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Comment Tommaso Monacelli

Introduction

Does globalization affect inflation? This issue has attracted considerable interest recently, especially among monetary policymakers. Much of the attention has focused on the role of globalization in the form of increased trade integration. Yet if the link between globalization and inflation seems suggestive, it is not clear whether it pertains to the *level* as opposed to the *volatility* of inflation (or both). For instance, Rogoff (2006) argues that globalization strengthens the degree of competition and therefore dampens the inflationary bias temptation of the monetary authority, thereby leading to lower *average* inflation. Somewhat differently, Bernanke (2006) argues that the link between globalization and inflation may work via two complementary channels: a direct (*terms of trade*) effect due to lower import prices,

Tommaso Monacelli is an associate professor of economics at Università Bocconi.

and an indirect (*pro-competitive*) effect due to competitive pressures, lower markups, and strategic complementarity (reduced pricing power of domestic firms).

Sbordone's approach aims at exploring the latter pro-competitive effect in detail. Her chapter is an example of how far the rigor of microfoundations can take us in the structural evaluation of inflation dynamics.[1] Her precise question is: does increased trade integration, by boosting the degree of competition in the economy, feature any sizable effect on the *slope* of the Phillips curve? In particular, can higher trade intensity be conducive to a *flattening* of the Phillips curve? Clearly, through this channel, any variation in the real marginal cost and/or output gap would lead (ceteris paribus) to a lower *variability* in inflation.[2]

In a nutshell, Sbordone's chapter interprets trade integration as a source of *real rigidity*, where the relevant definition of real rigidity is whatever structural factor reduces the elasticity of inflation to the real marginal cost. This "primary" link between marginal cost and inflation is a key dimension in the empirical literature on the new-Keynesian Phillips curve (NKPC henceforth).[3]

The conclusion is as honest as any endeavor in rigorous thinking can be: although in principle increased trade can entail a flattening of the Phillips curve, the sign and the strength of this effect depends on the second derivative of the (steady-state) price elasticity of demand to the number of consumed varieties. The sign of this derivative can lead, under certain conditions, even to a steepening of the Phillips curve.

In my comments I will argue that, although impeccable, Sbordone's reasoning on the topic is far from being exhaustive. I will make two points in particular. First, the link between increased trade and the competitive conditions of the economy should account for a more genuine dimension of openness: namely, the degree of *substitutability* of goods. If increased trade is synonymous with a wider spectrum of consumed varieties, the extent to which the same new varieties are close substitutes of the domestically produced ones bears crucial implications. Second, alternative sources of real rigidity may stem from other features of openness that are not modeled in Sbordone's framework. Such features include: (a) the share of imported inputs in production, and (b) the degree of pass-through of exchange rate movements to import prices. This will lead me to more general considerations on how "to build" an *open economy* version of the NKPC.

1. See Woodford (2003) for a summa of the extensive ramifications of this approach.

2. Recently Mishkin (2007) has argued that a flattening of the Phillips curve has been the result of an increased credibility of monetary policy leading to lower inflation. For this channel to be at work, though, one can only resort to a *state-dependent* pricing framework, thereby lower inflation reduces the frequency of price adjustment and hence, reduces the slope of the Phillips curve.

3. Galí and Gertler (1999); Sbordone (2002).

Pro-competitive Effects, Strategic Complementarity, and the Phillips Curve

In Sbordone's chapter, the link between trade and the slope of the NKPC works via variations in the *price elasticity* of demand, which in turn induce variations in the desired level of the markup. In a standard new-Keynesian model based on Dixit-Stiglitz constant elasticity of substitution (CES) preferences, the price elasticity of demand is a constant exogenous parameter. Sbordone introduces Kimball (1995) preferences over differentiated varieties, a feature that makes the price elasticity of demand a function of the quantity produced, thereby leading to a kinked demand function for any individual variety. Thus, increased trade leads to more varieties, and therefore, possibly to a lowered price elasticity of demand and to a flatter Phillips curve. In this vein, trade is conducive to the pro-competitive effect emphasized by Bernanke (2006).

