Local Currency Pricing and Pass-Through: An Empirical and Theoretical Analysis

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This paper explores the reasons behind a low elasticity of imported goods to the nominal exchange rates, analyzing empirically the law of one price and the degree of pass-through. The results show that, in the medium and long term, the degree of pass-through is low and the deviations from the law of one price on consumer prices are wide and persistent. These deviations are due to both local currency pricing strategies and the behavior of prices in the distribution services. Given these results, we propose a new decomposition of the consumer price index that takes into account multiple factors for the analysis of the degrees of pass-through. [JEL. Code: F4]

1. - Introduction

The traditional theory of open macroeconomics assumes that the elasticity of imported goods' prices to the exchange rate (degree of pass-through) is equal to one (complete pass-through). Changes in exchange rates modify the relative prices of domestic and foreign countries. For example, an appreciation in the exchange rate makes foreign goods cheaper in terms of domestic currency, and domestic goods more expensive in terms of foreign currency. This tends to switch the demand towards imported goods, reducing exports.

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In contrast with the theoretical literature, the empirical research shows a low degree of pass-through on imported prices, and close to zero on consumer prices: when the exchange rate changes, consumer prices do not react and, in turn, the relative prices of domestic and foreign goods, that determine final demand, do not change.\footnote{See AMITRANO A. - DE GRAVE P. - TULLIO G. (1997); BORENSTEIN E. - DE GREGORIO J. (1999); BURSTAIN A. - EICHENBAUM M. - REBELO S. (2002); CHARI V.V. - KEOH E. - MCGRATAN E.R. (2000); OSTFELD M. (2001).}

The differences between theoretical predictions and empirical evidence cast doubts on the adjustment power of nominal exchange rate and, consequently, on the benefits of flexible exchange rate regimes.\footnote{See FRIEDMAN M. (1953).} In the context of the so-called new open economy macroeconomics, several economists have tried to make a synthesis of older open macroeconomics model and recent empirical researches.\footnote{See LANE P.R. (2001) for an excellent general survey of the new open economy macroeconomics model.}

Bacchetta and van Wincoop (2001), Devereux and Engel (2002) and Corsetti and Pesenti (2002) study the pass-through in a framework in which firms sell goods directly to consumers and prices have nominal rigidity. Corsetti and Dedola (2002) study the pass-through in a theoretical model with vertical interaction between producers and consumers, without nominal rigidities.

With this work I extend the previous literature introducing some theoretical considerations on the basis of new empirical evidence. The analysis compares two alternative explanations of the low degree of pass-through: the former is based on nominal rigidities, the latter on distribution services.

The first part of the paper, composed by Sections 2 and 3, presents some empirical evidence; the second part, composed by Section 4, introduces a theoretical model. In Section 2, I use the model proposed by Engel (1999), (2002) to show how empirical results contradict the law of one price. In Section 3, I estimate a model based on Engel (2002) in order to test the role of distribution services and nominal rigidities in determining deviations from the law of one price. In Section 4, I give a theoretical explanation of the em-
pirical findings and I advance a new hypothesis for the analysis of open macroeconomic models.

2. - A Model on Law of One Price

The traditional theory of open macroeconomics assumes that 1) variations in the exchange rate change relative prices of domestic and foreign goods (complete pass-through) and that 2) in competitive markets, with no transportation or trade restrictions, the same good, if expressed in a unique currency, has the same price in different countries (law of one price). If both assumptions hold, a flexible exchange rate is a tool for adjusting international imbalances.

A vast empirical literature, however, shows that neither hypothesis holds. In particular, the law of one price (LOOP from now on) does not hold either in the short or the long run. In recent years the debate has focused on the importance of distribution services in determining deviations from the LOOP. De Gregorio, Giovannini and Wolf (1994) and Engel (1999), (2002) analyze LOOP decomposing the consumer price index into a component attributable to the price of non-traded goods, and a component attributable to the price of traded goods. As we will see in chapter 4, the separated evaluation of non-traded and traded goods plays a central role in the analysis of LOOP at consumer level. For this reason, for my empirical test of the LOOP I use Engel's (1999), (2002) model.

2.1 Empirical Evidence

Engel (1999), (2002) analyzes the LOOP using a price index $p_t$ that is a geometric weighted average of traded and non-traded goods prices:

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4 With the expression “non-traded good” we mean a good that has excessively high transportation costs relative to its value added to be traded in different markets. The hair cut is a classical example of this kind of good/service.
where $p_t$ is the log of the price index, $p_T^T$ is the log of the traded goods price index, $p_N^N$ is the log of the non-traded goods price index, and $\alpha$ is the share that non-traded goods take in the price index. Letting an asterisk represent the foreign country, we can also write:

\[(2) \quad p^*_t = (1 - \alpha^*) p_T^T + \alpha^* p_N^N\]

where $\alpha^*$ is non-traded goods' share in the foreign price index. The real exchange rate $q_t$ is given by:

\[(3) \quad q_t = s_t + p_t^* - p_t\]

where $s_t$ is the log of the domestic currency price of foreign currency. Substituting equation (1) and (2) in equation (3) we have:

\[q_t = s_t + (1 - \alpha^*) p_T^T + \alpha^* p_N^N - [(1 - \alpha) p_T^T + \alpha p_N^N]\]

We can divide this equation in two components; the relative price of traded goods between the countries:

\[x_t = s_t + p_T^T - p_T^T\]

and a component that is a weighted difference of the relative price of nontraded to traded goods prices in each country:

\[(4) \quad y_t = \alpha^* (p_N^N - p_T^N) - \alpha (p_N^N - p_T^N)\]

