Aggregate price adjustment in Europe, Japan and North America

Has short-run Phillips curves changed?

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1. Introduction

It is well-known and a prerequisite for the Keynesian macro model that prices and wages are rigid or sticky and adjust gradually in response to different types of shocks. This nominal rigidity has been confirmed in numerous empirical studies, see e.g. Gordon (1981, 1997). It has also been recognised that this rigidity differs across countries and time periods, see e.g. Gordon (1981, 1983) and also across different goods, see e.g. Okun (1981), Williamson and Wachter (??) or Assarsson (1989). It is therefore not very surprising that some authors found the Phillips curve changing during the 90s.

Different explanations for the price rigidity has been put forward in the literature. The most common is probably related to menu costs, i.e. the costs associated with marking price tags, reporting new prices to customers or maybe even the costs associated with upsetting the customers with price increases. Transactions between a few customers, particularly between firms, often involve negotiations in which price setting is involved. Clearly, such negotiations then represent a considerable cost and may explain the existence of long term agreements with fixed prices.

Also, as shown by e.g. Sheshinsky and Weiss (1977) and Rotemberg (19??) inflation makes fixed offers more costly, since nominal offers deviate more from their optimal levels, which move in line with the rate of inflation. Therefore, it is likely that the length of contracts in high-inflation periods is shorter than in low-inflation regimes. Hence, we expect the degree of price flexibility to have decreased as many countries recently turned into a low-inflation regime.

It is the purpose of this paper to empirically examine this hypothesis for 17 OECD countries. A corollary of this hypothesis is that the variance of output is correspondingly higher in the low-inflation regime. However, one cannot conclude that low inflation is destabilising, since the low-inflation regime itself is supposed to reduce the variance of price shocks.

2. Why does the rigidity of prices change over time?

The evidence of the *existence* of nominal price rigidity is extensive, both theoretically and empirically. The primary reason for the rigidity is the existence of adjustment costs in price setting. Adjustment costs can simply be the costs for marking price tags. More generally these costs refer also to other costs associated with the transactions between buyers and sellers, e.g. the costs for negotiations about price.

As Sheshinsky and Weiss (1977) have shown, for a monopolist operating in an inflationary environment, the frequency of price adjustment decreases if adjustment costs increase. The frequency of price change is determined where the marginal cost of price change equals the marginal benefit. The benefit of the price change is the revenue obtained by approaching the optimal price. The fixed price will deviate more from the optimal price as the rate of inflation increase. Hence, it is likely that the frequency of price changes will increase as the rate of inflation increase.

Transactions characterised as bilateral relations (see Williamson (1981??) and Williamson and Wachter (1981??)) depend on long term contracts in which prices determine the division of bilateral monopoly surpluses between buyers and sellers. Prices are often fixed for considerable time periods and recurrently negotiated in order to ensure a fair division of the surplus. The costs of such contracts are increased in high-inflation regimes and it is likely that the agents respond by changing to more flexible contracts or by altering the goods and services demanded such that the overall dependence of bilateral relations is reduced.

It is likely that the frequency of price changes and the periods during which prices are fixed will decrease as the rate of inflation is reduced. In the 1990ies as compared to the 70ies and 80ies, the rate of inflation slowed down in most industrialised countries. This implied an increase in contract lengths and a decrease in the degree of price flexibility. The implication of this is that a nominal shock in the short run will hit real variables more and prices less than in the earlier periods with higher inflation rates.

Recently, it has been observed that the unusually strong and persistent business cycle in the U.S. has proceeded with less inflation effects than expected. This has been interpreted as a 'new' economy phenomenon, see ??, by which Phillips curves have changed. As the analysis above indicates it is likely that short-run Phillips curves, or the degree of price flexibility, change as the long run rate of inflation decreases. These are the consequences of the behaviour of optimising agents, who minimise not only production but also transaction costs.

Below I analyse if such a shift in short run price rigidity has occurred during the recent transition from high to low inflation in 17 countries.

