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Sticky Information Phillips Curves: European Evidence

We estimate the Sticky Information Phillips Curve model of Mankiw and Reis (2002) using survey expectations of professional forecasters from four major European economies. Our estimates imply that inflation expectations in France, Germany, and the United Kingdom are updated about once a year, while in Italy, about once each 6 months.

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FORMATION OF EXPECTATIONS, information transmission, and learning have recently again attracted much interest.[1] Several new papers, including Mankiw and Reis (2002, 2003, 2006), argue that models in which agents update their information occasionally rather than instantaneously resolve some stylized business cycle puzzles.[2] These puzzles include the facts that, in the data, inflation

1. See Phelps (1969) and Lucas (1973) for early work on these issues.

2. Alternative related channels that build in sluggishness in the frictionless rational expectations models include rational inattention (Sims 2003) and learning (Branch 2004).

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is considerably persistent and disinflations are found to be costly.[3] Carroll's (2003) work on "epidemiological expectations" elaborates the theoretical microfoundations for the new sticky information paradigm. Reis (2006) and Mankiw and Reis (2006) also discuss the microfoundations of the sticky information approach and argue that the Sticky Information Phillips Curve (SIPC) combines sound theory (missing in the backward-looking Phillips curves) and good empirical performance (for the lack of which the standard New Keynesian Phillips curves are often criticized, e.g., by Rudd and Whelan 2006).

Interestingly, there has been little research on estimation of the key parameters of the SIPC. Carroll (2003) and Döpke et al. (2008) estimate the epidemiological model of transmission of information between households and forecasters using the U.S. and European survey data, respectively. Among the few papers we are aware of that estimate the SIPC directly are Khan and Zhu (2002, 2006). However, due to data limitations, Khan and Zhu have to use inflation and output forecasts obtained from a VAR model with actual inflation, output gap, and the world output gap as a proxy for the actual forecasts. Similarly, Kiley (2005), Korenok (2005), and Laforte (2005) also proxy for inflation expectations. In contrast to these papers, we use survey-based inflation expectations directly.

Using recent data from four major European economies, we estimate the parameter (λ) that governs the amount of information stickiness. We find that producers in France, Germany, and the United Kingdom update their information sets about once a year, while those in Italy about once each 6 months. These results are quite robust across the two estimation methods that we use (equation-by-equation estimation and seemingly unrelated regressions [SUR]) and the number of lags of right-hand side variables included. The estimates of λ close to 0.3 are consistent with those of Döpke et al. (2008), except for Italy, whose λ they pin down to be comparable to the other countries. Khan and Zhu find similar results for Canada, the United Kingdom, and the United States, and Korenok (2005) for the United States. Kiley (2005) reports that λ in his models ranges between 0.44 and 0.71 (in the U.S. data).

1. SIPC

1.1 The Model

Mankiw and Reis (2002) assume that for each period, only a fraction λ of firms gather the up-to-date information about the current state of the economy and recomputes and adjusts the optimal path of future prices. Remaining $(1 - \lambda)$ firms continue using their previous plans and set prices based on outdated information. The firm's probability of information updating is exogenously determined and independent of price adjustment history. Under this assumption, Mankiw and Reis derive the following closed economy version of the SIPC:

$$\pi_t = \frac{\alpha\lambda}{1-\lambda}\tilde{y}_t + \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-1-j}(\pi_t + \alpha \Delta \tilde{y}_t) + \varepsilon_t, \tag{1}$$

3. Inflation persistence is documented in many papers including European Central Bank (2005) and Pivetta and Reis (2007). An important paper by Ball (1994) estimates that the costs of disinflation in advanced economies are substantial.

where π_t is the inflation rate and $\tilde{y}_t$ the output gap. $E_t(\cdot)$ denotes the rational (mathematical) expectation as of time t. The parameter α measures the sensitivity of the optimal relative price to the current output gap and depends on the structure of the economy (e.g., the preferences, technology, and the market structure parameters).[4]

Note that in contrast to the standard (forward-looking) sticky price model, in which current expectations of the future state of the economy play an important role, what matters in the sticky information model (see equation (1)) are the past expectations of the present events.

