2, M3) where the marginal cost term was significant. Specifically, the reduced form

[9] Apart from a quadratic trend, alternative detrending methods have also been considered in the estimation of the different specifications: These include subtracting a linear trend, a cubic trend, an HP-filtered trend, and the sample mean from the series. Comparing these alternative estimations we find that the results for the cubic and the quadratic trend are very similar and that the specification with a simple deviation from mean is not sufficient to remove the trend present in most series and to induce stationarity. The results are available from the author on request.

coefficients estimates along with their significance levels were obtained from the estimation of the following reduced form model (the notation follows Gali et al. [6]) $\widehat{\pi}_t^d = E_t \gamma_f \widehat{\pi}_{t+1}^d + \gamma_b \widehat{\pi}_{t-1}^d + \lambda\,[.....]$. In the last row of each table the specific instrument set that was used in the estimations of the different specifications for each country is listed.

3.3.1 Comparison of results across countries

In discussing the results we want to focus on some systematic findings that emerge from the comprehensive evidence on estimations of different specifications of the hybrid NKPC for 9 euro area countries and the euro area itself. When screening the tables one striking result is the large degree of heterogeneity in the estimated structural parameters of the price setting model across euro area countries but also across specifications for each country. Concerning the estimated persistence of prices measured by both, θ and ω, we realize that persistence seems to be highest in Germany (table 3) and for the euro area aggregate (table 10) and lowest for Greece (table 7), the Netherlands (table 9) and Finland (table 5) while the results for Spain (table 4), France (table 6) and Italy (table 8) are fairly similar displaying an intermediate degree of persistence. The fact that persistence is found to be higher in countries with rather closed economies than in countries with rather open economies can be taken as a first indication that open economy considerations matter for the NKPC. This question, however, is formally tested across specifications within each country which will be presented in the next subsection.

When comparing the results with those of related studies and bearing in mind all the differences concerning instruments used and the sample length we find that they are more or less in line with Gali et al. [7] and McAdam and Willman [14] for the euro area. Our estimate for θ in the closed economy specification A of 0.78 is very similar to 0.79 in Gali et al. and 0.8 in McAdam and Willman while the estimates for β and ω are quite lower in Gali et al. but similar in McAdam and Willman. Comparing our results for Spain to those obtained by Gali and Lopez-Salido [8] we realize a considerable difference in that our estimates for θ and ω are consistently lower and the estimates for β are consistently higher than in the other paper for both, the closed economy as well as the open economy specifications. There is, however, an important difference in the empirical implementation of the NKPC in that Gali and Lopez-Salido consider only the case of constant returns to labor in production while we assume decreasing returns to labor (and imported intermediate goods). Compared to Sondergaard [20] our results for Italy, France and Spain yield somewhat lower estimates for the persistence parameter θ in the open economy specification but a comparison of the results between the two papers is difficult as the empirical implementation of the NKPC is rather different in Sondergaard (he uses other price indices and focuses on the traded sector only). Finally, our results for Germany, France and Spain are quite similar to the results in Leith and Malley [13] who estimate an open economy NKPC (corresponding to M2 in this paper) for the G7 countries. In particular, the ranking of the three countries with respect to price rigidity is the same in both papers with Germany showing the most rigid price setting behavior, followed by France and Spain.

3.3.2 Comparison of results across specifications

Next we focus on the question if structural price rigidity as derived from our results differs for different specifications of the same country. When comparing the estimates of the "price rigidity parameter" θ between the closed economy formulation M1 and the open economy formulation M2 a systematic difference emerges of the form that estimated price rigidity tends to be lower when imported intermediate prices are allowed to affect firm's marginal costs.[10] This is consistent with the idea that firms whose input prices vary more (due e.g. to volatile raw material prices) also adjust their prices more frequently than others. Exceptions from this tendency are Spain, Greece and Austria where the coefficients are basically unaffected by the introduction of open economy effects. The comparison of coefficients across models is summarized in Table 11 which shows the difference in the estimates of θ and ω between M1 and M2 in the first row of each country panel, the %-difference in parenthesis and the t-value for a t-test of statistically significant parameter difference of non-nested models.[11] Table 11 reveals that

[10] There is a discussion in the literature which parameter of the model appropriately indicates the degree of price rigidity in the case of a hybrid NKPC. Besides the probability of a price change, price rigidity can also be associated to the share of backward looking firms, ω, as they introduce some past-dependence in the pricing process. Based on this reasoning, Benigno and Lopez-Salido [3] propose a formula that combines θ and ω to derive the average duration between price changes: $D = \frac{1}{1-\theta}\frac{1}{1-\omega}$. However, as this derivation is valid only under certain assumptions and in order to be comparable to other studies we report the implied duration between price changes in the conventional form $D = \frac{1}{1-\theta}$ and interpret θ as the parameter indicating price rigidity.

