ECONOMIC PAPERS

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No. 13 May 1983

Supply of output equations in the EC-countries and the use of the survey based inflationary expectations

Paul DE GRAUWE*
Mustapha NABLI**

Internal paper

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We are grateful to M. Feyaerts for her competent research assistance and to T. de Hòra, M. Emerson, F. Papadia and E. de Souza for many helpful suggestions.

ABSTRACT

In this paper a supply of output model is developed and empirically tested for six EC-countries (Belgium, France, Germany, Italy, the Netherlands and the U.K.) during the sample period 1960-80. We study the empirical importance of inflationary surprise variables on the supply of output. The conclusion of this empirical analysis is that, at least during the seventies, inflationary surprises (as measured by a time-series procedure or based on the EC-survey) were insignificant in most countries.

We also tested for the empirical importance of the terms of trade and taxation variables in the supply of output equations. It is found that the (intermediate good) terms of trade had a significant negative effect on output in most EC-countries. The empirical evidence about the effect of taxation is mixed.

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I. INTRODUCTION

European countries have been subjected to substantial shocks during the seventies. One was the oil shock which occured twice (1973-1977 and 1979-1980) and which dramatically worsened the terms of trade of most European countries. Another "shock" was introduced in a more gradual way and was the result of a large increase of taxation of labor income (income taxes and social security contributions) during the same period.

Table 1 illustrates the size of these two shocks relative to GDP. The first column gives the increase of income taxes and social security contribution as a percentage of GDP for the industrialised countries, and the second column is the increased value of oil imports also expressed as a percentage of GDP. The latter figure is used as a broad indication of the OPEC-imposed increase of taxation of oil. The table illustrates that both supply shocks have been substantial. It also indicates that the (self-imposed) labor tax shock has been larger in most OECD-countries than the (externally imposed) oil shock. This is especially true for the small European oil importers where during 1970-1980 taxation on labor has increased by 5.8 percentage points of GDP whereas the increased oil tax (measured by the increased value of imports) was 3.8 % of GDP.

Most of the theoretical and empirical research on the macro-economic effects of these supply shocks has concentrated on the effects of the oil price shocks. Noteworthy here are the studies of Bruno and Sachs (1979), and (1982) and Giavazzi and Wyplosz (1981). Relatively little has been done to measure the macro-economic implications of the second supply shock.

The purpose of this study is to present the results of the estimation of supply of output equations for six EC-countries. The underlying theoretical framework is the Lucas supply of output equations extended to an open economy. The extension as developed by Fratianni and Nabli (1981) will be used, and applied to quarterly data. The salient features of this open-economy-supply-of-output equations is that it incorporates terms-of-trade effects and labor tax effects. This will allow one to draw some (tentative) conclusions as to the relative importance of the two supply shocks

Table 1 : Increase in taxation of labor and oil as a percent of GDP from 1970 to 1980

	Labor	Oil
EUROPEAN OIL IMPORTERS :		
Austria	6.3	2.7
Belgium	7.8	5.5
Denmark	2.9	3.0
Finland	1.9	5.7
France		2.8
Germany	5.1	3.0
Ireland	9.2	5.6
Italy	4.6	3.3
Netherlands	5.1	4.1
Sweden	8.3	4.4
Switzerland	7.0	2.2
Average	5.8	3.8
Standard deviation	2.3	1.3
OTHER INDUSTRIALISED COUNTRIES :		
Canada	1.2	1.7
Japan	5.4	4.2
U.K.	-0.2	0.8
U.S.	3.0	2.7
AVERAGE (ALL COUNTRIES)	4.6	3.4

NOTE : The first column (labor) represents the increase in income tax and social security contribution in percentage points of GDP; the second column represents the increased value of oil imports as a percent of GDP. For countries that produce domestic oil (Canada, U.K., U.S.) the increased value of oil imports is a bad proxy for the increased OPEC induced tax on oil.

SOURCES : IMF, International Financial Statistics, for oil; OECD Long Term trends in tax revenues of OECD member countries, Studies in taxation, 1981, p. 14.

of the seventies in affecting long-term output in EC-countries. In addition, the Fratianni-Nabli extension of the supply of output equations introduces institutional features such as wage indexation. (See also Marston (1981) on this). These are particularly important in many EC-countries. Its existence affects the specification and estimation of supply-of-output equations.

Price expectations play an important role in supply-of-output equations. Two alternative strategies will be followed here. In a first part, the supply of output equations will be estimated using a procedure based on time series analysis. In a second part, the EC-survey-based inflationary expectations variable will be used in the estimation of the supply-of-output equations. Finally, strong tests of rationality of this EC-inflationary expectations series will be performed.

II. THE THEORETICAL FRAMEWORK

This section makes extensive use of the theoretical sections in Fratianni and Nabli (1982) [1]. In order to derive the supply-of-output equations the following building blocks are used :

- a production function;
- a demand and supply function of labor determining the equilibrium in the labor market;
- a rational expectations formation assumption.

The demand and supply for labor equations together with the production function allow to derive a supply-of-output equation in the following way :

The production function is written as :

$$Y = AN^{\alpha_1} H^{\alpha_2} \quad ; \alpha_1 + \alpha_2 < 1 \tag{1}$$

where Y is domestic output, N is labor and H is an imported intermediate input. Firms maximise :

$$P_d Y - N W (1 + t_1)^{\delta_1} - P_h H \tag{2}$$

where P_d and P_h are the prices of Y and H; W is the nominal wage rate, t_1 is the tax on wages in the form of social security contributions paid by the employers. The value of the parameter δ_1 indicates how the firm values government services (including subsidies) generated by the tax. When $\delta_1 = 0$ there is no tax wedge problem; when $\delta_1 = 1$ the wedge problem is complete. From the first order maximisation condition one can derive the demand schedules of the two inputs, labor and the intermediate (imported) good (expressed in logs) :

$$h = h_0 + a_1 (p_d - w) + b_1 (p_d - p_h) - a_1 \delta_1 T_1 \tag{3}$$

---

[1] For more detail see Fratianni & Nabli (1982), pp. 4-8. In the next section a graphical interpretation of the model is presented.

$$n = n_0 + b_2\ (p_d - w) + a_2\ (p_d - p_h) - b_2\ \delta_1\ T_1 \qquad (4)$$

where p_d = the price of the domestic good in log

p_h = the price of the imported intermediate good in log

w = the nominal wage rate in log

$a_1 = \alpha_1/(1 - \alpha_1 - \alpha_2) > 0$

$a_2 = \alpha_2/(1 - \alpha_1 - \alpha_2) > 0$

$b_1 = (1 - \alpha_1)/(1 - \alpha_1 - \alpha_2) > 0$

$b_2 = (1 - \alpha_2)/(1 - \alpha_1 - \alpha_2) > 0$

$T_1 = \log\ (1 + t_1)$

Equation (4) is the labor demand equation. The demand for labor increases when real wages decline, when the terms of trade $(p_d - p_h)$ increase and when the tax wedge (T_1) declines. Note that if firms attach the same value to the services provided by the goverment as to the labor taxes they pay, $\delta_1 = 0$, and the tax variable diasappears from equations (3) and (4). The wage setting behavior (the supply of labor services) is assumed to take the following form :

$$w_t = (1 - b) \underset{t-1}{E}\ p_t + b\ p_t + \delta_2 T_2 \qquad (5)$$

where p_t is the aggregate price index, and $\underset{t-1}{E}\ p_t$ is the price in period t expected in period t-1; T_2 is the tax wedge; i.e. $T_2 = \log(1+t_2)$ where t_2 = the income tax paid by workers.

Labor contracts are negociated at the end of period t - 1 at which time workers make their best forecast concerning the overall price level for period t. In addition, workers may bargain for indexation clauses which will insulate them from the effects of forecast errors in the general price level. The degree of indexation is reflected in the value of b $(0 \leqslant b \leqslant 1)$; when b = 1 there is complete wage indexing and nominal wages adjust completely to changes in the current aggregate price index.

Finally workers may seek higher nominal wages the higher the level of taxes on wage income. The parameter δ_2 expresses the valuation by workers of government provided services (including transfers) relative to taxes paid. The term $\delta_2 T_2$ is to be interpreted as a tax push on the supply side of the labor market. Here also, if workers value government services (including transfers) as equal to the tax they pay, $\delta_2 = 0$, and workers will not seek to increase their gross wage claims. The aggregated price index p_t is defined as :

$$p_t = \lambda p_{d,t} + (1 - \lambda)\, p_{f,t} \tag{6}$$

where $p_{f,t}$ is the (domestic currency) price of the foreign good used in the consumption basket of domestic workers; ($p_{f,t} = p^{*}_{f,t} + s$; where p^{*}_{f} is the foreign currency price of the foreign good and s is the exchange rate); λ is the share of the domestic good in the consumption basket.