Then the real exchange rate is given by:

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5 In this price index only the non-traded component has a positive weight. When we use this index we say that, for example, the price of an hair cut is influenced more by a change in the rent of the beauty parlour than by change in the price of the shampoo. So, we could suppose that the results are biased in traded goods measurement. However, as Engel C. (1999) demonstrated, the traded weight has a low influence on consumer price index.
Engel estimates the ratio between the MSE (mean-squared error) of the component $x_t$ and $y_t$:

\[
\frac{MSE (x_t - x_{t-j})}{MSE (x_t - x_{t-j}) + MSE (y_t - y_{t-j})}
\]

where the MSE is calculated as follows\(^6\):

\[
MSE (x_t - x_{t-h}) = \text{Var} (x_t - x_{t-h}) + [E(x_t - x_{t-h})]^2
\]

where:

\[
E (x_t - x_{t-h}) = \frac{h}{N-1} (x_h - x_t)
\]

$h$ represents the lag, and $N$ the number of observations\(^7\). The variance is calculated as:

\[
\text{Var} (x_t - x_{t-n}) = \frac{N}{(N-h-1)(N-h)} \sum_{j=1}^{N-h} [x_{i+h} - x_j - E (x_{j+h} - x_j)]^2
\]

I repeated the analysis of Engel (1999, 2002) using two additional datasets in order to estimate the role of a different exchange rate regime in explaining deviations from LOOP. The analysis is on Canada, France, Italy, Germany, Japan and the US. The data are monthly and are over three different periods: from December 1973 to January 2001 (Engel data set), from January 1962 to January 2001, and from January 1962 to November 1973.

The sample from December 1973 to January 2001 is the same

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\(^6\) The ratio defined in the equation (6) does not use $MSE (q_t - q_{t-h})$ at denominator, but the sum $MSE (x_t - x_{t-h}) + MSE (y_t - y_{t-h})$. The explanation of this choice is that the comovements of $x_t$ and $y_t$ account for very little of the mean-squared error of real exchange rate changes.

\(^7\) Using $E$, $\text{Var}$ and Cov I indicate respectively the mean, the variance and the covariance.
studied by Engel (2002); for all countries $x_t$’s share of the MSE is above 0.90 at all horizons and they evolve similarly to Engel (2002) (Graph 1.1).

The largest sample, from January 1962 to January 2001, has the $x_t$’s share of the MSE high, but it is smaller than what found in the previous sample; the range is from 0.77 to 0.97 (Graph 1.2).

This result induced me to introduce the third sample, from 1962 to 1973 when the Bretton Woods system was effective. By doing that I have been able to study the influence of the exchange rate regime on the exchange rate pass-through\(^8\).

Also in this last sample for France, Germany and Japan the $x_t$’s share of the MSE is above 0.77; $x_t$’s share for France-US is between 0.77-0.82, Germany-US 0.87-0.91, Italy-US 0.55-0.81. As long as the time horizon expands also the $x_t$’s share of the MSE increases (Graph 1.3).

These results suggest that with a fixed exchange rate regime the deviations from LOOP are lower than in a flexible exchange rate regime. A possible explanation for this result can be given by considering that, under the two different currency arrangements, market participants may have different perceptions of the permanent/transitory nature of observed changes in exchange rates. Indeed, it seems reasonable to assume that changes in exchange rates under a fixed regime are deemed less “transitory” than in a flexible regime. Since firms in both the production and the distribution sectors will be induced to change their pricing strategy only for perceived permanent changes in exchange rates, then under flexible currency arrangements prices will be less responsive to changes in the exchange rates and, therefore, observed deviations from the LOOP will be larger than in a fixed currency arrangement, at least in the short run.

In particular, Canada-US has the lowest $x_t$’s share of the MSE: the values are between 0.45-0.52. Canada-US is the only couple that is in the same continent; following Engel e Rogers (1996) I suppose that the value of $x_t$ for these two countries is due to lower tran-

\(^8\) See Engel C. (1999).
Local Currency Pricing and Pass-Through: etc.

Graph 1

DEVIATION FROM LAW OF ONE PRICE

1.1 Data from December 1973 to January 2001

MSE Canada - US
MSECNU73

MSE France - US
MSEFRUS73

MSE Germany - US
MSEGEUS73

Data from December 1973 to January 2001
Graph 1 (continued)

DEVIATION FROM LAW OF ONE PRICE

1.1 Data from December 1973 to January 2001

MSE Italy - US
MSEITUS62

MSE Japan - US
MSEFRUS73

1.2 Data from January 1962 to January 2001

MSE Canada - US
MSECNUS62
GRAPH 1 (continued)

DEVIATION FROM LAW OF ONE PRICE

1.2 Data from January 1962 to January 2001

MSE France - US
MSEFRUS62

MSE Germany - US
MSEGEUS62

MSE Italy - US
MSEITUS62

Data from January 1962 to January 2001
Graph 1 (continued)

Deviation from Law of One Price

1.2 Data from January 1962 to January 2001

MSE Japan - US
MSEJPUS62

1.3 Data from January 1962 to November 1973

MSE Canada - US
MSECNUS62-73

MSE France - US
MSEFRUS62-73

Data from January 1962 to November 1973
1.3 Data from January 1962 to November 1973

MSE Germany - US
MSEGEUS62-73

MSE Italy - US
MSEITU62-73

MSE Japan - US
MSEJPUS62-73

Data from January 1962 to November 1973
sportation costs for intra-continental trade than for cross-continental trade.