1.2 The Data

We use the quarterly data between 1991Q4 and 2004Q4 for Germany, France, Italy, and the United Kingdom. The actual GDP and inflation series were obtained from OECD's Main Economic Indicators database.

The experts' inflation and output forecasts were collected by Consensus Economics, a major London-based macroeconomic survey firm. Each quarter since 1991 Consensus Economics publishes the consensus forecasts constructed as the median of 20–30 individual predictions of major banks and research institutes (in each country). The consensus forecasts are available up to six quarters ahead, i.e., for quarters $t+1$ through $t+6$.[5]

We use the GDP growth forecasts to extract expectations as of time s for the future output gap, $E_s\tilde{y}_{t+i}$, as follows. First, we have to bear in mind that the expectations reported in the survey refer to year-on-year changes rather than annualized quarterly changes as implied by the SIPC model. Second, we base our proxy of the expected output gap on the expectations of GDP growth $E_s y_{t+i}$ as follows. Denote y_t and y_t^* the log of output and the log of potential output, respectively. For each time period, s, in our sample, we construct a prolonged GDP time series, say $\hat{y}_s(t)$, by setting $\hat{y}_s(t) = y_t$ for $t \leq s$ and recursively computing $\hat{y}_s(t+1) = y_{t-3} + E_s\Delta y_{t-3,t+1}$, $\hat{y}_s(t+2) = y_{t-2} + E_s\Delta y_{t-2,t+2}, \ldots, \hat{y}_s(t+5) = \hat{y}_{t+1} + E_s\Delta y_{t+1,t+5}$, and $\hat{y}_s(t+6) = y_{t+2} + E_s\Delta y_{t-2,t+6}$. Where $E_s\Delta y_{i,j}$ denotes the expectation of GDP growth between time i and j formed at time s. We then apply the Christiano and Fitzgerald (2003) band-pass filter on this prolonged time series to decompose $\hat{y}_s(t)$ into (log) potential output $y_s^*(t)$ and the cyclical component: $\tilde{y}_s(t) = \hat{y}_s(t) - \tilde{y}_s^*(t)$. We use the cyclical component $\tilde{y}_s(t)$ as a proxy for the expected output gap. More specifically, we interpret the last six observations of this series as the expectation as of time s of the output gap in periods $s+1$ through $s+6$.[6]

4. The parameter α can be interpreted as a measure of the degree of real rigidity (Ball and Romer 1990).

5. Consensus Economics started collecting forecasts in the late 1989. In the first 2 years, however, the survey only asked about forecasts for the calendar year growth rates, i.e., fixed-event forecasts.

6. To illustrate the procedure, suppose we are interested in output gap expectations as of time $s =$ 2000Q1. We assume that the data on actual log GDP y_t are known until 2000Q1. The survey contains expected year-on-year growth rates for up to six quarters ahead: $E_{2000Q1}\Delta y_{1999Q2,2000Q2}$, $E_{2000Q1}\Delta y_{1999Q3,2000Q3}$, $\ldots$, $E_{2000Q1}\Delta y_{2000Q3,2001Q3}$. Using y_t and the expected growth rates, we recursively compute the prolonged GDP log-level series $\hat{y}_{2000Q1}(t)$ until six quarters ahead (until $t =$ 2001Q3). We then run the Christiano and Fitzgerald filter on $\hat{y}_{2000Q1}(t)$, $t =$ 1991Q4, $\ldots$, 2001Q3 and decompose it into the trend (potential) $y^*_{2000Q1}(t)$ and cyclical $\tilde{y}_{2000Q1}(t)$ components. Finally, we use the cycle observations $\tilde{y}_{2000Q1}(t)$, $t =$ 2000Q2, $\ldots$, 2001Q3 as proxies for the expected output gaps until 2001Q3, given the information as of 2000Q1.