Combining (1), (3), (4), (5) and (6) allows to derive the aggregate supply function :

$$\begin{aligned} y_t &= a_0 - a_1 T_t + a_1(1-b)(p_t - \underset{t-1}{E}\, p_t) + [a_1(1-\lambda) + a_2](p_{d,t} - p_{f,t}) \\ &\quad - a_2(p_{h,t} - p_{f,t}) + u_{s,t} \end{aligned} \tag{7}$$

where $T_t = \delta_1 T_{1,t} + \delta_2 T_{2,t}$

This is a Lucas-type <u>aggregate supply function</u> extended to an open economy. The term $a_1 T_t$ measures the effect of the total tax wedge (income tax + social contribution) to the supply of output. This effect is negative. The third term is the inflationary "surprise" effect. Its importance in the supply of output equation depends on the degree of wage indexation. With partial indexation the role of the inflationary surprises is reduced. With complete wage indexation (b = 1), it drops out altogether from the equation. The supply of output then only depends on relative prices and the tax wedge. The last two terms measure the term-of-trade effects on output. A decline of the final good terms of trade ($p_d - p_f$) has a negative effect on output. An increase in the relative price of imported intermediate goods (measured by $p_h - p_f$) has a negative effect on output.

In order to close the model an aggregate demand function is added :

$$y_t = \beta_1(m_t - p_t) - \beta_2(p_{d,t} - p_{f,t}) + \beta_3(G_t - p_t) + u_{d,t} \qquad (8)$$

where m_t = the nominal money stock
G_t = the fiscal impulse variable

The first term measures the impact of changes in the real money stock; the third term measures the effect of a real fiscal impulse; the second term is the terms-of-trade effect on aggregate demand. This is negative because an increase in the price of the domestic good relative to the foreign good reduces aggregate demand.

Economic agents are assumed to use all available information to forecast the future price level. The domestic price level is endogenously determined by the model. Solving for p_{dt} and taking expectatins yields :

$$\underset{t-1}{E}\ p_{dt} = \frac{1}{D}\{- a_0 + a_1 \underset{t-1}{E}\ T_t + \beta_1 \underset{t-1}{E}\ m_t$$
$$+ [a_1(1 - \lambda) + (\lambda - 1)(\beta_1 + \beta_3) + \beta_2] \underset{t-1}{E}\ p_{f,t}$$
$$+ a_2 \underset{t-1}{E}\ p_{ht} + \beta_3 \underset{t-1}{E}\ G_t\} \qquad (9)$$

where D is a constant which is a combination of all parameters.

This expression also allows to derive the unexpected price of the domestic good which plays a role in the aggregate sypply equation (7). One obtains :

$$p_{d,t} - \underset{t-1}{E}\ p_{dt} = \frac{1}{D}\ \{a_1(T_t - \underset{t-1}{E}\ T_t) + \beta_1(m_t - \underset{t-1}{E}\ m_t)$$
$$+ [a_1(1 - \lambda)b + (\lambda - 1)(\beta_1 + \beta_3) + \beta_2](p_{f,t} - \underset{t-1}{E}\ p_{f,t})$$
$$+ a_2(p_{ht} - \underset{t-1}{E}\ p_{ht}) + \beta_3(G_t - \underset{t-1}{E}\ G_t) + u_t\} \qquad (10)$$

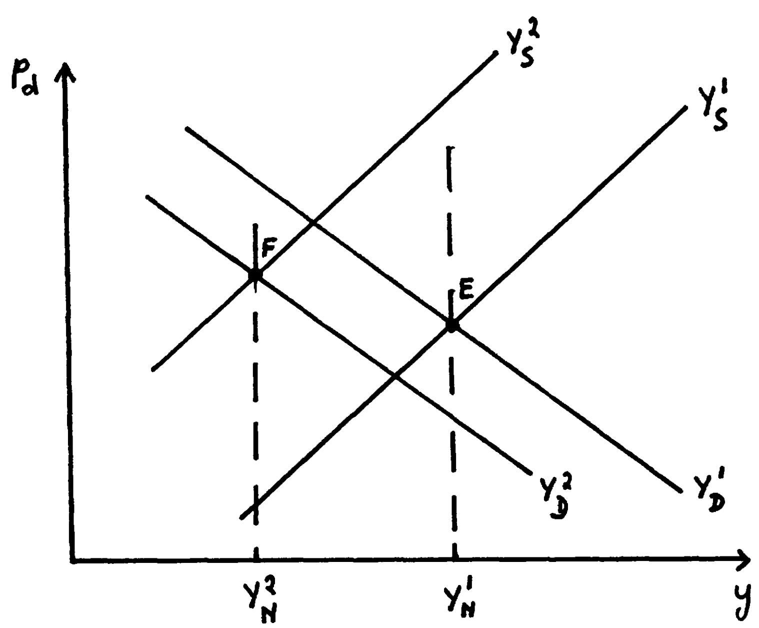
with $u_t = u_{d,t} - u_{s,t}$

Thus the unexpected level of domestic goods prices depends on the unexpected components of the underlying exogenous variables.

III. THE COMPARATIVE STATICS OF THE MODEL

In this section a brief analysis of the comparative statics of the model is presented. A graphical representation of the model is used. For a detailed algebraic solution, see Fratianni and Nabli (p. 8-11). The aggregate supply equation is represented by the upward sloping Y_S-curve; the aggregate demand curve by the downward sloping Y_D-curve. Y_N represents the "normal" output, i.e. the level of output which depends on the tax wedge and the terms of trade. It is obtained by setting $E\, p_t = p_t$ in the supply of output equation (7).

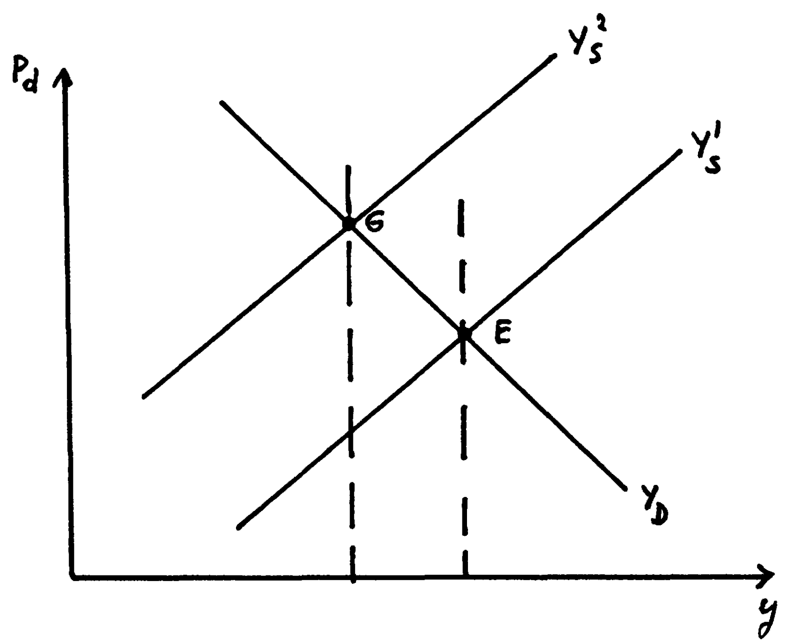
Figure 1



We now analyse the effects of several exogenous disturbances. First, a deterioration of the intermediate terms of trade $p_h - p_f$. This shock is shown by an upward shift of the Y_S-curve to Y_S^2. The aggregate demand effect will be deflationary, because the increased price level tends to deflate real money balances. The strength of this effect also depends on the policy reactions and the degree to which the authorities follow an accomodating monetary policy. In figure 1 a net deflationary demand effect is represented by the shift of Y_D to the left. A new equilibrium is reached in F with a permanently lower level of "normal" output.

An increase in the tax wedge has similar macroeconomic effects as a deterioration of the terms of trade. The supply curve is also shifted upwards. If the increased labor tax rate is used to finance transfers, the demand effects are likely to be negligible as the reduced after tax income is compensated by increased transfers. The economy moves from E to G (see figure 2).

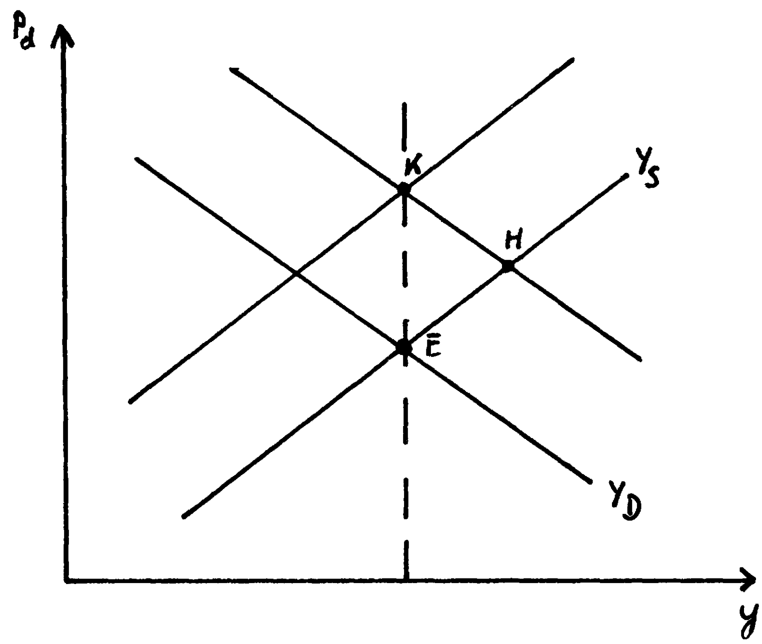
Figure 2



Here also the "normal" output level will decline permanently. Note that the size of this negative effect on output depends on the utility workers and firms attach to goverment services and transfers relative to the disutility of paying taxes. If the former is low the negative effect of the taxation on output will increase. This point illustrates how the degree of efficiency of the public sector has direct implications for the workings of the private sector.