[11] The test statistic is $\frac{\widehat{\theta}_{M1}-\widehat{\theta}_{M2}}{\sqrt{\widehat{\sigma}^2_{\theta_{M1}}+\widehat{\sigma}^2_{\theta_{M2}}}}$ where $\widehat{\sigma}_{\theta_{M1}}$ and $\widehat{\sigma}_{\theta_{M2}}$ are the empirical standard deviations of the coefficient estimates of $\widehat{\theta}_{M1}$ and $\widehat{\theta}_{M2}$. This test statistic is t-distributed with $(n_1+n_2-k_1-k_2)$ degrees of freedom where n_1 and n_2 are the number of observations underlying the estimation of M1 and M2, respectively, and k_1 and k_2 are the number of coefficients to be estimated in M1 and M2.

in 70% of all comparisons of M1 and M2 (14 out of 20 total specifications, i.e. specification A and B for each country) θ is higher for M1 than for M2, the average %-difference between the two models is 15.8% but the difference is never statistically significant for these 14 cases. There is only one statistically significant difference when comparing θ between M1 and M2 for France in specification B, but the difference goes the other direction, i.e. $\widehat{\theta}_{M1} - \widehat{\theta}_{M2} < 0$. In general it is very hard to find significant results in Table 11 on the difference of coefficients that are bounded between 0 and 1 (most of them even vary within a much smaller range between 0.4 and 0.7 in the case of θ) but a difference of more than 10% implying a difference in price duration of 1 to 2 months can be interpreted to be at least economically significant. The result that structural price rigidity turned out to be smaller in the open economy specification compared to the closed economy specification has also been found in Rubene and Guarda [17] for Luxembourg, while no significant difference across closed and open economy specifications has been found in Leith and Malley [13] for the G7 countries.

Interestingly, when moving from the open economy specification M2 to the most general model M3 - with imported and domestically produced intermediate inputs - θ is systematically found be be higher than in M2, many times also higher than in the closed economy case. This could reflect substitution of imported intermediate goods by domestic intermediate goods when the relative price of the former increases, thus mitigating the need for the firm to adjust prices. Table 11 reveals that in all but one cases (95%) θ increases from M2 to M3 and for 5 out of 10 countries even significantly. The average %-difference between θ in M2 and M3 over all specifications is 24.7%. In 75% of the cases price rigidity as measured by θ in M3 is also higher than in the closed economy specification M1, for 3 countries even significantly.

A similar pattern as has been described for θ can also be found for the parameter indicating the importance of backward-looking price setting ω: It is found to be lower in the open economy specification than in the closed economy and the general specification M3, however the pattern is somewhat less systematic (in 65% of all comparisons between M2 and M3 in table 11 ω is higher in M3). Contrary to the findings of Leith and Malley [13], these two parameters seem to be positively correlated across models in our analysis.

The estimates of the discount rate of firm's future profits, β, are found to be in a reasonable range between 0.9 and 1, in some cases even larger than 1 but never significantly larger than 1. Compared to related studies, e.g. Leith and Malley [13] and Gali et al. [7], our estimates of β are much closer to 1 which is also theoretically more plausible given that it reflects the quarterly subjective discount rate of future profits. Furthermore, the estimates of β are not systematically affected by the specification of the model.

The elasticity of substitution between the variable factors of production ρ can only be estimated imprecisely, as it is found to be significant only in very few cases. This implies that - with the exception of these few cases, e.g. M2B in France and M3B in Greece - assuming a Cobb-Douglas production technology, i.e. $\rho = 1$, or a Leontief production technology, i.e. $\rho = 0$, would fit the data equally well. This finding, which is also in line with the results in Leith and Malley [13], could be explained - as they state - by the fact that at the quarterly frequency firms may not be able to substitute between the different inputs in response to quarterly price movements, resulting in an imprecise estimation of this parameter.

3.3.3 Results related to the reduced form specification

When trying to assess which model (M1, M2 or M3) is most appropriate to characterize the inflation process in the euro area countries we turn to the performance of the model estimated in its reduced form. The reason is that when the reduced form coefficient on the marginal cost term λ cannot be estimated significantly we have an identification problem of the structural parameters of the model which then become unreliable (see Guay and Pelgrin [10]). Thus, the structural parameters of the model given in the tables are only conditional on a well specified reduced form. Comparing the reduced form coefficients on the marginal cost term we note that the general model M3 with imported and domestically produced intermediate inputs in production and the model M2 with only imported intermediate goods in production are found to be more appropriate to track the inflation process in all euro area countries than M1 as λ was found to be significant for M1 only in France and Finland (remember that the reduced form specification is only reported in the tables for those models where λ is significant). Thus, we conclude that open economy aspects matter for the performance and the fit of the NKPC. Another finding that emerges quite consistently from the estimates of the reduced form coefficients shown in the tables in the Appendix is that the weight on the forward looking coefficient, γ_f, is predominant in most countries (with the exceptions of Austria and Italy), thus confirming the dominance of forward looking behavior in the hybrid NKPC found in most other studies for European countries, see e.g. Gali et al. [7] and Sondergaard [20].[12]

[12] A qualification to this finding could be the result of Jondeau and Le Bihan [12] that the forward looking coefficient in a hybrid NKPC estimated by GMM appears to be biased upwards in small samples and in case of misspecification of the model's dynamics. This potential undermining of the reliability of the coefficients estimates doesn't seem to be a severe problem for our results as γ_f did generally not turn out to be particularly large in our estimations. Specifically, it was found to be larger than 0.65 only for Spain.

It should be noted also that for many countries differences in coefficients estimates between specifications A and B are more pronounced than differences between the model types M1, M2, M3 which indicates that the way of normalization is important for the results. This fact is also the reason why in Table 11 only models within specification either A or B are compared and not across specifications.