3. An empirical model for gradual nominal price adjustment

Let $Y \equiv P \cdot Q$ be nominal GDP, where *P* is the general price level (GDP deflator) and *Q* is real GDP measured in fixed prices. Measured in terms of relative changes we use logarithmic differences (lower-case letters) and then have $y \equiv p + q$. Then let $\overline{q}$ be the growth rate of trend or potential GDP and $\tilde{q} \equiv q - \overline{q}$ be the relative change of the output deviation. Suppose also that a nominal shock is defined as $\tilde{y} = y - \overline{q}$, i.e. measures the deviation of nominal GDP growth from the growth of potential GDP. As in Gordon (1981) we then can derive the price adjustment equation

$$p = \alpha \tilde{y} \tag{1}$$

and, by definition, an equation for the growth rate of output deviation as

$$\tilde{q} = (1-\alpha)\tilde{y} \tag{2}$$

These equations show that a nominal shock is composed of a price adjustment and an output deviation, α determining the composition. Clearly, if $\alpha = 1$ the classical case applies with potential output and full employment.

A dynamic price equation can be written

$$p_t = \alpha_0 + \sum_{i=0}^{N} \alpha_i \tilde{y}_{t-i} + \varepsilon_t \tag{3}$$

for time period t=1,…,T. To save degrees of freedom the lag length N is truncated, here at eight lags for the quarterly data that are used. The decomposition between price adjustment and output deviation now can be written

$$\alpha = \sum_{i=1}^{n} \alpha_i \leq 1 \qquad \text{price a}$$

djustment component

(4)

$$1-\alpha \qquad \text{output deviation component}$$

where the output deviation is $\tilde{q}$. We estimate (3) and measure (4) for the OECD countries in Table 1. We use quarterly data and let N=8, i.e. use a two-year lag (nine quarters). Prior to these estimations I performed Phillips-Perron unit root tests to ensure that the regression variables did not contain unit roots. Unit roots could be rejected for all the variables applied in this study.

In the estimates of (4) below I estimate the price adjustment coefficients by

a) pooled estimation with all countries in unbalanced panel
b) pooled estimation with all countries in balanced panel
c) estimation by OLS for each country
d) different tests for structural changes

4. Empirical results

The data

Data are national accounts statistics collected from national sources. The dependent variable is the change in the GDP deflator and the nominal shock is the change in nominal GDP relative to the change in the trend GDP as measured by a Hodrick-Prescott filter with the lambda parameter set to 1600 for the quarterly data used here.

Table 1 presents the data periods for the different countries in the sample. For some of the countries the data periods are very short, particularly with respect to the 10 parameters included in the model (4). Data for Austria, Ireland and Portugal are included in the pooled model but excluded from the individual estimates and the tests for structural change.

Table 1 about here

Descriptive statistics are given in tables 2 and 3. Table 2 reports data for all individual countries for the period 1965-1989. The mean quarterly inflation rate is about 1.5 percent (6 percent annually). The highest mean is reported for Greece – 3.5 percent – and the lowest for Japan – 0.4 percent. The highest standard deviation is for Portugal – 2.2 percent – and the lowest for Austria – 0.5 percent. Note that the time periods vary for the different countries.

For the period 1990 – 1998 inflation rates are quite lower, as can be seen in Table 3. The mean inflation rate is now 0.7 percent (less than 3 percent annually).

These figures show that Greece and Portugal are extreme cases with very high inflation and standard deviation of inflation. Note also that Ireland has below average inflation but above average standard deviation while Italy, Spain and the UK have above average inflation but below average standard deviation. One interpretation of this is that inflation in the latter countries though high may be less harmful than in most other countries. However, a regression of standard deviation on the mean reveals a highly significant positive correlation with the squared correlation coefficient equal to 0.85.

Table 2 about here

For the period 1990 – 1998 the picture is slightly different. Greece, Italy, Portugal, Spain and the UK have above average inflation and Denmark, Greece, Portugal and Sweden have above average standard deviation. Again, Greece and Portugal are the outliers though their inflation rates have fallen considerably compared to the earlier period. Both standard deviation and mean has fallen steadily since the beginning of the 80s.

