The relative prices of nontradables in terms of tradables: a strong indicator of inflation inertia Preliminary Version

Anne-Laure Baldi*
FORUM Université Paris 10

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Abstract

This paper examines the impact of a shock to the nominal exchange rate on the behavior the relative price of nontradable (N.T.) goods in terms of tradables (T). We develop a simple model of a small open economy producing T and N.T. goods with a monopolistic competition à la Dixit-Stiglitz (1977) and a sticky information context à la Mankiw and Reiss 2002) in the N.T. sector. The model predicts inflation inertia in the overall economy following a shock to the nominal exchange rate.

The dynamic effects of monetary policy on inflation and real activity currently give rise to a large debate among macroeconomists who discuss different versions of Philipps curve (see Woodford (2002), Mankiw and Reis (2002)). The nominal echange rate as a monetary policy instrument and its impact on real variables is however not specifically treated. Nevertheless the issue has been crucial over the last decade in many emerging countries: large adjustments of the relative price of nontradables in terms of tradables were observed (see figure **??** in annex) after the sudden and permanent shift in the nominal exchange rate due to the implementation of a pegged regime (1989 in Mexico, 1991 in Argentina and Chile and 1995 in Brasil) or inversely after its abandon (1995 in Mexico, 1999 in Brasil and Chile and 2002 in Argentina) According to the law of one price, shifts in the nominal exchange rate theoretically imply overall price adjustment unless asymetric rigidities (such as different sectoral adjustment speeds) allows for a staggered price adjustment in some

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sectors. Considering a basic segmentation based on T. and N.T. sector, a slowier price adjustment in the N.T. sector is reflected by a variation of the relative price of nontradables in terms of tradables which becomes an interesting indicator of inflation inertia. This paper examines the influence of nominal exchange rate shifts on the behavior of the relative price of nontradables in terms of tradables (RPN)

The literature dealing with the determinants of the RPN only focuses on real factors. It is an accepted feature of the process of development that long run upward trend of the ratio is due to higher productivity gains in the T than NT sector, referred to as the so-called Balassa-Samuelson effect. In this literature, competition is perfect, then the price of tradables equals marginal cost, capital is internationally perfectly mobile and labor is internationally perfectly immobile .The small open economy thus takes the world interest rate as given, which uniquely determines the wage rate by the equalization of marginal cost and the given world price. Perfect intersectoral labour mobility allows for wages equalisation accross sectors. Productivity gains in T. sector imply higher wages in both sectors what generates higher prices in N.T.,namely an appreciation of the real exchange rate. In the seminal Balassa Samuelson model, analytically the RPN depends only on the productivity differential and the labour intensity of each sector.

In addition to this equilibrium phenomenon a more recent literature identifies short run demand-side factors by droping either the international capital mobility or perfect competition hypothesis[1]. Under these modified assumptions relative prices are in the short and medium terms affected by government expenditures (Froot and Rogoff 1991, Allard-Prigent and alii 2000), terms of trade (De Gregorio & Wolf 1994), financial transfers (Edwards 1989) etc.

Nevertheless no theoretical work has investigated the influence of the nominal exchange rate on the short run trend of relative prices.We previously provided empirical evidence for a cointegration relationship between the RPN and the type of exchange rate regime: pegged regime are correlated with increasing RPN while flexible regime with decreasing RPN (Baldi and Mulder 2002). This paper presents a theoretical interpretation to these empirical evidence. We develop a simple model of a small open economy producing T and N.T. goods with a monopolistic competition *à la* Dixit-Stiglitz in the N.T. sector[2]. Following Mankiw and Reis (2001) we introduce a sticky information context in this last sector that prevents firms to adjust to current nominal evolutions. Each period the same fraction of the N.T. firms updates themselves on the current state of the economy and computes optimal

[1] See Duval (2000) for an exhaustive literature review and the table **??** in first appendix.

[2] Imperfect competition in the N.T. sector has already been considered in Allard-Prigent & alii (2000) allowing for real demand-side factors (government spendings) to play a role.

prices based on that information while the rest of the population continues to set prices based on old plans and outdated information Under such conditions after a sudden and permanent shift in the nominal exchange rate prices in the N.T. sector adjust slowier than in the T.sector. Even after the shift in nominal exchange rate most price setters in the NT sector are still making up prices based on old decisions and outdated information. As a result of this inertial behavior, inflation gradually moves contrary to the T sector where the law of one price prevails. A corresponding adjustment in the RPN generates an shift in the real exchange rate

This paper is organised as follows: in the following section we present the recent literature dealing with monetary policy, to jusify the class of models we are working with..In section II we present a two-goods model with sticky information.that specifically deals with nominal exchange rate shifts. Section III concludes.