Finally, the effects of a devaluation can be analysed as follows (see figure 3). A devaluation raises the domestic currency price of the foreign good (p_f). As a result, through substitution effects the aggregate demand is increased. At the same time the increased price level reduces the real cash balances. This tends to reduce aggregate demand. We assume here that the substitution effect dominates the real cash balance effect so that there

Figure 3



is a net expansion in demand. If the devaluation was unanticipated the economy moves from E to H. This positive output effect is due to the inflation surprise effect in the supply of output equation : the stimulation to output comes from the fact that workers had not anticipated the devaluation when they bargained for their current wages. As a result real wages decline.

A perfectly anticipated devaluation shifts the supply curve upwards, because wage earners have adjusted their nominal wages to reflect the (anticipated) devaluation. As a result, the economy moves to a point like K. The net effect on the output level is ambigous here. However, if we allow the nominal money stock (m) to increase in the same proportion as the price level (the real money stock (m-p) is unchanged in the aggregate demand equation) the effect of the devaluation on output is neutral. This can be seen as follows. The condition for a permanent positive supply effect of a devaluation is that the latter improves the terms of trade (the term $p_d - p_f$ must increase in the supply of output equation (7) to increase the supply). However, to increase aggregate demand permanently (assuming the real money stock to be kept unchanged) the terms of trade ($p_d - p_f$) should decline i.e. the domestic good must become cheap relative to the foreign good.

Since in the new equilibrium point demand must equal supply it follows that this can only be achieved if the terms of trade return to their initial level, thereby bringing demand and supply of output also to their initial level. Any other outcome would lead to inequality between demand and supply. For example, if the devaluation would lead to a deterioration of the terms of trade ($p_d - p_f$ declines) this would lead to excess demand for the domestic good, because aggregate demand increases and aggregate supply declines. This would tend to push up the domestic price level until equilibrium between demand and supply is restored.

It is also interesting to analyse the implications of full wage indexing. It can be shown that in a fully indexed economy a devaluation does not affect the level of output. The supply of output equation is only affected by the terms of trade variable and the tax wedge. Thus, the supply of output can only increase if the devaluation leads to an improvement in the terms of trade. As a result, the effects of a devaluation in a completely indexed wage system are identical to a perfectly anticipated devaluation in a rational expectations world.

Finally, complications can be added which have relevance to some EC-countries. For example, if the income tax system is progressive and if tax brackets are not indexed, a devaluation will automatically increase the tax wedge, because it increases the price level and the nominal wage. As a result, in such an institutional arrangement, a devaluation leads to an extra upward shift of the supply-curve, and the level of nominal output will be permanently reduced.

IV. EXTENSION OF THE MODEL

The previous discussion makes abstraction from the existence of a non-traded good sector. Even in the open economies that will be analysed empirically the non-traded goods sector is large enough (often 50 per cent or more of total GDP) to be given serious attention. The aggregate price level now must be redefined :

$$p = \lambda_1 p_d + \lambda_2 p_f + \lambda_3 p_0 \quad \text{and } \lambda_1 + \lambda_2 + \lambda_3 = 1 \tag{11}$$

where p_0 = the log of the non-traded good price level

λ_3 = the share of non-traded goods in the consumption basket.

The new version of the aggregate supply function of the traded goods sector becomes [2] :

$$y_t = a_0 - a_1 T_t + a_1(1 - b)\,[p_t - Ep_t] + (a_1\lambda_2 + a_2)(p_{dt} - p_{ft})$$

$$- a_2(p_{ht} - p_{ft}) - a_1\lambda_3(p_{0t} - p_{dt}) + u_t \tag{12}$$

There is an additional term, the internal terms of trade $(p_0 - p_d)$ in the supply of output equation. Its influence on industrial output is negative, i.e. an increase (decrease) in the price of non-traded goods relative to traded goods lowers (increases) output in the traded-goods sector.

The specification of the supply of output equation (12) will be used in the estimations reported in the next section.

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[2] See Fratianni & Nabli (1982), p. 26-27.

V. ESTIMATION OF THE MODEL

The estimation procedure consists in first, generating the price expectations using equation (9). To generate expectations of the exogenous variables in equation (9), simple autoregressive schemes of order 6 (AR(6)) were fitted by OLS. These were then substituted into (9) and the equation was estimated using observed inflation rates as dependent variables. The fitted values are interpreted as the expected values. Some general indications on the results are shown in appendix A. The next step is to estimate the supply equations.

Two alternative approaches were followed here. One approach uses a two-stage-estimation procedure, in which, first, the unexpected price component $(p_t - {}_{t-1}E\, p_t)$ is regressed on the unexpected parts of the exogenous variables in equation (10). The second stage consists in using the fitted unexpected price component, $(p_t - E_{pt})$, as an independent variable in the supply of output equation.

An alternative, one-stage-estimation procedure consists in using the difference between the observed inflation variable, p_t, and the expected inflation variable $({}_{t-1}E\, p_t)$ as generated by equation (9), directly into the supply equation.

The results of the estimation of the supply of output equation (12) for the sample period 1960-80 (quarterly data) are shown in tables 2 and 3. The equations were estimated with a lagged dependent variable. (In appendix D the supply of output equations are reestimated using less stringent restrictions on the lag structure). Seasonal dummies were added (but not reported in table 2) because the quarterly output data are heavily seasonally influenced.

The following interpretation of the results can be given. The single stage estimation procedure (table 2) generally yields results which are more in accordance with the prediction of the theory than the two stage estimation procedure (table 3). The inflation surprise variable $(\Delta p - E\Delta p)$ in the one stage estimation procedure is correctly signed in all countries except in the U.K. Statistical significance, however, is obtained only in the Netherlands and Italy. The intermediate (oil) terms of trade $(p_h - p_f)$ has the correct sign in all countries and is statistically significant in Belgium, France and the Netherlands. The tax wedge variable is significant only in

Table 2 : Supply of Output with and without Tax Wedge - OLS - Total Period

Country	c	t	T	$\Delta p - E\widehat{\Delta p}$	$p_d - p_f$	$p_h - p_f$	$p_o - p_d$	Y_{-1}	R^2	SE	μ	D.W.
Belgium 62.4-80.4	-0.034 (0.12)	0.0002 (2.75)	-	0.868 (1.48)	0.358 (3.06)	-0.042 (3.60)	-0.309 (1.66)	0.586 (4.94)	0.98	0.025	4.512	1.54
	-0.214 (0.61)	0.0002 (2.62)	-0.055 (1.16)	0.674 (1.12)	0.335 (2.84)	-0.036 (2.82)	-0.267 (1.41)	0.613 (5.05)	0.98	0.025	4.512	1.52
France 61.4-80.4	-0.240 (1.20)	0.0004 (4.57)	-	0.028 (0.03)	0.045 (0.47)	-0.070 (4.22)	-0.435 (3.04)	0.374 (2.91)	0.98	0.031	4.46	1.89
	-0.261 (1.26)	0.0004 (4.56)	-0.015 (0.38)	0.009 (0.01)	0.045 (0.46)	-0.069 (3.99)	-0.432 (2.99)	0.369 (2.83)	0.98	0.031	4.46	1.91
Nether-lands 62.1-79.4	-0.223 (0.69)	0.00017 (3.40)	-	0.346 (0.79)	-0.111 (1.13)	-0.042 (3.06)	-0.205 (1.27)	0.763 (11.02)	0.98	0.024	4.49	2.29
	0.642 (1.60)	0.00018 (3.08)	0.066 (1.37)	1.521 (2.66)	-0.075 (0.34)	-0.022 (0.64)	0.097 (0.56)	0.619 (6.83)	0.98	0.039	4.52	1.77
Italy 63.1-80.4	0.255 (0.89)	0.00019 (3.35)	-	1.465 (2.55)	-0.037 (0.17)	-0.026 (0.78)	0.117 (0.68)	0.632 (6.98)	0.97	0.039	4.52	1.80
	0.642 (1.59)	0.00018 (2.89)	0.064 (1.14)	1.391 (2.35)	-0.052 (0.21)	-0.013 (0.38)	0.127 (0.71)	0.631 (6.90)	0.97	0.038	4.50	1.79
Germany 61.4-80.4	0.669 (2.10)	0.00005 (1.37)	-	0.134 (0.16)	0.061 (0.81)	-0.010 (0.58)	0.204 (1.54)	0.780 (10.52)	0.99	0.025	4.51	1.84
	0.655 (2.00)	0.00007 (1.40)	-0.046 (0.70)	0.044 (0.05)	0.063 (0.82)	-0.005 (0.26)	0.215 (1.62)	0.755 (8.67)	0.98	0.026	4.51	1.82
U.K. 63.1-80.4	0.441 (1.46)	-0.00001 (0.49)	-	-0.480 (1.70)	0.035 (1.53)	-0.009 (0.87)	0.092 (0.67)	0.936 (12.31)	0.95	0.024	4.561	2.16
	0.856 (2.38)	0.00004 (0.97)	-0.141 (2.02)	-0.480 (1.74)	0.048 (2.09)	-0.011 (1.09)	0.028 (0.20)	0.916 (12.22)	0.95	0.024	4.561	2.04

Note : For data sources see Appendix B.

