Beyond monetary credibility: the impact of globalisation on the output-inflation trade-off in euro-area countries

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1. Introduction

This paper studies the impact of globalisation on cross-country variation in the degree of price stickiness, where the latter is approximated by the slope of the Phillips Curve. Globalization is taken to indicate the progressive rise in the share of intermediate to total inputs in production, whether imported or domestically produced. Because all intermediate goods prices tend to be sticky (Means 1935; Stigler and Kindahl 1970; Carlton 1986; Clark 1999) or at least less pro-cyclical than the price of labour (Basu 1995), countries whose production system is very much integrated with the rest of the world economy in a fashion that generates extensive "back-and-forth" trade should be characterised by relative price rigidity or, differently put, by a flatter Phillips Curve than more closed economies.

The theoretical approach builds on the New Keynesian Phillips Curve (NKPC) in that it is assumed that an exogenous demand shock alters real marginal costs and, through them, the producer desired price and thus possibly inflation. Against this framework, price setting is viewed as "the product of optimisation by monopolistically competitive firms subject to constraints" (Galì, Gertler and Lopez-Salido 2001, 5). Most of the available studies assume rigidities in nominal price setting due to *à la Calvo* (1983) contracts (Galì, Gertler and Lopez-Salido 2001; Rumler 2007; Sbordone 2007; Guerrieri et al 2008) meaning that producers change output prices at random intervals of time. We depart from this specification and posit that price rigidity or limited flexibility is the result from the presence of predetermined prices (i.e. intermediate goods prices), as originally formulated by Blanchard (1983) in his chain-of-production model.

The issue of the relationship between openness, whatever its definition, and the output-inflation trade-off is an extremely complex one. Not only do empirical analyses produce conflicting results, but there is also ambiguity about the theoretical assumptions.

Standard open economy models suggest, for example, a positive relationship between openness and price flexibility. The explanation is that a positive monetary shock that boosts import demand leading to real exchange rate depreciation is more likely to translate into an acceleration of inflation rather than into real output gains,

the higher the level of openness to trade. This mechanism implies a steeper Phillips Curve in relatively more open economies (Dornbusch 1976; Obstfeld and Rogoff 1996). Rogoff (2003) reaches a similar conclusion in that he argues that stronger competitive pressures from abroad make prices more flexible, which indeed steepens the Phillips Curve. This interpretation is in line with sectoral studies confirming that increased openness reduces mark-ups (Chen, Imbs and Scott 2004). Few New Keynesian studies achieve comparable results. Rumler (2007) finds that the rise in international competitive pressures has come with a steepening of the NKPC in 9 European countries over 1980-2003. His argument is as follows: because more open economies generally import greater amounts of intermediate goods than relatively closer economies and because the price of imported inputs tends to be more variable than that of domestic labour as well as of domestically produced intermediate goods, firms in more open economies should change prices more frequently than elsewhere.

At the other extreme are studies for which openness implies a flatter Phillips Curve, namely relative price rigidity. Borio and Filardo (2007) argue that globalisation has reduced the sensitivity of prices to domestic economic conditions, thereby accounting for a flatter Phillips Curve. Using a sample of 16 OECD countries over 1985-2005, they find that global measures of economic activity such as foreign output gaps and the deviation of import prices from the Consumer Price Index (CPI) have become more relevant than domestic factors in explaining inflation starting with the 1990s to coincide indeed with the greater internationalisation of production. An IMF study (2006) provides for a similar result using the share of non-oil trade in GDP as an indicator of openness. A majority of New Keynesian studies of the relationship between openness and inflation equally support the hypothesis that globalisation comes with greater nominal rigidity. The underlying argument is that stronger competitive pressures from abroad induce firms to leave prices unchanged after a shock so as not to loose customers to the competition. Reinforcing this view are survey-based data, according to which firms in the euro-area take decisions on prices with an eye at competitive conditions in the market in which they operate (Alvarez et al 2006)[1]. Guerrieri et al (2008) confirm this reading by demonstrating that foreign competition exercises a tangible impact on traded goods inflation because it reduces the desired mark-ups of domestic firms. Binyamini and Razin (2007) use a theoretical

[1] Blinder et al (1998) finds the same results for US-based firms.

model to argue in favour of a similar point and show that, when producers produce indifferently for the domestic and the foreign market, as in more open economies, changes in output should not necessarily push the marginal costs slope upwards if we assume decreasing returns to scale. In fact, supposing constant marginal costs in open economies, the producer desired price should remain unaltered even after a shock.

For others, the relationship between openness and the degree in price rigidity is just unclear. Temple (2002) does not find any systematic relationship between levels of openness to trade and the sacrifice ratio, which he uses as an alternative measure of the slope of the Phillips Curve just as in Ball (1993). Wu and Lin (2007) indicate that models without constant constraint do not show a direct and regular relationship between openness and inflation confirming that inflation is probably the result of some other country-specific factors. Obstfeld and Rogoff (1996) themselves recognise that the exchange rate effects of monetary policy shifts described in the standard Mundell-Flemming open economy model are quite unclear and not always supported by the data. Using a New Keynesian perspective, Sbordone (2007) applies an extended version of Calvo-type price setting[2] to conclude that the impact of foreign competition on the slope of the NKPC is far from clear. Ball (2006) generally criticises the hypothesis that an aggregate demand shock that raises marginal costs is not followed by inflation since this implies that one should find evidence of counter-cyclical movements in mark-ups, an assumption that is not supported by the data (see also Kohn 2006).

This paper speaks to the rich debate about the likely impact of openness on the output-inflation trade-off, but it is also an attempt to offer a contribution to the empirical modelling and estimation of the functional form of the Phillips Curve under globalisation.