1 Real effects of nominal shocks:timing of expectations matters

1.1 The Newclassical Phillips curve: no influence of monetary policy on real variables

Lucas model (1972) with imperfect informations (about price variation causes) is the seminal model from which the Newclassical Phillips curve originates. Relevent expectations are past expectations of current conditions and by asumption agents have rational expectations Unanticipated shocks only can influence real variables, what implies for the monetary policy to operate based on its own private information(Sargent and Wallace 1975, Barro,1976).

1.2 The New-keynesian Phillips curve

Monetary policy becomes relevent on real variables with Taylor (1977, 1979, 1980), Fisher (1977) even with anticipated shocks and rational expectations thanks to the introduction of nominal rigidities on prices. Producers operate in monopolistic competition environment*à la* Dixit and Stiglitz (1979) taking into account the demand of consumers, prices are fixed in advance because of contracts. Fundamental expectations are thus still past expectations of the current conditions. But here prices do not perfectly adjust to monetary shocks even if the shock becomes anticipated since prices are fixed. This implyes durable effects on general production level. This first generation of staggered price setting were critisized for two reasons: the nature of imperfections is not credible since agents could easily get rid of them. Second the

models fail to explain inflation inertia (Ball 1994). Staggered price models with Calvo (1983) features (see Woodford 1996, 2002) prolonged the analysis of Taylor and Fisher answering to the first critique (see Woodford 1996, 2002). In this second generation imperfect competition still holds among producers but only a fraction of good prices remain unchanged each period. To eliminate the possibility for agents to get rid of nominal rigidities on prices, every firm has the same probability each period of being one of the non-adjusting firms. This difference is fundamental regarding expectations: since agents are perfectly rational they anticipate that they might not be able to adjust their prices every periods and thus set their optimal price on the basis of current expectations regarding future conditions. Anticipating that they might not be able to change their prices at the exact period when the shock occurs, agents incorporate the effect of a future anticipated shock as soon as they can modify their prices. Thus anticipated shocks still impact the real side of the economy. But this also implies that the greatest impact of a shock occurs immediately (Ball 1994). Subsequently this second generation still fails to explain inflation inertia. Ball's critique is even harsher since he shows a contradiction: according to these models, desinflation always results in booms : when price setters anticipate a desinflation, inflation fails immediately. This fall in inflation, together with continued increase in the money supply, leads to higher output.

1.3 The sticky-information Phillips curve

To answer to this critique Ball, with Mankiw and Reis (see Mankiw and Reis 2001, Mankiw, Reis and Ball 2002) initiated a third generation of nominal rigidities where information and not prices are sticky. In this new class of model, every firm sets its price every period (contrary to the sticky price model), but in each period a fraction of firms obtains new information about the state of the economy and computes a new path of optimal prices. Other firms continue to set prices based on old plans and outdated information. As in the sticky price model each firm has the same probability of being one of the firms updating their pricing plans. Relevent expectations are as in the first generation model past expectations of current econmic conditions. This difference yields large differences in the dynamic pattern of prices and output in response to monetary policy. Even after a shock of monetary policy has occured, most price setters are still marking up prices based on old decisions and outdated information. As a result of this inertial behavior, inflation is little changed after the shock has occured.

This last generation model suits our objective to provide a theoretical interpretation to inflation inertia observed in Latin America following large shocks to nominal

exchange rate.

2 The model

In the following we consider a two good economy with tradable (T). and nontradable (N.T). goods. In the T. sector, the price is determined on the world market (law of one price), and firms operate in a perfectly competitive environement. By contrast, N.T. suppliers operate in a monopolistic competitive environement with information asymetries.

It has empirically been observed that N.T. sector is generally submitted to imperfect competition due to monopolistic agents. Under monopolistic competition suppliers have a degree of market power, and set their price taking into account the demand of consumers. Dixit and Stiglitz (1977) formalised the price setting in this context. Following Mankiw and Reis (2001) we introduce information asymetries in the N.T.sector that prevent a fraction of firms to adjust to current nominal evolutions The monopolistic environment implies that a supplier that fails to immediately adjust its price in response to a change in demand conditions does not suffer an unboundedly large (percentage) change in its sales.

We show why a nominal exchange rate shift is not transformed into a proportional overall inflation adjustment.

2.1 Preferences

We assume that individuals consume tradable and non tradable goods (respectively c_t and c_n) Preferences are given by the CES utility function:

$$U = \left\{ \gamma^{\frac{1}{\theta}} c_T^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} c_N^{\frac{\theta-1}{\theta}} \right\}^{\frac{\theta}{\theta-1}} \tag{1}$$

where θ is the elasticity of substitution across goods ($\theta > 0$) and $\gamma \in [0,1]$ .The consumer maximizes (1) subject to the budget constraint:

$$Z = P_T c_T + P_N c_N \tag{2}$$

where Z denotes after tax income and the prices of the goods are denoted by $p_i (i = T, N)$.