TABLE 1
SIPC REGRESSION: EQUATION-BY-EQUATION ESTIMATES

Information stickiness		λ	
Truncation at lag		4	6
France	$\alpha = 0.10$	0.271	0.188
		5.38*	5.40*
	$\alpha = 0.15$	0.268	0.189
		5.51*	5.34*
	$\alpha = 0.20$	0.271	0.191
		5.38*	5.28*
Germany	$\alpha = 0.10$	0.258	0.182
		5.73*	5.37*
	$\alpha = 0.15$	0.258	0.181
		5.71*	5.37*
	$\alpha = 0.20$	0.258	0.181
		5.72*	5.37*
Italy	$\alpha = 0.10$	0.612	0.457
		6.23*	3.39*
	$\alpha = 0.15$	0.580	0.495
		4.61*	3.74*
	$\alpha = 0.20$	0.612	0.544
		6.23*	5.15*
UK	$\alpha = 0.10$	0.271	0.201
		6.15*	6.15*
	$\alpha = 0.15$	0.270	0.202
		6.17*	6.14*
	$\alpha = 0.20$	0.271	0.202
		6.15*	6.13*

NOTES: The figures below the estimates are *t*-statistics. Estimation method: nonlinear least squares, estimation sample: 1991Q4 to 2004Q4.
*denotes significance at the 1% level.

For the expert expectations of the inflation rate, we also face the first problem mentioned above that the expectations reported in the survey refer to year-on-year changes rather than annualized quarterly changes. Analogous to the previous paragraph, we compute annualized expected quarterly inflation rates by prolonging the actual consumer price index time series based on the expected year-to-year inflation rates and transforming this prolonged series into the expected quarterly inflation rates.

1.3 The Results

We assume that the updating firms in each period simply adopt professional forecasts to form rational expectations of inflation and output gap up to six quarters ahead. Consequently, the infinite sum in equation (1) is truncated alternatively at four and six lags.[7] To increase the precision of estimates of λ, on which we primarily focus, we impose that the parameter α lies between 0.10 and 0.20, a range considered plausible in the literature.[8] We estimate equation (1) first individually for each country using nonlinear least squares (Table 1) and then jointly using SUR (Table 2).

7. The results with five lags do not differ considerably and are available from the authors upon request.

8. We also estimated both parameters jointly. While the estimates of λ remain about the same as in Tables 1 and 2, α is estimated imprecisely. Therefore, we impose α as suggested by, e.g., Mankiw and Reis (2002) and Khan and Zhu (2006).

TABLE 2

SIPC REGRESSION: SEEMINGLY UNRELATED REGRESSIONS

Information stickiness		λ	
Truncation at lag		4	6
France	$\alpha = 0.10$	0.213	0.146
		5.41*	5.12*
	$\alpha = 0.15$	0.216	0.146
		5.47*	5.15*
	$\alpha = 0.20$	0.219	0.144
		5.56*	5.13*
Germany	$\alpha = 0.10$	0.296	0.158
		5.84*	5.57*
	$\alpha = 0.15$	0.294	0.160
		5.85*	5.59*
	$\alpha = 0.20$	0.292	0.160
		5.87*	5.58*
Italy	$\alpha = 0.10$	0.451	0.526
		8.15*	5.62*
	$\alpha = 0.15$	0.472	0.569
		7.97*	6.49*
	$\alpha = 0.20$	0.494	0.571
		7.87*	7.23*
UK	$\alpha = 0.10$	0.190	0.177
		5.09*	5.57*
	$\alpha = 0.15$	0.193	0.177
		5.13*	5.57*
	$\alpha = 0.20$	0.196	0.176
		5.18*	5.58*

NOTES: The figures below the estimates are *t*-statistics. Estimation method: nonlinear least squares, estimation sample: 1991Q4 to 2004Q4.
*denotes significance at the 1% level.