The empirical analysis is conducted on a sample of 6 European countries over 1970-2006 with special emphasis being placed on inflation dynamics under the EMU regime. The justification for the sample choice is threefold. First, if cross-country variation in price rigidity persists even once inflation expectations have been securely anchored as in EMU (European Commission 2008; Mayes and Virén in this volume), then it is not to be excluded that the output-inflation trade-off is influenced by factors

[2] In her model, the elasticity of demand is not constant and indeed changes depending on the relative market share of the differentiated goods.

other than monetary policy, and here globalization seems like an appropriate candidate explanation[3]. Second, because in EMU most of the exogenous demand shocks are common to all member countries, be it a change in the interest rate by the European Central Bank (ECB) or the size of the fiscal stimulus under pressures to comply with the Stability and Growth Pact (SGP), cross-country differences in price rigidity that persist even after the establishment of a common inflation targeting system imply that EMU has strong distributional effects. Third, the globalisation process has proceeded hand in hand with the intellectual success of liberalist economic theories and of monetarism with its belief that government action is at the root of inflation. Yet, and quite paradoxically, the internationalisation of production has strengthened the case for more active demand management to the extent that this should produce real effects in the short to medium-run, especially in the euro-area given the successful anchoring of inflation expectations.

The rest of the paper is structured as follows. Section 2 discusses the definition of globalization adopted in this paper and provides evidence of the importance of intermediate inputs in production and in international trade. Section 3 offers indicative evidence regarding the relationship between the fragmentation of production processes and price stickiness. Section 4 presents the baseline model. Section 5 lays out the econometric model and discusses the results. Section 6 concludes.

2. What is globalisation?

Standard trade theory indicates that increased openness to trade leads to increased specialization and to the development of international production-sharing activities in the form of "back-and-forth" transactions of parts and components across countries. This produces a "splitting of a product process into two to more steps that can be undertaken in different locations but that lead to the same final product" (Deardorff 2001). Known in the literature as "international fragmentation", this phenomenon is a

[3] This piece of research is partly a criticism to the prevailing view that the recent flattening of the Phillips Curve depends exclusively upon changes in monetary policy regimes through the anchoring of inflation expectations and the stronger activism of central bankers (Williams 2006; Roberts 2006; Boivin and Giannoni 2006; Smets and Wouters 2007). In contrast, we would like to suggest that changes in production and international trade should have played a role too.

constituent part of the globalization process (Jones and Kierzkowski 1990; Ruane and Görg 2001; Yeats 2001; Kimura and Ando 2005; Helg and Tajoli 2005; Ando 2006). The empirical evidence in support of international fragmentation and of its close connection with globalization is robust and almost uncontroversial. Hummels et al (1998) and Kleinert (2003) similarly confirm that international trade concerns more and more intermediate rather than final goods.

This is but only one aspect of globalization. The other one is so-called "domestic fragmentation" normally defined as fragmentation within national borders (Kimura and Ando 2005) or, differently put, as the share of intermediate to total inputs. The increasing importance of intermediate goods in production processes certainly derives from the triumph of the paradigm emerged at the beginning of the previous century, for which roundabout production delivers stronger increasing returns than in-line production (Young 1928). Nevertheless, we posit that it is the internationalisation of trade that has created opportunities for firms to produce larger shares of intermediate relative to final goods, which they can subsequently export. We thus talk about domestic fragmentation to describe the fact that, under globalisation, countries are producing more intermediate than final goods. Overall, domestic fragmentation seems to have increased over the 1990s in most industrialised countries. For example, in 1995, the share of intermediate goods in national production had reached a substantial median of 57% across all OECD countries.

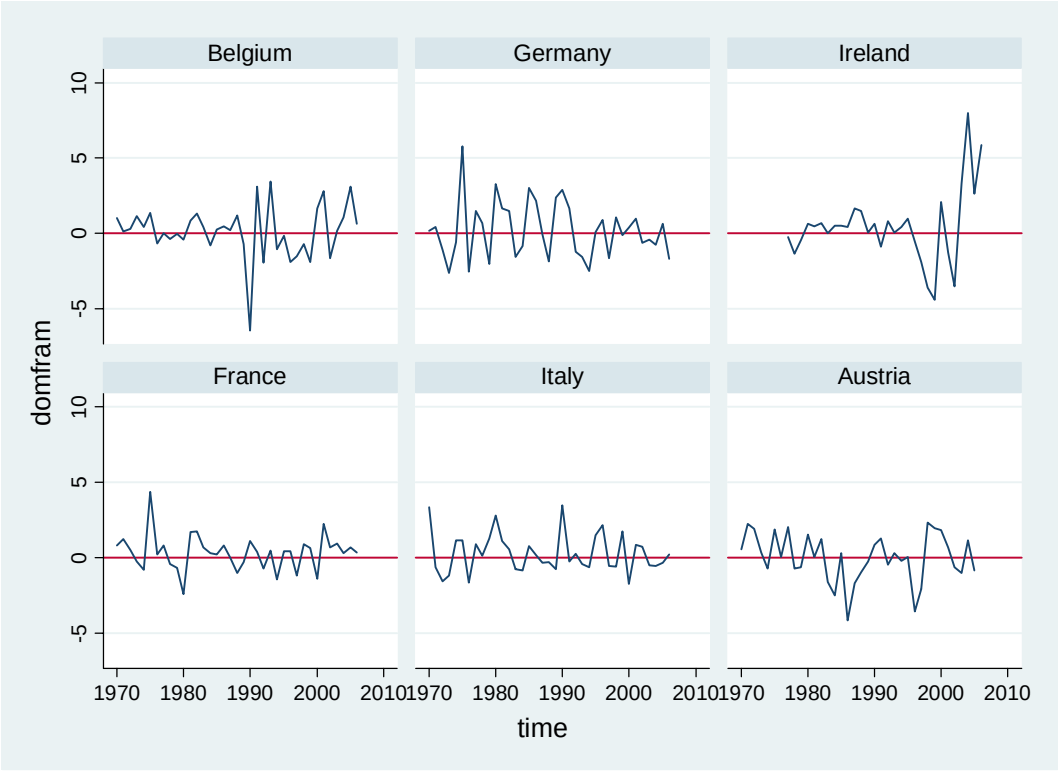
Of course, there remains significant variation across sectors as well as across countries. Figure 1 provides for an overview of domestic fragmentation in 6 euro-zone countries, namely Belgium, Germany, Ireland, France, Italy and Austria over 1970-2006. The lines measure the difference between the change in the total manufacturing production index and the change in the manufactured intermediate goods production index. Values above zero suggest that the country in question is producing more final than intermediate goods, which equates with a modest degree of domestic fragmentation. In contrast, values below zero indicate that the country under analysis produces more intermediate than consumption goods[4], namely that it is characterised by a high degree of domestic fragmentation. Germany is the country that has been more continuously engaged in round-about production[5]. Austria and Italy follows