Sbordone's model is, however, isomorphic to a closed economy model enriched with two nonstandard features: (a) a nonconstant CES aggregator à la Kimball; (b) the presence of a finite number of varieties. The latter is treated as an exogenous extensive margin, since firms' entry and exit decisions are not analyzed. In the absence of these features, the model would nest the standard Calvo-Yun sticky-price model.

In particular, the aggregate consumption index can be written:

$$\int_0^N \psi\left(\frac{c(i)}{C}\right) di = 1,$$

where N is the steady-state number of varieties, which is a free parameter, and $\psi(\cdot)$ is an increasing strictly concave function. Notice that the number varieties do not exert any effect on preferences, not even a basic "love for variety" effect à la Dixit-Stiglitz-Spence.

To simplify, let me abstract from the presence of firm-specific inputs, which can constitute per se an alternative and complementary source of real rigidity. Sbordone shows that the elasticity of (domestically produced goods price) inflation to the real marginal cost can be written:

$$\zeta = \kappa_C\left[\frac{1}{1 + \theta(N)\varepsilon_\mu(N)}\right]. \tag{1}$$

In the previous expression, κ_C denotes the elasticity of inflation to the real marginal cost in the standard Calvo-Yun model, $\theta(N)$ is the steady-state value of the price elasticity of demand (which in turn depends on the number of varieties N), and $\varepsilon_\mu(N) > 0$ is the steady-state elasticity of the markup function to the number of varieties. Notice that, in the spirit of the aforementioned "pro-competitive effect," we have $\theta'(N) > 0$. The elasticity $\varepsilon_\mu(N)$ captures the sensitivity of the desired (equilibrium) markup to other firms' prices, and hence a "strategic-complementarity motive" in price setting.

It is clear that the effect on the slope ζ of an increase in the number of varieties N depends on the sign of the first derivative of $\varepsilon_{\mu}(N)$ with respect to N. Sbordone shows that $\varepsilon'_{\mu}(N) < 0$, so an increase in N can have an ambiguous effect on ζ. In addition, Sbordone shows under what conditions the pro-competitive effect (via a variation in $\theta[N]$) prevails over the strategic complementarity effect (via a variation in $\varepsilon_{\mu}[N]$) in lowering the elasticity ζ of the marginal cost function (and therefore in inducing an increased real rigidity effect). Under certain calibrations, however, a rise in N can even lead to a higher value of the elasticity ζ.

An Open Economy Model with Strategic Complementarity

In this section I argue that accounting for *openness* can substantially alter the strength of the strategic-complementarity effect working via the markup elasticity $\varepsilon_{\mu}(N)$. What this argument requires is opening the economy to trade and distinguishing the role of imported goods as potentially *imperfect substitutes* of domestically produced goods.

In the following, I sketch a model of a small open economy in which imports enter the consumption basket via a Kimball aggregator, as in Gust, Leduc, and Vigfusson (2006). Prices are assumed to be flexible throughout.

The consumption aggregator of domestic households is defined as the function:

$$G\left(\frac{C_{H,t}(i)}{C_t}, \frac{C_{F,t}(i)}{C_t}\right) = [(1 - N^*)C_{H,t}^{1/\rho} + N^* C_{F,t}^{1/\rho}]^{\rho} - \frac{1}{(1 + \eta)\gamma} + 1,$$

where $C_H(i)$ and $C_F(i)$ denote consumption of domestically produced and imported variety i, respectively, N^* is the *share* of *imported* goods in consumption, $\eta \neq 0$ is a parameter that governs the curvature of the demand function (with $\eta = 0$ implying a typical CES demand function for variety i), ρ is a parameter that governs the elasticity of substitution between domestic and imported goods, and $\gamma > 1$.

