LATVIJAS BANKA

ISBN 9984–676–73–0

ALEKSEJS MEĻIHOVS
ANNA ZASOVA

ESTIMATION OF THE PHILLIPS CURVE FOR LATVIA

3• 2007

WORKING PAPER

The views expressed in this publication are those of the authors, employees of the Monetary Policy Department of the Bank of Latvia. The authors assume responsibility for any errors and omissions.

CONTENTS

ABBREVIATIONS

CSB – Central Statistical Bureau of Latvia
GDP – gross domestic product
S.D. – standard deviation
S.E. – standard error
UK – the United Kingdom
US – the United States of America

ABSTRACT

The current paper aims at estimating the formation mechanism of business inflation expectations to find out how the latter affect the inflation dynamics. To attain this goal, the authors estimated the traditional Phillips curve, new Keynesian Phillips curve and hybrid Phillips curve. The results obtained testify to a better explanatory power to describe the dynamics of Latvia's core inflation of the hybrid Phillips curve compared with the traditional and new Keynesian Phillips curves. Moreover, the outcomes of the research indicate that companies in Latvia adjust their output prices quite frequently implying that the pass-through of changes in inflation expectations to actual prices is quite prompt.

Key words: *Phillips curve, new Keynesian Phillips curve, hybrid Phillips curve, inflation persistence*

JEL classification codes: *C22, E31*

INTRODUCTION

For central banks, inflation dynamics has always figured as a major focus of the economic development, with the perception of its causes and qualities an even more important challenge. In the evolutionary course of economic theory, three approaches pursuing the same aim of explaining inflationary dynamics but stemming from different assumptions have emerged.

In 1958, A. W. Phillips published a paper (18) suggesting a relationship between the unemployment rate and wage inflation. Building on the research by A. W. Phillips, P. A. Samuelson and R. M. Solow (20) coined a new term "Phillips curve" in 1960, which implies interdependence of inflation and unemployment rates. In the 1970s, when a number of countries faced stagflation (high inflation combined with high unemployment), economists failed to tackle the situation employing the traditional Phillips curve; this served as an impetus for the emergence of a new theory.

Another approach to inflation dynamics was suggested by J. B. Taylor, a supporter of the Keynesian economic school, and G. A. Calvo, an economist, in the early 1980s. It was based on a radically new pricing mechanism producing a curve that became known as the new Keynesian Phillips Curve. Over time, a third approach generating the hybrid Phillips curve combining the two previous theories started to evolve. The significance of the Phillips curve for the contemporary economic theory is confirmed by the Nobel Prize award in 2006 going to Edmund Phelps for his contribution to the evolution of the Phillips curve theory and his efforts to investigate the short-term and natural unemployment levels.

Of late, trend inflation issues are gaining importance in Latvia as well. Nowadays, with the rate of inflation (including also core inflation) soaring, understanding the inflation formation mechanism and the reasons of persisting inflationary pressures in the country is particularly crucial.

Inflation expectations formed by consumers are a statistically significant factor that affects actual inflation in Latvia.(1) The current paper aims at estimating the formation mechanism of business inflation expectations to find out how the latter affect inflation dynamics. To attain this goal, we have estimated the traditional Phillips curve, the new Keynesian Phillips curve and the hybrid Phillips curve.

The results obtained testify that the hybrid Phillips curve has a better explanatory power to describe the dynamics of Latvia's core inflation than the traditional and the new Phillips curves. Moreover, the outcomes of the research indicate that in Latvia companies adjust their output prices quite frequently, and it implies that the pass-through of changes in inflation expectations to actual prices is quite prompt. Around a half of all Latvian companies are forward-looking, i.e. they form inflation expectations taking into account information on economic fundamentals that might have a say on price changes in the future.

Section 1 introduces theoretical aspects underlying the traditional, new and hybrid Phillips curves. Section 2 deals with the data used in the paper. Section 3 presents the results obtained in the estimation process of Phillips curve models.

1. THEORETICAL BACKGROUND OF PHILLIPS CURVES

1.1 The Traditional Phillips Curve

The Phillips curve theory started to evolve in 1958 when A. W. Phillips proved that in the economy of the UK in the sample period (1861–1957) there was an inverse relationship between wage inflation and unemployment rate.(18) Building on the article by A. W. Phillips, P. A. Samuelson and R. M. Solow (20) coined a new term "the Phillips curve" in 1960, linking the level of unemployment with the rate of inflation and assuming that the higher the unemployment level, the lower the rate of inflation (a trade-off between inflation and unemployment) and vice versa; in other words, consistently with this theory, lower unemployment might be achieved at the cost of higher rate of inflation.

In the 1970s, a number of countries faced stagflation, i.e. high unemployment was combined with high inflation. As it was not in line with the Phillips curve theory, some economists, M. Friedman, a Noble Prize winner, as the most active faultfinder among them, came forth with criticism of relationship under the original or traditional Phillips curve. Attempts to explain stagflation led to further evolution of the existing Phillips curve theory. It seemed plausible that allowing a higher rate of inflation would bring about only a short-lived decline in unemployment, whereas expansionary monetary policy pursued over a longer horizon would only lead to higher inflation, without any downward effect on unemployment.

This implies that the original relation of the Phillips curve holds only in the short run, while in a longer run the Phillips curve relation changes due to inflation expectations, and the Phillips curve becomes vertical. The most significant contributors to the evolution of the Phillips curve theory, relying heavily on inflation expectations, were M. Friedman (4) and E. Phelps (17).

Usually, the following equation describes the standard Phillips curve:

$$\pi_t = \beta E_{t-1}\{\pi_t\} + \lambda Y_t^c \qquad [1]$$

where π_t is inflation, E is the expectations operator and Y_t^c is the indicator of cyclical position of economy.

Equation [1] demonstrates that under the traditional Phillips curve the current inflation is affected by the business cycle and inflation expectations formed in the previous period. In the long run, the economy returns to its potential level of development, and, provided that inflation expectations are not systematically biased, long-term $\beta = 1$, and the long-term Phillips curve is vertical.

1.2 The New Phillips Curve

J. B. Taylor and G. A. Calvo laid the foundations for the new Phillips curve at the beginning of the 1980s. The main distinction between the two Phillips curves, the traditional and the new, consists in the pricing process (for more detailed discussion see (21)).

The new Phillips curve rests on the assumption that companies operate in a monopolistically competitive environment, maximising their profits in restricted price adjustment circumstances. Most often, the implied restrictions refer to price resetting frequency that companies can afford.

It is assumed that the economy comprises *i* companies, $i \in [0; 1]$. All companies are identical, and at one period of time, each company can reset prices for its output with a probability $(1-\theta)$; with a probability θ, the output price of the respective company is kept fixed. It is also assumed that probability $(1-\theta)$ does not depend on the length of the time period when output prices were last reset. Hence it may be suggested that the period between price adjustments corresponds to exponential distribution, and the expected period T during which prices remain unchanged is $E(\mathrm{T}) = \frac{1}{1-\theta}$. The larger the probability that the company will fail to reset prices, the longer the expected period between price adjustments. For instance, in a model using quarterly data with probability $\theta = 0.75$, prices will be reset once a year on average. Such specification of the pricing process allows for quite a realistic description of the actual pricing process in macroeconomics.

