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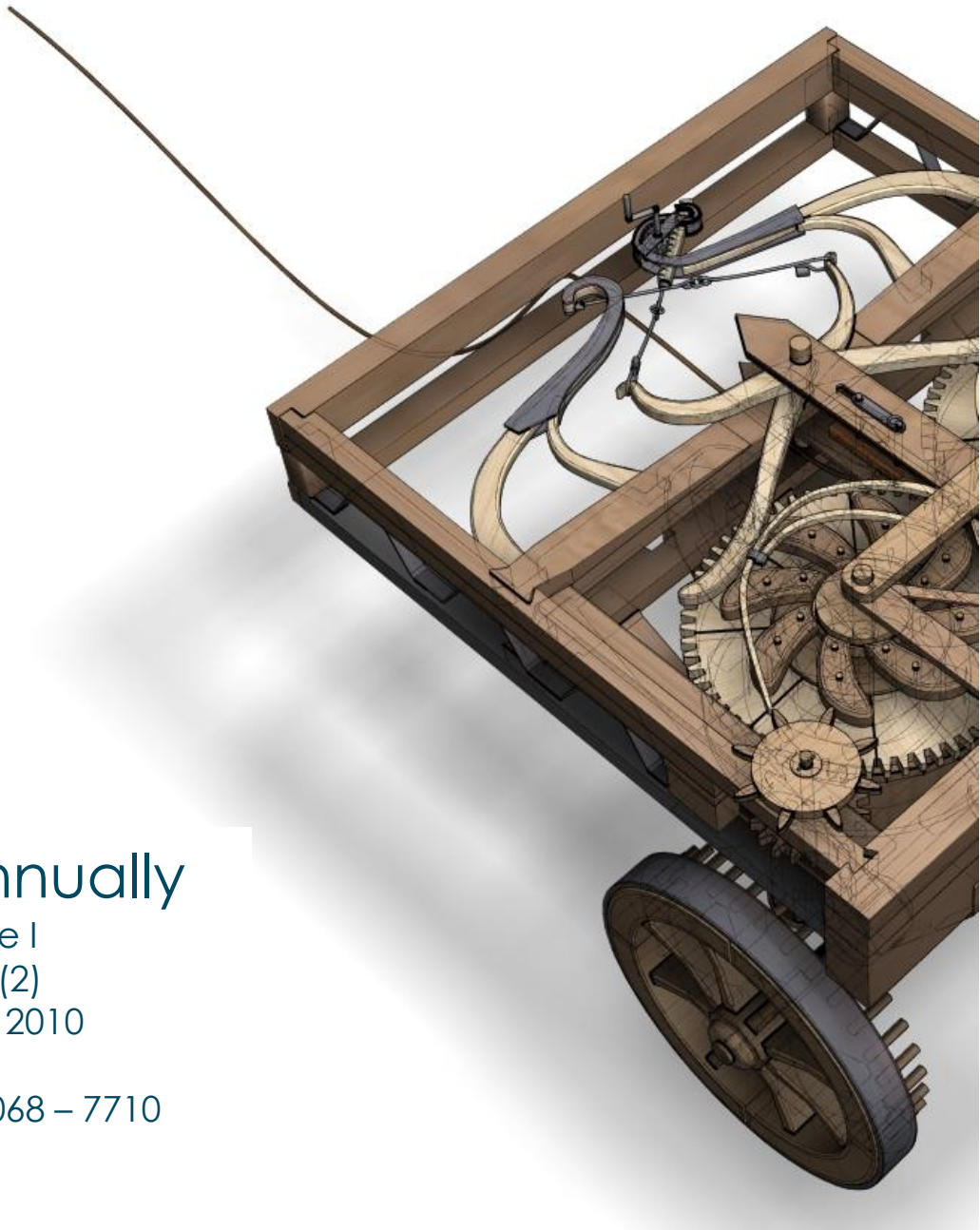

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THE LAW OF ONE PRICE: SURVEY OF A FAILURE

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Abstract

This paper aims to survey the literature about the Law of One Price in order to document its failure in terms of actual application. After a brief theoretical overview, which starts from classical economists' thought, the reported literature has been classified on the basis of three main streams: pricing-to-market (also considering investigations about differences between domestic and export prices), national borders, and tradability of goods. Reviewed works have been selected in order to provide a dedicated survey for 'the Law', which is absent in previous works about this topic. Therefore, the investigation has been kept intentionally separate from PPP-related debate.