We can draw main two conclusions from the model analyzed in this chapter: 1) the movements of the real exchange rate are due to $x_i$’s share of the MSE, that is the measure of the deviation from LOOP, either in fixed exchange rate regime or flexible exchange rate regime; 2) countries that are close enough and have a fixed exchange rate regime, have smaller deviations from LOOP.

It is important to note that by using this framework we can show that the LOOP fails when tested empirically, but we cannot understand why it fails. In particular, the model does not provide information on the degree of passthrough (henceforth $PT$). This is a major problem because the LOOP does not hold either if there is price discrimination and complete $PT$ ($p_t \neq s_i p^*_t$, $PT = 1$), or if $PT$ is less than 1 ($0 \leq PT < 1$). For this reason in the next Section I will use a model that takes into account the relationship between LOOP and $PT$.

3. – Distribution Services and Local Currency Pricing

The empirical evidence on LOOP and $PT$ is at odds with theoretical predictions of traditional macroeconomic theory. Recent research on open economy macroeconomics has produced a synthesis of dynamic intertemporal approaches with older sticky-price models of macroeconomic fluctuation. This synthesis, which is known as new open economy macroeconomics, has allowed economists to tackle classical problems with new tools, assuming, for example, absence of perfect competition, a low degree of $PT$, and nominal rigidities.

These assumptions derive by modeling how firms set prices in relation to the exchange rate. A fundamental study in this field is Krugman (1987) that studies the pricing to market behaviour ($PTM$ from now on). $PTM$ behavior is the destination-specific adjustment of markups in response to exchange rate changes. Knetter (1993) analyzes a specific variety of $PTM$: the local currency price stability, (henceforth $LCP$) which defines a situation in which firms set prices in the currency of the foreign market.
If firms set prices following LCP strategies, the LOOP fails and the degree of PT is zero: firms set prices in foreign currency and exchange rate changes do not modify consumer price. An alternative explanation of price setting behavior is that firms set prices in the currency of their own country. This behavior is called producer currency pricing (PCP): if firms set price following PCP strategies, the LOOP holds and the degree of PT is one.\footnote{In Section 4 I will show that the relation between LCP, PCP, PT and LOOP does not hold always.}

Empirical research shows that the PT is extremely low when measured on imported prices, and nearly zero when measured on consumer prices – i.e., a failure of LOOP. The new open economy macroeconomic models provide several explanations for these phenomena; among them I have selected the following three:

1) Corsetti and Dedola (2002) focus on the vertical interaction between producer and retailer, hence a low PT depends on the interaction of both sectors;

2) Obstfeld (2002a) asserts that the exchange rate can adjust relative prices only at a producer price level while no adjustment is possible at consumer price level;

3) Engel and Devereux (2001) claim that a low degree of PT is due to nominal rigidities caused by firms that apply LCP strategies.

In recent years the literature has concentrated on LCP models.\footnote{See Betts C.M. - Devereux M.B. (2000).} For this reason, in this Section I use the model of Engel (2002) in which the author uses a LCP framework. I will show that an alternative specification of this model delivers conclusions, both at a theoretical and at an empirical level, that are different from those achieved by Engel (2002).

In conclusion, in this Section I want to:

1) use my empirical estimates to understand the causes of deviations from the LOOP and the low degree of PT on consumer prices;

2) understand if a low degree of PT on consumer prices is due to LCP strategies, as in Engel (2002), to distribution services prices, or to both factors.
3.1 *The Model*

In this Section I introduce the model of Engel (2002), and my alternative specification.\(^\text{11}\)

Engel studies two elements that can induce deviations from LOOP: LCP strategies, and a high impact of the price of distribution services on the consumer price. For this reason the model studies two components of the consumer price: the price of the physical good, or the traded component, on which the LOOP should hold, and the price of distribution services, that is non-traded and is not directed influenced by change in the exchange rate. Potentially, therefore, deviations from the LOOP on consumer prices can be due to both factors.

Following Engel (2002), let the home price of imported good \(i\) (\(P_i\)) be a composite of the price of traded goods \(P_i^t\) for which the LOOP holds \(P_i^t = S P_i^*\); and the price of non-traded distribution services, \(P_{iS}\). If the output of the final consumer product is a CES function of the traded good and the distribution service (with elasticity equal to \(\lambda e 1 - \lambda\), respectively), the consumer price of good \(i\) can be written as:

\[
P_i = (\alpha^\lambda P_{iS}^{1-\lambda} + (1 - \alpha)^\lambda P_i^{1-\lambda})^{\frac{1}{1-\lambda}} = (\alpha^\lambda P_{iS}^{1-\lambda} + (1 - \alpha)^\lambda P_i^{1-\lambda})^{\frac{1}{1-\lambda}}.
\]

We cannot observe \(P_i\) directly because consumer prices consist of both traded and non-traded components.

If \(\lambda \to 1\), the equation (7) becomes a Cobb-Douglas function, from which we can derive (where \(\lambda\) subscripts are logs, and where the \(\lambda\) subscripts are dropped):

\[
p - s - P^* = k + az + (1 - \alpha) u
\]

\(^\text{11}\) For the new elaboration of the Engel's model I am grateful to Luca Dedola.
where $k$ is a constant, $\alpha$ is the cost share of non-traded distribution services, $z \equiv p_s - s - p_s^*$ is the price of services in the home country relative to the foreign country, and $u \equiv \bar{p} - s - \bar{p}^*$ represents the LOOP and is not directly observable.