Some sensitivity analysis with the calibrated parameters of the model has shown that assuming a higher steady state markup μ increases the estimate of the persistence parameter θ consistently across models and specifications.[13]

The estimates of the average duration of prices implied from θ which in our analysis vary between 6 and 12 months for most specifications are found to be consistently lower than suggested by the evidence in the studies on the micro consumer price data in the IPN where the average duration turns out to be about one year for most countries. As our estimates are derived from aggregate data as opposed to micro data in the other studies, aggregation - besides the fact that different price indices are considered - could explain part of the difference.

4 Conclusions

In this paper an open economy hybrid New Keynesian Phillips Curve is estimated for 9 euro are countries and the euro area aggregate. The model is estimated in three different variants (specifications): in the closed economy specification with only the labor share as the driving variable of inflation, in the open economy specification with imported intermediate goods in production, and in the more general open economy specification which additionally includes also domestically produced intermediate inputs in production. From the comparison of our results across these specifications we find that the degree of structural price rigidity as measured by the Calvo probability of changing a price is systematically higher for the closed economy case than in the open economy case with only imported intermediate inputs in production. A reason for this could be that when firms face more variable input costs as they import from volatile international markets they tend to adjust their prices more frequently. This is in contrast to the existing literature on the open economy NKPC, see e.g. Leith and Malley [13] on the G7 countries and Gali and Lopez-Salido [8] on Spain, who found that the structural parameters of the model were largely unaffected by the introduction of open

[13]The results for varying μ from 1.1 to 1.4 are available on request.

economy factors. However, these papers estimated the open economy NKPC for relatively large and closed economies for which our results are also less clear cut than for the whole set of countries.

When comparing the open economy case with only imported intermediate inputs and the most general specification with imported and domestically produced intermediate inputs structural price rigidity is found to be systematically higher in the latter case. This could be due to substitution of imported by domestic intermediate goods when the relative price of the former increases, thus mitigating the need for the firm to adjust prices. The general open economy model was also found to be the most appropriate specification to characterize the inflation process in most euro area countries as it could fit the data best in the reduced form estimations of the model.

The main contribution of this paper is to deliver a comprehensive evidence on the empirical performance of the open economy NKPC in different variants and specifications. In that, however, it can only be a starting point as more refined models would have to be developed to incorporate some stylized facts of price setting in open economies, like pricing to market, exchange rate dynamics, current account issues, etc. A further extension would also be to apply the open economy NKPC to alternative estimation techniques like maximum likelihood, the three-step GMM (3S-GMM) or the continuously updated GMM (CUE) estimators (as has been done in Guay and Pelgrin [10] for the US).

References

[1] Balakrishnan, J.and J.D. Lopez-Salido (2002), "Understanding UK Inflation: The Role of Opennes", Bank of England Working Paper No. 164.

[2] Bardsen, G., Jansen, E.S. and R. Nymoen (2004), "Econometric Evaluation of the New Keynesian Phillips Curve", Oxford Bulletin of Economics and Statistics 66(S1), 671-686.

[3] Benigno, P. and J.D. Lopez-Salido (2001), "Inflation Persistence and Optimal Monetary Policy in the Euro Area", ECB Working Paper No. 178.

[4] Calvo, G. (1983), "Staggered Prices in a Utility Maximising Framework", Journal of Monetary Economics 12(3), 383-398.

[5] Freystätter, H. (2003), "Price setting behavior in an open economy and the determination of Finnish foreign trade prices", Bank of Finland Studies in Economics and Finance, E25.

[6] Gali, J. and M. Gertler (1999), "Inflation Dynamics: A Structural Econometric Analysis", Journal of Monetary Econmics 44, 195-222.

[7] Gali, J., Gertler, M. and J.D. Lopez-Salido (2001), "European Inflation Dynamics", European Economic Review 45, 1237-1270.

[8] Gali, J. and J.D. Lopez-Salido (2001), "A New Phillips Curve for Spain", BIS Papers No. 3.

[9] Gali, J., Gertler, M. and J.D. Lopez-Salido (2003), "Robustness of the Estimates of the Hybrid New Keynesian Phillips Curve", mimeo.

[10] Guay, A. and F. Pelgrin (2004), "The U.S. New Keynesian Phillips Curve: An Empirical Assessment", Bank of Canada Working Paper 2004-35.

[11] Hansen, L. (1982), "Large Sample Properties of Generalized Method of Moments Estimators", Econometrica 50, 1029-1054.

[12] Jondeau, E. and H. Le Bihan (2003), "ML vs GMM Estimates of Hybrid Macroeconomic Models (with an Application to the "New Keynesian Phillips Curve")", Banque de France Notes D'Etudes et de Recherche No. 103.

[13] Leith, C. and J. Malley (2003), "Estimated Open Economy New Keynesian Phillips Curves for the G7", forthcoming in the Journal of the European Economic Association 2004.

[14] McAdam, P. and A. Willman (2003), "New Keynesian Phillips Curves: A Reassessment Using Euro Area Data", ECB Working Paper No. 265.

[15] Obstfeld, M. and Rogoff, K. (1995), "Exchange Rate Dynamics Redux", Journal of Political Economy 103(3), 624-660.

[16] Razin, A. and C.W. Yuen (2002), "The 'New Keynesian' Phillips curve: closed economy versus open economy", Economic Letters 75(1), 1-9.