[4] Possibly, excesses are then exported to trade partners.
[5] This should imply that Germany has been participating into strong international production-sharing activities, as already suggested by the available literature (Yeats 2001).

suits. Belgium, Ireland and France have a rather more patchy pattern, yet, whilst both Belgium and France have been possibly enhancing their participation to cross-border vertical production chains over the 1990s, Ireland seems instead to have largely re-directed production towards final goods.

In a nutshell, globalisation is here taken to indicate the rise in the share of intermediate to total inputs in production, whether imported or domestically produced.

Figure 1. Measuring domestic fragmentation in the euro-zone (1970-2006)



Source: author's own elaboration based on data from EUROSTAT.

3. Sketchy empirical evidence

For descriptive purposes only, we measure the country-specific degree in price stickiness by looking at the relative volatility in the adjusted real output. The approach is indebted to Gordon (1981). We assume that the analysed demand-driven exogenous shock is represented by a change in the log of nominal GDP (y_n). By definition, such

a shock must be divided between a price component (p) and a real-GDP component (y_r) both given in logs:

$$y_n = p + y_r \qquad (1)$$

Equation (1) states simply that any change in nominal GDP must be divided between a change in the aggregate price level and a change in real GDP. More precisely, we assume that the former is always equivalent to a constant fraction (α) so that the latter equals to ($1-\alpha$):

$$y_n = \alpha p + (1-\alpha) y_r \qquad (2)$$

We further subtract from both sides of equation (2) the growth rate of trend real GDP and, to simplify the notation, just add a "hat" to variables defined net of trend real output:

$$\hat{y}_n = \alpha p + (1-\alpha)\hat{y}_r \qquad (3)$$

According to equation (3), over the short-term ($\hat{y}_r \neq 0$), any change in nominal GDP must be accompanied by some price adjustment of coefficient α and some real output fluctuation that is greater, the lower the value of α. The estimation of the coefficient of gradual price adjustment (α) can thus take the following alternative two forms:

$$p = \alpha \hat{y}_n \qquad (4)$$

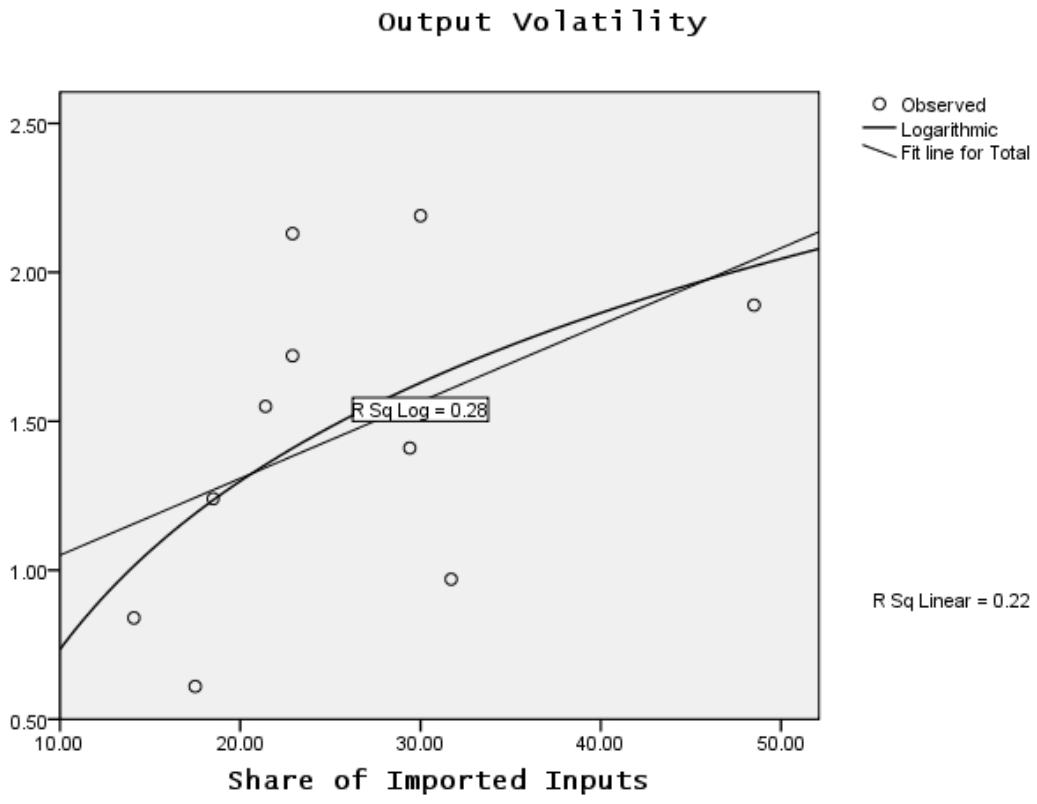
$$\hat{y}_r = (1-\alpha)\hat{y}_n \qquad (5)$$

By implication, great output volatility is indicative of price stickiness. This is so provided that (i) the change in nominal GDP is assumed exogenous; and if not, that (ii) non-labour income is not large enough to offset a change in nominal GDP; or that

(iii) firms are not able to fully react to demand shocks by mere work-sharing (see Gordon 1981, 498). All of these assumptions are plausible in this research context.