Table 3 : Supply of Output Equations Tax Wedge Variable, (2-SLS) - Total period

Country	c	t	T	$\widehat{\Delta p - E\Delta p}$	$\hat{p}_d - p_f$	$p_h - p_f$	$p_o - \hat{p}_d$	Y_{-1}	R^2	SE	μ
Belgium 63.1-80.4	-0.033 (0.09)	0.0001 (1.02)	-0.069 (1.37)	0.486 (0.55)	+0.185 (1.48)	-0.018 (1.52)	-0.005 (0.03)	0.824 (7.62	0.98	0.027	4.517
France 61.4-80.4	-0.066 (0.30)	0.0003 (3.09)	-0.022 (0.53)	1.594 (1.17)	0.012 (0.11)	-0.044 (2.58)	-0.191 (1.42)	0.578 (4.79)	0.98	0.034	4.445
Netherlands 62.1-79.4	0.228 (0.44)	0.0002 (2.71)	0.052 (0.94)	-0.042 (0.08)	-0.129 (1.32)	-0.047 (3.17)	-0.155 (1.01)	0.736 (9.87)	0.99	0.025	4.496
Italy 63.1-80.4	0.708 (1.86)	0.0001 (2.84)	0.037 (0.77)	0.509 (0.84)	-0.296 (1.59)	0.010 (0.35)	0.218 (1.50)	0.663 (7.97)	0.98	0.039	4.527
Germany 61.4-80.4	1.072 (3.45)	0.00003 (0.70)	-0.053 (0.88)	-1.107 (1.20)	0.022 (0.30)	0.019 (1.22)	0.399 (3.24)	0.733 (8.89)	0.99	0.024	4.516
U.K. 63.1-80.4	1.002 (2.81)	0.00004 (1.27)	-0.142 (2.04)	-0.700 (2.01)	0.045 (1.96)	-0.014 (1.62)	0.115 (0.28)	0.873 (11.40)	0.95	0.024	4.561

Table 4 : Supply of Output Equations without tax wedge (2-SLS), Total period

Country	c	t	$\widehat{\Delta p - E\Delta p}$	$\hat{p}_d - p_f$	$p_h - p_f$	$p_o - \hat{p}_d$	Y_{-1}	R^2	SE	μ
Belgium 62.4-80.4	0.127 (0.43)	0.0001 (1.31)	0.728 (0.93)	0.222 (1.79)	-0.027 (2.35)	-0.094 (0.49)	0.790 (7.43)	0.98	0.027	4.512
France 61.4-80.4	-0.036 (0.17)	0.0002 (3.07)	1.639 (1.78)	0.014 (0.13)	-0.046 (2.79)	-0.196 (1.47)	0.587 (4.95)	0.98	0.033	4.461
Netherlands 62.1-79.4	-0.165 (0.53)	0.0002 (3.35)	-0.050 (0.10)	-0.126 (1.29)	-0.043 (3.03)	-0.165 (1.07)	0.760 (10.85)	0.99	0.024	4.496
Italy 63.1-80.4	0.498 (1.88)	0.0002 (3.07)	0.544 (0.90)	-0.292 (1.57)	0.008 (0.30)	0.240 (1.70)	0.670 (8.12)	0.98	0.039	4.527
Germany 61.4-80.4	1.105 (3.61)	0.0 (0.48)	-0.887 (0.97)	0.022 (0.31)	0.014 (0.90)	0.392 (3.18)	0.763 (11.17)	0.99	0.024	4.511
U.K. 63.1-80.4	0.602 (1.97)	-0.0 (0.13)	-0.681 (1.91)	0.031 (1.38)	-0.014 (1.53)	0.176 (1.35)	0.883 (11.27)	0.95	0.024	4.561

the case of the U.K. The results with the other two terms-of-trade variables are poor. Only in the case of Belgium and the U.K. does the final goods terms of trade ($p_d - p_f$) exhibit a significant positive effect on output. The internal terms of trade ($p_o - p_d$) has a significant negative effect on output in Belgium and France.

As indicated earlier, the quality of the estimation results using a two-stage-estimation procedure is lower [3]. The inflation surprise variable is only significantly positive in France, and has an incorrect sign in three out of six cases. The coefficient of the terms of trade variables and the tax wedge variable are less affected by this two-stage procedure.

On the whole one can state that the results are mixed. For some countries the theoretical predictions of the effects of inflation surprises, terms of trade changes and tax wedge variables are confirmed. However, these three effects are usually not confirmed <u>together</u> in the different countries.

In order to test for possible structural breaks during the sample period, the supply-of-output equations were estimated during the seventies separately. Formal tests of significance of the structural break in the estimated equations (Chow test) are given in table 5. Two tentative periods for the break are considered, i.e. 1971 and 1973. The results indicate that significant structural shifts in the coefficients of the supply of output equations have occured since 1971 in Belgium, France, Germany and Italy, and since 1973 in the Netherlands and in the U.K.

Since the break is stronger for most countries in 1971 the results for the sample period 1971-80 are given in table 6. We also give the estimated results for the period 1973-1980 in table 7 because these estimates will be compared with the estimates obtained using the EC-inflationary expectations variable for which data are available only since 1973.

The general impression of the supply equations obtained during the seventies is that the estimated coefficients of the terms-of-trade variables have more often the correct sign and are significant in more cases than when the model is estimated for the whole sample period. Also the tax wedge variable increases in significance during the 1973-80 period. However, the inflation surprise variable has the wrong sign in three out of six cases.

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[3] We should point out a limitation in these results. The estimated standard errors in the two stage estimation are incorrect, since we have estimated actually in two steps, and in this case correction should be made for the standard errors. This has not been done for the results presented.

Table 5 : Chow-test (F-ratio) for structural shift in coefficients since 1971

	since 1971	since 1973
Belgium	4.22	3.58
France	2.85	2.53
Germany	2.33	2.05
Italy	2.54	1.52
Netherlands	1.54	2.12
U.K.	0.96	2.73

NOTE : The F-ratio for rejecting the null-hypothesis of no structural shift is 1.9 at a probability level of 95 % (2.6 at probability level of 99 %).

Table 6 : Supply of Output with and without Tax Wedge - OLS - The Seventies (71.1 - 80.4)

Country	c	t	T	$\Delta p - \widehat{E\Delta p}$	$p_d - p_f$	$p_h - p_f$	$p_o - p_d$	Y_{-1}	R^2	SE	μ	D.W.
Belgium	0.901 (1.49)	0.0001 (1.21)	-	2.452 (2.94)	0.422 (3.47)	-0.028 (1.72)	-0.014 (0.07)	0.599 (4.33)	0.93	0.021	4.67	1.43
	0.773 (1.26)	0.0001 (1.53)	-0.091 (1.16)	2.214 (2.59)	0.439 (3.60)	-0.018 (0.97)	-0.019 (0.09)	0.528 (3.51)	0.93	0.021	4.67	1.25
France	0.402 (0.91)	0.0001 (0.85)	-	-0.260 (0.35)	0.107 (1.27)	-0.019 (0.84)	-0.016 (0.09)	0.747 (3.79)	0.92	0.021	4.65	1.54
	0.339 (0.73)	0.0001 (0.81)	-0.026 (0.49)	-0.302 (0.40)	0.108 (1.27)	-0.017 (0.71)	0.0005 (0.00)	0.750 (3.75)	0.92	0.021	4.66	1.58
Netherlands 71.1 - 79.4	1.337 (1.56)	0.0002 (2.27)	-	0.379 (0.32)	-0.080 (0.40)	-0.062 (3.14)	-0.101 (0.19)	0.347 (1.97)	0.82	0.029	4.65	2.20
	0.963 (0.86)	0.00025 (2.16)	-0.083 (0.53)	0.292 (0.24)	-0.094 (0.47)	-0.060 (2.87)	-0.063 (0.11)	0.326 (1.78)	0.82	0.029	4.65	2.12
Italy	0.691 (1.33)	0.0003 (2.91)	-	1.242 (1.85)	0.292 (0.90)	-0.103 (1.89)	-0.486 (1.56)	0.325 (1.48)	0.90	0.038	4.69	1.34
	0.795 (1.48)	0.0003 (2.89)	0.059 (0.79)	1.208 (1.79)	0.270 (0.82)	-0.103 (1.86)	-0.488 (1.56)	0.344 (1.55)	0.93	0.039	4.70	1.31
Germany	1.022 (2.05)	0.0001 (1.86)	-	-0.091 (0.09)	0.188 (1.93)	-0.030 (1.10)	-0.005 (0.01)	0.614 (4.24)	0.93	0.020	4.68	1.55
	1.092 (1.95)	0.0001 (1.78)	-0.025 (0.28)	-0.064 (0.07)	0.205 (1.78)	-0.027 (0.86)	0.023 (0.74)	0.580 (3.03)	0.95	0.022	4.68	1.52
U.K.	0.353 (0.53)	-0.00002 (0.61)	-	-0.631 (1.53)	0.034 (1.19)	-0.006 (0.35)	0.042 (0.21)	0.973 (7.73)	0.78	0.029	4.623	1.98
	0.789 (1.12)	0.0001 (0.96)	-0.249 (1.53)	-0.720 (1.77)	0.053 (1.73)	-0.008 (0.48)	-0.027 (0.14)	0.985 (7.98)	0.80	0.028	4.623	1.88