Table 3 about here

Estimation with pooled data in unbalanced panel for 17 countries

Estimation for the period 1963-1999

Since the decrease in inflation rates is a general phenomenon across all the countries in the study it is likely that the expected increase in contract lengths will occur in all

Table 4 about here

the countries and therefore we estimate the price equation in a pooled data set with data for all countries. The model can be written

$$p_{jt} = \alpha_{0jt} + \sum_{i=0}^{n} \alpha_{ji} \tilde{y}_{jt-i} + \varepsilon_{jt} \qquad (5)$$

where j=1,…,M is the countries. In the most general case parameters can be defined across both countries and time and in the most restrictive case common coefficients for all countries and time periods. In Table 4 we report the estimates from an unbalanced pooled model in which we estimate the model with common coefficients for all the 17 countries. The sum of the coefficients for the first year $\sum_{i=0}^{4} \alpha_i$ is 0.82 and for the second year $\sum_{i=5}^{8} \alpha_i$, 0.18, so that the sum for the whole period is 1.00. A Wald test for the null hypothesis that all the coefficients sum to unity cannot be rejected. The estimation was done for the period 1963:2 – 1999:1 which is the longest available period for any single country (Germany).

Estimation with unbalanced data for the period 1963-1989

The sum of the first-year coefficients is 0.87 and for the second year 0.13 the total being 1.00. Again, in this case we cannot reject that the sum is unity. The p-value for the Wald test is 0.85.

Table 5 about here

Estimation with unbalanced data for the period 1990-1999

The sum of the first-year coefficients is 0.55 and for the second year 0.37 the total being 0.92. In this case the hypothesis of complete price adjustment within two years is firmly rejected at the two percent significance level.

Table 6 about here

A Chow test for equality of coefficients for the two time periods was also performed. The F-value for that Wald test is 21.65 and we can clearly reject this hypothesis at any reasonable significance level.

Estimation with pooled data in balanced panel

The previous estimations were done for unbalanced data and hence varying time periods for the different countries. In the balanced data we use the same time periods for all the countries.

Estimation for the period 1979-1998

The sum of the first-year coefficients is 0.70 and for the second year 0.28 the total being 0.98. I cannot reject the hypothesis that the sum of the coefficients is unity, the p-value being 0.13.

Table 7 about here

We can also perform a Chow test for equality of coefficients for the two time periods. The F-value for that Wald test is 16.24 and we can clearly reject this hypothesis.

Estimation with balanced data for the period 1979-1989

The sum of the first-year coefficients is 0.80 and for the second year 0.20 the total being 1.00. Again, we cannot reject the hypothesis that the sum of the coefficients is unity.

Table 8 about here

Estimation with balanced data for the period 1990-1998

The sum of the first-year coefficients is 0.55 and for the second year 0.37 the total being 0.92. The Wald test firmly rejects the hypothesis that the sum of the coefficients is unity.

Table 9 about here

We can also perform a Chow test for equality of coefficients for the two time periods. The F-value for that Wald test is 16.24 and we can clearly reject this hypothesis.

Differences across countries

We now turn to the country-specific estimates. In these estimations we exclude Austria and Portugal due to problems with data. We estimate the same model (5) as above without restrictions and allowing the residual variance to vary across countries. Table 10 first reports the results for the longest possible period in each county and gives the one and two years effects. Since we have observed differences across countries both in the mean and standard deviation of inflation rates it is not surprising that prices responses differ between the countries.

Table 10 about here

Canada, Finland, France, Germany, Netherlands and the US have first-year response coefficients below 0.5 (on average 0.4). Their mean inflation rate is 4.7 percent annually. The other countries' mean inflation rate is 8.1 and their first-year response on average 0.7. If we include Belgium and Japan, with first-year responses of 0.507 and 0.535 respectively, the pattern is even more obvious. It seems that countries with lower inflation rates also have slower price adjustment.

Changes over time

Table 11 about here

Table 12 about here

Wald tests for structural break in 1990

Table 13 about here

The relationship between price adjustment and the rate of inflation

As mentioned previously one could expect the speed of adjustment to be correlated with the rate of inflation. As the rate of inflation decreases, long term nominal contracts are written which imply a slower adjustment to nominal shocks. Long term contracts with fixed conditions are more common for heterogeneous goods and hence one could also expect relative prices on heterogeneous goods to decline somewhat as the rate of inflation decreases.