Equation-by-equation estimation. Table 1 summarizes the results of estimating the relation of equation (1) with truncation lags $N = 4$ and 6 for values of α between 0.1 and 0.2 for Germany, France, Italy, and the United Kingdom. As the theoretical model in equation (1) does not have a constant, we exclude it in the empirical estimation.[9]

We find the following five key results. First, all estimates of λ are highly significant for all parameterizations of the model. Given that we only estimate one parameter, the *t*-statistics—which range between 3.4 and 6.2—can also be used as a measure of the goodness of fit of the model. Second, for France, Germany, and the United Kingdom, their values lie around 0.20–0.30. This is about the size one would expect and is in line with the findings in Khan and Zhu (2002), Döpke et al. (2008), and Korenok (2005). Third, there is a lot of homogeneity across these three countries. In the same parameterizations, λ do not differ by more than 0.02. Fourth, the results for Italy deviate quite substantially from the outcomes for the other countries: λ is estimated around 0.5–0.6, which implies about twice as high frequency of information updating as elsewhere in our sample.[10] In addition, unlike for other countries, the estimates for Italy are more sensitive with respect to the values chosen for α. Finally, the models

9. If the constant is included, it is insignificant.

10. The frequency of information updating is given by $1/\lambda$.

including up to six lags of the sequence of expectation terms generally show a better fit to the data and a smaller λ (this latter result is also evident from the results in Khan and Zhu 2006). Both of these findings could be related to the smaller approximation error of the specifications with six lags.

Our estimates of λ are typically a bit smaller than Carroll's (2003) estimates for the United States. This indicates that the information transmission process is somewhat slower in the three European countries considered here in this study. This is in line with the evidence of Döpke et al. (2008), who estimate the Carroll (2003) model for European countries and find the information updating process of households to be also somewhat slower than for the U.S. economy.

SUR estimation. As the residuals of the individual equations are substantially cross-correlated,[11] we investigate in Table 2 how using the SUR affects our baseline results approach to improve the efficiency of the estimation.

We again found that all coefficients are highly significant and (with the exception of Italy) lie between 0.14 and 0.18 for truncation at lag 6 and between 0.19 and 0.30 for truncation at lag 4. In addition, the likelihood ratio tests confirm that we cannot reject the null hypothesis that the λ are equal for France, Germany, and the United Kingdom.[12] Obviously, the hypothesis that λ for Italy is also equal to the parameters in the other three countries is rejected at any sensible significance level. A possible explanation for this finding of a bigger λ in Italy is a higher level of and uncertainty about inflation in the estimation sample in Italy compared with the other three countries. For much of the estimation sample, roughly until 1996, the Italian inflation rate was around 5%, a level that presumably caused inflation expectations to be less anchored, and the frequent information updating more beneficial.

Imposing equal λ across France, Germany, and the United Kingdom yields no big surprises. For all parameterizations, λ is highly significant and lies between the individual country estimates. For truncation at lag 4, we find $\lambda = 0.3$, and for truncation at lag 6, we find $\lambda = 0.16$. The estimates again seem to be robust to the particular value chosen for α.

2. CONCLUSION

This paper attempts to estimate the main parameter of the SIPC developed in Mankiw and Reis (2002) in four large European countries using survey-based expectations. We find that λ—the fraction of firms with up-to-date information—ranges between 0.15 and 0.3 for Germany, France, and the United Kingdom, and between 0.5 and 0.6 for Italy in the quarterly data. The possible extensions of this work include investigating how the frequency of updating varies across other countries and time periods, or more generally, what other factors determine its size.

11. The average cross-correlation of residuals among countries is 0.22; three of the six cross-correlations are significantly different from zero at the 10% significance level.

12. We only present the test statistic for one particular value of α, as for other specifications the outcomes are very similar. For $\alpha = 0.15$ and truncation at lag 4, the LR-statistic is 1.19 (p-value 0.55). For $\alpha = 0.15$ and truncation at lag 6, the LR-statistic is 0.84 (p-value 0.66).

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