Firstly, we have indeed assumed that the change in nominal GDP is the only transmitter of demand shocks produced either by monetary or fiscal authorities, hence fully exogenous. Secondly and assuming that full exogeneity is not necessarily a real-world scenario, given that the share of labour is about the same across all core EU member states and that work-sharing is the exception rather than the norm in highly institutionalised labour markets such as those of the EU, cross-country differences in output volatility can be well said to result almost entirely from differences in price rigidity.

Figure 2. Output volatility and imported input share under EMU



Source: author's own elaboration based on data from AMECO, and Campa and Goldberg (2006).

Having taken real output volatility as a measure of the degree in price stickiness, we relate the standard deviation in the gap between actual and trend GDP at 2000 prices with the share of imported inputs in total costs as calculated by Campa and Goldberg (2006). The data refer to the EMU period. Figure 1 represents the curve estimation. The general indication is that the stronger the reliance on external markets for the acquisition of intermediate inputs, the greater price rigidity ($R^2 \log 0.28$).

4. The baseline model

Our baseline model consists of a very simplified version of the open economy NKPC. The standard formalization of the NKPC foresees that only a fraction $(1-\theta)$ of firms is able to reset their price, whilst all other firms keep it unchanged. They do so by choosing a price p_t that minimises the following loss function:

$$\min E_{t-1} \sum_{k=0}^{\infty} (\theta\beta)^k \left(p_t - p_{t+k}^*\right)^2 \qquad (6)$$

where E_{t-1} denotes expectations formed on the basis of information available in $t-1$; the term $E_{t-1}\left(p_t - p_{t+k}^*\right)^2$ describes the expected loss in profits at time $t+k$, which derives from the fact that firms are unable to set an optimal price due to the presence of frictions (or rigidities); it is a quadratic function so as to approximate a general profit function; β is a discount factor suggesting that firms put less weight on future than on today's losses; finally, the summation term suggests that firms consider the implications of the price set today for all future periods.

Equation (6) implies a solution of the following form:

$$p_t = (1-\theta\beta) \sum_{k=0}^{\infty} (\theta\beta)^k E_t p^*_{t+k} \qquad (7)$$

The term p_t^* denotes the log of the optimal price, namely the static equilibrium price in the absence of any form of rigidity. By definition, this is given by:

$$p_t^* = \mu_t^* mc_t \qquad (8)$$

where μ^* is the log of the optimal mark-up, namely the static equilibrium mark-up in the absence of any form of rigidity and mc_t is the log of nominal marginal costs. It should be noted that μ^* is a decreasing function of the elasticity of demand or degree of product market competition (η_t):

$$\mu^* = \left(1 - \frac{1}{\eta_t}\right)^{-1} \qquad (9)$$

Assuming a Cobb-Douglas production function of the form $Y = AN^{\alpha}$, the term mc_t can be rewritten as:

$$mc_t = \left(\frac{1}{\alpha}\right)\frac{w_t n_t}{y_t} \qquad (10)$$

Objective (6) is subject to demand conditions; these are a decreasing function of the relative price of each firm and an increasing function of the level of aggregate demand given by the consumption of domestic and internationally produced final goods:

$$y_t = \left(\frac{p_i}{p}\right)^{-\eta}\left(w_1 c^{1-\beta} + w_2 c^{*1-\beta}\right)^{\frac{1}{1-\beta}} \qquad (11)$$

where w_1 and w_2 are the Armington weights for domestic and foreign consumption goods respectively; $\frac{1}{\beta}$ is the elasticity of substitution between the two goods. As in Kose and Yi (2001), it is assumed that demand for the foreign consumption good leads to exports of the domestic intermediate good under “back-and-forth” trade, hence also that demand for domestic final goods leads to imports of the internationally

produced intermediate good. Equation (11) explicitly introduces open economy factors.

When accounting for the fact that domestic firms employ not only domestic labour[6] but also intermediate goods, both domestically produced and imported, we obtain the following new definition of nominal marginal costs:

$$mc_t = \left(\frac{1}{\alpha}\right)\frac{w_t n_t}{y_t}\frac{p_t i_t}{y_t}\frac{p_t i_t^m}{p_t i_t / y_t} \qquad (12)$$

where $\frac{p_t i_t}{y_t}, \frac{p_t i_t^m}{p_t i_t / y_t}$ are respectively the nominal share of domestic intermediate goods and imported intermediate goods in production.

From equation (7) we calculate the first-order stochastic difference equation to obtain after a series of re-arrangements:

$$\pi_t = \beta E_t \pi_{t+1} + \frac{(1-\theta)(1-\theta\beta)}{\theta}\left(\mu + mc_t - p_t\right) \qquad (13)$$

The term $\left(\mu + mc_t - p_t\right)$ represents real marginal costs, which according to equation (12) can be also re-written as:

$$rmc_t = \frac{w_t n_t}{p_t y_t}\frac{p_t i_t}{p_t y_t}\frac{p_t i_t^m}{p_t i_t / p_t y_t} \qquad (14)$$

One point of departure from the price rigidity specification described in equation (1) is that $(1-\theta)$ is not the fraction of firms that is able to reset the price and θ the share of firms that is unable to change output prices due to the presence of *à la Calvo* (1983) contracts. Rather, $(1-\theta)$ is the fraction of firms that can easily target the optimal price because they do not use intermediate goods, neither imported nor domestically produced, whilst θ is the remaining population of national firms, which is subject to nominal rigidities due to the incidence of pre-determined prices in their individual production function. Not dissimilarly from the original specification (see

[6] We assume that there is no international labour mobility.