[17] Rubene, I. and Guarda, P. (2004), "The New Keynesian Phillips Curve: Empirical Results for Luxembourg", Banque Centrale du Luxembourg Working Paper No. 11.

[18] Sbordone, A.M. (2002), "Prices and Unit Labor Costs: A New Test of Price Stickiness", Journal of Monetary Economics 49, 265-292.

[19] Smets, F. and R. Wouters (2002), "Opennes, Imperfect Exchange Rate Pass-Through and Monetary Policy", ECB Working Paper No. 128.

[20] Sondergaard, L. (2003), "Inflation Dynamics in the Traded Sectors of Frane, Italy and Spain", mimeo.

[21] Tille, C. (2001), "The Role of Consumption Subsitutability in the International Treansmission of Monetary Shocks", Journal of International Economics 53, 421-444.

[22] Verbeek, M. (2000), "A Guide to Modern Econometrics", John Wiley & Sons Ltd, West Sussex.

A Appendix

Table 1: GMM Estimates for Austria, dependent variable quarter-on-quarter gdp inflation

AT	θ	β	ω	ρ	Implied duration (in months)
M1A	0.65***	0.96***	0.34**	-	8.7
M1B	0.59***	0.98***	0.16**	-	7.3
M2A	0.62***	0.96***	0.34***	2.6	7.9
M2A	0.64***	0.95***	0.34**	1	8.4
M2B	0.52***	0.99***	0.15**	6.6	6.3
M2B	0.51***	0.92***	0.18**	1	6.1
M3A	0.59***	0.94***	0.35***	-0.2	7.3
M3B	0.60***	0.97***	0.16**	1	7.6
Reduced form estimates					
	γ_f	γ_b	λ		
M2A	0.47***	0.54***	0.10**		
M3A	0.46***	0.53***	0.07*		
Instrument list: price inflation (2,4), wage inflation (1-4), labor share (1-6)					
Time span considered: 1964 Q1 - 2003 Q2					

Note: The stars attached to the coefficients estimates show the significance levels, where * denotes significance at the 10%, ** at the 5% and *** at the 1% level. Models M1, M2 and M3 refer to expression (10) "including" (12) estimated for the closed economy case (M1), i.e. $s_{m^f} = 0$ and $s_{m^d} = 0$, for the open economy case with imported intermediate inputs (M2), i.e. $s_{m^f} \neq 0$ and $s_{m^d} = 0$, and the most general specification with imported and domestically produced intermediate inputs (M3), i.e. $s_{m^f} \neq 0$ and $s_{m^d} \neq 0$. M1 is estimated without ρ as this parameter does not appear in the closed economy specification. Specifications A and B refer to expressions (13) and (14), respectively. The duration of prices implied from θ is calculated as $\frac{3}{1-\theta}$ and given in months for comparison with other papers in the IPN.

Table 2: GMM Estimates for Belgium, dependent variable quarter-on-quarter gdp inflation

BE	θ	β	ω	ρ	Implied duration (in months)
M1A	0.47***	0.99***	0.63***	-	5.7
M1B	0.56***	0.999***	-0.24*	-	6.9
M2A	0.56**	0.98***	0.40***	-0.61	6.9
M2A	0.59***	1.04***	0.49***	1	7.5
M2B	0.49***	0.94***	-0.19**	0.03	6
M2B	0.52***	1.05***	0.44***	1	6.2
M3A	0.73***	0.99***	0.19	-3.8**	11.4
M3B	0.60***	0.86***	-0.08***	-1.3***	7.5
Reduced form estimates					
	γ_f	γ_b	λ		
M2A	0.55***	0.46**	0.08*		

Instrument list: price inflation (2-4), wage inflation (1-4), labor share (1-4), detrended output (1-4), ratio of wages to import prices (1-4)
Time span considered: 1980 Q1 - 2003 Q2

Table 3: GMM Estimates for Germany, dependent variable quarter-on-quarter gdp inflation

DE	θ	β	ω	ρ	Implied duration (in months)
M1A	0.73***	0.99***	0.59***	-	11.1
M1B	0.80***	1.02***	0.20	-	15.2
M2A	0.58***	1.07***	0.53***	5.3**	7.2
M2A	0.76***	0.98***	0.65***	1	12.3
M2B	0.70***	1.03***	0.39**	5.9*	9.9
M2B	0.80***	0.99***	0.30**	1	15
M3A	0.86***	0.97***	0.72***	1	21.4
M3B	0.83***	1.01***	0.45**	3.04	17.4
Reduced form estimates					
	γ_f	γ_b	λ		
M2A	0.58***	0.43***	0.05*		

Instrument list: price inflation (2-4), wage inflation (1-4), labor share (1-4), ratio of wages to import prices (1-6)
Time span considered: 1970 Q1 - 2003 Q2

Table 4: GMM Estimates for Spain, dependent variable quarter-on-quarter gdp inflation

ES	θ	β	ω	ρ	Implied duration (in months)
M1A	0.56***	0.99***	0.18**	-	6.9
M1B	0.49***	0.99***	0.10*	-	5.9
M2A	0.55***	1.01***	0.18***	1.16**	6.6
M2A	0.61***	0.997***	0.16***	1	7.8
M2B	0.52***	0.98***	0.10**	0.59*	6.3
M2B	0.56***	0.995***	0.12**	1	6.9
M3A	0.70***	1.00***	0.18***	1	10.0
M3B	0.66***	1.00***	0.14***	1	8.9
Reduced form estimates					
	γ_f	γ_b	λ		
M2A	0.56***	0.45***	0.11***		
M2B	0.92***	0.09*	0.12*		
M3A	0.78***	0.23***	0.24***		