Keywords: Law of one price, purchasing power parity, relative prices, exchange rate

JEL Classification: E30, F15, F31, F40, F41

1. Introduction

The Law of One Price (LoOP), is usually presented as the 'one good version' of the well-known concept of Purchasing Power Parity (PPP). Conceptually, LoOP implies PPP whilst the contrary is not true. PPP theory was first developed in XVI century at the University of Salamanca in Spain, and proposed in its contemporary fashion by Gustav Cassel (1918, 1922) between the two World Wars. This contribution was mainly founded on the debate about the restoration of the world financial system after the World War I, given that many countries which adopted the gold standard system before the war had to abandon gold convertibility of their currencies afterwards. Thus, the problem to evaluate correct exchange rates arose, as relative gold values could not be used anymore.

The basic idea behind PPP is that the nominal exchange rate between two currencies should be equal to the ratio of aggregate price indices between the two countries. In this way, PPP implies that a unit of currency of the first country would have the same purchasing power in terms of the second country's currency. This theory encountered enormous consensus. Parsley-Wei (1996) held that almost all of the theories for the determination of exchange rate and open-economy macroeconomic models use LoOP and PPP concepts. This opinion is widely accepted. For example, Dornbusch-Krugman (1976) wrote: 'under the skin of any international economist lies a deep-seated belief in some variant of PPP'; Rogoff (1996) said: 'most [economists] instinctively believe in some variant of PPP as an anchor for long-run real exchange rates', and explained that, today, PPP has a key role in relevant macroeconomic matters such as, for example, fixing the correct exchange rate for a newly-created currency, or forecasting medium and long-term exchange rate movements, or analysing the price differential in income comparisons among countries.

In its purest version, the Law on One Price states that the same good must have the same price wherever it is sold, including in different countries, once its price is expressed in terms of the same currency. In the event of different prices for the same good, arbitrage would immediately operate: agents would buy it where the price is lower in order to resell it where the price is higher, until the difference disappears. The presence of trasportation costs implies a more general condition for LoOP to work: whether transportation is possible, the price paid for a good can differ among places.

In sight of a dedicated survey for 'the Law', which is absent in previous works about this topic, this paper will try to document that LoOP does not survive the move from theory to practice. This result will be shown through a review of the relevant literature, trying to show how LoOP is depicted as a failure in many studies.

The main difficulty was to isolate contributions that effectively have impact on the LoOP debate. Many streams of literature have seen the light since the first papers in the 1970s, as explained in Goldberg-Knetter (1997): many of them deal with LoOP indirectly, referring to market power of firms, to PPP, or to other aspects.

The review will be presented avoiding literature focused on the dynamics of exchange rate as a mean to reach LoOP, within PPP debate. However, also PPP is generically rejected in dedicated studies, at least in the short-run; most of the times, this rejection is based exactly upon the failure of the LoOP, as it is explained for example in Engel (1993), Rogers-Jenkins (1995), and Engel-Rogers (1995).

In what follows, the literature review will show that this theoretically fascinating law fails for several reasons. Section two will present a brief theoretical overview of LoOP's roots in classical economists' thought; the subsequent Sections deal with the different reasons why LoOP may fail: Section three will review literature about *pricing-to-market* theory (referring to empirical investigations about differences between domestic and export prices); Section four will deal with national borders' effect; Section five will focus on the tradability of goods; Section six will present the conclusive question.

2. The Law of One Price: a theoretical introduction

A good point to start is probably the most famous empirical investigation about the 'Law': Big Mac price comparison all over the world first published by the Economist in 1986. Big Mac prices (quoted in dollars) varied widely from country to country, with a maximum difference between the lowest and the highest price (China and Switzerland, respectively) of more than four dollars. The choice of the Big Mac can be explained considering that it is a highly traded good (at least its ingredients are) and it is very well-known and recognized as a 'standardized' good. Standardization is important at this stage of the analysis because it can 'mimic' prefect knowledge and perfect information, typical of the Walrasian competitive equilibrium. Dispersion in Big Mac price is evidently due to both different taxation systems, and to another important topic: differentiation. True, the Big Mac is not sold identically everywhere, because geographical location influences ingredients and their prices, but the point is that the McDonald's hamburger could satisfy consumers in different ways moving around the world. This occurs because people in different places have different tastes and different habits, firms have different degrees of power.