It is assumed that companies differ in output they produce (Y_{it}) and in output pricing dynamics (P_{it}). Each company faces a constant elasticity demand function, i.e.

$$Y_{it} = \left(\frac{P_{it}}{P_t}\right)^{-\varepsilon} Y_t \qquad [2]$$

where P_t and Y_t denote the aggregate price level and the total output in the economy respectively.

Nominal marginal production costs of company *i* in period *t* are NMC_{it}, but β is the discount factor. The company maximises its anticipated discounted profit taking into account the expected marginal cost dynamics and accounting for a possibility that it might fail to adjust its output prices for every period. In this event, the maximisation task of company *i* is given by

$$\max_{P_{it}} E_t \sum_{j=0}^{\infty} (\beta\theta)^j \left[\frac{P_{it}}{P_{t+j}} Y_{it+j} - \frac{NMC_{it+j}}{P_{t+j}} Y_{it+j}\right] \qquad [3]$$

subject to the demand function [2].

The first order optimisation condition is

$$E_t \sum_{j=0}^{\infty} (\beta\theta)^j Y_{t+j} \left[\frac{1-\varepsilon}{P_{t+j}} \left(\frac{P_{it}}{P_{t+j}}\right)^{-\varepsilon} + \frac{\varepsilon}{P_{t+j}} \frac{NMC_{it+j}}{P_{t+j}} \left(\frac{P_{it}}{P_{t+j}}\right)^{-(1+\varepsilon)}\right] = 0 \qquad [4].$$

Rewriting equation [4], we obtain

$$P_{it} E_t \sum_{j=0}^{\infty} (\beta\theta)^j Y_{t+j} P_{t+j}^{\varepsilon-1} = \frac{\varepsilon}{\varepsilon - 1} E_t \sum_{j=0}^{\infty} (\beta\theta)^j Y_{t+j} NMC_{it+j} P_{t+j}^{\varepsilon-1} \qquad [5].$$

The log-linear form of equation [5] is

$$p_{it}^* = (1-\beta\theta) E_t \sum_{j=0}^{\infty} (\beta\theta)^j nmc_{it+j} \qquad [6].$$

Equation [6] shows the optimal price set by company *i* for period *t*, while the small letters in it indicate percentage deviations of respective variables from the steady state. By quasi differencing equation [6], the actual optimal price can be expressed as a function of today's marginal production costs and expected price changes:

$$p_{it}^* = (1-\beta\theta) nmc_{it} + \beta\theta E_t p_{it+1} \qquad [7].$$

Expressed in log-linear form, company's real marginal production costs RMC_{it} in period *t* are

$$rmc_{it} \equiv nmc_{it} - p_t \qquad [8].$$

Combining equations [7] and [8], we obtain the optimal price of company *i* as a function of its real marginal production costs:

$$p_{it}^* = (1-\beta\theta)[rmc_{it} + p_t] + \beta\theta E_t p_{it+1} \qquad [9].$$

As all companies are identical and therefore set the same optimal prices, we can omit index *i* from equation [9]. The ratio of companies that adjust their prices in period *t* is $(1-\theta)$, while the average price level of other companies is equal to the last period's p_{t-1} average price level. Therefore, in accordance with the Law of Large Numbers, the cumulative price level in period *t* is equal to the weighted average of last period's price and the prices adjusted in period *t*:

$$p_t = \theta p_{t-1} + (1-\theta) p_t^* \qquad [10].$$

Assuming that inflation in period *t* is $\pi_t \equiv p_t - p_{t-1}$ and combining equations [9] and [10], we obtain an equation for inflation in period *t*, which shows that the rate of inflation is affected by inflation expected in next periods and company's mark-up over marginal production costs, which depends on the degree of price elasticity:

$$\pi_t = \lambda rmc_t + \beta E_t \{\pi_{t+1}\} \qquad [11]$$

where $\lambda \equiv \dfrac{(1-\theta)(1-\beta\theta)}{\theta}$ [12].

Equation [11] for next periods can be written as

$$\pi_{t+1} = \lambda rmc_{t+1} + \beta E_t \{\pi_{t+2}\}$$

$$\pi_{t+2} = \lambda rmc_{t+2} + \beta E_t \{\pi_{t+3}\} \qquad [11a]$$

$$\pi_{t+3} = \lambda rmc_{t+3} + \beta E_t \{\pi_{t+4}\} \text{ etc.}$$

Substituting equation [11a] into equation [11], we obtain an equation showing that inflation today corresponds to the expected discounted marginal cost flow:

$$\pi_t = \lambda \sum_{j=0}^{\infty} \beta^j E_t \{rmc_{t+j}\} \qquad [13].$$

Denoting the natural logarithm of actual output with y_t and that of potential output with y_t^*, we obtain the expression for output gap $x_t \equiv y_t - y_t^*$. Assuming that marginal costs are proportional to the output gap and that wages are flexible, the former can be expressed as a function of x_t:

$$rmc_t = kx_t \qquad [14].$$

Combining equations [11] and [14], we obtain

$$\pi_t = \lambda kx_t + \beta E_t \{\pi_{t+1}\} \qquad [15].$$

Equation [15] shows that, similar to the traditional Phillips curve, the new Phillips curve implies that current inflation depends on economic cycles and inflation expectations. Unlike the standard Phillips curve, however, the new theory suggests that the actual inflation is affected by currently expected inflation of next periods rather than lagged inflation of previous periods (often described as π_{t-1} assuming adaptive expectations).

1.3 The Hybrid Phillips Curve

The hybrid Phillips curve rests on the assumption that not all companies in the economy form rational expectations and that for a part of them inflation expectations are based on lagged inflation of the previous period[1]. Assume that the price level for period t of forward-looking companies is, p_t^f whereas that of backward-looking companies is p_t^b. Assume also that the share of backward-looking companies to the total number of companies is ω and that of forward-looking companies is $(1-\omega)$ respectively. The companies that adjust their prices in period t do it consistently with equation [9]:

$$p_t^f = (1-\beta\theta)[rmc_t + p_t] + \beta\theta E_t p_{t+1}^f \qquad [16].$$

[1] For more detailed discussion and equation derivation results see, for instance, J. Galí and M. Gertler (6), J. Galí et al (7).

On account of forward-looking companies being identical and, consequently, setting identical optimal prices, variables without index *i* can also be included in equation [16].

With regard to backward-looking companies, it is assumed that 1) their pricing policy is optimal at the steady state, i.e. their pricing strategy does not systematically differ from the optimal; 2) setting the price in period *t*, the companies make use only of such information that was available prior to period *t* – 1. Taking this into account, the pricing strategy of backward-looking companies can be given as

$$p_t^b = p_{t-1}^* + \pi_{t-1} \qquad [17]$$

where p_{t-1}^* is the index of prices adjusted in period $t-1$, and $\pi_{t-1} = p_{t-1} - p_{t-2}$. Equation [17] implies that the backward-looking companies set their prices on the basis of price changes of the companies that adjusted their prices in the previous period, and take into account the expected rate of inflation equal to the previous period's inflation rate, as inflation expectations of backward-looking price setters are adaptive.

The aggregate price level p_t in the economy for period *t* is obtained from the average weighted level of prices that are determined by

- companies adjusting their output prices in period *t*. Their share in the economy is $(1-\theta)$, of which $(1-\omega)$ are forward-looking companies that set prices consistently with equation [16]; the rest set prices consistently with equation [17];
- companies not adjusting their output prices in period *t*. Their share is θ.