Table 7 : Supply of Output Equations in Level with Tax Wedge Variable 1973(iv) - 1980(iv) (2-SLS)

Country	c	t	T	$\widehat{\Delta p} - E\Delta p$	$\hat{p}_d - p_f$	$p_h - p_f$	$p_o - \hat{p}_d$	Y_{-1}	R^2	SE	μ	D.W.
Belgium	1.179 (1.94)	-0.0 (0.63)	-0.183 (1.73)	0.758 (0.56)	-0.118 (0.43)	-0.003 (0.11)	0.523 (1.08)	0.766 (4.61)	0.92	0.023	4.698	0.82
France	0.656 (1.22)	0.0 (0.01)	-0.053 (0.77)	0.614 (0.45)	0.038 (0.23)	-0.003 (0.11)	0.155 (0.79)	0.837 (3.48)	0.81	0.023	4.692	1.71
Netherlands	2.308 (1.97)	0.0001 (0.87)	-0.207 (1.43)	-2.613 (0.88)	-0.226 (1.19)	-0.044 (2.03)	1.416 (1.75)	0.184 (0.99)	0.94	0.024	4.658	2.22
Italy	0.271 (0.46)	0.0001 (1.49)	0.072 (0.82)	0.367 (0.36)	-0.148 (0.60)	-0.031 (0.76)	0.226 (1.07)	0.822 (5.06)	0.90	0.042	4.741	1.50
Germany	2.041 (2.29)	0.0003 (0.57)	-0.057 (0.53)	-0.197 (0.12)	0.475 (1.32)	0.055 (1.43)	0.603 (2.06)	0.523 (1.90)	0.95	0.022	4.701	1.49
U.K.	2.747 (2.67)	0.0001 (1.28)	-0.414 (2.03)	-0.368 (0.75)	0.061 (1.94)	-0.058 (2.50)	-0.364 (1.54)	0.645 (3.37)	0.84	0.026	4.628	1.801

VI. THE SUPPLY OF OUTPUT EQUATIONS USING THE EC SURVEY BASED INFLATION EXPECTATIONS

In this section the results of estimating the supply of output model using the EC-survey based inflationary expectations are reported. Details of the method used in constructing this series is given in Papadia (1981). The inflationary surprise variable used in the supply of output equation ($\Delta p - E\Delta p$) is now defined as the difference between the observed inflation in period t and the EC-inflation expectations for the same period. Thus this variable represents the forecast error obtained with the EC inflation expectations variable [4].

Comparing these results with the previous results reported in table 7 (which use a time-series procedure to estimate inflationary expectations) one can conclude that the two methods lead to estimates of the supply function with comparable statistical qualities. The inflation surprise variable is statistically significant only in the case of Italy, and has the wrong sign in three out of six cases. The coefficients of the other variables in the equations are affected very little. Thus, one can conclude that the evidence of a significant inflationary surprise effect on the supply of output is weak when one uses the EC inflationary expectations variable. Note, however, that a similar result is obtained when one uses inflationary expectations variables based on time series analysis (TS-inflationary expectations variable).

The failure of both the EC-inflationary expectations variable and of the TS-expectations variable to yield significant inflation surprise effects (Lucas-effect) in the supply of output during the seventies can be interpreted in two ways. One is that there is no evidence of a Lucas surprise effect in EC-countries possibly because of strong wage indexation. A second interpretation is that the price expectations as they are measured, do not represent the expectations adequately. As a result, the inflationary surprise variable constructed on the basis of the EC data or on the basis of time series analysis does not represent the true inflationary surprises of economic agents.

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4 It should be noted that the EC inflation expectations variable is a one year forecast of inflation. Since the observations used here are quarterly we assumed that these forecasts made by the individuals surveyed are linear forecasts over the whole year. This assumption allowed us to easily transform the one year forecasts to forecasts over one quarter.

Table 8 : Supply of Output Equations in Level with Tax Wedge Variable, EC-inflationary expectations 1973(iv)-1980(iv)

Country	c	t	T	$\widehat{\Delta p - E\Delta p}$	$\hat{p}_d - p_f$	$p_h - p_f$	$p_o - \hat{p}_d$	Y_{-1}	R^2	SE	μ	D.W.
Belgium	2.004 (2.52)	-0.0001 (0.96)	-0.257 (1.97)	1.223 (1.28)	-0.155 (0.77)	0.032 (0.72)	0.664 (2.45)	0.695 (4.29)	0.93	0.022	4.702	0.72
France	0.633 (1.22)	0.0 (0.32)	-0.708 (1.02)	1.675 (1.39)	0.057 (0.38)	-0.004 (0.15)	0.169 (0.85)	0.777 (3.66)	0.82	0.023	4.694	1.96
Netherlands	1.239 (1.10)	0.0002 (1.94)	-0.242 (1.78)	-1.788 (1.29)	-0.265 (1.09)	-0.024 (0.84)	0.894 (1.57)	0.221 (1.29)	0.92	0.022	4.659	2.05
Italy	0.503 (0.95)	0.0001 (2.36)	0.086 (1.13)	1.371 (2.07)	0.586 (0.02)	-0.013 (0.33)	0.053 (0.28)	0.734 (5.37)	0.92	0.037	4.745	1.58
Germany	2.005 (2.05)	0.0005 (0.70)	-0.063 (0.55)	-0.285 (0.19)	0.473 (1.19)	0.049 (0.96)	0.593 (1.92)	0.512 (1.94)	0.95	0.022	4.704	1.42
U.K.	2.165 (1.39)	0.0001 (1.37)	-0.437 (1.68)	-0.590 (0.95)	0.045 (1.18)	-0.110 (1.94)	-0.247 (0.71)	0.670 (2.39)	0.83	0.028	4.619	1.64

One way to test whether this is the correct interpretation is to analyze whether or not these inflationary expectations data incorporate readily available information about variables that affect future inflation rates (e.g. money supply, foreign prices, exchange rates ...). If it is found that these expectations series do not reflect this information one can conclude that they do not measure the state of expectations correctly.

Note that we continue to assume here that expectations are formed rationally. Sceptics might argue that a failure of the expectations data to reflect readily available information (if confirmed) could also be interpreted as evidence that expectations are not formed rationally. We will return to this issue in the next section.

VII. THE EC-INFLATIONARY EXPECTATIONS VARIABLE AND RATIONAL EXPECTATIONS

In this section we ask the question whether the EC-survey-based inflationary expectations data are consistent with the hypothesis of rational expectations. We deal with the same question concerning the TS-inflationary expectations.

One can test for rationality of the EC-data in several ways. One test, usually called a "weak" test, consists in analyzing the time series pattern of the forecasting error obtained form the EC-data. A minimum requirement of rational expectations formation is that the forecasting error should not be systematically related to its own past and, therefore, should not be predictible from its own past. Such tests were performed by Papadia (1981). He found that in low-inflation countries (Belgium, Netherlands, Germany and France) the EC-inflationary expectations variable passed the weak test of rationality. In the high-inflation countries, however, (Italy, Denmark, U.K.) the weak test of rationality was not met. See also Batchelor (1982).

A second way to test for rationality consists in relating the forecasting errors to variables that are readily available and are known to affect the future inflation rates.

This idea can be formulated as follows[5]. The inflation rate in period t is related to the past changes of the money stock and of the foreign price level. We formalize this as follows :

$$\Delta p_t = a_o + \sum_{i=1}^{n} a_i \Delta m_{t-i} + \sum_{i=1}^{n} b_i \Delta p_{f,t-i} + v_t \qquad (13)$$

Rational expectations implies that economic agents use all available information at period t when forecasting next periods price level. In particular economic agents will use the evidence that the price level in period t+1 is related to present and past money and foreign price variables. Thus

$$\underset{t}{E}\, \Delta p_{t+1} = c_o + \sum_{i=1}^{n} c_i \Delta m_{t+1-i} + \sum_{i=1}^{n} e_i \Delta p_{f,t+1-i} + v_{t+1} \qquad (14)$$

5 See Mishkin (1981). For a recent application in the foreign exchange market see, P. Hartley (1982).

A test of rational expectations then consists in estimating the two equations (13) and (14) separately, and, testing for the equality of the coefficients i.e. rational expectations implies that $a_o = c_o$, $a_i = c_i$ and $b_i = e_i$. An alternative estimating approach is found by deriving the forecasting error from equation (13) and (14). This yields

$$\Delta p_{t+1} - \underset{t}{E}\, \Delta p_{t+1} = (a_o - c_o) + \sum_{i=1}^{n} (a_i - c_i)\, \Delta m_{t+1-i} + \sum_{t=1}^{n} (b_i - e_i)\, \Delta p_{f,t+1-i} + u_{t+1} - v_{t+1} \qquad (15)$$

Rational expectations implies that a regression of the forecasting error $(\Delta p_{t+1} - \underset{t}{E}\, \Delta p_{t+1})$ on the money stock and foreign price series should yield coefficients that are not significantly different from zero.