Blanchard 1983), by predetermined prices we mean domestic as well as imported intermediate goods prices. By implication, the greater the share of intermediate inputs in production, whether imported or domestically produced, the greater the value of θ and hence also the degree of price stickiness.

To our knowledge, there is no systematic analysis of the open economy NKPC with predetermined prices[7]. Blanchard's model consists of the formalization of an intuitive and persuasive way of thinking of possible explanations for price rigidity. The general idea is that price stickiness rises in the number of price decisions or stages of production. The reason for the recent benign neglect of the chain-of-production model suggested by Blanchard is twofold.

First, the model assumed in-line production, whilst today's is mainly of a roundabout nature. However, we suggest that the postulation of in-line production derives from a narrow reading of the original model or, better, that the latter can still be employed based on input-output tables rather than on a simple linear chain of production. A similar idea is implicit in Gordon (1990), where the author stresses "the role of the input-output table in translating prompt price adjustment at the individual level to gradual price adjustment at the aggregate level" (p.1152).

Second, the chain-of-production model is difficult to test empirically. It is not the same as saying that the prices of intermediate goods adjust faster than that of final goods. In fact, if an exogenous demand shock affects first the demand for final goods and only later that of intermediate goods, we would see the prices of the former adjusting faster than the prices of the latter (Blinder et al. 1998, 199). We propose a method of approximating the average number of price decisions in an economic system. We argue in fact that the number of price decisions rises with international and domestic fragmentation. In other words, we posit that the larger the share of imported or domestically produced intermediate inputs, the greater price stickiness. The implications of large imported input shares for price stickiness should have been manifest from Figure 2. Furthermore, the intuition that price rigidity rises also with the degree of domestic fragmentation is confirmed by results in Huang and Liu (2001) and in Rumler (2007), who shows that the degree of price rigidity rises when the

[7] An interesting application of Blanchard's vertical chain of production model to a de facto NKPC under the assumption that the economy is closed is available in Huang and Liu (2001) and in Shapiro (2006).

model that is estimated includes domestically produced intermediate goods, besides imported ones.

An alternative and vastly used price rigidity specification is based on menu costs (Mankiw 1985). The core argument builds on the following loss function:

$$\pi(p^*) - \pi(p) \approx \pi'(p^*)(p^* - p) - \frac{1}{2}\pi''(p^*)(p^* - p)^2 \qquad (15)$$

where p^* is the profit-maximising price and p is the initial output price. Because the first derivative of equation (1) is 0, the profit loss is second order. More precisely, the costs from non-adjustment are smaller, the closer the firm's predetermined price to the profit maximising price. Given that the profit-maximising price is a function of the size of the demand shock, the size of the shock crucially determines the opportunity to change output prices. In this respect, this specification is not apt to explain the cross-country variation in price stickiness in EMU given that here demand shocks are of approximately the same size, and so should be the costs from non-adjustment.

In light of the elements of the model laid down above, we estimate the following equation:

$$\pi_t = \alpha_1 \pi_{t+1} + \alpha_2 rmc_t + \varepsilon \qquad (16)$$

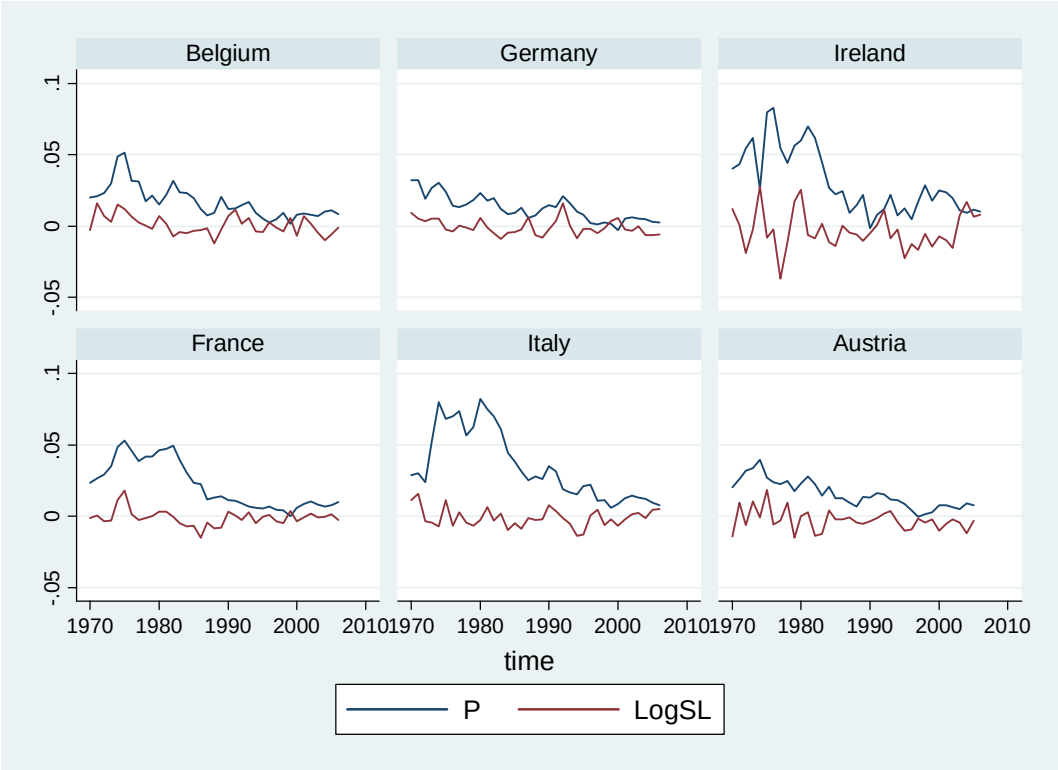
where π_{t+1} is the log expected inflation, which we imagine being a function of the current output gap, and rmc_t is the log change in the share of labour, domestic and imported intermediate inputs in GDP.