LoOP, which has been defined by Lamont and Thaler (2003) as the 'Second Law of Economics', is basically a logical consequence of the perfect competitive equilibrium, where perfectly informed agents, in a world built upon certainty, buy and sell identical goods. Then, international arbitrage would ensure the strong applicability of LoOP, apart from transportation cost, as the famous analogy that Hume (1752) wrote, saying that all water, whatever it communicates, always remains at one level.

The idea that the *same* commodities should be sold at the *same* price is traceable in Cournot (1838) who, referring to the market mechanism, wrote that buyers and sellers 'are so united by the relations of unrestricted commerce that prices take the same level throughout [the market] with ease and rapidity' (p. 51). Still before Cournot, Smith (1776, p. 376) wrote: 'the corn which grows within a mile of the town, sells there for the same price as that which comes from twenty miles distance. But the price of the latter must generally not only pay the expenses of raising and bringing it to the market, but afford too the ordinary profits of agriculture to the farmer'. Jevon's Law of Indifference is similar in content, (quoted in Edgeworth, 1896, p. 786): 'in the same open market, at any one moment, there cannot be two prices for the same kind of article'. Menger (1871) stated that the more the market is organized, the easier the determination of the 'economic price' is. This hypothetical view of the market was slightly adjusted in the words of Marshall (1920, p.325), who underlined that 'the more nearly perfect a market is, the stronger the tendency for the same price to be paid for the same thing […] in all parts of the market'. It must be noted that Marshall speaks about a tendency, which is different from an 'easy and rapid' unique price. In these words, there is an allowance for whatever can influence the price determination process, such as expenses of delivery, taxes/tariffs, and information costs. These are crucial steps in defining validity for the law. Recalling the famous metaphor of scissors, however, the author sees the price as a result of interaction between cost and utility. However, price differences for even identical products were considered, as in Jevons (1871, p. 137) who underlined that those differences can 'arise from extraneous circumstances, such as defective credit of the purchasers, their imperfect knowledge of the market, and so on'.

3. Firms' behavior and Pricing-to-Market: differences between domestic and export prices

Papers reported in this Section mainly describe data supporting differences in prices between different places. The reason for this difference is explained as a result of price discrimination policies (also known as *pricing to market* approach, originally introduced by Krugman, 1987), chosen by firms on the basis of geographical location. Pricing to market (PTM) theory does not support LoOP. It has been analysed with reference to either contesTable markets, (as in Baldwin 1988, Dixit 1989, Baldwin-Krugman 1989, and Shiha-Chavas 1995), and menu costs (as in Delgado 1991), and imperfect competition (as in Dornbusch 1987). There are numerous other contributions dealing with this theory, such as: Alexius (1996), Adolfson (1999), Feenstra (1989), Feenstra-Kendall (1997), Gagnon-Knetter (1995), Hooper-Mann (1989), Kichian-Khalaf (2000), Marston (1990).

Isard (1977) is most probably the first reference to LoOP failure. In the first part of his contribution, the author finds that the ratio of the American wholesale price index to the German export price index (monthly data referring to industrial sectors, values expressed in dollars), is stably correlated to the nominal exchange rate. This result is confirmed by the second part of his work, where the same analysis is replicated using annual data on export prices (for US and Germany). In the third part, he presents two regressions: firstly he regress the ratio of US import unit value by country of origin relative to US export unit value on the exchange rate, a dummy variable, and lagged errors; and secondly he considers again the same regression, but this time he regress the variation of the dependent variable on the variation of the independent ones. This analysis confirmed results obtained in previous two Sections of his work, leading him (p. 942) to hold that 'in reality the law of one price is flagrantly and systematically violated by empirical data'.

Kravis-Lipsey-Kalter (1977), analyzed the relationship between exchange rate changes, export and domestic prices. They start out from the conditions necessary for LoOP to hold: the existence of identical internationally-traded goods, and either the existence of a unique source of supply or the absence of transportation costs (alternatively, the equality of delivery from all origins to every destination). Thus, they consider a number of reasons, both static and dynamic, for expecting deviations from LoOP. Static reasons are the oligopolistic power of firms, which face different demand schedules with diverse elasticity in each market; profit-maximising behaviour, which induces different mark-up approaches; product differentiation (before and after sale); credit terms and delivery conditions (coherently with Kravis-Lipsey, 1971). Dynamic reasons are market share allocation and price-competition strategies; uncertainty and informative asymmetries; customer-seller partnerships and purchasing habits. All of these reasons explain why price cannot be identical in diverse locations and unavoidably push price out from LoOP predictions. Comparing then German and American export price for machinery and equipment sector, authors found very little evidence of correlation in export-price changes in these two countries when prices are expressed in American dollars. In order to analyze price discrimination operated by firms, Kravis-Lipsey-Kalter highlighted divergences between export and wholesale prices, looking for small ranges of variation in the export/domestic price ratio for US and Germany (because a very small range of variation would imply that prices in home and foreign markets move identically). Results are unequivocal: there is neither equality in export and domestic prices, nor in their movements. Investigating the pass-through grade, then, they found that it is complete and that only gradually exporters tend to reduce it.