Since the estimation of this equation does not provide valuable information on the degree of PT, Engel redefines $u$ as follows:

\begin{equation}
(9) 
\quad u = -\gamma s + \epsilon
\end{equation}

where $1 - \gamma$ is the degree of PT, $s$ is nominal exchange rate and $\epsilon$ is an unobservable shock. If $\gamma = 0$ the LOOP on physical goods holds. Viceversa, if $\gamma \neq 0$ the LOOP does not hold on physical good prices; in particular, if $\gamma = 1$ the price is fixed in the currency of the importer country ($LCP$). Deviation from LOOP on consumer prices can be due not only to pricing strategies of the firm, but also to the prices of distribution services: if this is the case $\alpha$ will be positive and significant. The LOOP in equation (9) depends on the $PT$, the nominal exchange rate and the unobservable shock $\epsilon$. Engel assumes that $\epsilon$ is uncorrelated with $s$; and has a small variance. He also defines the relative price of services as $v \equiv p_s - p_s^*$ and assumes that is uncorrelated with $s$. Since $z \equiv p_s - s - p_s^*$ and $v \equiv p_s - p_s^*$, then $z = v - s$. Under this assumptions the probability limit of the OLS estimate of $\alpha$ from equation (8) is given by:

$$
\hat{\alpha} + \frac{(1 - \alpha) \left[ \text{Cov} (\epsilon, v) + \gamma \text{Var} (s) \right]}{\text{Var} (v) + \text{Var} (s)}
$$

Under the hypothesis that the LOOP holds for traded goods ($\gamma = 0$), the asymptotic bias is small since

$$
\frac{\text{Cov} (\epsilon, v)}{\text{Var} (s)}
$$

is likely to be small. But when $PT$ is zero ($\gamma = 1$), the asymptotic bias of the estimate of $\alpha$ from this regression could be large and the information on the regressor not reliable.
Engel rewrites equation (8) grouping $u$ with $z$:

$$p - s - p^* = k + \alpha (z - u) + u$$

(10)

The probability limit of $\alpha$ from this regression is given by:

$$\alpha + \frac{\text{Cov} (\varepsilon, v) - \text{Var} (\varepsilon) - \gamma (1 - \gamma) \text{Var} (s)}{\text{Var} (v) + \text{Var} (\varepsilon) - 2 \text{Cov} (\varepsilon, v) + (1 - \gamma)^2 \text{Var} (s)}.$$  

(11)

If LOOP holds ($\gamma = 0$), the asymptotic bias is small because \text{Var}(s) is large relative to the other variances and covariances. But if $\gamma = 1$, the asymptotic bias is much higher. The difference between $z$ and $u$ is observable and is:

$$z - u = \frac{1}{1 - \alpha} \left[ p_s - \frac{p - (p_s - p^*)}{1 - \alpha} \right]$$

substituting $z - u$ and $u$ in the equation (10), Engel writes:

$$p - s - p^* = k + \frac{\alpha}{1 - \alpha} \left[ p_s - \frac{p - (p_s - p^*)}{1 - \alpha} \right] - \gamma s + \varepsilon$$

(12)

Engel estimates this equation. In equation (12), if $\gamma \neq 0$ the LOOP does not hold. Moreover, if non-traded distribution services cause deviations from LOOP on consumer prices, $\alpha/(1 - \alpha)$ is positive (since $\alpha \in (0; 1)$), high and significant, and the $R^2$ is high. Alternatively, if deviations from LOOP are due to LCP strategies the slope coefficient $\alpha/(1 - \alpha)$ is biased downward (and may be negative because of the bias), and the $R^2$ will be low (Engel, 2002, p. 28). Engel uses the price index of services less rent as a proxy for the costs of distribution services. The prices of tradable goods are constructed from the OECD data on food prices and prices of non-food commodities. The analysis is on changes from 1 to 24 months.

The results of Engel (2002) show that $\alpha/(1 - \alpha)$ is negative, and
that the $R^2$ is low – a piece of evidence which suggests that firms follow LCP strategies.

Equation (12), however, can be rewritten in another way. Starting from equation (8) and substitute $z \equiv p_s - s - p^*$ and using the hypothesis (9), we can write the equation (12) as:

\begin{equation}
(13) \ p - s - p^* = k + \alpha (p_s - p^*) - [\gamma + \alpha (1 - \gamma)] s + (1 - \alpha) \varepsilon
\end{equation}

If $\nu \equiv p_s - p^*$, we can rewrite the equation (13) as:

\begin{equation}
(14) \ p - s - p^* = k + \alpha \nu - [\gamma + \alpha (1 - \gamma)] s + (1 - \alpha) \varepsilon
\end{equation}

The equation (14) derives from Engel's equation (12), but it offers a more lucid interpretation: it allows to distinguish between the relative prices of the distribution sector and the nominal exchange rate. In addition, I have calculated the asymptotic bias of the regressors. I suppose, as in Engel that $\varepsilon$ and $\nu$ are uncorrelated with $s$. Under this assumption, the probability limit of the OLS estimate of $\alpha$ is given by12:

\begin{equation}
(15) \ \alpha + (1 - \alpha) \frac{\text{Cov} (\nu, \varepsilon)}{\text{Var} (\nu)}
\end{equation}

for $\beta = [\gamma + \alpha (1 - \gamma)]$ it is equal to:

$[\gamma + \alpha (1 - \gamma)]$

Comparing the equation (11) with the equation (15) we can see that my coefficient $\alpha$ has a smaller asymptotic bias than the coefficient of Engel and $\beta$ is consistent. This different specification of Engel's model has an important advantage: by distinguishing the exchange rate $s$ and the relative price of distribution services $\nu$, it allows to have estimators with a smaller asymptotic bias.