The bundle of foreign imported goods reads:

$$C_{F,t} = \frac{1}{N^*} \int_0^{N^*} \frac{(1 - N^*)}{(1 + \eta)\gamma} \left[\left(\frac{1 + \eta}{1 - N^*}\right) \frac{C_{F,t}(i)}{C} - \eta\right]^{\gamma} di, \tag{2}$$

with $C_{H,t}$ having a similar expression.

Optimal demand for the individual domestic variety reads:

$$C_{H,t}(i) = (1 - N^*) \left[\frac{1}{(1 + \eta)} \left(\frac{P_{H,t}(i)}{\tilde{P}_t}\right)^{1/(\gamma - 1)} \left(\frac{P_{H,t}}{\tilde{P}_t}\right)^{\gamma(\gamma - \rho)}\right], \tag{3}$$

where $P_{H,t}(i)$ is the price of domestic variety i, $P_{H,t}$ is the utility-based price of the bundle $C_{H,t}$ of domestic goods, and $\tilde{P}_t$ is an aggregate price index that depends on both the price of the domestic consumption bundle and on the price of the imported bundle:

$$\tilde{P}_t = [(1 - N^*)\, P_{H,t}^{\gamma/(\gamma-\rho)} + N^*\, P_{F,t}^{\gamma/(\gamma-\rho)}]^{(\gamma-\rho)/\gamma}. \tag{4}$$

Notice that $\tilde{P}$ differs from the utility-based aggregate consumer price index (CPI) but is still a homogeneous of degree one function.

In this context, the optimal *desired* markup for the domestic firms reads:

$$\mu_{H,t} = \left[\gamma + \eta(\gamma - 1)\left(\frac{P_H}{\tilde{P}}\right)^{\rho/(\rho-\gamma)}\right]^{-1}. \tag{5}$$

Notice that $\eta = 0$ implies $\mu_{H,t} = \mu_H$ for all t, which is the standard CES case of constant desired markup. With $\eta \neq 0$ the desired markup features an additional time varying endogenous term $\eta(\gamma - 1)\,(P_H/\tilde{P})^{\rho/(\rho-\gamma)}$, which we could think of as a *strategic-complementarity factor*.

By using (4) and defining the terms of trade $S_t = P_{F,t}/P_{H,t}$ as the relative price of imported goods, the desired markup can be expressed as a function of the terms of trade

$$\mu_{H,t} = h(\gamma, \eta, \rho, N^*, S_t). \tag{6}$$

We can, in turn, define $\varepsilon_{\mu_H}(N^*)$ as the *elasticity* of the desired markup to the terms of trade; that is, the open economy analog to $\varepsilon_{\mu}(N)$ in Sbordone's model. We notice that a *terms-of-trade* induced strategic-complementarity effect requires $\varepsilon_{\mu_H}(N^*)$ to be *positive.* Consider, in fact, a terms-of-trade appreciation (a fall in S_t), in the form of a fall in the relative price of imported goods. For a strategic-complementarity effect to be at work, this should lead, via (6), to a *fall* in the desired markup of domestic firms $\mu_{H,t}$, which should in turn generate an incentive for domestic firms to also *reduce* their prices.

Furthermore, we notice that (6) allows us to evaluate the effect on the elasticity $\varepsilon_{\mu_H}(N^*)$ of an increase in the number of *imported* varieties, as opposed to an increase in the *overall* number of varieties as analyzed in Sbordone's chapter. The latter aspect is important, for an increase in trade genuinely corresponds to an increase in the share of varieties imported *relative* to the share of varieties produced domestically. This relative effect naturally suggests that the elasticity of substitution between imported and domestic varieties may play a crucial role in the analysis. A first pass on the data reminds us that both S_t and the markup are countercyclical in the United States (see, e.g., Backus, Kehoe, and Kydland 1994), so the unconditional correlation between $\mu_{H,t}$ and S_t is likely to be positive.