Duly accounting for the above stated, the aggregate price level in period *t* consistently with the Law of Large Numbers is expressed by the following log-linear form:

$$p_t = (1-\theta)p_t^* + \theta p_{t-1} \qquad [18]$$

where $p_t^* = (1-\omega)p_t^f + \omega p_t^b$ [19].

Using equations [17] and [18], the difference between the price level set by backward-looking companies for period *t* and the cumulative price level for period *t* can be expressed as

$$p_t^b - p_t = -\pi_t + \frac{1}{1-\theta}\pi_{t-1} \qquad [20].$$

p_t^* is derived from equation [18]:

$$p_t^* = \frac{p_t - \theta p_{t-1}}{1-\theta} \qquad [21].$$

Substituting p_t^* in equation [19] with equation [21] and deducting p_t from both sides of the equation, we obtain

$$\frac{\theta}{1-\theta}\pi_t = (1-\omega)\left(p_t^f - p_t\right) + \omega\left(p_t^b - p_t\right) \qquad [22].$$

Equation [16] suggests that

$$p_t^f - p_t = (1-\beta\theta)rmc_t - \beta\theta p_t + \beta\theta E_t\left\{p_{t+1}^f\right\} \qquad [23].$$

Expressing p_t^f from equation [22], substituting the difference $\left(p_t^b - p_t\right)$ in it with the right-hand side factors of equation [20], and leading the obtained equation one period ahead employing the expectations operator, we obtain

$$E\left\{p_{t+1}^f\right\} = \frac{\theta + (1-\theta)\omega}{(1-\theta)(1-\omega)}E\{\pi_{t+1}\} - \frac{\omega}{(1-\theta)(1-\omega)}\pi_t + E\{p_{t+1}\} \qquad [24].$$

Substituting the right-hand side of equation [24] into equation [23] to replace $E\left\{p_{t+1}^f\right\}$ with the right-hand side of equation [24], we obtain

$$p_t^f - p_t = (1-\beta\theta)rmc_t + \left[1 + \frac{\theta + (1-\theta)\omega}{(1-\theta)(1-\omega)}\right]\beta\theta E\{\pi_{t+1}\} - \frac{\beta\theta\omega}{(1-\theta)(1-\omega)}\pi_t \qquad [25].$$

Substituting the right-hand side of equations [25] and [20] into equation [22], rearranging the resulting equation, and using equation [14] which expresses real marginal production costs as a function of real output gap, we arrive at the hybrid Phillips curve:

$$\pi_t = \lambda k x_t + \gamma^f E_t\{\pi_{t+1}\} + \gamma^b \pi_{t-1} \qquad [26]$$

where $\lambda \equiv \dfrac{(1-\omega)(1-\theta)(1-\beta\theta)}{\varphi}$ [26a],

$$\gamma^f \equiv \frac{\beta\theta}{\varphi} \qquad [26b],$$

$$\gamma^b \equiv \frac{\omega}{\varphi} \qquad [26c]$$

but $\varphi \equiv \theta + \omega[1 - \theta(1-\beta)]$ [26d].

All coefficients in equation [26] are functions of the model's structural parameters θ (a parameter describing price persistence), ω (a parameter describing price inertia), and β (a discount factor).

2. DATA USED FOR ESTIMATION

Similar to, for example, J. Lendvai (13), D. Hargreaves, H. Kite and B. Hodgetts (10), P. Gerlach-Kristen (9), we have used core inflation (π_t), from which the direct effect on consumer prices of fuel, unprocessed food and administered prices is excluded, as the indicator of inflation. Although central banks usually use consumer prices as a measure of price stability, there is a broadly-based assumption that monetary policy should focus on core inflation to escape the impact of highly volatile categories (e.g. unprocessed food). Core inflation is likewise comparatively unresponsive to changes in the methodology of consumer price index calculation.(9)

Two indicators were used to estimate the impact of business cycles and marginal production costs: the real output gap (Y_t^c), and the unemployment gap (UR_t^c). The structural level of these indicators was calculated by applying the Hodrick-Prescott filter or HP-filter[2] to seasonally adjusted series of GDP at constant prices and job-seekers ratio respectively.

The job-seekers ratio to economically active population (from Latvia's labour surveys) has been used as an indicator of unemployment. This indicator reflects the situation in the labour market more accurately than does the registered unemployment rate, because it covers also people who are looking for work on their own and do not apply to the State Employment Agency. However, when compared with the indicator of registered unemployment rate it has a drawback: job-seekers ratio data in the breakdown by quarter are available only from 2002, while in the preceding period (1996 to 2001), the data were broken down by year.

At the same time, figures of registered unemployment are available in the breakdown by month. In order to address the data shortage problem, the annual job-seekers indicators till 2001 were interpolated[3], thus producing a quarterly unemployment series for 1996–2006. The data on GDP at constant prices are available in the breakdown by quarter for the entire sample period.

The contribution of external factors to changes in core inflation is estimated using the nominal effective exchange rate of the lats ($NEER_t$) and the average producer price level in Latvia's 13 major trade partner countries[4] (P_t^f). $NEER_t$ is calculated as the average geometrically weighted exchange rate index of the lats (in currencies of Latvia's major trade partner countries)[5]:

---

[2] Smoothing parameter (λ) is 1 600.

[3] More detailed information on assumptions used in data interpolation will be provided by the authors at request.

[4] They are Denmark, Estonia, Finland, France, Germany, Italy, Lithuania, the Netherlands, Poland, Russia, Sweden, the UK and the US.

[5] (12).

$$NEER_t = \prod_{i=1}^{n} \left(\frac{1}{e_{it}} \right)^{w_i} \qquad [27]$$

where $n = 13$ (the number of major trade partner countries), e_{it} is country's i average exchange rate index (in lats) for the respective period (fourth quarter of 1995 as the base), w_i is country's i share in Latvia's foreign trade turnover with the 13 major trade partner countries in 2000–2002 on average.