12 See Section 3 of Appendix.
3.2 Empirical Analysis

In this section I discuss my estimation of equation (14). I used data from Canada, France, Italy, Germany, Japan and US. Data are monthly from December 1973 to January 2001. I used a consumer price index from OECD and Banca d’Italia\(^{13}\). I used LS with a Newey-West correction.

With our estimates we want understand whether the relative prices of distribution services \(p_s - p'_s\) cause deviations from LOOP, and to measure the degree of \(PT (1 - \gamma)\).

The relation between the dependent variable and the relative price of services is direct, and it is inverse with the nominal exchange rate. The degree of \(PT\) is close zero for all countries.

I used three different proxies of the relative price of distribution services: consumer price index of services \((nt3)\), all services less rent \((nt1)\), rent \((nt2)\). The value of the coefficient on distribution services varies depending on the proxy used: consumer price index of rent is the less responsive, the range of values is between 0.022 and 0.564; the coefficient on price index of services less rent has the higher value, between 0.110 and 0.926. The consumer price index of rent gives a low contribution to the explanation of deviations from LOOP: an increase of rent will have a smaller impact than other distribution services prices on the consumer price of a tradable good, also on a two years time horizon. My estimates suggest that the distribution services contribute to deviations from LOOP as the time horizon increases. Using as approximation the consumer price index of all services less rent, on 1 and 24 months, the value of coefficients are: Canada 0.110-0.539, France 0.143-0.947, Germany 0.253-0.604, Italy 0.262-0.926, Japan 0.124-0.425. See Graph 2 for the graphic analysis for each distribution coefficient.

These values diverge from those found by Engel: my estimates show that distribution services contribute to deviations from LOOP as the time horizon increases.

\(^{13}\) For an accurate description of the data see Section 2 of Appendix.
DISTRIBUTION SERVICES

2.1 Canada

Canada nt1

Canada nt2

Canada nt3


**Graph 2 (continued)**

**DISTRIBUTION SERVICES**

2.2 France

France n1

France n2

France n3
Graph 2 (continued)

Distribution Services

2.3 Germany

Germany nt1

Germany nt2

Germany nt3
DISTRIBUTION SERVICES

2.4 Italy

Italy nt1

Italy nt2

Italy nt3
DISTRIBUTION SERVICES

2.5 Japan

Japan m1

Japan m2

Japan m3
As in Engel (2002) my results show deviation from the law of one price ad a low degree of PT, but the values of relative distribution services’ coefficients do not allow to attribute a low degree of PT to LCP strategies only. Engel (2002) tests the hypothesis of LCP against the PCP one, looking at the LOOP on the unobservable prices of physical goods. His results show that the LOOP on physical goods does not hold, and the distribution services do not contribute on the deviation from LOOP on consumer price level. Therefore, the main difference between my results and the results of Engel is that the price of distribution services contributes to the deviation from the LOOP on consumer prices, highlighting that a low degree of PT cannot be only attribute to LCP strategies. The difference between my results and the results of Engel is particularly meaningful if we consider that they are derived from the same data set, on the same time interval, on the same countries and following the same hypothesis of Engel.

These results suggested me some theoretical considerations on the nature and the interpretation of deviations from LOOP and the degree of PT. I will discuss them in the next section.

4. - Law of One Price, Producer Prices and Retailer Prices

The empirical results of the previous section show a low degree of PT and an important role of the price of distribution services in explaining deviations from LOOP. The PCP and LCP theories, not taking into account the role played by the distribution sector prices, appear unable to offer a strong explanation of the causes at the basis of deviations from LOOP.

In this Section I construct a price index made of all the elements that are responsible for the formation of the consumer price of a good. By doing we try to isolate all the components that may contribute to deviations from the LOOP.

4.1 Producer Currency Pricing and Zero Pass-Through

In order to understand which factors contribute to deviations from LOOP we have to define an equation where each component
of the consumer price enters separately. In the literature different attempts have been made. Corsetti and Dedola (2002) hypothesize a retail price index made by producer price and distribution services. Corsetti and Pesenti (2002) introduce a two-countries model, in which producers sell domestic goods in home as well as foreign markets and can potentially practice price discrimination across borders. Producers choose the degree of $PT$ of the exchange rate to export prices; $PT$ is indexed by the parameter $\eta$, such that $\eta = 0$ corresponds to LCP and $\eta = 1$ to PCP. Finally Obstfeld (2002a) assumes that the consumer price index depends on producer price and on the markup of retailer. On the basis of this literature let us use a price index as follows:\footnote{This price index derives from the following equations:}

\begin{equation}
\begin{aligned}
    p_T^i &= \frac{\phi}{\phi - 1} (S^{-\eta} \tilde{P}_T^* + P_N^i) \\
\end{aligned}
\end{equation}

where $p_T^i$ is the consumer price index, $\phi/(\phi - 1)$ is the markup of the retailer (with $\phi > 1$), $S$ is the nominal exchange rate, $\eta$ is the degree of $PT$ in the domestic market ($0 \leq \eta \leq 1$) defined by the producer, $\tilde{P}_T^*$ is the predetermined component of price in foreign currency fixed by the producer, and $P_N^i$ is the price index of distribution services. The consumer price index is made of the producer price $\tilde{P}_T^*$, nominal exchange rate $S$, degree of $PT$ in the domestic market defined by the producer, $\eta$, distribution services price $P_N^i$ and the retailer markup $\phi/(\phi - 1)$.