To examine this I regress the first year coefficient above, i.e. $\sum_{i=0}^{4} \alpha_{ijt} = \overline{\alpha}_{jt}$ on p_{jt} for t=1,2 where 1=time period up to 1989 and 2=1990 until end of period. The results

Table 14 about here

from this regression is shown in Table 14 above. There is a highly significant positive relationship between the first year rate of price adjustment and the quarterly rate of inflation. The speed of adjustment decreases by 0.25 for a decrease in the inflation rate with one percentage point. The mean decrease in the rate of inflation for the countries above were about five percentage points between the earlier period – about 7.5-8 percent - and the recent years – about 2-2.5 percent. According to the regression above this means that the first year speed of adjustment decreases from some 0.8 to some 0.5 due to the decreasing inflation rate and consequently that the first year output deviation increases by the same degree.

Econometric problems

5. Conclusions

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Tables and figures

Table 1. Countries and data periods. Sources are the domestic national accounts and for the hours worked data OECD Employment Outlook.	
Austria	1970:1 – 1999:1
Belgium	1961:1 – 1998:4
Canada	1961:1 – 1999:1
Denmark	1977:1 – 1999:1
Finland	1975:1 – 1998:4
France	1965:1 – 1999:1
Germany	1965:1 – 1999:1
Greece	1961:1 – 1998:4
Ireland	1961:1 – 1999:1
Italy	1970:1 – 1999:1
Japan	1965:1 – 1999:1
Netherlands	1977:1 – 1998:4
Portugal	1961:1 - 1998:4
Spain	1970:1 – 1999:1
Sweden	1961:1 – 1998:4
United Kingdom	1963:1 – 1999:1
USA	1961:1 – 1999:1

Table 2. Summary statistics for inflation in various countries and time periods. Annual percentage change for the period 1965:1 – 1989:4.

Area	**Common**	**Austria**	**Belgium**	**Canada**	**Denmark**	**Finland**	**France**
Mean	0.078574	0.051078	0.052399	0.059630	0.070137	0.080045	0.075377
Max	0.286207	0.104985	0.133739	0.153355	0.119552	0.152457	0.148118
Min	-0.036530	0.012467	0.006849	0.010753	0.029112	0.013697	0.012852
Std dev	0.055723	0.022951	0.026211	0.033264	0.024243	0.030073	0.034344
Area	**Germany**	**Greece**	**Ireland**	**Italy**	**Japan**	**Netherl**	**Portugal**
Mean	0.040299	0.118674	0.094145	0.131464	0.052051	0.027359	0.126676
Max	0.087441	0.262978	0.225859	0.229658	0.220286	0.077939	0.276252
Min	0.004975	0.009211	0.015179	0.055804	-0.004507	-0.036530	-0.008658
Std dev	0.019479	0.073757	0.054779	0.055417	0.044171	0.025262	0.084564
Area	**Spain**	**Sweden**	**UK**	**USA**			
Mean	0.125843	0.073643	0.088737	0.049218			
Max	0.245387	0.148200	0.286207	0.109160			
Min	0.040686	0.023388	0.023346	0.009631			
Std dev	0.049797	0.030163	0.058947	0.025337			

Table 3. Summary statistics for inflation in various countries and time periods. Annual percentage change for the period 1990:1 – 1998:4.

Area	**Common**	**Austria**	**Belgium**	**Canada**	**Denmark**	**Finland**	**France**
Mean	0.034140	0.025881	0.023176	0.014867	0.018740	0.022917	0.019002
Max	0.214530	0.046457	0.040363	0.037118	0.049630	0.078459	0.034949
Min	-0.021989	0.006048	0.004831	-0.007456	-0.015166	-0.005894	0.000964
Std dev	0.034292	0.011242	0.009981	0.011389	0.011343	0.017135	0.008018
Area	**Germany**	**Greece**	**Ireland**	**Italy**	**Japan**	**Netherl**	**Portugal**
Mean	0.028996	0.122971	0.019488	0.048764	0.006229	0.021226	0.070235
Max	0.095754	0.214530	0.049275	0.099086	0.030754	0.040179	0.132927
Min	0.005964	0.029318	-0.016732	0.016252	-0.021989	0.006667	0.019249
Std dev	0.021097	0.053740	0.016335	0.021936	0.013819	0.006851	0.037366
Area	**Spain**	**Sweden**	**UK**	**USA**			
Mean	0.045260	0.032518	0.036783	0.025318			
Max	0.073612	0.100141	0.086482	0.046545			
Min	0.002865	-0.002962	0.006107	0.008921			
Std dev	0.021208	0.029733	0.020834	0.010293			