Instrument list: price inflation (2-4), wage inflation (1-4), labor share (1-4), detrended output (1-4), ratio of wages to import prices (1-4)

Time span considered: 1980 Q1 - 2003 Q2

Table 5: GMM Estimates for Finland, dependent variable quarter-on-quarter gdp inflation

FI	θ	β	ω	ρ	Implied duration (in months)
M1A	0.57***	1.00***	0.49*	-	6.9
M1B	0.37***	1.05***	0.07*	-	4.8
M2A	0.53***	0.99***	0.58***	-2.6	6.4
M2A	0.64***	0.999***	0.55*	1	8.4
M2B	0.41***	0.99***	0.09*	-0.75	5.1
M2B	0.40***	1.11***	0.11*	1	5.1
M3A	0.65***	0.93***	0.46***	-4.3	8.7
M3B	0.50***	0.99***	0.30**	-2.4***	6
Reduced form estimates					
	γ_f	γ_b	λ		
M1A	0.57***	0.46***	0.28***		
M2A	0.54***	0.45***	0.14***		
M3B	0.49***	0.52***	0.05**		

Instrument list: price inflation (2-6), wage inflation (1-4), commodity price inflation (1-6), labor share (2-6), detrended output (2-6), ratio of wages to import prices (2-4)
Time span considered: 1975 Q1 - 2003 Q2

Table 6: GMM Estimates for France, dependent variable quarter-on-quarter gdp inflation

FR	θ	β	ω	ρ	Implied duration (in months)
M1A	0.71***	0.99***	0.57**	-	10.3
M1B	0.32**	1.15***	0.16***	-	4.5
M2A	0.65***	0.99***	0.48***	2.6	8.7
M2A	0.65***	0.99***	0.51***	1	8.7
M2B	0.50***	0.98***	0.10**	1.9***	6
M2B	0.50***	1.00***	0.12***	1	6
M3A	0.71***	0.94***	0.56***	-4.3	10.5
M3B	0.62***	0.975***	0.13**	-0.6	7.8
Reduced form estimates					
	γ_f	γ_b	λ		
M1B	0.42***	0.60***	0.25***		
M2A	0.63***	0.40***	0.33***		
M2B	0.51***	0.54***	0.38***		

Instrument list: price inflation (2-4), wage inflation (1-4), commodity price inflation (1-4), labor share (1-4), detrended output (1-4), ratio of wages to import prices (1-6)
Time span considered: 1978 Q1 - 2003 Q2

Table 7: GMM Estimates for Greece, dependent variable quarter-on-quarter gdp inflation

GR	θ	β	ω	ρ	Implied duration (in months)
M1A	0.62*	0.99***	0.38**	-	7.9
M1B	0.32**	0.97***	0.30***	-	4.5
M2A	0.43**	0.98***	0.21	-17.7	5.3
M2A	0.45***	0.995***	0.41***	1	5.5
M2B	0.30***	0.99***	0.19***	-0.6	4.3
M2B	0.34***	0.99***	0.22***	1	4.5
M3A	0.41***	0.99***	0.40***	1.6**	5.1
M3A	0.52***	0.99***	0.39***	1	6.3
M3B	0.57***	1.00***	0.32***	2.8***	7.0
Reduced form estimates					
	γ_f	γ_b	λ		
M2A	0.55***	0.42**	3.83**		
M3A	0.62**	0.40*	0.18*		
Instrument list: wage inflation (1-4), labor share (1-4) detrended output (1-4), ratio of wages to import prices (1-4), the share of imported intermediate goods in production (1-4)					
Time span considered: 1970 Q1 - 2003 Q2					

Table 8: GMM Estimates for Italy, dependent variable quarter-on-quarter gdp inflation

IT	θ	β	ω	ρ	Implied duration (in months)
M1A	0.66**	0.98***	0.42*	-	8.7
M1B	0.45***	0.99***	0.12***	-	5.5
M2A	0.68***	0.99***	0.34**	-0.3	9.6
M2A	0.68***	0.997***	0.35**	1	9.6
M2B	0.41***	1.08***	0.14***	-0.98	5.4
M2B	0.44***	1.08***	0.17***	1	5.4
M3A	0.72***	0.99***	0.49**	1	10.7
M3B	0.54***	1.00***	0.29***	-1.96	6.5
Reduced form estimates					
	γ_f	γ_b	λ		
M2A	0.33***	0.67***	0.20**		
M3A	0.23**	0.60***	0.02***		
Instrument list: price inflation (2-4), commodity price inflation (1-4), labor share (1-4), detrended output (1-4), ratio of wages to import prices (1-6)					
Time span considered: 1970 Q1 - 2003 Q2					

Table 9: GMM Estimates for the Netherlands, dependent variable quarter-on-quarter gdp inflation