In the following, I systematically evaluate the sign of the elasticity $\varepsilon_{\mu_H}(N^*)$

and how the magnitude of the same elasticity varies with the share of imported varieties N^*. Log-linearizing (5) and (4) around a steady-state with $S = 1$, and combining, one can write the following expression for ε_{μ_H}:

$$\varepsilon_{\mu_H} = \frac{\eta(\gamma - 1)\,\rho\, N^*}{[\gamma + \eta(\gamma - 1)]^2\,(\rho - \gamma)} > 0.$$

Hence, we see that: (a) ε_{μ_H} is increasing in N^* (suggesting that indeed the degree of strategic complementarity is strengthened by stronger trade integration); (b) the sign of ε_{μ_H} depends on the values of γ, η, ρ.

Parameters γ, η, ρ feature in the expression for the (trade) *elasticity of substitution* between domestic and imported varieties, which reads:

$$\rho^T \equiv \frac{\rho}{(\rho - \gamma)(1 + \eta)}.$$

The calibrated values of γ, η, ρ will in turn depend on which value for ρ^T can be considered realistic. The literature is, however, far from unanimous on the likely empirical magnitude of the trade elasticity. Macroeconomists think it is low, in a range between 1.2 and 2, whereas the micro/trade literature typically believes that such elasticity is very high.[4] For instance, Bernard et al. (2003) set $\rho^T = 4$, Heathcote and Perri (2002) estimate $\rho^T = 0.9$. Estimates from open economy dynamic stochastic general equilibrium (DSGE) models such as Justiniano and Preston (2006), De Walque, Smets, and Wouters (2006), and Rabanal and Tuesta (2005) estimate values around $\rho^T = 1.5$. Adolfson et al. (2007) is the first DSGE study that estimates a value for ρ^T in the high range, and in particular equal to 5. At the other end of the spectrum, however, Corsetti, Dedola, and Leduc (2008) set $\rho^T = 0.5$.

When using the Kimball aggregator, a typical source of uncertainty concerns the curvature of the demand function governed by η. Here the range varies from the value $\eta = -2$ chosen by Levin, Lopez-Salido, and Yun (2007) to the value $\eta = -6$ chosen by Dotsey and King (2005) (DK henceforth), with higher values of η (in absolute value) corresponding to a more pronounced curvature of the demand function (i.e., to a more pronounced smoothed kink).

Figure 10C.1 plots the value of ε_{μ_H} as a function of N^* conditional on $\eta = -2$ but for alternative values of the trade elasticity ρ^T. At the high end of the spectrum I choose the value $\rho^T = 4$ calibrated in Bernard et al., whereas at the low end I choose the value $\rho^T = 0.5$ as in Corsetti, Dedola, and Leduc (2008).[5]

Two aspects are worth emphasizing. First, the elasticity of the markup function to the terms of trade is *positive* and *increasing* in N^*. This con-

4. See Ruhl (2008) for an argument trying to reconcile both views.

5. In particular I choose $\gamma = 1.1$ as in Gust, Leduc, and Vigfusson (2006), so that the chosen value for ρ^T implies residually a value for ρ. Notice that $\gamma = 1$ generates the standard CES case.