As we have seen in Section 3, LCP and PCP theories suppose

\begin{itemize}
    \item The first equation is composed of $p_T^i$, traded component, and of $P_N^i$ nontraded component. The second equation states that the traded component consists of a pre-determined component $P_T^*$ defined in the currency of the exporter and of a weighted exchange rate.
    \item I constructed the price index on the basis of the equations above and considering the hypothesis that consumer prices depend also on price strategies adopted by retailers and on the variations of their markups.
    \item For a more detailed description of the equations see Obstfeld M. (2002b) and the other papers quoted above.
\end{itemize}
that if producers set prices in foreign currency (LCP) the degree of \( PT \) on retail price is zero and LOOP does not hold; on the other hand if producers set prices in home currency (PCP), the degree of \( PT \) is one, and the LOOP holds. These theories explain the degree of \( PT \) only through producer pricing strategy; however, in the last Section, I noted that the degree of \( PT \) on consumer price depends also on distribution services.

My price index, defined in (16) allows us to estimate the degree of \( PT \) on consumer prices in a more accurate way. Using equation (16) I show that the \( PT \) on consumer prices may be very low and the LOOP does not hold, even if producers set prices in their own currency (PCP and \( \eta = 1 \)). This result contrasts with the existing theoretical literature. I support this claim using some examples.

Let us suppose that in the short term the retailer takes the producer price \( \bar{P}^T \) and the distribution services price \( P^N \) as given. The degree of \( PT \) at the production is determined by the producer. Let us assume that we register a variation of the exchange rate. 1) If \( \eta = 1 \), and the retailer does not change his markup \( \phi/(\phi - 1) \), \( p^T \) changes following the variation of the exchange rate. On the contrary, 2) if the retailer changes his markup in order to compensate for variations of \( S \), \( p^T \) remains constant. In the first case, consumer prices completely reflects producer choices on \( PT \), given the markup of the retailer and the cost of distribution services. In the second case, the consumer price does not follow the variation of the exchange rate and remains constant. In order to understand why the retailer might decide not to change its price, even in the case of a \( PT \) equal to 1, let us suppose that the currency of the importer country depreciates and that the demand elasticity of substitution for imported good is high. If in the importer country there are substitute goods whose price does not change after the depreciation, the retailer cannot raise the price of the good he sells: if he did that he would lose the market. Hence, the retailer may decide to keep price con-

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15 As equation (16) defined, the degree of \( PT \) on consumer price is never equal to one, because there is the retailer markup and the prices of distribution services. I assume that the price of distribution services are always positive, and the retailer markup could be also equal to zero.

16 The demand could apply to home substitute goods and to third country substitute goods.
tants and to reduce his markup. In this case, the degree of PT on consumer price is zero even if the producer sets the price in his own currency (PCP strategy). This possibility is not contemplated by the existing literature which, in case of PCP strategies, predicts a degree of PT equal to 1\textsuperscript{17}.

If the elasticity of substitution takes values that do not allow the retailer to increase his price, the retailer has the option to decrease his markup, or to choose another producer that offers a substitute good whose price is not changed\textsuperscript{18}. This second strategy would allow the retailer to keep his markup constant. As in Obstfeld (2001), if the retailer changes his supplier, the producer is induced to reduce his markup to go on selling to the retailer.

If the retailer cannot change supplier (as in the case of car sellers) he can change his warehouse stocks (increasing stocks with exchange rate appreciation, and decreasing stocks with an exchange rate depreciation)\textsuperscript{19}, delay the deliveries, or supply a quite different good (with a higher or lower quality) keeping the price constant\textsuperscript{20}.

It is possible to raise an objection to this way of reasoning: if the producer knows the elasticity of the demand in the market and that the retailer cannot change the consumer price, he would impose to the retailer the highest possible price, in order to get all retailer’s surplus. In this case, the retailer would have a markup equal to zero and no space for any price strategy. This objection seems reasonable but in reality does not take into account the fact that, when the producer applies strategies of price discrimination, he must meet the condition of international arbitrage. Corsetti e Dedola (2002) analyze under what conditions arbitrage between retail and wholesale markets becomes a constraint on the pricing strategy of monopolistic producers. Let us assume that the producer sells the good $h$ in his home market $H$ at retail level and in the foreign

\textsuperscript{17} See, for example, Engel C. (2002).
\textsuperscript{18} In this Section I analyse the retailer behaviour after a producer price change. For an analysis on consumer behavior see Burstein A. - Eichenbaum M. - Rebelo S. (2002).
\textsuperscript{19} The variation of warehouse stocks could be a kind of insurance of exchange rate risk.
\textsuperscript{20} For example, a car could change a lot with more or less optionals.
country $F$ at wholesale level. If the producer sets the wholesale price in country $F$ above the consumer price in his own country, retailers would find profitable to buy it from retailers that operate in $H$ rather than in the producer market. In this case the retailer of $F$ is making arbitrage operations. Hence, the producer has the possibility to make price discrimination, but he has to consider the possibility of arbitrage operations among retailers. This framework permits to reconcile the presence of a markup for the retailer and fixed price in imported country currency. It is thus possible to have PCP strategies and zero $PT$ when distribution services’ prices and pricing strategies of retailers are taken into consideration.