5. Extended empirical analysis

We conduct the empirical analysis on a sample of 6 euro-zone countries including Belgium, Germany, Ireland, France, Italy and Austria using annual data over the period 1970-2006. Figure 3 below illustrates that in most of the European countries under analysis spikes in the labour share have often been associated with rises in

inflation, with the only striking exception of Ireland from 1970 to 1980 and of Italy from 1970 to the late 1980s, at a time when inflation dynamics were probably very much conditioned by monetary policy, and in particular by the central bank's obligation to monetize Italy's growing public debt. Another crucial indication coming out of these data is that inflation has been moving more closely to real marginal costs starting with the 1990s in most countries.

Figure 3. Change in the GDP deflator and in the labour share (1970-2006)



Source: author's own elaboration based on data from AMECO.

To better assess the relationship between the labour share and inflation in the EU, we estimate equation (13) and modifications of it that incorporate the new definition of real marginal costs provided in equation (14) using the Arellano-Bond dynamic-panel method, which allows us to control for the simultaneity bias as well as to incorporate lags of the dependent variable.

The dependent variable is given by the log change of the GDP deflator (AMECO database). The instrumental variable is one lag of inflation to reflect the empirical evidence on the average frequency of price adjustments, for which prices in

the euro-zone are normally changed yearly (Alvarez et al 2006). Under the assumption that the economy is closed, our independent variables are future expected inflation and changes in real marginal costs, where the latter are approximated by the change in the labour share (in logs) indeed because we have assumed a Cobb-Douglas production function. Similarly to Batini et al (2005), we also include the output gap to account for the fact that the equilibrium price may change due to external pressures. More precisely, the output gap is measured as the log change in the difference between real GDP at 2000 prices and trend GDP at 2000 prices (AMECO database).

Figure 4 below presents estimates of the coefficients. Model 1 shows estimates for the pure form of equation (13). The rate of inflation expected in the following period proves very significant with a coefficient of 0.51, a result that is comparable to those obtained in Batini et al (2005) and that confirms the New Keynesian belief that forward-looking inflation expectations play a role. Most interestingly, the coefficient on future inflation is slightly greater than that on lagged inflation, which is 0.48, notwithstanding the fact that backward-looking expectations are also relevant, as highlighted in the numerous recent criticisms to the explanatory power of New Keynesian models (Galì and Gertler 1999; Rudd and Whelan 2005). In contrast, the labour share is not statistically significant when taken in isolation, a result that further supports the recently voiced doubts about the capacity of the NKPC to predict actual inflationary pressures. Model 2 suggests that the significance of the real labour costs does not improve if we eliminate the other constituent part of the New Keynesian models, that is expected inflation. Model 3 represents the closed-economy estimation in its most complete form that includes the output gap as a measure of changing competitive pressures. This hybrid NKPC including both the labour share and output gap performs fairly well.

Figure 4. The impact of globalization on slope of the New Keynesian Phillips Curve (1970–2006) - Arellano-Bond dynamic panel data estimation

	Model (1)	**Model (2)**	**Model (3)**
cons	0.00 (0.00)	0.02 (0.01)***	0.00 (0.00)
π_{t-1}	0.48 (0.05)***	0.87 (0.04)***	0.31 (0.04)***
π_{t+1}	0.51 (0.05)***		0.05 (0.05)
$\Delta \log SL$	-0.07 (0.07)	0.05 (0.08)	0.25 (0.05)***
$\Delta \log Y$			0.62 (0.05)***
N. observations	204	204	204

Key: Standard errors in parentheses.
*** = significance at 1%; **= significance

We further extend the analysis to the open economy. Under the assumption that the economy is integrated with the rest of the world, real marginal costs include the real cost of domestically produced and imported intermediate goods, besides labour costs. We thus need to find a measure for the intermediate input share and for the imported intermediate input share. As concerns the former, we do so by calculating the difference between the yearly rate of change in total industrial production and the yearly rate of change in intermediate inputs production, using for both the 2000 index (EUROSTAT Database), as in Figure 1. This is our measure of domestic fragmentation. On the other hand, the imported intermediate input share is captured by a dummy with values of 0 for countries that produce their own intermediate inputs and of 1 for countries that import the majority of the intermediate inputs used in production. This is our measure of international fragmentation. The distribution of the dummies 0,1 is based on data available in Campa and Goldberg (2006). To assess the importance of open economy factors, we estimate the following linear OLS regression:

$$\pi = \Delta \log SL + dom.fram. + \Delta \log SL * dom.fram. + \text{int}.fram. + \Delta \log SL * \text{int}.fram + \varepsilon \quad (17)$$

We have thus given up lags of the dependent variable and focused on the importance of labour shares (as opposed to output gaps) in the determination of inflation.

Figure 5 presents the results. Model (1) represents the estimation in its most complete form. The labour share is not statistically significant when taken in isolation as in the dynamic panel-data estimation. Nevertheless, real marginal labour costs become significant when interacted with some measure of fragmentation in production, be it domestic or international fragmentation. In interaction with our measure of domestic fragmentation, the New Keynesian indicator of inflation appears significant and displays a coefficient of 0.38. This suggests that relatively high shares of intermediate inputs in production limit firms' capacity to adjust prices in response to a shock by about 60%. Most interestingly, the triple interaction term that includes the labour share, domestic as well as international fragmentation appears with an even larger negative coefficient of 0.41. The fact that this is negatively signed provides support to the main prediction of the model, namely that highly fragmented production systems display greater price rigidity then less fragmented ones or, differently put, are characterised by a relatively flatter Phillips Curve.