This is the approach which is followed here. The forecasting error obtained from the inflationary expectations series is regressed on readily available series of money stock, foreign prices (including the exchange rate). We also add here the series of non-tradable goods prices. The result of these estimations is shown in table 9. Table 9 also shows the F-test of the joint significance of the coefficients of the lagged money and price series (see last columm). The F-ratio exceeds the critical value for three out of six countries (Belgium, Germany and Italy) in the regression of the EC-inflationary expectations series, whereas the F-ratio exceeds its critical value only in the Belgian case in the regression of the TS-inflationary expectations series. Thus in the case of the EC-survey based inflationary expectations there is evidence that in three countries not all available information is used by economic agents.

As indicated earlier, these results suggest two possible interpretations. One interpretation is that the survey-based inflationary expectations do not reflect the true expectations of economic agents which are formed rationally. In this view the survey-based inflationary expectations data are defective in reflecting the true market expectations. A second possible interpretation is that economic agents do not form expectations in a rational way. The failure of the EC-data on inflationary expectations to be consistent with the rational expectations assumption then reflects the lack of rationality of economic agents.

The empirical tests provided here do not allow to discriminate between the two interpretations. Nevertheless we tend to favor the first interpretation for the following reasons. Although it may be true that the average individual who is surveyed in the EC-data does not exhibit rational behavior, this does not mean that the market expectations are irrational. One central point of rational expectations theory is that "not all market participants have to be rational in order for markets to display rational expectations. As long as unexploited profit opportunities are eliminated by some participants in a market, the market will behave as though expectations are rational despite irrational participants in that market" [6].

It should be stressed that the failure of the EC-inflationary expectations variable to reflect all available information is not the only reason why it performs poorly in the supply of output equations. This can be seen from the fact that the TS-inflationary expectations variable also performed poorly in the estimated supply equation during the seventies, despite the fact that (with the exception of Belgium) it was unrelated to past money and foreign price variables.

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6. See F. Mishkin (1981), p. 295.

Table 9 : Regression of inflation forecasting errors on past money and price variables - 1973(iv) - 1980(iv)

Country	Dependent Variable	c	DLM1(-1)	DLM1(-2)	DLM1(-3)	DLM1(-4)	DLPF(-1)	DLPF(-2)	DLPF(-3)	DLPF(-4)
Belgium	Δp - EΔp									
TS		-0.0012 (0.38)	-0.035 (0.37)	-0.021 (0.24)	-0.001 (0.02)	-0.025 (0.34)	0.147 (3.21)	0.097 (1.31)	-0.0 (0.0)	-0.060 (1.03)
EC		0.002 (0.73)	0.039 (0.53)	0.055 (0.81)	-0.0005 (0.0)	0.006 (0.11)	0.067 (1.93)	0.067 (1.19)	0.016 (0.32)	-0.079 (1.77)
		DLPO(-1)	DLPO(-2)	DLPO(-3)	DLPO(-4)	R^2	SE	μ	D.W.	F
TS		0.013 (0.04)	0.145 (0.48)	0.027 (0.11)	-0.189 (0.72	0.37	0.005	0.0003	1.89	2.370
EG		-0.011 (0.05)	0.058 (0.25)	-0.353 (6.83)	0.145 (0.72)	0.35	0.004	0.002	2.39	2.259

Country	Dependent Variable	c	DLM1(-1)	DLM1(-2)	DLM1(-3)	DLM1(-4)	DLPF(-1)	DLPF(-2)	DLFF(-3)	DLPF(-4)
France	Δp - EΔp									
TS		0.008 (0.54)	-0.017 (0.33)	0.026 (0.43)	0.031 (0.49)	-0.004 (0.07)	0.006 (0.11)	0.038 (0.52)	0.037 (0.52)	-0.015 (0.26)
EC		0.021 (1.91)	-0.013 (0.34)	-0.010 (0.22)	0.001 (0.02)	-0.008 (0.19)	0.067 (1.69)	-0.034 (0.65)	0.042 (0.79)	-0.015 (0.35)
		DLPO(-1)	DLPO(-2)	DLPO(-3)	DLPO(-4)	R^2	SE	μ	D.W.	F
TS		0.136 (0.54)	-0.045 (0.18)	-0.142 (0.64)	-0.374 (1.15)	0.24	0.007	0.003	1.82	0.430
EC		-0.349 (1.92)	-0.183 (1.00)	-0.246 (1.53)	0.070 (0.30)	0.40	0.005	0.003	1.97	0.923

Table 9 : continued

Country	Dependent Variable	c	DLM1(-1)	DLM1(-2)	DLM1(-3)	DLM1(-4)	DLPF(-1)	DLPF(-2)	DLPF(-3)	DLPF(-4)
Germany	Δp - EΔp									
TS		0.004 (0.95)	-0.037 (0.97)	-0.022 (0.56)	-0.045 (1.11)	-0.055 (1.27)	0.007 (0.18)	0.008 (0.20)	0.027 (0.66)	-0.037 (1.00)
EC		0.006 (1.70)	-0.028 (0.84)	0.009 (0.25)	-0.019 (0.54)	-0.052 (1.38)	-0.080 (2.80)	-0.011 (0.30)	0.009 (0.25)	0.037 (1.13)
		DLPO(-1)	DLPO(-2)	DLPO(-3)	DLPO(-4)	R^2	SE	μ	D.W.	F
TS		-0.239 (1.05)	0.183 (0.77)	-0.138 (0.60)	0.056 (0.30)	0.26	0.005	0.0001	1.17	0.470
EC		-0.073 (0.37)	-0.239 (1.15)	-0.016 (0.08)	0.068 (0.41)	0.68	0.004	0.0008	1.17	2.770

Country	Dependent Variable	c	DLM1(-1)	DLM1(-2)	DLM1(-3)	DLM1(-4)	DLPF(-1)	DLPF(-2)	DLPF(-3)	DLPF(-4)
Italy	Δp - EΔp									
TS		0.022 (0.57)	0.041 (0.38)	-0.059 (0.53)	-0.090 (0.79)	0.013 (0.12)	0.053 (0.43)	-0.033 (0.26)	0.178 (1.45)	-0.029 (0.26)
EC		0.046 (1.46)	0.009 (0.11)	-0.020 (0.22)	-0.127 (1.40)	-0.099 (1.13)	0.186 (1.90)	-0.033 (0.33)	0.098 (0.99)	-0.074 (0.82)
		DLPO(-1)	DLPO(-2)	DLPO(-3)	DLPO(-4)	R^2	SE	μ	D.W.	F
TS		0.053 (0.16)	-0.189 (0.52)	-0.493 (1.26)	0.052 (0.14)	0.35	0.014	0.0005	1.46	0.723
EC		-0.718 (2.71)	-0.152 (0.52)	-0.328 (1.04)	-0.023 (0.08)	0.60	0.011	-0.001	1.68	1.997

Table 9 : continued

Country	Dependent Variable	c	DLM1(-1)	DLM1(-2)	DLM1(-3)	DLM1(-4)	DLPF(-1)	DLPF(-2)	DLPF(-3)	DLPF(-4)
Netherlands	$\Delta p - E\Delta p$									
TS		-0.002 (0.61)	0.009 (0.06)	0.003 (0.71)	-0.016 (1.87)	0.006 (1.31)	0.065 (0.78)	0.051 (0.07)	0.070 (1.01)	-0.028 (0.30)
EC		0.003 (0.81)	-0.026 (0.90)	0.007 (0.28)	-0.070 (2.53)	-0.002 (0.06)	-0.009 (0.16)	0.005 (0.09)	0.048 (0.87)	-0.036 (0.63)
		DLPO(-1)	DLPO(-2)	DLPO(-3)	DLPO(-4)	R^2	SE	μ	D.W.	F
TS		0.117 (0.69)	-0.033 (0.34)	0.022 (0.78)	-0.106 (0.22)	0.40	0.006	0.0001	2.42	0.675
EC		-0.073 (0.31)	-0.030 (0.13)	0.066 (0.28)	-0.118 (0.47)	0.62	0.006	-0.002	2.40	1.615

Country	Dependent Variable	c	DLM1(-1)	DLM1(-2)	DLM1(-3)	DLM1(-4)	DLPF(-1)	DLPF(-2)	DLPF(-3)	DLPF(-4)
U.K.	$\Delta p - E\Delta p$									
TS		0.025 (1.28)	-0.130 (1.17)	0.259 (2.16)	-0.113 (0.80)	-0.354 (2.65)	-0.032 (0.51)	-0.086 (1.59)	-0.023 (0.49)	-0.203 (0.45)
EC		0.045 (2.13)	-0.103 (0.85)	0.181 (1.37)	-0.130 (0.84)	-0.182 (1.25)	-0.047 (0.70)	-0.088 (1.49)	-0.015 (0.28)	0.052 (1.05)
		DLPO(-1)	DLPO(-2)	DLPO(-3)	DLPO(-4)	R^2	SE	μ	D.W.	F
TS		0.168 (0.95)	0.247 (1.22)	-0.280 (1.38)	-0.408 (2.26)	0.59	0.013	0.0002	1.96	1.551
EC		0.005 (0.03)	-0.142 (0.64)	-0.573 (2.57)	-0.192 (0.37)	0.61	0.014	0.001	1.71	1.678

VIII. CONCLUSION AND POLICY IMPLICATIONS

In this study a supply of output model was developed and empirically tested for six EC-countries (Belgium, France, Germany, Italy, Netherlands, and the U.K.) during the sample period 1960-80.