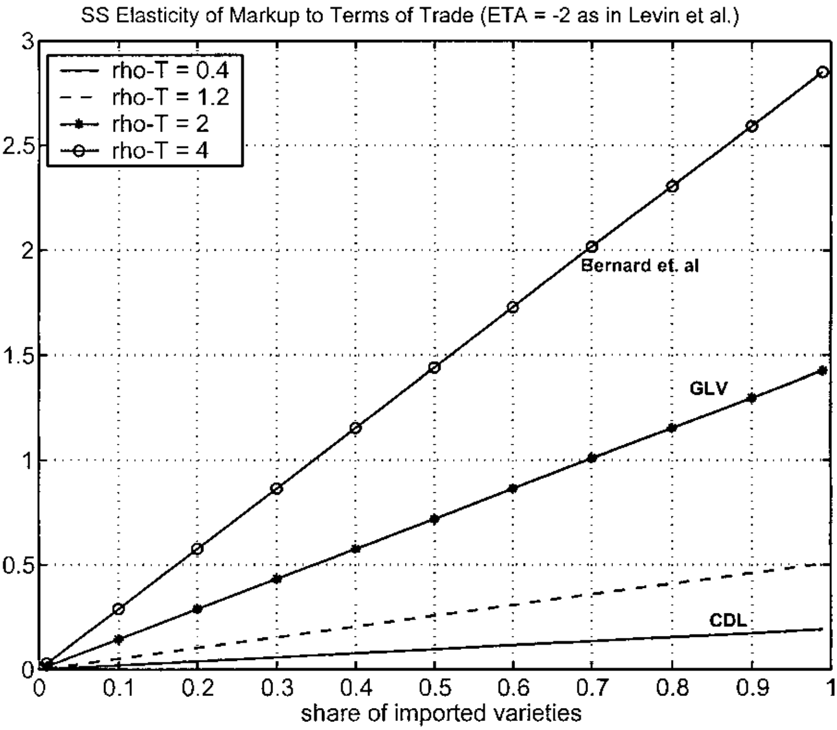

Fig. 10C.1 Effect of varying the share of imported varieties on the steady-state elasticity of the markup to the terms of trade, case $\eta = -2$

Notes: GLV stands for Gust, Leduc, and Vigfusson (2006), CDL for Corsetti, Dedola, and Leduc (2006).

firms that an open economy pro-competitive effect acting via the terms of trade is at work, and is increasing in the share of imported varieties in the economy. Second, and most importantly, the partial derivative of $\varepsilon_{\mu H}$ is strongly affected by the value of the trade elasticity of substitution. The larger the elasticity ρ^T the stronger the effect on $\varepsilon_{\mu H}$ of any given increase in N^*, and therefore the stronger the induced "strategic-complementarity" effect. Intuitively, if increased trade amounts to a larger share of *imported* varieties, any variation in the price of those varieties will exert a stronger competitive effect on the prices of *domestic* varieties, the more closely substitutable the same imported varieties are relative to the domestically produced ones.

Figure 10C.2 displays the results of a similar exercise, but now conditional on a value of $\eta = -6$ as in Dotsey and King (2005). Hence we see that the curvature of the demand function also matters, with a more pronounced curvature leading to an even stronger effect of the number of varieties on the markup elasticity. However, the intensity of this partial effect is of an

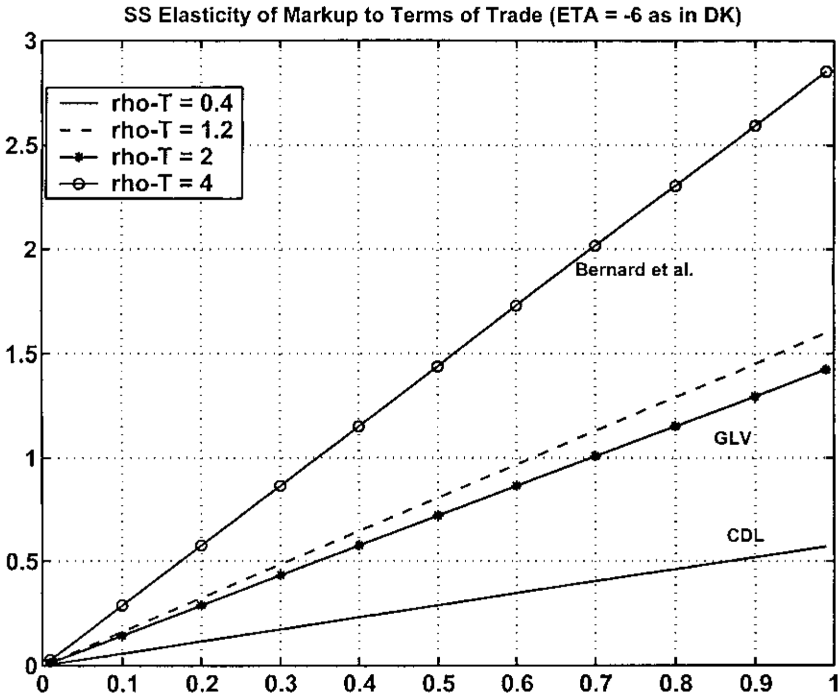

Fig. 10C.2 Effect of varying the share of imported varieties on the steady-state elasticity of the markup to the terms of trade, case $\eta = -6$