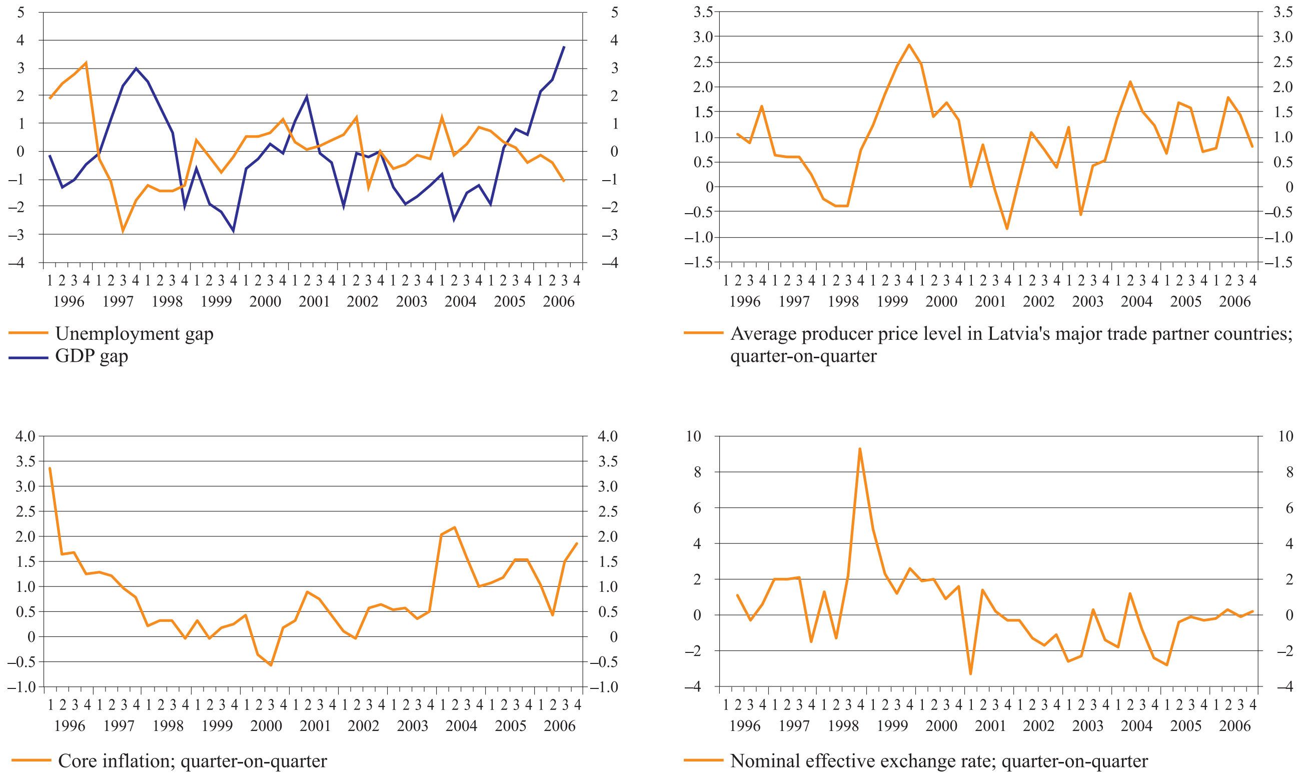
The average producer price level in Latvia's major trade partner countries is calculated as

$$P_t^f = \frac{NEER_t * P_t^{LV}}{REER_t} \qquad [28]$$

where P_t^{LV} is Latvia's producer price level, and $REER_t$ is the real effective exchange rate calculated on the basis of producer price level.

Chart 1 shows the dynamics of indicators to be used in the analysis from the first quarter of 1996 to the fourth quarter of 2006.

Chart 1
Dynamics of seasonally adjusted indicators[6]
(from Q 1, 1996 to Q 4, 2006; %)



Sources: CSB, Bank of Latvia and authors' calculations.

3. ESTIMATION OF THE PHILLIPS CURVE FOR LATVIA

In the estimation of Phillips curves for Latvia, each type of the two Phillips curve models (with Y_t^c and UR_t^c as approximation indicators of marginal production cost) is estimated for the closed and open economy, with and without a vector of externality variables.

The hypotheses that have been developed relative to equation coefficients and that build on the economic theory are as follows:

- when assessing models with Y_t^c in equation [1] (for the traditional Phillips curve), equation [15] (for the new Phillips curve) and equation [26] (for the hybrid Phillips curve), the coefficient λ should be positive. At the same time, in the models where UR_t^c was used as a cyclicality indicator, the coefficient λ in equations [1], [15] and [26], according to the theory, should be negative;
- in open economy models, the coefficients of foreign output price changes should be positive, while those of the nominal effective exchange rate should be negative.

[6] X-12 ARIMA method has been employed in seasonal adjustment of the series.

All models are estimated using the Generalised Method of Moments, GMM[7], building on orthogonal conditions specified for each outcome of the estimated model. The instrument variable vector z_t is made up of core inflation, Y_t^c and UR_t^c, the nominal effective exchange rate of the lats and the average producer price level in Latvia's major trade partner countries. All instruments are included with a 1–3 period lag. The model does not include indicator variables for period *t*, as information on some indicators of period *t* was not yet available at the moment of expectations formation, whereas instrument variables with a lag over 3 periods were not included not to "overload" the model due to the short available series. *J*-statistic suggests an acceptable specification of instrumental variables; the null hypothesis that the equation error is uncorrelated with structural model instruments is accepted with at least 74% confidence (see appendices for more detailed information). The model results should be approached with caution, as the series available for analysis are short and on this account the plausibility of results is reduced to some extent.

3.1 Estimating the Traditional Phillips Curve

Table 1 shows estimation results of the traditional Phillips curve model for both closed and open economies[8] (see Appendix 1 for more detailed statistical data on the traditional Phillips curve estimation). The coefficients of indicators describing the cyclical position of economic development are not statistically significant for closed economy models.

The coefficients of indicators describing the cyclical position of the economy for open economy models, on the other hand, are statistically significant and with the correct sign. The contribution of external factors is likewise significant, with the exception for the model with the output gap, in which the impact of the nominal effective exchange rate is estimated as insignificant.

---

7 All models are estimated using the Newey-West covariance assessment with 1–3 period lag.

8 On account of adaptive expectations qualities, it is assumed that an economic agent expects next-period inflation to be at the same rate as at the moment, i.e. $E_{t-1}\{\Delta p_t\} = \Delta p_{t-1}$.

Table 1

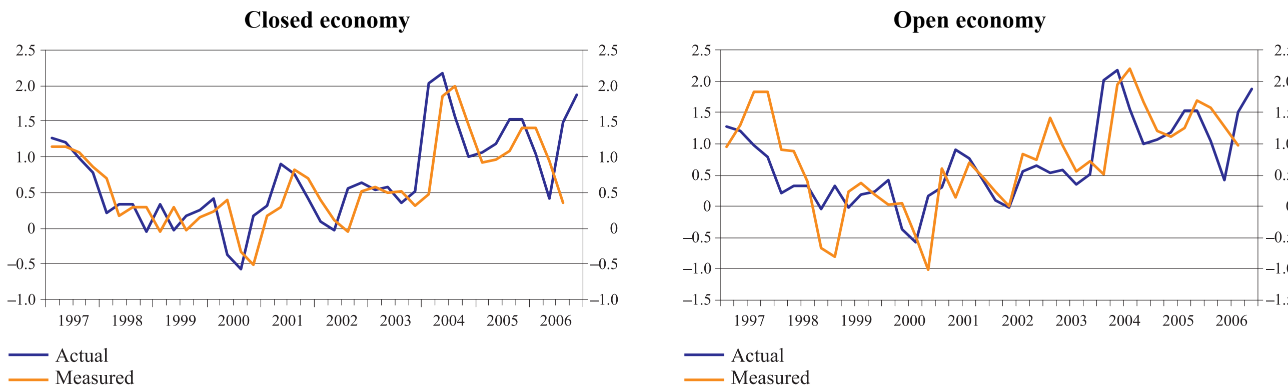
Traditional Phillips curve estimation results

Model specification	β	λ	η	μ
Closed economy *Orthogonal condition:* $E_t\{(\Delta p_t - \lambda Y_t^c - \beta E_{t-1}\{\Delta p_t\})z_t\} = 0$				
GDP gap (probability)	0.888 (0.000)	–0.001 (0.959)	–	–
Unemployment gap (probability)	0.914 (0.000)	0.014 (0.624)	–	–
Open economy *Orthogonal condition:* $E_t\{(\Delta p_t - \lambda Y_t^c - \beta E_{t-1}\{\Delta p_t\} - \eta \Delta p_t^f - \mu \Delta neer_t)z_t\} = 0$				
GDP gap (probability)	0.726 (0.000)	0.238 (0.000)	0.396 (0.000)	–0.017 (0.356)
Unemployment gap (probability)	0.899 (0.000)	–0.356 (0.007)	0.132 (0.013)	–0.168 (0.001)

Chart 2

Actual and measured core inflation

(quarter-on-quarter growth; Q 1; %)



Model specification: unemployment gap.