Table 4. Pooled estimation for whole period.
Dependent Variable: p
Method: GLS (Cross Section Weights)
Date: 11/08/99 Time: 10:30
Sample: 1963:2 1999:1
Included observations: 144
Total panel (unbalanced) observations 2093
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α_0	-0.000111	0.000178	-0.623131	0.5333
$\tilde{y}_t$	0.444487	0.014838	29.95679	0.0000
$\tilde{y}_{t-1}$	0.097009	0.011718	8.278752	0.0000
$\tilde{y}_{t-2}$	0.059093	0.011278	5.239549	0.0000
$\tilde{y}_{t-3}$	0.071974	0.011996	5.999802	0.0000
$\tilde{y}_{t-4}$	0.145614	0.014001	10.40007	0.0000
$\tilde{y}_{t-5}$	0.055422	0.011214	4.942404	0.0000
$\tilde{y}_{t-6}$	0.014066	0.013188	1.066590	0.2863
$\tilde{y}_{t-7}$	0.042384	0.013408	3.161004	0.0016
$\tilde{y}_{t-8}$	0.064614	0.011334	5.700799	0.0000

Weighted Statistics

R-squared	0.825479	Mean dependent var	0.017394
Adjusted R-squared	0.824725	S.D. dependent var	0.016114
S.E. of regression	0.006746	Sum squared resid	0.094804
Log likelihood	9606.776	F-statistic	1094.725
Durbin-Watson stat	1.688992	Prob(F-statistic)	0.000000

Unweighted Statistics

R-squared	0.791320	Mean dependent var	0.015734
Adjusted R-squared	0.790418	S.D. dependent var	0.014767
S.E. of regression	0.006760	Sum squared resid	0.095199
Durbin-Watson stat	1.831057		

Table 5. Pooled estimation for the early period 1967-1989.
Dependent Variable: p
Method: GLS (Cross Section Weights)
Date: 11/08/99 Time: 10:34
Sample: 1963:2 1989:4
Included observations: 107
Total panel (unbalanced) observations 1471
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α_0	-5.65E-05	0.000255	-0.221823	0.8245
$\tilde{y}_t$	0.468526	0.016572	28.27129	0.0000
$\tilde{y}_{t-1}$	0.096775	0.013341	7.253778	0.0000
$\tilde{y}_{t-2}$	0.051759	0.012693	4.077724	0.0000
$\tilde{y}_{t-3}$	0.075618	0.013207	5.725564	0.0000
$\tilde{y}_{t-4}$	0.177714	0.014971	11.87048	0.0000
$\tilde{y}_{t-5}$	0.042582	0.012840	3.316278	0.0009
$\tilde{y}_{t-6}$	0.015916	0.015306	1.039858	0.2986
$\tilde{y}_{t-7}$	0.020135	0.015438	1.304254	0.1924
$\tilde{y}_{t-8}$	0.048404	0.012099	4.000664	0.0001

Weighted Statistics			
R-squared	0.836192	Mean dependent var	0.021509
Adjusted R-squared	0.835183	S.D. dependent var	0.017543
S.E. of regression	0.007122	Sum squared resid	0.074105
Log likelihood	7154.618	F-statistic	828.6659
Durbin-Watson stat	1.628357	Prob(F-statistic)	0.000000

Unweighted Statistics			
R-squared	0.783957	Mean dependent var	0.019084
Adjusted R-squared	0.782626	S.D. dependent var	0.015309
S.E. of regression	0.007137	Sum squared resid	0.074427
Durbin-Watson stat	1.792122		