In the theoretical part we focused on how inflationary surprises, terms of trade changes and changes in taxation of labor income affect the output level in the open sector of the economy.

In order to study the empirical importance of the inflationary surprise variable on the supply of output two alternative indicators of inflationary surprises were used. One indicator is based on time series analysis (TS), the other indicator we used is based on the EC-inflationary expectations variable as published by the EC-Commission. The conclusion of this empirical analysis is that, at least during the seventies, inflationary surprises (as measured either by the TS-procedure or by the EC) were insignificant in most countries. Tests of rationality of these inflationary expectations data revealed that in three out of six countries the EC-inflationary expectations series did not pass the strong test of rationality. We concluded, however, that this is not the only reason for the poor performace of the EC-series in the supply of output equation, as the TS-inflationary expectations data do not perform better despite the fact that (except in one country) they passed the strong rationality test.

Finally, the empirical evidence concerning the role of terms of trade changes on output indicates that especially the intermediate (oil) terms of trade has had a significant negative effect on output in most EC-countries. The theoretically predicted negative effect of the tax wedge variable was only found to be significant in one out of six countries during the whole sample period. There is evidence, however, that since 1973 this variable has had a significant negative effect on output in three countries (Belgium, the Netherlands and the U.K.).

What are the policy implications of these results ?

There are essentially two. One is that the oil induced supply shocks which occured during the seventies were aggravated by the simultaneous and large increase in the taxation of labor during the same period. Our results confirm the results obtained by others (Bruno & Sachs (1979)) indicating the significant negative effect of the oil shock on aggregate output in European countries. At the same time, however, these countries imposed on themselves a "labor tax shock" which tended to make the use of labor in the supply of output less and less attractive. This negative effect appears to have been significant in three of the six countries analysed here during the Seventies. Thus these countries compounded the externally generated supply shock by a domestic one. The first shock could not be avoided, the second shock was entirely home made. The latter led to a decline of the "natural" level of output which went beyond the one produced by the oil shock. In so doing it aggravated the adjustment problems faced by these countries following the oil shock.

A second implication of the results of this paper relates to the determinants of the business cycle and the policies to follow to stabilize the business cycle. One important implication of the inflation surprise variable in aggregate supply equations is that it provides a basis for a theory of the business cycle. This theory as developed by Lucas (1975) and Barro (1981) can be summarized very briefly as follows. Unanticipated monetary shocks lead to inflationary surprises. These then lead through the supply of output equation, to variations in output. Thus, the variability of output can be explained by the unexpected variability of monetary policies. The way to stabilize output then consists in making monetary policies more stable and predictible. The weak evidence about the output effects of inflationary surprises found in this paper casts doubt about this explanation of the business cycle in the European countries analyzed here. They also cast doubt about the methods to stabilize output. The link between the supply of output decisions and monetary shocks does not appear to be a strong one empirically. This also implies that stabilization of the growth rate of the money supply is unlikely to be sufficient (although probably necessary) to stabilize output. Put differently, the evidence, using European data, is not in favor of the new equilibrium theory of the business cycle, and its policy preciption which suggests that it suffices to stabilize the growth rate of the money stock in order to stabilize output. This does not mean that a greater stability of monetary policies is not important or that inflation does not matter. It suggests only that the empirical basis of the new business cycle theory is weak in the EC-countries and that the traditional approach to the stabilization of the business cycle, in particular the use of budgetary policies should not be discarted.

APPENDIX A : ESTIMATION RESULTS

In this appendix the results of estimating equation (9) are reported and interpreted. Table A.1 presents the result of estimating rational expectations equations for expected inflation rates (equation 9). $E\Delta m$ is the systematic component of the time series of changes of the money stock generated by an AR(6). $E\Delta p_f$ and $E\Delta p_o$ are obtained in a similar way. These generated series are interpreted as the market's expectations of future changes in the money stock, the foreign price level (including the exchange rate) and the price of non-traded goods. The results confirm what was found by Fratianni & Nabli (1982) : the expected part of the inflation rate is mostly unrelated to money. The foreign price variable, however, has a more pronounced and significant effect on expectations about inflation. The strongest effect is exerted by the systematic component of the domestic non-traded goods prices.

Table A.1 : Rational Expectations Equations for Expected Inflation Rates 1960-1980 - Quarterly data

Country	c	$\widehat{E\Delta m}$	$\widehat{E\Delta p}_f$	$\widehat{E\Delta p}_o$	$\widehat{\Delta X}$	R^2	SE	μ	D.W.
Belgium 62.4-80.4	0.003 (1.58)	0.030 (0.70)	0.114 (1.64)	0.642 (6.73)	-0.017 (0.78)	0.49	0.007	0.014	1.30
France	-0.003 (1.33)	0.011 (0.51)	0.107 (2.39)	0.970 (8.82)	-0.005 (0.59)	0.68	0.005	0.017	1.53
Netherlands	0.001 (0.42)	0.023 (0.99)	0.084 (0.96)	0.801 (5.00)	0.020 (0.95)	0.31	0.007	0.015	1.67
Italy	0.001 (0.16)	-0.012 (0.29)	0.200 (2.19)	0.809 (5.06)	0.004 (0.19)	0.62	0.011	0.023	1.51
Germany	0.003 (2.73)	-0.025 (1.33)	0.083 (1.85)	0.680 (8.84)	0.009 (0.54)	0.61	0.005	0.010	1.51
U.K.	0.0004 (0.15)	0.050 (0.61)	0.149 (2.05)	0.792 (6.91)	-0.004 (0.15)	0.54	0.012	0.023	1.26

APPENDIX B : DATA SOURCES

List of variables and sources used in empirical work (quarterly data)

Countries covered : Belgium (B), France (F), Germany (G), Italy (I), Netherlands (N), United Kingdom (U.K.)

Theoretical symbol	Period	Description	Source
Y	60-80	(i) Index of industrial production	(i) International Financial Statistics (IFS), Country Tables, ## 66
	60-80	(ii) Index of Industrial Production-Manufacturing	(ii) OECD, Main Economic Indicators
P_d	60-80	(i) Wholesale Price Index	(i) IFS, Country Tables ## 63
	60-80	(ii) Domestic Goods Prices	(ii) UN, Monthly Bulletin
P	60-80 60-80 B,N 60-79 G 60-80 F 62-80 I	Consumer Price Index (i) Total (ii) Goods less food	(i) IFS, Country tables, ## 64 (ii) OECD, Consumer Price Indices : Sources and Methods and Historical Series, March 1980.
P_f^*	60-80	World Export index-Manufactured goods (in US dollars)	UN, Monthly Bulletin, Special table : c
P_h^*	60-80	(i) All Commodities Prices Index	(i) IFS, Commodity Proce Table, line 76 ax
	60-80	(ii) Saudi Arabia Petroleum price (US $/barrel)	(ii) IFS, Commodity Price Table, line 76 aa
P_o	60-80	Food and Services Consumer Price Index. Calculated as $P_o = [p - (\lambda_1 P_d + \lambda_2 pf)] \lambda_3$	OECD, Consumer Price Indices : Sources and Methods and Historical Series, March 1980.

APPENDIX B : continued

Theoretical Symbol	Period	Description	Source
W	57-80	Wages : Hourly Earnings	IFS, Country Tables, ## 65
T	57-80	Total Transfer Payments of General Government, Nominal GDP.	G. Warren Nutter, Growth of government in the West, American Enterprise Institute, 1978, Table B-1, period 1950-1969 OECD, National Accounts of OECD Countries, Table 9, period 1979-1978 (items 17 + 18 + 19 + 20 + 21).

APPENDIX C : NOTES ON FORECASTING OF EXOGENOUS VARIABLES

The exogenous variables in the model are :

- money stock	M1	
- domestic goods prices	P_o	
- exports	X	
- exchange rate	E	(average of quarter)
- international prices	WPF	
- oil prices	WPHO	

At this preliminary stage the forecasts of exogenous variables used to generate expectations on prices are based on single autoregressive schemes of order 6 (AR(6)).

These equations are fitted by OLS separately for two periods :

- up to 1970 only
- after 1970 only.

1) Exchange rate : (for all countries)

   - for the first period of fixed exchange rates, we set $\Delta \log E = 0$
   - for the second period an AR(6) is used but in general no lag is significant - so the series is essentially white noise.

2) World prices : WPF

   - for the first period : the series is almost flat, and no coefficients are significant, so we take $\Delta \log WPF = 0$.
   - for the second period : the regression does not yield significant coefficients, but we use AR(6).

3) Oil prices : WPHO

   We suppose it is white noise, changes in oil prices are unpredictable.

4) For M_1, P_o, and X in general, AR(6) equations yield significant coefficients, but only for some of the lags.