NL	θ	β	ω	ρ	Implied duration (in months)
M1A	0.61***	0.98***	0.31***	-	7.8
M1B	0.42***	0.93***	0.13***	-	5.1
M2A	0.49***	0.95***	0.31***	0.3	5.9
M2A	0.52***	0.97***	0.32***	1	6.3
M2B	0.37***	0.92***	0.17***	0.3	4.8
M2B	0.39***	0.91***	0.17***	1	4.9
M3A	0.62***	0.97***	0.30***	0.17	7.8
M3B	0.53***	0.95***	0.20***	1	6.4
Reduced form estimates					
	γ_f	γ_b	λ		
M2B	0.66***	0.30***	0.115***		
M3B	0.65**	0.30***	0.06***		
Instrument list: price inflation (2-4), wage inflation (1-4), labor share (1-4), detrended output (1-4)					
Time span considered: 1977 Q1 - 2003 Q2					

Table 10: GMM Estimates for the Euro Area, dependent variable quarter-on-quarter gdp inflation

EA	θ	β	ω	ρ	Implied duration (in months)
M1A	0.78***	1.02***	0.48***	-	13.6
M1B	0.59***	0.99***	0.37***	-	7.3
M2A	0.67***	1.02***	0.50***	5.7	9.1
M2A	0.68***	1.02***	0.50***	1	9.6
M2B	0.51***	0.999***	0.19**	0.41	6.1
M2B	0.51***	1.00***	0.21***	1	6.1
M3A	0.64***	1.03***	0.44***	1	8.4
M3B	0.52***	1.02***	0.20*	1.01*	6.3
Reduced form estimates					
	γ_f	γ_b	λ		
M2A	0.29***	0.72***	0.11***		
M3A	0.52***	0.49***	0.09***		
Instrument list: price inflation (2-4), wage inflation (1-4), commodity price inflation (1-4), labor share (1-6), ratio of wages to import prices (1-4)					
Time span considered: 1970 Q1 - 1998 Q4					

Table 11: Difference in coefficients estimates across models M1, M2 and M3 and corresponding t-tests for all countries

		Sepcification A		Sepcification B	
		θ	ω	θ	ω
AT	M1-M2 (%-difference)	0.030 (5.5)	0.003 (0.9)	0.082 (16.2)	-0.017 (-9.7)
	t-value	0.161	0.019	0.676	-0.173
	M2-M3 (%-difference)	-0.018 (-3.0)	0.010 (3.0)	-0.099 (-19.5)	0.011 (6.4)
	t-value	-0.082	0.063	-0.890	0.113
	M1-M3 (%-difference)	0.011 (1.8)	0.013 (4.1)	-0.017 (-2.7)	-0.006 (-3.5)
	t-value	0.049	0.080	-0.127	-0.054
BE	M1-M2 (%-difference)	-0.088 (-15.7)	0.226 (56.1)	0.069 (14.0)	-0.048 (25.4)
	t-value	-0.498	0.852	0.552	-0.330
	M2-M3 (%-difference)	-0.173 (-30.1)	0.210 (52.1)	-0.109 (-22.2)	-0.112 (58.9)
	t-value	-1.437	0.905	-2.498***	-1.707*
	M1-M3 (%-difference)	-0.261 (-35.5)	0.436 (226.2)	-0.040 (-6.7)	-0.161 (205.3)
	t-value	-1.504	1.643*	-0.344	-1.175
DE	M1-M2 (%-difference)	0.150 (26.0)	0.063 (12.0)	0.106 (15.2)	-0.188 (-48.4)
	t-value	0.721	0.291	0.534	-0.638
	M2-M3 (%-difference)	-0.281 (-48.6)	-0.191 (-36.2)	-0.131 (-18.9)	-0.060 (-15.4)
	t-value	-1.096	-0.744	-0.650	-0.205
	M1-M3 (%-difference)	-0.131 (-15.3)	-0.128 (-17.8)	-0.026 (-3.1)	-0.248 (-55.3)
	t-value	-0.469	-0.470	-0.133	-0.788
ES	M1-M2 (%-difference)	-0.048 (-7.9)	0.020 (12.9)	-0.070 (-12.5)	-0.020 (-17.4)
	t-value	-0.436	0.221	-0.830	-0.267
	M2-M3 (%-difference)	-0.084 (-13.7)	-0.026 (-16.1)	-0.100 (-17.8)	-0.027 (-22.8)
	t-value	-0.901	-0.321	-1.318	-0.381
	M1-M3 (%-difference)	-0.132 (-19.0)	-0.005 (-2.8)	-0.170 (-25.7)	-0.047 (-32.7)
	t-value	-1.248	-0.053	-2.063**	-0.578
FI	M1-M2 (%-difference)	0.047 (8.9)	-0.098 (-16.8)	-0.047 (-11.2)	-0.022 (-24.8)
	t-value	0.187	-0.278	-0.607	-0.321
	M2-M3 (%-difference)	-0.126 (-23.9)	0.129 (22.1)	-0.083 (-20.8)	-0.211 (-235.4)
	t-value	-0.569	0.481	-0.904	-1.571*
	M1-M3 (%-difference)	-0.079 (-12.1)	0.031 (6.8)	-0.133 (-26.5)	-0.234 (-77.6)
	t-value	-0.371	0.096	-1.433	-1.801*
FR	M1-M2 (%-difference)	0.060 (9.1)	0.089 (18.4)	-0.178 (-35.7)	0.053 (52.5)
	t-value	0.191	0.293	-3.607***	0.767
	M2-M3 (%-difference)	-0.058 (-8.8)	-0.082 (-17.1)	-0.119 (-23.9)	-0.027 (-26.1)
	t-value	-0.285	-0.355	-1.997**	-0.359
	M1-M3 (%-difference)	0.002 (0.3)	0.006 (1.1)	-0.297 (-48.1)	0.027 (20.9)
	t-value	0.007	0.021	-5.767***	0.368