Table 6. Pooled estimation for the later period 1990-1998.
Dependent Variable: p
Method: GLS (Cross Section Weights)
Date: 11/08/99 Time: 10:36
Sample: 1990:1 1999:1
Included observations: 37
Total panel (balanced) observations 622
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α_0	2.40E-05	0.000251	0.095671	0.9238
$\tilde{y}_t$	0.349924	0.018885	18.52914	0.0000
$\tilde{y}_{t-1}$	0.072605	0.015945	4.553500	0.0000
$\tilde{y}_{t-2}$	0.058906	0.014584	4.039157	0.0001
$\tilde{y}_{t-3}$	0.061025	0.016771	3.638607	0.0003
$\tilde{y}_{t-4}$	0.010425	0.020122	0.518100	0.6046
$\tilde{y}_{t-5}$	0.109048	0.014873	7.331933	0.0000
$\tilde{y}_{t-6}$	0.048109	0.014073	3.418642	0.0007
$\tilde{y}_{t-7}$	0.098794	0.018333	5.388808	0.0000
$\tilde{y}_{t-8}$	0.109151	0.018229	5.987929	0.0000

Weighted Statistics

R-squared	0.679030	Mean dependent var	0.009047
Adjusted R-squared	0.674310	S.D. dependent var	0.009098
S.E. of regression	0.005192	Sum squared resid	0.016497
Log likelihood	2651.147	F-statistic	143.8579
Durbin-Watson stat	1.784423	Prob(F-statistic)	0.000000

Unweighted Statistics

R-squared	0.701258	Mean dependent var	0.007810
Adjusted R-squared	0.696865	S.D. dependent var	0.009507
S.E. of regression	0.005234	Sum squared resid	0.016767
Durbin-Watson stat	1.971261		

Table 7. Pooled estimation with balanced data for whole period.
Dependent Variable: p
Method: GLS (Cross Section Weights)
Date: 11/08/99 Time: 10:39
Sample: 1979:2 1998:4
Included observations: 79
Total panel (balanced) observations 1343
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α_0	-0.000388	0.000171	-2.266206	0.0236
$\tilde{y}_t$	0.419584	0.016374	25.62441	0.0000
$\tilde{y}_{t-1}$	0.076508	0.014719	5.198022	0.0000
$\tilde{y}_{t-2}$	0.038411	0.012420	3.092727	0.0020
$\tilde{y}_{t-3}$	0.065192	0.013012	5.010194	0.0000
$\tilde{y}_{t-4}$	0.098803	0.016588	5.956223	0.0000
$\tilde{y}_{t-5}$	0.071872	0.013608	5.281416	0.0000
$\tilde{y}_{t-6}$	0.037031	0.012139	3.050588	0.0023
$\tilde{y}_{t-7}$	0.054439	0.012882	4.225926	0.0000
$\tilde{y}_{t-8}$	0.117874	0.013865	8.501578	0.0000
Weighted Statistics				
R-squared	0.829387	Mean dependent var		0.015413
Adjusted R-squared	0.828235	S.D. dependent var		0.015184
S.E. of regression	0.006293	Sum squared resid		0.052790
Log likelihood	5196.446	F-statistic		720.0014
Durbin-Watson stat	1.815333	Prob(F-statistic)		0.000000
Unweighted Statistics				
R-squared	0.803219	Mean dependent var		0.013579
Adjusted R-squared	0.801890	S.D. dependent var		0.014189
S.E. of regression	0.006316	Sum squared resid		0.053168
Durbin-Watson stat	1.995778			

Table 8. Pooled estimation with balanced data for the early period 1967-1989.
Dependent Variable: p
Method: GLS (Cross Section Weights)
Date: 11/08/99 Time: 10:46
Sample: 1979:2 1989:4
Included observations: 43
Total panel (balanced) observations 731
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α_0	-0.000865	0.000273	-3.171129	0.0016
$\tilde{y}_t$	0.463494	0.017872	25.93355	0.0000
$\tilde{y}_{t-1}$	0.087210	0.018184	4.796034	0.0000
$\tilde{y}_{t-2}$	0.030267	0.014831	2.040833	0.0416
$\tilde{y}_{t-3}$	0.072590	0.015140	4.794552	0.0000
$\tilde{y}_{t-4}$	0.148745	0.016634	8.942154	0.0000
$\tilde{y}_{t-5}$	0.040623	0.016702	2.432255	0.0152
$\tilde{y}_{t-6}$	0.035771	0.014975	2.388629	0.0172
$\tilde{y}_{t-7}$	0.018112	0.015324	1.181931	0.2376
$\tilde{y}_{t-8}$	0.110128	0.016041	6.865500	0.0000