Because of the assumption of monopolistic competition in the N.T. sector that implies that producers take the demand function into account to determine their

price we estimate the demand function of N.T goods only.
Following Dixit and Stiglitz (1977), we assume that consumption of N.T. goods has the following constant-elasticity-subsitution from:

$$C_N = \left[\sum_{i=1}^{\infty} c_i^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{3}$$

with $\varepsilon > 1$, the elasticity of substitution accross N.T. goods. Maximising utility subject to its budget constraint for N.T. goods $P_N c_N$, it yields the following relationship between the price index of the N.T. sector and the price of each N.T. goods :

$$P_N = \left[\sum_{i=1}^{\infty} p_i^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{4}$$

with $\varepsilon > 1$. The demand function for N.T.good is then derived from (3) and (4) :

$$c_i = C_N \left(\frac{p_i^*}{P_N} \right)^{-\varepsilon} \tag{5}$$

2.2 Production

Production of the tradable (y_T) and the nontradable (y_N) good are given by:

$$\begin{aligned} y_T &= a_T L_T^{\alpha} K_T^{1-\alpha} \\ y_N &= a_N L_N \end{aligned} \tag{6}$$

where $0 < \alpha \leq 1, K_T$ is capital in the tradable sector. It is internationally mobile then the domestic interest rate is equal to the world interest rate, which is hereafter taken as exogeneous. L_i are labor imputs in sector i. Labor is internationally immobile The nontradable goods sector uses only labor, hence capital is specific to the tradable sector.

2.2.1 Tradable sector

Firms maximize their profit subject to their technical constraint:

$$\begin{aligned} Max \quad & (p_T y_T - w L_T - r K_T) \\ K, L \quad & subject\ to\ y_T = a_T L_T^{\alpha} K_T^{1-\alpha} \end{aligned} \tag{7}$$

maximization program yields :

$$\left\{ \begin{array}{c} w = \alpha p a_T k_T^{1-\alpha} \\ r = (1-\alpha) p a_T \ k_T^{-\alpha} \end{array} \right. \Leftrightarrow \left\{ \begin{array}{c} w = q(\alpha a_T k_T^{1-\alpha}) \\ r = q\left[(1-\alpha) a_T k_T^{-\alpha}\right] \end{array} \right. \tag{8}$$

according the law of one price $p_T = q p_T^f$ with q the nominal exchange rate and p_T^f the foreign tradable price that we normalize to one Then (8) yields:

$$w = r^{\frac{-(1-\alpha)}{\alpha}} \left(\frac{q a_T}{\psi}\right)^{\frac{1}{\alpha}} \tag{9}$$

where $\psi = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$

2.2.2 Nontradable sector

Monopolistic competition holds among producers which allows firms a degree of market power and hence a decision about how to set their prices. There is an infinite quantity of firms each producing only one good, c_i.

Firms maximize their profit taking into account their own demand function subject to their technical constraint. In equilibrium the demand function for each good equals its production : $y_i = c_i$. The maximisation program of each firm has thus the following form:

$$\left\{ \begin{array}{ll} Max & y_i p_i^* - w L_i \\ p & \text{subject to } y_i = a_N L_N \text{ and } c_i = y_i = C_N \left(\frac{p_i^*}{P_N}\right)^{-\varepsilon} \end{array} \right. \tag{10}$$

with y_i following (5).

Maximization program yields :

$$p_i^* = \frac{\varepsilon}{\varepsilon - 1} \frac{w}{a_N} \tag{11}$$

In equilibrium each producer sets an identical price, and this common price will be $P_N^* = p_i^*$.

Following Mankiw and Reis (2001) we introduce information asymetries about nominal evolutions. A slow diffusion of informations could arise because a monitoring of current conditions is too costly for a fraction of firms to be worthwhile. We assume that each period a fraction $\lambda$of the population updates themselves on the current state of the economy and computes optimal prices based on that information. The rest of the population, (1-λ),continues to set prices based on old plans and outdated information. Each firm has the same probability $0 \leq \lambda \leq 1$ of being one of the firms updating their pricing plans, regardless of how long it has been since its last update.