These considerations are important for evaluating the adjusting power of the exchange rate. The part of the literature that believes that a low $PT$, measured at consumer price level, is a signal of LCP strategies affirms that a flexible exchange rate regime is not able to change the relative price of home and foreign goods while it has the undesirable effect of causing deviations from the LOOP. Even if I do share this point, I do not believe that these conclusions may be drawn on the basis of a model like that estimated in Section 3. Consumer price indexes do not deliver direct information on firms price setting strategies. We are not able to understand if the exchange rate can change the wholesale price. This conclusion sharply contrasts with what LCP and PCP theories forcefully affirm. If we were in the situation described above, in which the $PT$ at the production is equal to 1 while it is zero on consumer prices, the wholesale demand could be redirected towards those goods whose price were relatively more convenient. This would give origin to expenditure switching at producer level. In this case the deviations from LOOP are due to pricing strategies of retailers and to distribution services, and not to a flexible exchange rate regime.

I believe that future research on $PT$ and LOOP has to carefully consider all the components of consumer prices, in particular, distribution services and retailer pricing strategies are very important. The producer price plays a major role in determining the consumer price of an internationally traded good because in most cases it is its biggest component, however there are other factors that influence the degree of $PT$ measured on retail price and deviations from the LOOP.
5. - Conclusions

The traditional theory of open macroeconomics supposes a complete degree of pass-through. A variation in the exchange rate changes the relative price of domestic and foreign goods, and demand asks for goods with relative lower prices; the literature calls this process “expenditure switching”.

The empirical literature has demonstrated that these hypotheses do not hold: the degree of pass-through on consumer prices is close to zero and the relative price of domestic and foreign goods does not change.

Recent research on open macroeconomics has tried to link theoretical hypothesis and empirical evidence. One of the most widely accepted explanations of a low degree of pass-through is the local currency pricing theory. This theory asserts that exporters set prices ex ante in the currency of the buyer’s country.

This paper studies the local currency pricing theory from a theoretical and empirical point of view. The empirical analysis is composed of two Sections: in Section 2 I study the law of one price using an empirical model of Engel (1999, 2002). As in Engel (2002), the results show large and persistent deviations from the law of one price, in the short and in the medium term.

In Section 3 I analyze the degree of pass-through using a model based on Engel (2002). In our formulation, the model compares the explicative power of the local currency pricing theories versus the theories that attribute a low degree of pass through to the cost of distribution services. My results show a low degree of pass-through to consumer price (close to zero) in the short and in the long run, and a consistent role of distribution services in determining the deviation from the law of one price in a period longer than six months.

The local currency pricing theory explains the low degree of pass-through and the deviation from law of one price with nominal rigidities of consumer prices. This explanation does not consider other variables, for example distribution services, that can influence the degree of pass-through on retail price. However, my empirical analysis shows that, in the medium term, also the cost of distri-
bution services contributes to a low degree of pass-through on consumer price.

For this reason, in the last Section, I have created a price index that is more comprehensive than those previously used in the literature. In my synthesis I have drawn from Corsetti and Dedola (2002), Corsetti and Pesenti (2002) and Obstfeld (2002a). I isolated three main factors: distribution services prices, pricing strategies of retailers and producer pricing strategies. The local currency pricing theory considers only producer pricing strategies. This choice leads to misinterpretations of the pass-through on consumer prices: as I have shown, even if the degree of pass-through is equal to zero on consumer prices, it could be equal to one at producer level, if the producer sets his price in his own currency (producer currency pricing).

This clarification is fundamental for the evaluation of the expenditure switching effect. If the producer price follows the exchange rate value, the wholesale prices would change, and the demand could switch to cheaper goods. In this case the exchange rate changes wholesale prices, and can induce expenditure switching effects at this level of the production process. The local currency pricing theory does not consider this possibility.

If we use a consumer price index for the empirical analysis on pass-through we would not detect producer pricing strategies and this would lead us to derive wrong conclusions also on the optimal exchange rate regime. If prices are fixed in producer currency, a flexible exchange rate regime is more suitable; viceversa, if prices are fixed in the local currency, nominal exchange rate flexibility cannot achieve any relative price adjustment and, in this case, nominal exchange rate fluctuations have the undesirable effect of leading to deviations from the law of one price. This suggests that if prices are a fixed ex ante in consumers’ currencies, a fixed exchange rate regime is preferred.

Recent empirical literature has studied these two pricing strategies using consumer price indices. However, as I highlighted in Section 4, consumer price indices do not provide information on the real producers’ pricing strategies. Indeed, it is possible to conclude for a local currency pricing strategy, even if producers fix pri-
ces in their own currency. For this reason, to decide, e.g., on the optimal currency regime, it is fundamental to work with more disaggregate prices, as retailers and wholesalers prices.

My price index takes into account more factors that are responsible for a low pass-through on consumer price level. It gives us information not only on producer price strategies, but also on pricing strategies of retailers and on the elasticity of demand in a specific sector.

For these reasons I do believe that future researches on pass-through, law of one price and the adjustment power of the exchange rate, have to carefully consider the variety of components of which a consumer price is made of. By doing that it will be possible to understand if there is an expenditure switching effect and at which level of the production process it works.
1. - Abbreviations

LOOP: law of one price;
LCP: local currency pricing;
PCP: producer currency pricing;
PT: pass-through;
PTM: pricing to market.

2. - The Data

Our empirical analysis is on Canada, France, Italy, Germany, Japan and US I use consumer price data from OECD and Bank of Italy. Data are monthly on four components of the consumer price index: food, all commodities less food, rent, and all services less rent. I use the first two as approximation of tradeables, and the latter two as a proxy of nontradeables goods.