Table 11: Difference in coefficients estimates... continued

		Sepcification A		Sepcification B	
		θ	ω	θ	ω
GR	M1-M2 (%-difference)	0.175 (39.9)	-0.026 (-6.4)	0.026 (8.8)	0.110 (57.5)
	t-value	0.395	-0.106	0.191	1.115
	M2-M3 (%-difference)	-0.074 (-16.5)	0.021 (5.1)	-0.276 (-92.6)	-0.125 (-65.5)
	t-value	-0.271	0.095	-2.438**	-1.162
	M1-M3 (%-difference)	0.102 (19.6)	-0.005 (-1.4)	-0.250 (-43.5)	-0.015 (-4.9)
	t-value	0.241	-0.021	-1.680*	-0.126
IT	M1-M2 (%-difference)	-0.026 (-3.8)	0.074 (21.0)	0.042 (10.4)	-0.020 (-14.1)
	t-value	-0.069	0.028	0.406	-0.264
	M2-M3 (%-difference)	-0.034 (-5.0)	-0.143 (-40.7)	-0.130 (-32.0)	-0.143 (-99.5)
	t-value	-0.133	-0.493	-1.790*	-1.536
	M1-M3 (%-difference)	-0.060 (-8.3)	-0.069 (-14.0)	-0.088 (-16.3)	-0.163 (-57.0)
	t-value	-0.170	-0.204	-0.833	-1.804*
NL	M1-M2 (%-difference)	0.120 (24.5)	-0.0003 (-0.1)	0.047 (12.6)	-0.041 (-23.7)
	t-value	0.616	-0.002	0.549	-0.538
	M2-M3 (%-difference)	-0.129 (-26.3)	0.014 (4.5)	-0.157 (-42.3)	-0.024 (-14.4)
	t-value	-0.929	0.109	-1.790*	-0.258
	M1-M3 (%-difference)	-0.009 (-1.4)	0.014 (4.6)	-0.111 (-20.9)	-0.065 (-33.3)
	t-value	-0.047	0.100	-1.261	-0.721
EA	M1-M2 (%-difference)	0.093 (13.7)	-0.020 (-4.0)	0.082 (16.2)	0.178 (93.6)
	t-value	0.414	-0.090	1.102	1.219
	M2-M3 (%-difference)	0.042 (6.2)	0.065 (13.0)	-0.018 (-3.5)	-0.012 (-6.4)
	t-value	0.313	0.377	-0.255	-0.081
	M1-M3 (%-difference)	0.136 (21.2)	0.045 (10.3)	0.065 (12.3)	0.166 (81.9)
	t-value	0.649	0.210	0.728	0.991

Note: M1-M2 gives the difference of the estimated coefficients values of θ and ω for specification A according to expression (13) and specification B according to expression (14) for M1 and M2 and in parenthesis the %-difference between M1 and M2: 100(M1-M2)/M2. The t-values are based on the test statistic $\frac{\widehat{\theta}_{M1}-\widehat{\theta}_{M2}}{\sqrt{\widehat{\sigma}^2_{\theta_{M1}}+\widehat{\sigma}^2_{\theta_{M2}}}}$ where $\widehat{\sigma}_{\theta_{M1}}$ and $\widehat{\sigma}_{\theta_{M2}}$ are the empirical standard deviations of the coefficient estimates of $\widehat{\theta}_{M1}$ and $\widehat{\theta}_{M2}$. This test statistic is t-distributed with $(n_1 + n_2 - k_1 - k_2)$ degrees of freedom where n_1 and n_2 are the number of observations underlying the estimation of M1 and M2, respectively, and k_1 and k_2 are the number of coefficients to be estimated in M1 and M2. The stars attached to the t-values show the significance levels, where * denotes significance at the 10%, ** at the 5% and *** at the 1% level.

European Central Bank working paper series

For a complete list of Working Papers published by the ECB, please visit the ECB's website (http://www.ecb.int)

448 "Price-setting behaviour in Belgium: what can be learned from an ad hoc survey?" by L. Aucremanne and M. Druant, March 2005.

449 "Consumer price behaviour in Italy: evidence from micro CPI data" by G. Veronese, S. Fabiani, A. Gattulli and R. Sabbatini, March 2005.

450 "Using mean reversion as a measure of persistence" by D. Dias and C. R. Marques, March 2005.

451 "Breaks in the mean of inflation: how they happen and what to do with them" by S. Corvoisier and B. Mojon, March 2005.

452 "Stocks, bonds, money markets and exchange rates: measuring international financial transmission" by M. Ehrmann, M. Fratzscher and R. Rigobon, March 2005.

453 "Does product market competition reduce inflation? Evidence from EU countries and sectors" by M. Przybyla and M. Roma, March 2005.

454 "European women: why do(n't) they work?" by V. Genre, R. G. Salvador and A. Lamo, March 2005.