Following Mankiw and Reis, a N.T. firm that last updated its plan j periods ago sets the price:

$$x_t^j = E_{t-1} P_{N,t}^* \tag{12}$$

And the N.T. price index is :

$$P_{N,t} = \lambda \sum_{j=0}^{\infty} (1-\lambda)^j x_t^j \tag{13}$$

Putting together (11), (12) and (13)yields the following expression for the N.T. price level:

$$P_{N,t} = \frac{\varepsilon}{\varepsilon - 1} \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-j} \frac{w_t}{a_N} \tag{14}$$

and combined with (9), considering that in the short run productivity in both sectors rates are constant as well as international interest rate it yields

$$P_{N,t} = \frac{\varepsilon}{\varepsilon - 1} \frac{r^{\frac{-(1-\alpha)}{\alpha}} \left(\frac{a_T}{\psi}\right)^{\frac{1}{\alpha}}}{a_N} \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-j} q_t \tag{15}$$

Relevent expectations are past expectations of current economic conditions what allows for a gradual adjustment of inflation in the N.T. sector. Even after the shock to the nominal exchange rate, most price setters are still marking up their prices based on an outdated nominal exchange rate.

Meanwhile, in the T. sector the law of price holds and with the foreign price normalised to one, the T ¨price is

$$P_{T,t} = q_t \tag{16}$$

Different speeds of adjustment in both sectors imply a new path of RPN.

The implementation of a pegged regime corresponds to a sudden desinflation, namely, a sudden and permanent shift in the nominal exchange rate. In period 0 of the pegged regime, the central bank sets q_t the same as it was in the previous period and, at the same time, announces that q_t will thereafter remain constant. The model predicts a gradual reduction in inflation in the overall economy. This corresponds to an appreciation of the real exchange rate [3], that can contribute to deteriorate

[3] We first explicit the relationship between the RPN and real exchange rate. The common definition of real exchange rate is (in logarithms) :

$$q = e + p - p^f \tag{17}$$

the current account. Trade balance evolutions in the begining of the nineties in Latin America support this last prediction: from +8 to -8 millions US$ between 1990 and 1998 in Argentina and from - 7 to -30 millions US$ between 1990 and 1994 in Mexico (see figure **??** in annex). The increasing deficits of current accounts were highlighted in the analysis of the financial crisis in Latin America during the nineties because it contributed to further burden the external debt, thus increasing the financial subordination of the countries.

The opposed case is the abandon of a pegged regime: the model predicts a decrease of the RPN. As Sgard (2003) points out, hyperinflation did not occur neither in Argentina nor in Brasil after the currency crisis and the abandon of the pegged regime : by the second quarter of 1999 in Brasil, the initial 35% depreciation in the exchange rate had only produced an 8% annualised inflation. Over the same period of time, the price of internationaly traded-goods had increasingled by 11% and that of non-traded goods by 1,5%. *To be completed with Argentinean figures.*

3 Concluding remarks

This paper questioned the effect of a shock to nominal echange rate on the behavior of the domestic real exchange rate taken as the relative price of nontradables in terms of tradables (RPN). The existing literature identifies only real-side factors: the long-run upward trend of the ratio is linked to the Balassa-Samuelson effect, as well as fluctuations due to demand factors such as terms of trade, government expenditures etc.Nevertheless no theoretical work has emphasised the impact of nominal shock to the RPN .

We presented a simple model to explicit the impact of a shock to the nominal exchange rate on the RPN. Its basic features are a two-good economy with perfect

with e, p and p^f being the exchange rate, and the domestic and foreign total economy price levels respectively. This can be decomposed in two parts:

$$q = e + (1-\alpha)p_t + \alpha p_n - (1-\alpha^f)p^f - \alpha^f p_n^f \tag{18}$$

with α and a^fbeing the share of the nontradable sector in domestic and foreign GDP respectively. (18) is equivalent to:

$$q = q_t + \alpha[(p_t - p_n) - (p_t^f - p_n^f)] \tag{19}$$

where $q_t = e + p_t - p_t^f = 0$ with the law of one price in the tradable sector. Given a stable foreign price differential between tradables and nontradables, the real exchange rate becomes

$$q = \alpha(p_t - p_n) \tag{20}$$

competition environment in the T sector and monopolistic competition *à la* Dixit-Stiglitz with a sticky information context in the N.T. sector.à la Mankiw and Reis (2001) The model predicts inflation inertia after a shock to the nominal exchange rate in the N.T. sector and thus a new path of RPN. The next step of this program is to explore the microeconomic fundations for such nominal rigidity asymetries accross sectors.

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Appendices

A Literature Review

Synthesis of the literature survey. Source : R.Duval(2001)

B Statistic Datas

Ratio of Price Indices of Nontradables to Tradables (January 1991=100)

Inflation rate

Trade Balance in millions US dollars

Defining the tradable sector (from Baldi & Mulder 2002)