Chart 2 shows that core inflation measured in the model is consistently one-period-ahead biased, for the most part due to model specification. The open economy model provides for a better reflection of inflation trends; however, sometimes the external factors reinforce the inflation variance estimated in the model. On the other hand, it leads to a conclusion that the inflation formation process in Latvia is not consistent with the assumption on which the traditional Phillips curve model is based, i.e. that inflation dynamics are driven by inflation expectations formed in the previous period for the current period.

3.2 Estimating the New Phillips Curve

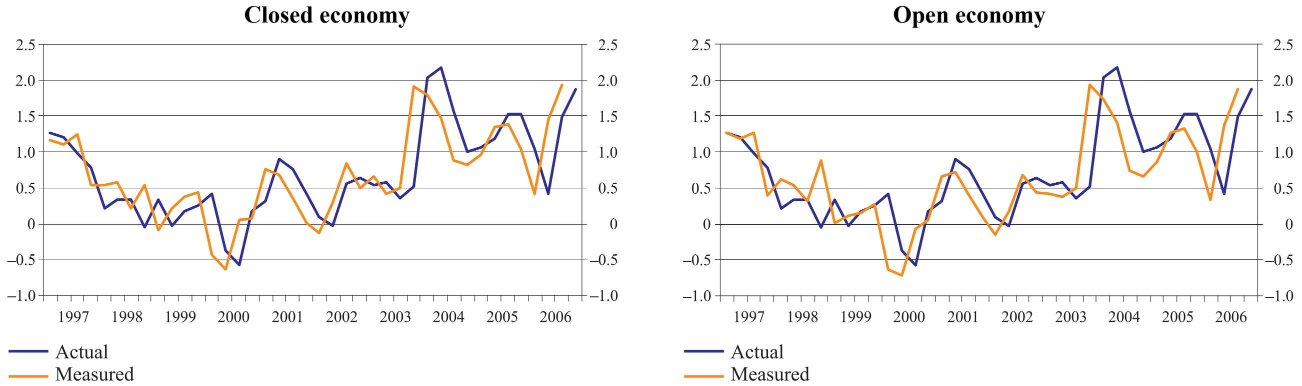
Table 2 shows the results of the new Phillips curve estimation for closed economy[9] (see Appendix 2 for more detailed statistical data on the new Phillips curve estimation). In both model specifications, the coefficients of approximation indicators for marginal production costs have correct signs and are statistically significant at least at a 10% level of significance. At the same time, β is close to 1 in both cases.

When the model is augmented with a vector of external variables corresponding to the case of an open economy, estimation results change (see Table 2). The coefficients of approximation indicators become more significant, while those of variables determining external environment do not have correct signs.

Table 2
New Phillips curve estimation results

Model specification	β	λk	η	μ
Closed economy *Orthogonal condition:* $E_t\left\{\left(\Delta p_t - \lambda k Y_t^c - \beta E_t\left\{\Delta p_{t+1}\right\}\right) z_t\right\} = 0$				
GDP gap (probability)	1.032 (0.000)	0.148 (0.000)	–	–
Unemployment gap (probability)	0.923 (0.000)	–0.183 (0.090)	–	–
Open economy *Orthogonal condition:* $E_t\left\{\left(\Delta p_t - \lambda k Y_t^c - \beta E_t\left\{\Delta p_{t+1}\right\} - \eta \Delta p_t^f - \mu \Delta neer_t\right) z_t\right\} = 0$				
GDP gap (probability)	0.993 (0.000)	0.136 (0.000)	–0.001 (0.990)	0.051 (0.089)
Unemployment gap (probability)	0.995 (0.000)	–0.158 (0.009)	–0.112 (0.024)	0.050 (0.057)

Chart 3
Actual and measured core inflation
(quarter-on-quarter growth; %)



Model specification: unemployment gap.

[9] In the estimation of the new and hybrid Phillips curves, logged actual core inflation in period $t+1$ is used instead of $E_t\left\{\Delta p_{t+1}\right\}$. A similar approach is used by R. M. John (11).

Chart 3 shows that core inflation measured with this model specification is also systematically biased with 1-period lag. As in the case of traditional Phillips curve estimation, it suggests that Latvia's inflation formation process is not consistent with the assumptions underlying the new Phillips curve model, i.e. that inflation dynamics is driven solely by current inflation expectations formed for the next period.

3.3 Estimating the Hybrid Phillips Curve

Table 3 shows the results of the hybrid Phillips curve estimation (see Appendix 3 for more detailed statistical data on the hybrid Phillips curve model estimation). The coefficients reflecting the impact of past and future inflation expectations on the current inflation are restricted to make a sum of 1: $\gamma^f + \gamma^b = 1$.

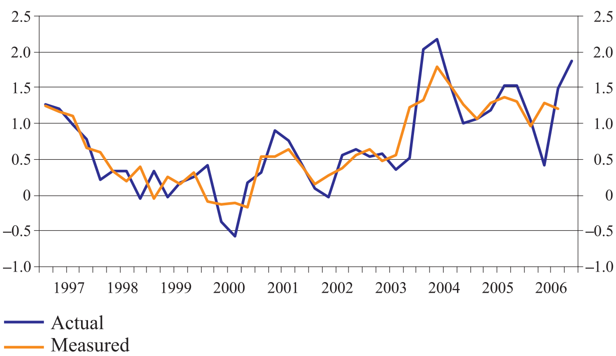
Table 3
Hybrid Phillips curve estimation results

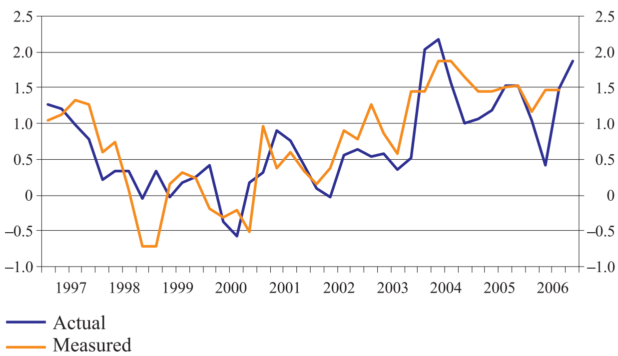
Model specification	γ^b	γ^f	λk	η	μ
Closed economy *Orthogonal condition:* $E_t\{(\Delta p_t - \lambda k Y_t^c - \gamma^f E_t\{\Delta p_{t+1}\} - \gamma^b \Delta p_{t-1})z_t\} = 0$					
GDP gap (probability)	0.540 (0.000)	1 – 0.540 (–)	0.139 (0.000)	–	–
Unemployment gap (probability)	0.479 (0.000)	1 – 0.479 (–)	–0.041 (0.090)	–	–
Open economy *Orthogonal condition:* $E_t\{(\Delta p_t - \lambda k Y_t^c - \gamma^f E_t\{\Delta p_{t+1}\} - \gamma^b \Delta p_{t-1} - \eta \Delta p_t^f - \mu \Delta neer_t)z_t\} = 0$					
GDP gap (probability)	0.565 (0.000)	1 – 0.565 (–)	0.095 (0.000)	0.169 (0.000)	–0.110 (0.000)
Unemployment gap (probability)	0.543 (0.000)	1 – 0.543 (–)	–0.204 (0.016)	0.106 (0.002)	–0.155 (0.000)

The estimated coefficients are statistically significant and consistent with the theory. The model with the output gap specification as marginal production cost approximation factor implies that the impact of adaptive expectations on current inflation is larger than the impact of forward-looking inflation expectations. At the same time, the model with unemployment gap suggests that the impact of forward-looking inflation expectations is somewhat stronger.