Model (3) uses the most traditional definition of globalization. Openness is measured as the propensity of each country to import, i.e. share of imports in GDP. The overall model provides much weaker results than model (1). Most importantly, the interaction term between the labour share and openness is not statistically significant nor is openness a crucial variable given the zero coefficient. This may be related to the fact that openness is here treated as exogenous, even if it is now generally recognised that it is an endogenous variable (Romer 1993). Nevertheless, this does not exclude the possibility that openness is just in itself a bad approximation of globalization, not least because in a New Keynesian world it requires anti-cyclical mark-ups.

In order to make also a contribution to the debate about the explanatory power of the open economy NKPC (labour-share-based) relatively to the traditional (output-gap-based) PC, we further estimate the traditional PC. Model (2) estimates the traditional Phillips Curve. The output gap is significant and bears a very large coefficient. Yet, the interaction term between the output gap and our measure of domestic fragmentation appears with a more modest coefficient of 0.03; on the other hand, variable capturing total real marginal costs in an open economy is not even

significant, thereby suggesting that the open economy (NKPC is a better predictor of inflation than the traditional PC.

Figure 5. The impact of globalization on slope of the New Keynesian Phillips Curve (1970–2006) – linear OLS estimation

	Model (1)	**Model (2)**	**Model (3)**
cons			0.03
			(0.00)***
$\Delta \log SL$	-0.5		0.32
	(0.22)		(0.29)
dom. fram.	0.002	0.00	
	(0.00)**	(0.00)	
$\Delta \log SL * dom.fram.$	0.38		
	(0.20)**		
$\Delta \log Y$		0.93	
		(0.02)***	
$\Delta \log Y * dom.fram.$		0.03	
		(0.01)**	
$\text{int}.fram$	0.02	0.00	
	(0.00)***	(0.00)	
$\Delta \log SL * dom.fram.* \text{int}.fram..$	-0.41		
	(0.24)**		
$\Delta \log Y * dom.fram.* \text{int}.fram.$		-0.02	
		(0.02)	
openness			-0.00
			(0.00)***
$\Delta \log SL * openness$			-0.005
			(0.00)
N. observations	215	215	222
Adjusted R^2	0.24	0.94	0.12

Key: Standard errors in parentheses.
*** = significance at 1%; **= significance at 5%

6. Conclusions

This paper has analysed the impact of globalisation on the output-inflation trade-off or, differently put, on the slope of the Phillips Curve. Whilst most of the available literature equates globalisation with enhanced product market competition, we prefer a more qualitative definition of the internationalisation process, namely the participation of each individual country in the international production chain, which is

here approximated by the size of the share of intermediate inputs in production, whether domestically produced or imported. The incentive for using a measure of globalisation alternative to stronger product market competition is that the latter unrealistically implies counter-cyclical mark-ups. We find that real marginal costs anticipate inflation only when interacted with a measure of domestic and/or international fragmentation. Indirectly, we thus suggest that only the open economy NKPC is a good indicator of inflationary pressures. The data support the following prediction of the model: countries with more fragmented production systems are characterised by greater price stickiness than less integrated economic systems.

The policy implications are immense. The globalisation processes has proceeded hand in hand with the intellectual success of liberalist economic theories and of monetarism with its belief that government action is at the root of inflation. Paradoxically, the internationalisation of production has but strengthened the case for more active demand management to the extent that this should produce real effects in the short to medium-run now that inflation expectations have been anchored, as it seems to be the case for the euro-area.

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References

Alvarez L. J. et al (2006), “Sticky Prices in the Euro-Area: A Summary of the New Micro-Evidence”, in: *Journal of the European Economic Association*, 4, 2-3, 575-584.

Ando M. (2006), “Fragmentation and vertical intra-industry trade in East Asia”, in: *North American Journal of Economics and Finance*, 17, 257-281.

Ball L. (2006), “Has Globalization Changed Inflation?”, NBER Working Paper N.12687, November.

Ball L. (1993), “What Determines the Sacrifice Ratio?”, NBER Working Paper N.4306, March.

Ball L. et al (1988), “The New-Keynesian Economics and the Output-Inflation Trade-Off”, Brookings Paper on Economic Activity, 1, 1-82.

Basu S. (1995), “Intermediate Goods and Business Cycles: Implications for Productivity and Welfare”, in: *American Economic Review*, 85, 3, 512-531.

Blanchard O. J. (1983), “Price Asynchronization and Price Level Inertia”, in: Dornbusch R. and Simonsen M. H. (eds.), *Inflation, Debt and Indexation*, Cambridge, Massachusetts, 3-24.

Blinder A. et al (1998), *Asking about Prices. A new Approach to Understanding Price Stickiness*, NY.

Binyamini A. and Razin A. (2007), “Flattened Inflation-Output Trade-Off and Enhanced Anti-Inflation Policy as an Equilibrium Outcome of Globalization”, Hong Kong Institute for Monetary Research, Working Paper, N.23.

Boivin J. and Giannoni M. (2006) "Has Monetary Policy Become More Effective?" in: *Review of Economics and Statistics*, 88, 3, 445-462.

Borio C. and Filardo A. (2007), “Globalisation and Inflation: new cross-country evidence on the global determinants of domestic inflation”, Bank for International Settlements Working Paper N.227, May.

Campa J. and Goldberg L. (2006),”Distribution Margins, Imported Inputs, and the Sensitivity of the CPI to Exchange Rates”, NBER Working Paper N.12121.

Campa J. and Goldberg L. (1997), “The Evolving External Orientation of Manufacturing Industries: Evidence from Four Countries”, in: *Economic Policy Review*, 3, 2.

Carlton D. (1986), “Rigidity of Prices”, in: *American Economic Review*, 76, 4, 637-658.

Chen N., Imbs J. N. and Scott A. (2004), “Competition, Globalization and the Decline of Inflation”, CEPR Discussion Paper, N.4695.

Clark T. E. (1999), “The responses of prices at different stages of production to monetary policy shocks”, in: *Review of Economics and Statistics*, 81, 420-433.