455 "Central bank transparency and private information in a dynamic macroeconomic model" by J. G. Pearlman, March 2005.

456 "The French block of the ESCB multi-country model" by F. Boissay and J.-P. Villetelle, March 2005.

457 "Transparency, disclosure and the Federal Reserve" by M. Ehrmann and M. Fratzscher, March 2005.

458 "Money demand and macroeconomic stability revisited" by A. Schabert and C. Stoltenberg, March 2005.

459 "Capital flows and the US 'New Economy': consumption smoothing and risk exposure" by M. Miller, O. Castrén and L. Zhang, March 2005.

460 "Part-time work in EU countries: labour market mobility, entry and exit" by H. Buddelmeyer, G. Mourre and M. Ward, March 2005.

461 "Do decreasing hazard functions for price changes make any sense?" by L. J. Álvarez, P. Burriel and I. Hernando, March 2005.

462 "Time-dependent versus state-dependent pricing: a panel data approach to the determinants of Belgian consumer price changes" by L. Aucremanne and E. Dhyne, March 2005.

463 "Break in the mean and persistence of inflation: a sectoral analysis of French CPI" by L. Bilke, March 2005.

464 "The price-setting behavior of Austrian firms: some survey evidence" by C. Kwapil, J. Baumgartner and J. Scharler, March 2005.

465 "Determinants and consequences of the unification of dual-class shares" by A. Pajuste, March 2005.

466 "Regulated and services' prices and inflation persistence" by P. Lünnemann and T. Y. Mathä, April 2005.

467 "Socio-economic development and fiscal policy: lessons from the cohesion countries for the new member states" by A. N. Mehrotra and T. A. Peltonen, April 2005.

468 "Endogeneities of optimum currency areas: what brings countries sharing a single currency closer together?" by P. De Grauwe and F. P. Mongelli, April 2005.

469 "Money and prices in models of bounded rationality in high inflation economies" by A. Marcet and J. P. Nicolini, April 2005.

470 "Structural filters for monetary analysis: the inflationary movements of money in the euro area" by A. Bruggeman, G. Camba-Méndez, B. Fischer and J. Sousa, April 2005.

471 "Real wages and local unemployment in the euro area" by A. Sanz de Galdeano and J. Turunen, April 2005.

472 "Yield curve prediction for the strategic investor" by C. Bernadell, J. Coche and K. Nyholm, April 2005.

473 "Fiscal consolidations in the Central and Eastern European countries" by A. Afonso, C. Nickel and P. Rother, April 2005.

474 "Calvo pricing and imperfect common knowledge: a forward looking model of rational inflation inertia" by K. P. Nimark, April 2005.

475 "Monetary policy analysis with potentially misspecified models" by M. Del Negro and F. Schorfheide, April 2005.

476 "Monetary policy with judgment: forecast targeting" by L. E. O. Svensson, April 2005.

477 "Parameter misspecification and robust monetary policy rules" by C. E. Walsh, April 2005.

478 "The conquest of U.S. inflation: learning and robustness to model uncertainty" by T. Cogley and T. J. Sargent, April 2005.

479 "The performance and robustness of interest-rate rules in models of the euro area" by R. Adalid, G. Coenen, P. McAdam and S. Siviero, April 2005.

480 "Insurance policies for monetary policy in the euro area" by K. Küster and V. Wieland, April 2005.

481 "Output and inflation responses to credit shocks: are there threshold effects in the euro area?" by A. Calza and J. Sousa, April 2005.

482 "Forecasting macroeconomic variables for the new member states of the European Union" by A. Banerjee, M. Marcellino and I. Masten, May 2005.

483 "Money supply and the implementation of interest rate targets" by A. Schabert, May 2005.

484 "Fiscal federalism and public inputs provision: vertical externalities matter" by D. Martínez-López, May 2005.

485 "Corporate investment and cash flow sensitivity: what drives the relationship?" by P. Mizen and P. Vermeulen, May 2005.

486 "What drives productivity growth in the new EU member states? The case of Poland" by M. Kolasa, May 2005.

487 "Computing second-order-accurate solutions for rational expectation models using linear solution methods" by G. Lombardo and A. Sutherland, May 2005.

488 "Communication and decision-making by central bank committees: different strategies, same effectiveness?" by M. Ehrmann and M. Fratzscher, May 2005.

489 "Persistence and nominal inertia in a generalized Taylor economy: how longer contracts dominate shorter contracts" by H. Dixon and E. Kara, May 2005.

490 "Unions, wage setting and monetary policy uncertainty" by H. P. Grüner, B. Hayo and C. Hefeker, June 2005.

491 "On the fit and forecasting performance of New-Keynesian models" by M. Del Negro, F. Schorfheide, F. Smets and R. Wouters, June 2005.

492 "Experimental evidence on the persistence of output and inflation" by K. Adam, June 2005.

493 "Optimal research in financial markets with heterogeneous private information: a rational expectations model" by K. Tinn, June 2005.

494 "Cross-country efficiency of secondary education provision: a semi-parametric analysis with non-discretionary inputs" by A. Afonso and M. St. Aubyn, June 2005.

495 "Measuring inflation persistence: a structural time series approach" by M. Dossche and G. Everaert, June 2005.

496 "Estimates of the open economy New Keynesian Phillips curve for euro area countries" by F. Rumler, June 2005.