Weighted Statistics			
R-squared	0.883414	Mean dependent var	0.021959
Adjusted R-squared	0.881959	S.D. dependent var	0.019740
S.E. of regression	0.006782	Sum squared resid	0.033165
Log likelihood	2811.954	F-statistic	607.0298
Durbin-Watson stat	1.806736	Prob(F-statistic)	0.000000

Unweighted Statistics			
R-squared	0.811925	Mean dependent var	0.018360
Adjusted R-squared	0.809578	S.D. dependent var	0.015598
S.E. of regression	0.006806	Sum squared resid	0.033402
Durbin-Watson stat	1.963160		

Table 9. Pooled estimation with balanced data for the later period 1990-1998.
Dependent Variable: p
Method: GLS (Cross Section Weights)
Date: 11/08/99 Time: 10:48
Sample: 1990:1 1998:4
Included observations: 36
Total panel (balanced) observations 612
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α_0	4.27E-05	0.000258	0.165285	0.8688
$\tilde{y}_t$	0.349561	0.019086	18.31467	0.0000
y_{t-1}	0.072976	0.016002	4.560487	0.0000
y_{t-2}	0.057368	0.014840	3.865632	0.0001
$\tilde{y}_{t-3}$	0.062048	0.016978	3.654608	0.0003
$\tilde{y}_{t-4}$	0.009401	0.020126	0.467112	0.6406
$\tilde{y}_{t-5}$	0.110645	0.015183	7.287526	0.0000
$\tilde{y}_{t-6}$	0.048468	0.014156	3.423802	0.0007
$\tilde{y}_{t-7}$	0.096503	0.018447	5.231370	0.0000
$\tilde{y}_{t-8}$	0.109448	0.018470	5.925609	0.0000

Weighted Statistics

R-squared	0.678054	Mean dependent var	0.009097
Adjusted R-squared	0.673241	S.D. dependent var	0.009137
S.E. of regression	0.005223	Sum squared resid	0.016423
Log likelihood	2570.878	F-statistic	140.8757
Durbin-Watson stat	1.780468	Prob(F-statistic)	0.000000

Unweighted Statistics

R-squared	0.701532	Mean dependent var	0.007868
Adjusted R-squared	0.697070	S.D. dependent var	0.009567
S.E. of regression	0.005265	Sum squared resid	0.016690
Durbin-Watson stat	1.974161		

Table 10. Estimates of α for selected countries and time periods.			
Country	α first five quarters	α second year	α after two years
Austria 1972:2 – 1999:1	0.626	0.365	0.991
Belgium 1963:2 – 1998:4	0.829	0.177	1.006
Canada 1963:2 – 1999:1	0.677	0.306	0.983
Denmark 1979:2 – 1999:1	0.687	0.229	0.916
Finland 1977:2 – 1998:4	0.555	0.293	0.848
France 1967:2 – 1999:1	0.728	0.241	0.969
Germany 1967:2 – 1999:1	0.499	0.310	0.809
Greece 1963:2 1998:4	1.000	0.033	1.033
Ireland 1963:2 – 1998:4	0.889	0.079	0.968
Italy 1972:2 – 1999:1	0.874	0.135	1.009
Japan 1967:2 – 1999:1	0.847	0.154	1.001
Netherlands 1979:2 – 1998:4	0.731	0.097	0.828
Portugal 1963:2 – 1999:1	0.847	0.116	0.963
Spain 1972:2 – 1999:1	0.911	0.131	1.042
Sweden 1963:2 – 1998:4	0.667	0.332	0.999
United Kingdom 1965:2 – 1999:1	0.993	-0.002	0.991
USA 1963:2 – 1999:1	0.491	0.444	0.935