Deardorff A. V. (2001), “Fragmentation in simple trade models”, in: *North American Journal of Economics and Finance*, 12, 121-137.

Dornbusch R. (1976), “Exchange Rates Expectations and Monetary Policy”, in: *Journal of International Economics*, 6, 231-244.

European Commission (2008), *EMU@10 – successes and challenges after ten years of Economic and Monetary Union*, Brussels, May.

Galì J. and Gertler M. (1999), “Inflation Dynamics: A Structural Econometric Analysis”, in: *Journal of Monetary Economics*, 44, 195-222.

Galì J., Gertler M. and Lopez-Salido D. (2001), “European Inflation Dynamics”, NBER Working Paper N.8218, April.

Gordon R. (1990), “What is New-Keynesian Economics?”, in: *Journal of Economic Literature*, 19, June, 493-530.

Gordon R. (1981), “Output Fluctuations and Gradual Price Adjustment”, in: *Journal of Economic Literature*, 19, June, 493-530.

Guerrieri L., Gust C. and Lopèz-Salido D. (2008), “International Competition and Inflation: A New Keynesian Perspective”, Board of Governors of the Federal Reserve System, International Finance Discussion Paper, N.918.

Helg R. and Tajoli L. (2005), “Patterns of international fragmentation of production and the relative demand for labour”, in: *North American Journal of Economics and Finance*, 16, 233-254.

Huang K. and Liu Z. (2001), “Production chains and general equilibrium aggregate dynamics”, In: *Journal of Monetary Economics*, 48, 437-462.

Hummels D., Ishii J. and Yi K. M. (2001), “The Nature and Growth of Vertical Specialization in World Trade”, in: *Journal of International Economics*, 54, 1, 75-96.

Ihrig J. et al (2007), “Some Simple Tests of the Globalization and Inflation Hypothesis”, International Finance Discussion Papers, Board of Governors of the Federal Reserve System, N.891, April.

IMF (2006), “How Has Globalization Affected Inflation?”, Washington.

Jones R. W. and Kierzkowski H. (1990), “The Role of Services in Production and International Trade: A Theoretical Framework”, in: Jones R. and Krueger A. (eds.), *The Political Economy of International Trade*, Oxford.

Kimura F. and Ando M. (2005), “Two-dimensional fragmentation in East Asia: Conceptual Framework and Empirics”, in: *International Review of Economics and Finance*, 14, 317-348.

Kleinert J. (2003), “Growing Trade in Intermediate Goods: Outsourcing, Global Sourcing, or Increasing Importance of MNE Networks?”, in: *Review of International Economics*, 11, 3, 464-482.

Kohn D. L. (2006), “The Effects of Globalization on Inflation and Their Implications for Monetary Policy”, remarks at the Federal Reserve Bank of Boston’s 51st Economic Conference, Chatham, Massachusetts, June.

Kose M. A. and Yi K. M. (2001), “International Trade and Business Cycles: Is Vertical Specialization the Missing Link?”, in: *The American Economic Review*, 91, 2, 371-375.

Lucas R. (1973), “Some International Evidence on the Output-Inflation Tradeoffs”, in: *The American Economic Review*, 63, 3, 326-334.

Mankiw G. (1985), “Small Menu Costs and Large Business Cycles: a macroeconomic model of monopoly” in: *Quarterly Journal of Economics*, 100, 529-537.

Mankiw G. and Summers L. (1986) “Money Demand and the Effects of Fiscal Policies”, in: *Journal of Money, Credit and Banking*, 18, November, 415-429.

Means G. C. (1935), “Industrial prices and their relative inflexibility”, US Senate Document 13, 74th Congress, 1st Session, Washington D.C.

Obstfeld M. and Rogoff K. (1996), *Foundations of International Macroeconomics*, Cambridge, Massachusetts.

Roberts J. M. (2006), "Monetary Policy and Inflation Dynamics", in: *International Journal of Central Banking*, 2, September, 193-230.

Rogoff K. (2003), “Globalization and Global Disinflation”, Federal Reserve Bank of Kansas City.

Ruane F. and Görg H. (2001), “Globalization and Fragmentation: Evidence for the Electronics Industry in Ireland”, in: Arndt S. W. and Kierzkowski H., *Fragmentation. New Production Patterns in the World Economy*, Oxford, 144-164.

Rudd J. and Whelan K. (2005), “New Tests of the New Keynesian Phillips Curve”, in: *Journal of Monetary Economics*, 52, 6, 1167-1181.

Rumler F. (2007), “Estimates of the Open Economy New Keynesian Phillips Curve for Euro Area Countries”, in: *Open Economy Review*, 18, 427-451.

Sbordone A. (2007), “Globalization and Inflation Dynamics: the Impact of Increased Competition”, NBER Working Paper N.13556.

Shapiro A. H. (2006), “Estimating the New Keynesian Phillips Curve: A Vertical Production Chain Approach”, Federal Reserve Bank of Boston Working Paper N.11.

Stigler G. J. and Kindahl J. K. (1970), *The Behaviour of Industrial Prices*, NBER, NY.

Temple J. (2002), “Openness, Inflation, and the Phillips Curve: A Puzzle”, in: *Journal of Money, Credit and Banking*, 34, 2, May.

Williams J. C. (2006), "The Phillips Curve in an Era of Well-Anchored Inflation Expectations," unpublished working paper, Federal Reserve Bank of San Francisco, September.

Wu C. S. and Lin J. L. (2007), “The Relationship between Openness and Inflation in NIEs and the G7”, mimeo.

Yeats A. J. (2001), “Just How Big is Global Production Sharing?”, in: Arndt S. W. and Kierzkowski H., *Fragmentation. New Production Patterns in the World Economy*, Oxford, 108-143.

Young (1928), “Increasing Returns and Economic Progress”, in: *Economic Journal*, 38, 527-542.