Following Engel (2002), in (6) I use a price index for a consumer that has Cobb-Douglas preferences and weights these items with the same weights they receive in the 2001 US consumer price index. The weights $\alpha$ and $\alpha^*$ are set equal to 0.587 for all countries: this value is the US weight for nontraded goods; it is generally higher than for OECD countries, but this should only bias the results in favor of finding a significant role for the relative price of nontraded goods.

In the model (14) I approximate the independent variables with the price index of all commodities less food, and the distribution services with three different price indexes: rent, all services less rent, and a sum of both with the same weights they receive in

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21 The weights are these: 0.157 for food; 0.256 for commodities less food; 0.312 for rent; 0.275 for services less rent.
22 I exclude food because its price is very volatile and it depends by distribution costs.
the 2001 US consumer price index. I use three different approximations of distribution services to estimate the value of each of them.

I run some tests on the stationarity of the series: I perform four kinds of tests following Bodo, Parigi and Urga (1990) and Engel (2002); I analyze also the series’ plots on levels and first-order differences. I perform 118 tests. The series are all very persistent. The augmented Dickey Fuller including a constant, no time trend, and three lags, is able to reject a unit root at the 5% level for only one series (at 10% level for only three of them). Hence, it makes sense to look at changes rather than levels.

I analyze the equation on three periods: from December 1973 to January 2001, from January 1962 to January 2001, and from January 1962 to November 1973. The maximum lag is 18 months. The variables are:

\[ x_i: \text{real exchange rate calculated on traded goods.} \]
\[ y_i: \text{variables defined in (4).} \]

The data for the model (14) are from December 1973 to January 2001.

The maximum lag is 24 months. The variables are:

\[ s_i: \text{nominal exchange rate;} \]
\[ (p_i - s_i - p_i): \text{real exchange rate calculated on consumer price index of all commodities less food;} \]
\[ nt1_i: \text{relative prices of all services less rent;} \]
\[ nt2_i: \text{relative prices of rent;} \]
\[ nt3_i: \text{relative prices of all services.} \]

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23 In Engel, C. (2002) distribution services are approximated with all services less rent. Engel does not consider rent prices because they are very volatile. In my opinion rent prices have a considerable influence on the consumer price of tradable goods.

24 For the analytical construction of variables see Sections 2 and 3.

25 All the variables are log.
3. - Asymptotic Distortion of Regressors

The probability limit of the estimate $\alpha$ from regression (14) is given by:

$$\hat{\alpha} = \frac{\sum y'x'_1 \sum x'_2 - \sum y'x'_2 \sum x'_1}{\sum x'_1^2 \sum x'_2^2 - (\sum x'_1x'_2)^2}$$

it follows:

$$\hat{\alpha} = \frac{\alpha \text{Var}(v) \text{Var}(s) - \beta \text{Cov}(v,s) \text{Var}(s) + (1 - \alpha) \text{Cov}(v,\varepsilon) \text{Var}(s)}{\text{Var}(v) \text{Var}(s) - [\text{Cov}(v,s)]^2}$$

we group the coefficients:

$$\hat{\alpha} = \alpha \frac{\text{Var}(v) \text{Var}(s) - [\text{Cov}(v,s)]^2}{\text{Var}(v) \text{Var}(s) - [\text{Cov}(v,s)]^2} +$$

$$\text{Var}(v) \text{Var}(s) - [\text{Cov}(v,s)]^2$$

$$\text{Cov}(v,s) \text{Var}(s) - \text{Cov}(s,\varepsilon) \text{Cov}(v,s) +$$

and that is:

$$\hat{\alpha} = \alpha + (1 - \alpha) \frac{\text{Cov}(v,\varepsilon) \text{Var}(s)}{\text{Var}(v) \text{Var}(s)}$$

The probability limit of the estimate $\beta = [\gamma + \alpha(1 - \gamma)]$ from regression (14) is given by:

$$\hat{\beta} = \frac{\sum y'x'_1 \sum x'_2 - \sum y'x'_2 \sum x'_1}{\sum x'_1^2 \sum x'_2^2 - (\sum x'_1x'_2)^2}$$
we write:

\[
\hat{\beta} = \alpha \frac{\text{Cov}(v, s) \cdot \text{Var}(s) - \text{Var}(s) \cdot \text{Cov}(v, s)}{\text{Var}(v) \cdot \text{Var}(s) - [\text{Cov}(v, s)]^2} + \beta \frac{\text{Var}(v) \cdot \text{Var}(s) - [\text{Cov}(v, s)]^2}{\text{Var}(v) \cdot \text{Var}(s) - [\text{Cov}(v, s)]^2} + (1 - \alpha) \frac{\text{Cov}(v, \epsilon) \cdot \text{Var}(v) - \text{Cov}(s, \epsilon) \cdot \text{Cov}(v, s)}{\text{Var}(v) \cdot \text{Var}(s) - [\text{Cov}(v, s)]^2}.
\]

then:

\[
\hat{\beta} = \beta - (1 - \alpha) \frac{\text{Cov}(s, \epsilon) \cdot \text{Var}(v) - \text{Cov}(v, \epsilon) \cdot \text{Cov}(v, s)}{\text{Var}(s) \cdot \text{Var}(v) - \text{Cov}^2(v, s)}.
\]

hence, the asymptotic bias of \( \hat{\beta} \) is:

\[
[\gamma + \alpha (1 - \gamma)]
\]
BIBLIOGRAPHY


— —, Exchange Rates and Adjustment: Perspectives from the New Open Economy Macroeconomics, University of California Berkeley, mimeo, June 2002b.