Notes: GLV stands for Gust, Leduc, and Vigfusson (2006), CDL for Corsetti, Dedola, and Leduc (2006).

order of magnitude smaller than the partial effect induced by the choice of alternative values of ρ^T.

Building an Open Economy NKPC

The openness dimension may be conducive to channels of real rigidity that are independent of any source of strategic complementarity in price setting. Consider, to start with, the *primary* form of the NKPC (the inflation and real marginal cost relationship analyzed by Sbordone) derived in the open economy model of Galí and Monacelli (2005):

$$\pi_{H,t} = \beta E_t \{\pi_{H,t+1}\} + \kappa_H mc_t, \tag{7}$$

where the slope $\kappa_H \equiv (1 - \theta\beta)(1 - \theta)/\theta$, as typical in the Calvo-Yun framework, depends on the discount factor β and on the probability θ of not being able to reset the price optimally. Notice that in (7) there is no role of openness as a real rigidity factor. Two key assumptions are responsible for this result. First, complete exchange rate pass-through on import prices. Second, imports are final *consumption* goods only.

This does not imply, however, that openness does not exert any influence on inflation. In fact, the form of the primary NKPC for *CPI inflation* π_t reads:

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa_H mc_t + \frac{\alpha}{1-\alpha}\tilde{q}_t,$$

where α is the share of imported goods in consumption (a measure of the degree of openness), and $\tilde{q}_t \equiv [\Delta q_t - \beta\Delta E\{q_{t+1}\}]$ is a composite term capturing leads and lags of the real exchange rate q_t (all in percentage deviations from steady state). The composite term $\tilde{q}_t$ summarizes the role of open economy factors, but once again the latter do not exert any effect on the elasticity of inflation to the real marginal cost, which still coincides with κ_H.

Introducing Imports as Intermediate Production Inputs

Suppose now that imports are modeled both as final consumption goods and intermediate *production inputs.* Let δ be the share of intermediate imports over total imports and ω be the share of intermediate imports in total production inputs. The production function for variety i therefore reads $Y(i) = H^{1-\phi}(i)\, M^{\phi}(i)$, where H is labor hours, M is an imported production input, and $\phi \equiv \omega\delta$. In this case, the expression for the (log) real marginal cost becomes $mc_t = (1-\phi)(w_t - p_{H,t}) + \phi z_t$, where z_t is the relative price of imported inputs, w_t is the nominal wage rate, and $p_{H,t}$ is the price of domestically produced goods (all in logs).

The implied CPI-NKPC becomes:

$$\pi_t = \beta E_t\{\pi_{t+1}\} + (1-\phi)\kappa_H\, lsh_t + \xi_t, \tag{8}$$

where $lsh_t \equiv (w_t + n_t - p_{H,t}) - y_t$ is the time varying *labor income share,* $\lambda \equiv \alpha(1-\delta)$, and $\xi_t \equiv [\lambda/(1-\lambda)]\tilde{q}_t + \kappa_H\phi z_t$ is a composite term in the relative prices $\tilde{q}_t$ and z_t.

Hence, in this case the elasticity of inflation to the labor share $(1-\phi)\kappa_H$ depends on the share of imported inputs ϕ, with a higher share leading to a smaller elasticity. Notice, however, that it is trade openness in *production* inputs that acts as a real rigidity factor, whereas the elasticity of inflation to the labor share is not affected by openness in *consumption* imports.