Table 11. Estimates of α for selected countries before 1990.			
Country	α first five quarters	α second year	α after two years
Austria 1972:2 – 1989:4	0.612	0.340	0.952
Belgium 1963:2 – 1989:4	0.898	0.094	0.992
Canada 1963:2 – 1989:4	0.689	0.274	0.963
Denmark 1979:2 – 1989:4	0.535	0.116	0.651
Finland 1977:2 – 1989:4	0.616	0.410	1.026
France 1967:2 – 1989:4	0.724	0.191	0.915
Germany 1967:2 – 1989:4	0.504	0.307	0.811
Greece 1963:2 - 1989:4	1.026	0.000	1.026
Ireland 1963:2 – 1989:4	0.939	0.050	0.989
Italy 1972:2 – 1989:4	0.911	0.115	1.026
Japan 1967:2 – 1989:4	0.988	0.059	1.047
Netherlands 1979:2 – 1989:4	0.784	0.083	0.867
Portugal 1963:2 – 1999:1	0.873	0.085	0.958
Spain 1972:2 – 1989:4	0.952	0.156	1.108
Sweden 1963:2 – 1989:4	0.681	0.301	0.982
United Kingdom 1965:2 – 1989:4	1.013	-0.030	0.983
USA 1963:2 – 1989:4	0.443	0.428	0.871

Table 12. Estimates of α for selected countries after 1989.			
Country	α first five quarters	α second year	α after two years
Austria 1990:1 – 1999:1	0.703	0.422	1.125
Belgium 1990:1 – 1998:4	0.321	0.281	0.603
Canada 1990:1 – 1999:1	0.358	0.446	0.804
Denmark 1990:1 – 1999:1	0.665	0.323	0.989
Finland 1990:1 – 1998:4	0.266	0.283	0.549
France 1990:1 – 1999:1	0.293	0.384	0.677
Germany 1990:1 – 1999:1	0.486	0.294	0.780
Greece 1990:1 - 1998:4	0.624	0.540	1.164
Ireland 1990:1 – 1998:4	0.083	-0.513	-0.429
Italy 1990:1 – 1999:1	0.688	0.307	0.995
Japan 1990:1 – 1999:1	0.192	0.671	0.863
Netherlands 1990:1 – 1998:4	0.143	0.160	0.303
Portugal 1990:1 – 1999:1	0.668	0.239	0.907
Spain 1990:1 – 1999:1	0.888	0.187	1.075
Sweden 1990:1 – 1998:4	0.401	0.390	0.791
United Kingdom 1990:1 – 1999:1	0.458	0.744	1.202
USA 1990:1 – 1999:1	0.701	0.474	1.175

Table 13. Wald tests for structural break in 1990:quarter 1. Countries for which significant changes have been detected are marked with italics.		
Country	χ^2-value	p-value
Austria	6.092	0.807
Belgium	*39.496*	*0.000*
Canada	10.474	0.400
Denmark	*20.838*	*0.022*
Finland	*17.895*	*0.057*
France	*28.814*	*0.001*
Germany	16.020	0.099
Greece	*68.928*	*0.000*
Ireland	*56.293*	*0.000*
Italy	8.822	0.549
Japan	*46.599*	*0.000*
Netherlands	7.144	0.712
Portugal	*59.888*	*0.000*
Spain	*23.179*	*0.010*
Sweden	*22.006*	*0.015*
United Kingdom	*33.827*	*0.000*
USA	10.941	0.362

Table 14. Regression of estimate of price rigidity on the rate of inflation.
Dependent Variable: First year adjustment coefficient
Method: Least Squares
Date: 11/08/99 Time: 17:04
Sample(adjusted): 1 30
Included observations: 30 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.344666	0.067718	5.089722	0.0000
100*p*	0.048854	0.010347	4.721509	0.0001

R-squared	0.443259	Mean dependent var	0.609000
Adjusted R-squared	0.423375	S.D. dependent var	0.274793
S.E. of regression	0.208667	Akaike info criterion	-0.231817
Sum squared resid	1.219170	Schwarz criterion	-0.138403
Log likelihood	5.477250	F-statistic	22.29265
Durbin-Watson stat	1.779887	Prob(F-statistic)	0.000059