In contrast to the estimation of the new Phillips curve, the results of the hybrid Phillips curve for an open economy suggest that all coefficients are statistically significant and with correct signs, leading to a conclusion that these models are more suitable for measuring Latvia's inflation formation process. The inclusion of external factors into the model improved the estimate of the impact of inflation expectations: irrespective of the indicator used as approximation for marginal production costs, model results point to a stronger impact of backward-looking inflation expectations (γ^b = 0.565; 0.543).

Chart 4
Actual and measured core inflation
(quarter-on-quarter growth; Q 1; %)





Model specification: unemployment gap.

Chart 4 shows that, the above stated notwithstanding, trend core inflation is better described by such a Phillips curve whose construction is known to be useful for a closed economy. The estimated inflation dynamics for an open economy is somewhat more volatile than for a closed economy due to the presence of the nominal effective exchange rate variable in the model.

In both cases, the model-estimated inflation dynamics is not systematically biased from the actual inflation dynamics; it suggests that the assumptions underlying the hybrid Phillips curve model are more appropriate to describe Latvia's inflation formation process.

Notwithstanding stronger volatility of the estimated inflation, the hybrid Phillips curve model for an open economy captures more comprehensive information and, from this point of view, is more interesting for further profound analysis. Moreover, this model produces a more consistent estimation of coefficients irrespective of the indicator used in marginal production cost approximation. Building on this model, its structural type with coefficient normalisation has been calculated (see Table 4).

Table 4
Hybrid Phillips curve estimation results. Structural model with coefficient normalisation for open economy

Orthogonal condition:

$$E_t\left\{\left(\pi_t + (1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1}Y_t^c - \theta\phi^{-1}\beta E_t\left\{\pi_{t+1}\right\} - \omega\phi^{-1}\pi_{t-1} - \eta\Delta p_t^f - \mu\Delta neer_t\right)z_t\right\} = 0$$

Model specification	ω	θ	β	η	μ	γ^b	γ^f	λk
						Measured values		
GDP gap (probability)	0.657 (0.000)	0.309 (0.000)	0.99 (–)	0.134 (0.000)	–0.004 (0.790)	0.682	0.317	0.171
Unemployment gap (probability)	0.492 (0.000)	0.391 (0.000)	0.99 (–)	0.087 (0.006)	–0.131 (0.001)	0.558	0.439	–0.215

Measured structural parameters of the model are statistically significant (except the coefficient of the nominal effective exchange rate in the model with GDP gap) and consistent with the theory. The model with unemployment gap for this specification produces comparatively similar measurements of parameter values.

The measured value of parameter θ fluctuates within the range of 0.309 and 0.391; this implies that the expected time for prices remaining constant is around one and a half quarters. The measured value of parameter ω shows that around a half of all companies (49.2%) form their own inflation expectations building on lagged inflation, i.e. they are backward-looking. Table 5 shows the measurements of θ and ω for the euro area and the US.

Table 5
Comparison of euro area and US indicators with average estimated indicators of Latvia

	ω	θ	γ^b	γ^f
Latvia*	0.492	0.391	0.558	0.439
Euro area**	0.335	0.922	0.272	0.689
US**	0.451	0.827	0.364	0.599

* Structural model of the hybrid Phillips curve using unemployment gap as approximation variable of business cycles and marginal production costs.
** Structural model of coefficient normalisation assuming constant return to scale.(7)

Table 5 shows that the behaviour of Latvia's economic agents to a large extent differs from that of euro area and US economic agents. In Latvia, considerably more companies are backward-looking in respect to inflation dynamics than in the euro area on average where such companies account for around one third of all. At the same time, the period during which prices are supposed to remain constant is shorter in Latvia than in the euro area (around 3 years) and the US (around 1.5 years). It suggests overall that Latvian companies, if their vision regarding future prices changes, are able to adjust prices more efficiently and that in the periods of surging inflation rate it is more difficult to bring down companies' inflation expectations in Latvia vis-à-vis the euro area and the US due to stronger persistence of inflation expectations in Latvia.

CONCLUSIONS

To describe the dynamics of Latvia's core inflation in the period between the first quarter of 1996 and the first quarter of 2006, we have estimated models with the new and hybrid Phillips curves. We believe that the hybrid Phillips curve model is more appropriate for the analysis of Latvia's core inflation, and the unemployment gap is most suitable for economic cyclicality approximation. Despite the new Phillips curve model producing statistically significant parameter estimates consistently with the theory, like the traditional Phillips curve, it seriously constrains the expectations formation process of economic agents. The hybrid Phillips curve can be considered a trade-off, as it allows for the operation of forward-looking economic agents along with those whose future forecasts stem from the current growth of the economy.

Model results suggest that around 50% of Latvian companies form adaptive inflation expectations or are backward-looking, whereas the average time between two consecutive price adjustment events is around 6 months. The comparison of the study results with similar outcomes from papers on the euro area and the US enabled the authors to conclude that the behaviour of economic agents in Latvia is notably different. First, companies with rational expectations or those that are forward-looking prevail in both the euro area and the US. Second, the expected time for prices to remain constant in Latvia is considerably shorter than in the euro area (3 years) and the US (1.5 years).

In Latvia, inflation expectations are an important factor affecting the actual inflation rate. Moreover, quite frequent output price adjustments in Latvia imply that changes in inflation expectations would relatively soon pass through to actual prices in Latvia. Model results suggest that around a half of all Latvian companies are forward-looking, implying that they are forming their inflation expectations on the basis of information about those economic fundamentals that may have implications for price changes in the future. It leads to an inference that timely and broadly-based information about the expected inflation dynamics and changes in it supplied to the companies would lower inflation expectations and, consequently, also the actual inflation rate. Simultaneously, the comparatively large number of companies with adaptive inflation expectations in Latvia adds to the persistence of overall inflation expectations in the country and renders the task of reducing inflation expectations more complicated.