Sticky Import Prices

Suppose, next, that along with domestic consumption prices import prices are also sticky. For simplicity we assume that only imported consumption goods prices are sticky in local currency, whereas the prices of imported inputs remain flexible.[6] The main implication of import price stickiness is that it leads to deviations from the law of one price (or, alternatively, imperfect exchange rate pass-through). Both domestic and imported goods

6. Recent evidence in Gopinath and Rigobon (2007) finds pervasive evidence of price stickiness for import prices at the dock.

inflation are now driven by a NKPC-type equation (see, e.g., Monacelli 2005):

$$\pi_{H,t} = \beta E_t \{\pi_{H,t+1}\} + \kappa_H mc_t$$
$$\pi_{F,t} = \beta E_t \{\pi_{F,t+1}\} + \kappa_F \psi_{F,t},$$

where $\psi_{F,t}$ is a term that captures log deviations from the law of one price (which in turn act as variations in the real marginal cost for local importers). Combining the two previous equations one obtains the following CPI-NKPC equation:

$$\pi_t = \beta E_t \{\pi_{t+1}\} + (1 - \lambda)(1 - \phi)\kappa_H \, lsh_t + \chi_t, \tag{9}$$

where $\chi_t \equiv (1 - \lambda)\phi\kappa_H z_t + \lambda\kappa_F[\psi_{F,t} + (\lambda - \alpha)s_t]$ is a new composite term in the relative prices z_t and s_t (the log terms of trade), and in the "law-of-one-price gap" $\psi_{F,t}$.

Hence, the main implication of introducing import price stickiness (imperfect pass-through) is that the elasticity of inflation to the labor share depends now on the degree of openness in *both* consumption and production imports, λ and ϕ, respectively. In both cases, a higher degree of openness decreases the elasticity of inflation to the labor share, contributing to an increase in real rigidity.

In order to assess the quantitative importance of openness in consumption goods relative to openness in production inputs as a real rigidity factor, we look at some numbers. We set the share of imported inputs over *total imports* in the United States to $\delta = 0.38$, as from estimates in Bardhan and Jaffee (2004). We set the share of imported goods in consumption equal to $\alpha = 0.25$, and the share of imported inputs in *total inputs* in the United States to $\omega = 0.082$, as from Campa and Goldberg (2006). With these numbers at hand we can compute values for λ and ϕ. Finally, we set $\beta = 0.99$ and the Calvo probability of not resetting prices $\theta = 0.75$ (a typical value in the literature).

In the benchmark closed economy model the value for the marginal cost elasticity is:

$$\kappa_H \equiv \frac{(1 - \theta\beta)(1 - \theta)}{\theta} = 0.0858.$$

In the case in which imports are both consumption goods and intermediate production inputs (see equation [8]) the elasticity of inflation to the labor share reduces to

$$(1 - \phi)\kappa_H = 0.0832.$$

Notice that the reduction in the labor share elasticity is, however, not quantitatively important.

Finally, in the case in which I introduce both imports as production inputs *and* deviations from the law of one price (as a result of stickiness in import consumption prices), I obtain a value for the labor share elasticity (see equation [9]):

$$(1 - \lambda)(1 - \phi)\kappa_H = 0.0632.$$

Hence, we see that import price stickiness may in principle act as a quantitatively more important real rigidity factor relative to openness in production inputs.

Conclusions

Sbordone's chapter is clear, rigorous, and intriguing. The issue of how trade globalization may exert an impact on inflation dynamics is, however, far from being exhausted here. In particular, I have argued that openness can potentially act as an important *real rigidity* factor if we properly account for: (a) the degree of substitutability between imported and domestically produced goods; (b) the role of imports as intermediate production inputs; and (c) incomplete exchange rate pass-through as a result of price stickiness in import consumption prices. Accounting for all these features may contribute to better shape the debate on the role of trade integration in affecting the form of the Phillips curve, and therefore on the likely *quantitative* effects of globalization on inflation dynamics.

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