We obtained the following AR-models for forecasting exogenous variables :

BELGIUM

Period 1		Period 2	
Δm_1	AR(1, 4)	Δm_1	AR(4)
Δp_o	AR(2)	Δp_o	AR(1, 2)
Δx	AR(1, 4)	Δx	AR(4, 5)
		Δe	W.N.

GERMANY

Period 1		Period 2	
Δm_1	AR(2,3,4,6)	Δm_1	AR(3,4,5,6)
Δp_o	AR(2)	Δp_o	AR(1,2,3)
Δx	AR(1,2,4)	Δx	AR(1,3)
		Δe	W.N.

FRANCE

Period 1		Period 2	
Δm_1	AR(4)	Δm_1	AR(1,2,3,4)
Δp_o	AR(1,2)	Δp_o	AR(3,4)
Δx	AR(1,2,4,5,6)	Δx	AR(3,4,5,6)
		Δe	AR(1)

ITALY

Period 1		Period 2	
Δm_1	AR(2,3,4,5,6)	Δm_1	AR(3,4,5,6)
Δp_o	W.N.	Δp_o	W.N.
Δx		Δx	AR(1)
		Δe	W.N.

NETHERLANDS

Period 1		Period 2	
Δm_1	AR(1,3,4)	Δm_1	AR(3,4,5,6)
Δp_o	W.N.	Δp_o	AR(2,4)
Δx	AR(1,2,3,4)	Δx	W.N.
		Δe	W.N.

APPENDIX D : EXPLORING LAG STRUCTURES IN THE SUPPLY OF OUTPUT FUNCTION

In the initial phase a common lag structure is used for all countries based on a Koyck lag by introducing the lagged dependent variable. This assumes that the lag structure is the same for all explanatory variables.

Some results are available showing the sensitivity of the estimates to this assumption. For this purpose the basic supply equation with tax wedge is used here and estimated for the whole period.

The findings for the various countries show improvement for Belgium and Germany.

For Belgium a two-period lag on the intermediate terms of trade improves the fit significantly. For Germany, a polynomial lag of degree 2 on unexpected inflation improves the equation significantly, with three lags on that variable positive and significant. A peculiar result, however, is the strong negative impact of the $(p_o - p_d)$ variable (as expected), but then a strong positive effect for the twice lagged variable.

For the Netherlands the improvement of the results is less significant, and shows a stronger effect of the oil terms of trade with a lag up to four periods.

For France a one-period lag on fiscal terms-of-trade and $(p_o - p_d)$ improves the results slightly. And for the UK, a polynomal lag of degree 2 on unexpected inflation yields significant positive effects for the first two periods and negative coefficients for the following three periods. For the $(p_o - p_d)$ variable the polynomal lag shows a weak negative impact for the first two periods, and strong positive effects contrary to the theory for lags 3 and 4 (as for Germany).

Finally for Italy alternative lag structures do not yield any better results for a model which does not seem to fit Italian data well.

The overall evidence is that when the model has a good explanatory power, it is possible to improve on it by searching for better lag structures (Belgium, Germany), while when the model does not fit the data well no improvement can be achieved looking for alternative lag structures (Italy).

Table A.2 : Supply of output equations

Belgium

$$y = \underset{(0.28)}{-0.084} + \underset{(3.89)}{0.0003}\, t - \underset{(0.72)}{0.031}\, T + \underset{(0.63)}{0.333}(\Delta p - E\Delta p) + \underset{(3.64)}{0.383}(p_d - p_f)$$

$$- \underset{(4.45)}{0.0475}(p_h - p_f)_{-2} - \underset{(2.19)}{0.349}(p_o - p_d) + \underset{(4.53)}{0.487}\, y_{-1}$$

SE = 0.023

$$y = \underset{(1.30)}{-0.435} + \underset{(17.1)}{0.0006}\, t - \underset{(0.47)}{0.023}\, T + \underset{(0.76)}{0.465}(\Delta p - E\Delta p) + \underset{(5.37)}{0.588}(p_d - p_f)$$

$$- \underset{(8.86)}{0.080}(p_h - p_f)_{-2} - \underset{(7.18)}{0.883}(p_o - p_d)$$

SE = 0.026

$$y = \underset{(0.71)}{-0.206} + \underset{(4.09)}{0.003} - \underset{(1.43)}{0.061}\, T_{-1} + \underset{(0.50)}{0.265}(\Delta p - E\Delta p) + \underset{(3.70)}{0.384}(p_d - p_f)$$

$$- \underset{(4.50)}{0.0468}(p_h - p_f)_{-2} - \underset{(2.22)}{0.349}(p_o - p_d) + \underset{(4.47)}{0.474}\, y_{-1}$$

SE = 0.022

Germany

$$y = \underset{(5.98)}{2.217} + \underset{(7.28)}{0.00028}\, t - \underset{(2.66)}{0.178}\, T + \underset{(1.56)}{1.378}(\Delta p - E\Delta p) + \underset{(2.81)}{1.402}(\Delta p - E\Delta p)_{-1}$$

$$+ \underset{(1.741)}{1.088}(\Delta p - E\Delta p)_{-2} + \underset{(0.93)}{0.436}(\Delta p - E\Delta p)_{-3} + \underset{(0.69)}{0.060}(p_d - p_f) - \underset{(0.29)}{0.005}(p_h - p_f)_{-1}$$

$$- \underset{(2.21)}{0.436}(p_o - p_d) + \underset{(6.37)}{1.172}(p_o - p_d)_{-2}$$

$\bar{R}^2 = 0.98$
SE = 0.028

Netherlands

$$y = \underset{(0.03)}{0.0155} + \underset{(8.92)}{0.0005}\, t - \underset{(0.42)}{0.287}(\Delta p - E\Delta p) - \underset{(1.08)}{0.161}(p_d - p_f) - \underset{(3.83)}{0.102}(p_h - p_f)$$

$$- \underset{(1.406)}{0.018}(p_h - p_f)_{-1} + \underset{(0.57)}{0.013}(p_h - p_f)_{-2} - \underset{(0.44)}{0.005}(p_h - p_f)_{-3} - \underset{(2.72)}{0.075}(p_h - p_f)_{-4}$$

$$- \underset{(0.06)}{0.014}(p_o - p_d)$$

$$y = \underset{(0.92)}{-0.295} + \underset{(3.22)}{0.00018} + \underset{(0.71)}{0.321}(\Delta p - E\Delta p) - \underset{(0.83)}{0.081}(p_d - p_f) - \underset{(2.89)}{0.052}(p_h - p_f)$$

$$- \underset{(0.10)}{0.0009}(p_h - p_f)_{-1} + \underset{(1.77)}{0.020}(p_h - p_f)_{-2} + \underset{(1.37)}{0.011}(p_h - p_f)_{-3} - \underset{(1.45)}{0.027}(p_h - p_f)_{-4}$$

$$- \underset{(1.42)}{0.226}(p_o - p_d) + \underset{(8.90)}{0.756}\, y_{-1}$$

France

$$y = \underset{(0.021)}{0.0048} + \underset{(0.51)}{0.00024}\, t - \underset{(0.51)}{0.021}\, T + \underset{(0.40)}{0.329}(\Delta p - E\Delta p) + \underset{(0.62)}{0.064}(p_d - p_f)$$

$$- \underset{(2.50)}{0.045}(p_h - p_f)_{-1} - \underset{(1.00)}{0.134}(p_o - p_d)_{-1} + \underset{(4.45)}{0.572}\, y_{-1}$$

SE = 0.033

$$y = \underset{(0.70)}{-0.203} + \underset{(20.62)}{0.006}\, t - \underset{(1.24)}{0.062}\, T + \underset{(0.09)}{0.088}(\Delta p - E\Delta p) + \underset{(1.68)}{0.203}(p_d - p_f)_{-1}$$

$$- \underset{(6.06)}{0.094}(p_h - p_f) - \underset{(4.07)}{0.474}(p_o - p_d)_{-1}$$

SE = 0.039

U.K.

$$y = \underset{(11.83)}{4.156} + \underset{(3.60)}{0.0001}\, t - \underset{(1.71)}{0.167}\, T + \underset{(1.513)}{0.551}(\Delta p - E\Delta p) + \underset{(1.477)}{0.263}(\Delta p - E\Delta p)_{-1}$$

$$- \underset{(0.17)}{0.043}(\Delta p - E\Delta p)_{-2} - \underset{(2.04)}{0.369}(\Delta p - E\Delta p)_{-3} - \underset{(1.95)}{0.714}(\Delta p - E\Delta p)_{-4} + \underset{(1.38)}{0.0453}(p_d - p_f)$$

$$- \underset{(1.88)}{0.072}(p_h - p_f) + \underset{(0.25)}{0.010}(p_h - p_f)_{-1} - \underset{(0.09)}{0.024}(p_o - p_d) + \underset{(0.44)}{0.055}(p_o - p_d)_{-1}$$

$$+ \underset{(0.90)}{0.112}(p_o - p_d)_{-2} + \underset{(3.28)}{0.386}(p_o - p_d)_{-3} + \underset{(2.44)}{0.638}(p_o - p_d)_{-4}$$

$$SE = 0.032$$

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