APPENDICES

Appendix 1

Estimation of traditional Phillips curve models

Appendix 1.1

Closed economy

$$\Delta p_t = c(1)E_{t-1}\{\Delta p_t\} + c(2)Y_t^c$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient		S.E.	*t*-statistic	Probability
C(1)	0.888		0.029	30.727	0.000
C(2)	–0.001		0.013	–0.052	0.959
Determination coefficient	0.476	Mean dependent variable			0.007
Adjusted determination coefficient	0.462	S.D. of dependent variable			0.006
S.E. of regression	0.005	Sum squared error			0.001
Durbin–Watson statistic	1.751	*J*-probability			0.743

$$\Delta p_t = c(1)E_{t-1}\{\Delta p_t\} + c(2)U_t^c$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient		S.E.	*t*-statistic	Probability
C(1)	0.914		0.032	28.689	0.000
C(3)	0.014		0.029	0.494	0.624
Determination coefficient	0.476	Mean dependent variable			0.007
Adjusted determination coefficient	0.462	S.D. of dependent variable			0.006
S.E. of regression	0.005	Sum squared error			0.001
Durbin–Watson statistic	1.751	*J*-probability			0.765

Appendix 1.2
Open economy

$$\Delta p_t = c(1)E_{t-1}\{\Delta p_t\} + c(2)Y_t^c + c(3)\Delta p_t^f + c(4)*\Delta neer_t$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient	S.E.	*t*-statistic	Probability
C(1)	0.726	0.072	10.033	0.000
C(2)	0.238	0.035	6.701	0.000
C(3)	0.396	0.070	5.658	0.000
C(4)	–0.017	0.018	–0.936	0.356

Determination coefficient	0.171	Mean dependent variable	0.007
Adjusted determination coefficient	0.100	S.D. of dependent variable	0.006
S.E. of regression	0.006	Sum squared error	0.001
Durbin–Watson statistic	1.040	*J*-probability	0.844

$$\Delta p_t = c(1)E_{t-1}\{\Delta p_t\} + c(2)U_t^c + c(3)\Delta p_t^f + c(4)*\Delta neer_t$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient	S.E.	*t*-statistic	Probability
C(1)	0.899	0.061	14.679	0.000
C(3)	–0.356	0.124	–2.866	0.007
C(4)	0.132	0.051	2.608	0.013
C(5)	–0.168	0.045	–3.730	0.001

Determination coefficient	0.143	Mean dependent variable	0.007
Adjusted determination coefficient	0.069	S.D. of dependent variable	0.006
S.E. of regression	0.006	Sum squared error	0.001
Durbin–Watson statistic	1.533	*J*-probability	0.798

Appendix 2
Estimation of new Phillips curve models

Appendix 2.1
Closed economy

$$\Delta p_t = c(1)E_t\{\Delta p_{t+1}\} + c(2)Y_t^c$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient	S.E.	t-statistic	Probability
C(1)	1.032	0.020	52.759	0.000
C(2)	0.148	0.024	6.271	0.000

Determination coefficient	0.250	Mean dependent variable	0.007
Adjusted determination coefficient	0.229	S.D. of dependent variable	0.006
S.E. of regression	0.005	Sum squared error	0.001
Durbin–Watson statistic	1.450	*J*-probability	0.898

$$\Delta p_t = c(1)E_t\{\Delta p_{t+1}\} + c(2)U_t^c$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient	S.E.	t-statistic	Probability
C(1)	0.923	0.030	30.942	0.000
C(2)	–0.183	0.043	–4.249	0.000

Determination coefficient	0.452	Mean dependent variable	0.007
Adjusted determination coefficient	0.437	S.D. of dependent variable	0.006
S.E. of regression	0.005	Sum squared error	0.001
Durbin–Watson statistic	1.901	*J*-probability	0.837

Appendix 2.2
Open economy

$$\Delta p_t = c(1)E_t\{\Delta p_{t+1}\} + c(2)Y_t^c + c(3)\Delta p_t^f + c(4) * \Delta neer_t$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient	S.E.	*t*-statistic	Probability
C(1)	0.993	0.080	12.362	0.000
C(2)	0.136	0.031	4.393	0.000
C(3)	–0.001	0.071	–0.013	0.990
C(4)	0.051	0.029	1.747	0.089

Determination coefficient	0.313	Mean dependent variable	0.007
Adjusted determination coefficient	0.254	S.D. of dependent variable	0.006
S.E. of regression	0.005	Sum squared error	0.001
Durbin–Watson statistic	1.523	*J*-probability	0.856

$$\Delta p_t = c(1)E_t\{\Delta p_{t+1}\} + c(2)U_t^c + c(3)\Delta p_t^f + c(4) * \Delta neer_t$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient	S.E.	*t*-statistic	Probability
C(1)	0.995	0.059	16.856	0.000
C(2)	–0.158	0.057	–2.786	0.009
C(3)	–0.112	0.047	–2.363	0.024
C(4)	0.050	0.025	1.973	0.057

Determination coefficient	0.393	Mean dependent variable	0.007
Adjusted determination coefficient	0.341	S.D. of dependent variable	0.006
S.E. of regression	0.005	Sum squared error	0.001
Durbin–Watson statistic	1.808	*J*-probability	0.801

Appendix 3
Estimation of hybrid Phillips curve models

Appendix 3.1
Closed economy

$$\Delta p_t = c(1)\Delta p_{t-1} + (1-c(1))E_t\{\Delta p_{t+1}\} + c(2)Y_t^c$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient		S.E.	*t*-statistic	Probability
C(1)	0.540		0.040	13.431	0.000
C(2)	0.139		0.015	9.254	0.000
Determination coefficient	0.620	Mean dependent variable			0.007
Adjusted determination coefficient	0.609	S.D. of dependent variable			0.006
S.E. of regression	0.004	Sum squared error			0.001
Durbin–Watson statistic	1.668	*J*-probability			0.911

$$\Delta p_t = c(1)\Delta p_{t-1} + (1-c(1))E_t\{\Delta p_{t+1}\} + c(2)U_t^c$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient		S.E.	*t*-statistic	Probability
C(1)	0.481		0.038	12.533	0.000
C(2)	–0.043		0.024	–1.781	0.083
Determination coefficient	0.738	Mean dependent variable			0.007
Adjusted determination coefficient	0.731	S.D. of dependent variable			0.006
S.E. of regression	0.003	Sum squared error			0.000
Durbin–Watson statistic	2.580	*J*-probability			0.757

Appendix 3.2
Open economy

$$\Delta p_t = c(1)\Delta p_{t-1} + (1-c(1))E_t\{\Delta p_{t+1}\} + c(2)Y_t^c + c(3)\Delta p_t^f + c(4) * \Delta neer_t$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient	S.E.	*t*-statistic	Probability
C(1)	0.565	0.060	9.414	0.000
C(2)	0.095	0.019	4.861	0.000
C(3)	0.169	0.024	6.949	0.000
C(4)	–0.110	0.024	–4.485	0.000

Determination coefficient	0.523	Mean dependent variable	0.007
Adjusted determination coefficient	0.482	S.D. of dependent variable	0.006
S.E. of regression	0.004	Sum squared error	0.001
Durbin–Watson statistic	1.566	*J*-probability	0.808

$$\Delta p_t = c(1)\Delta p_{t-1} + (1-c(1))E_t\{\Delta p_{t+1}\} + c(2)U_t^c + c(3)\Delta p_t^f + c(4) * \Delta neer_t$$

Instrument list: Δp_{t-1} Δp_{t-2} Δp_{t-3} Y_{t-1}^c Y_{t-2}^c Y_{t-3}^c U_{t-1}^c U_{t-2}^c U_{t-3}^c Δp_{t-1}^f Δp_{t-2}^f Δp_{t-3}^f $\Delta neer_{t-1}$ $\Delta neer_{t-2}$ $\Delta neer_{t-3}$

	Coefficient	S.E.	*t*-statistic	Probability
C(1)	0.543	0.091	5.954	0.000
C(2)	–0.204	0.081	–2.527	0.016
C(3)	0.106	0.031	3.447	0.002
C(4)	–0.155	0.031	–5.044	0.000

Determination coefficient	0.440	Mean dependent variable	0.007
Adjusted determination coefficient	0.392	S.D. of dependent variable	0.006
S.E. of regression	0.005	Sum squared error	0.001
Durbin–Watson statistic	1.719	*J*-probability	0.807

BIBLIOGRAPHY

1. BEŅKOVSKIS, Konstantīns, PAULA, Daina. *Inflation Expectations in Latvia: Consumer Survey Based Results.* Riga : Latvijas Banka, 2007. Working Paper 1/2007 [cited 29 March 2007]. Available: *http://www.bank.lv/images/img_lb/izdevumi/english/citas/WP_1_2007.pdf*
2. BRISSIMIS, Sophocles N., MAGGINAS, Nicholas S. *Inflation Forecasts and the New Keynesian Phillips Curve*. Bank of Greece Working Paper, No. 38, May 2006 [cited 29 March 2007]. Available: *http://www.bankofgreece.gr/publications/pdf/Paper200638.pdf*
3. DHYNE, Emmanuel, ÁLVAREZ, Luis J., LE BIHAN, Hervé, VERONESE, Giovanni, DIAS, Daniel, HOFFMANN, Johannes, JONKER, Nicole, LÜNNEMANN, Patrick, RUMLER, Fabio, VILMUNEN, Jouko. *Price Setting in the Euro Area: Some Stylized Facts from Individual Consumer Price Data.* ECB Working Paper, No. 524, September 2005 [cited 29 March 2007]. Available: *http://www.ecb.int/pub/pdf/scpwps/ecbwp524.pdf*
4. FRIEDMAN, Milton. The Role of Monetary Policy. *American Economic Review*, vol. 58, No. 1, March 1968, pp. 1–17 [cited 29 March 2007]. Available: *http://www.jstor.org/view/00028282/di950399/95p01092/0*
5. GALATI, Gabriele, MELICK, William. *The Evolving Inflation Process: an Overview*. Bank for International Settlements, BIS Working Papers, No. 196, February 2006 [cited 29 March 2007]. Available: *http://www.bis.org/publ/work196.pdf*
6. GALÍ, Jordi, GERTLER, Mark. *Inflation Dynamics: a Structural Econometric Analysis*. NBER Working Paper, No. 7551, February 2000 [cited 29 March 2007]. Available: *http://www.nber.org/papers/W7551*
7. GALÍ, Jordi, GERTLER, Mark, LÓPEZ-SALIDO, David J. *European Inflation Dynamics*. NBER Working Paper, No. 8218, April 2001 [cited 29 March 2007]. Available: *http://www.nber.org/papers/W8218*
8. GALÍ, Jordi, GERTLER, Mark, LÓPEZ-SALIDO, David J. *Robustness of the Estimates of the Hybrid New Keynesian Phillips Curve*. NBER Working Paper, No. 11788, November 2005 [cited 29 March 2007]. Available: *http://www.nber.org/papers/W11788*
9. GERLACH-KRISTEN, Petra. *A Two-Pillar Phillips Curve for Switzerland*. Swiss National Bank Working Paper, No. 2006–9, June 2006 [cited 29 March 2007]. Available: *http://www.snb.ch/d/download/publikationen/working-paper_06_09.pdf*
10. HARGREAVES, David, KITE, Hannah, HODGETTS, Bernard. *Modelling New Zealand Inflation in a Phillips Curve*. Reserve Bank of New Zealand Bulletin, vol. 69, No. 3, 2006 [cited 29 March 2007]. Available: *http://www.rbnz.govt.nz/research/bulletin/2002_2006/2006sep69_3hargreaveskitehodgetts.pdf*
11. JOHN, Roberts M. *How Well Does the New Keynesian Sticky-Price Model Fit the Data?* Board of Governors of the Federal Reserve System, February 2001 [cited 29 March 2007]. Available: *http://www.federalreserve.gov/pubs/feds/2001/200113/200113pap.pdf*

12. Latvijas Maksājumu Bilance. Latvia's Balance of Payments. No. 3/2006 [cited 29 March 2007]. Available: *http://www.bank.lv/images/img_lb/izdevumi/latvian/maksbil/2006-03/VMB_2006_03_complete.pdf*
13. LENDVAI, Julia. *Hungarian Inflation Dynamics*. *Magyar Nemzeti Bank* Occasional Paper, No. 46, November 2005 [cited 29 March 2007]. Available: *http://english.mnb.hu/Engine.aspx?page=mnben_muhelytanulmanyok&ContentID=7725*
14. LLAUDES, Ricardo. *The Phillips Curve and Long-Term Unemployment*. ECB Working Paper, No. 441, February 2005 [cited 29 March 2007]. Available: *http://www.ecb.int/pub/pdf/scpwps/ecbwp441.pdf*
15. PALOVITTA, Maritta. *Inflation Dynamics in the Euro Area and the Role of Expectations*. Bank of Finland Discussion Papers, No. 20, 2002 [cited 29 May 2007]. Available: *http://www.bof.fi/en/julkaisut/tutkimukset/keskustelualoitteet/2002/dp2002_20.htm*
16. PALOVITTA, Maritta, VIRÉN, Matti. *The Role of Expectations in the Inflation Process in the Euro Area*. Bank of Finland Discussion Papers, No. 6, 2005 [cited 29 May 2007]. Available: *http://www.bof.fi/en/julkaisut/tutkimukset/keskustelualoitteet/2005/dp2005_06.htm*
17. PHELPS, Edmund S. Phillips Curves, Expectations of Inflation and Optimal Unemployment Over Time. *Economica*, vol. 34, No. 135, 1967, pp. 254–281 [cited 29 March 2007]. Available: *http://www.jstor.org/view/00130427/di009983/00p0106v/0*
18. PHILLIPS, Alban William. The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957. *Economica*, vol. 25, No. 100, November 1958, pp. 283–299 [cited 29 March 2007]. Available: *http://www.jstor.org/view/00130427/di009947/00p00034/0*
19. RUMLER, Fabio. *Estimates of the Open Economy New Keynesian Phillips Curve for Euro Area Countries*. ECB Working Paper, No. 496, June 2005 [cited 29 March 2007]. Available: *www.ecb.int/pub/pdf/scpwps/ecbwp496.pdf*
20. SAMUELSON, Paul A., SOLOW, Robert M. Analytical Aspects of Anti-Inflation Policy. *American Economic Review*, Papers and Proceedings, vol. 50, No. 2, May 1960, pp. 177–194 [cited 29 March 2007]. Available: *http://www.jstor.org/view/00028282/di950362/95p0107z/0*
21. TAYLOR, John B. *Staggered Price and Wage Setting in Macroeconomics*. Stanford University, July 1998 [cited 29 March 2007]. Available: *www.stanford.edu/~johntayl/Papers/handbook.pdf*
22. TILLMANN, Peter. *The New Keynesian Phillips Curve in Europe: Does it Fit or Does it Fail?* Deutsche Bundesbank Discussion Paper, No. 04/2005 [cited 29 March 2007]. Available: *www.bundesbank.de/download/volkswirtschaft/dkp/2005/200504dkp.pdf*
23. TILLMANN, Peter. *The Calvo Model of Price Setting and Inflation Dynamics in Germany*. University of Bonn, November 2005 [cited 29 March 2007]. Available: *http://www.iiw.uni-bonn.de/tillmann/tillmann_nkpc_Germany.pdf*