The existence of empirically relevant deviations from LoOP suggest that arbitrage is not present as it should be, Elzinga-Hogarty (1978) made a significant contribution to LoOP debate, because they showed an important deviation in the 1975 f.o.b. price of bituminous coal between Eastern and Western Kentucky: 27.03 dollars against 13.75 dollars respectively. Considering that the nationwide average shipping cost for one ton of coal was just 5 dollars in the same year, this result underlines very clearly the failure of the law.

On the presence and the extent of arbitrage, Richardson (1978) tried to summarize results from a disaggregated commodity arbitrage between US and Canada. His results show that arbitrage does not operate significantly for every commodity group, and that even when it does, it is not perfect. Differentiating his contribution from previous results obtained by Isard (1977) and by Kravis-Lipsey-Kalter (1977), Richardson underlines that only in rare cases Canadian commodity prices respond to American commodity prices. In order to explain his point of view, the author proceeded with an econometric evaluation of an approximation of the law of one price which expresses the Canadian price of a good as a function of the exchange rate, of the US price of the same good, of transportation costs, and of a set of residuals. This approach allows him to focus on two extremes: the perfect arbitrage between Canadian and American markets and the complete absence of any form of arbitrage. It is worth underlining two aspects. Firstly, such a specification would also represent a test for absolute PPP, and, secondly, investigations about arbitrage could give some information about the *tradability* of commodities. There is some scepticism about this point in Curtis (1971), Dunn (1970, 1972), and Rosenberg (1976). Richardson tried to readdress his analysis to avoid serial correlation and the lack of data for transport costs through a monotonic transformation of the period to period inflation rate. The result is a uniform failure of LoOP. Parameters representing elasticity of the Canadian price to the exchange rate and to the US price are shown to be significantly different from 1: this implies the absence of parity conditions in the price of commodities, suggesting that it can be much more descriptive to treat goods from different countries as differentiated with respect to domestic products, despite their conventional classification under similar headings.

Comparison between two imaginary extremes (LoOP and the absence of any arbitrage) is also used to depict the adjustment of relative prices to the exchange rate in Dornbusch (1987), who found that product substitutability, relative to the number of firms, and market structure actually drive price levels. This author defines an alternative to the law of one price, named Keynesian, where goods are neither fully homogeneous nor

substituTable, wages are fixed (or sticky) in national currencies, and therefore exchange rate movements alter relative prices. Evidently, this affects the world distribution of demand and employment, revising also the idea of a constant mark-up in cross-border market strategies of firms. Then, after a theoretical Section where he traced the implications of diverse equilibrium price models (the Cournot equilibrium, the Dixit-Stiglitz model, and the Salop circle-competitive model), he pursued his analysis through an empirical investigation, comparing US export prices in dollars with those of Germany and Japan, finding great variability. The main conclusion addresses the question whether a small country should open its frontiers to take advantage of the world market due to price reductions caused by tariffs abatement: the answer is negative, in the case of less than perfectly competitive market structure. This is consistent with the idea that price determination in different countries does not depend only on tariffs, transaction and transportation costs.

Giovannini (1988) investigated the pricing policy of firms selling in domestic and foreign markets. He also explained the correlation between the exchange rate and the domestic and export prices, underlying deviations from LoOP. Compared to other contributions about international discriminating monopolistic models, such as, for example, Gottfries (1986), Giovannini considered that firms have to commit themselves to given prices at the beginning of each period; furthermore, differently from other papers where price fixation policies of firms are described as local currency based (as for example in Aizenman, 1985), Giovannini hypothesized that, when prices are predetermined, currency used for denomination of exports is a crucial issue in deviating from LoOP. One important finding is that exchange rate dynamics (and its uncertainty) affect firm's profit expectations and therefore price policies. Following this approach, the author proves that exchange rate appreciations/depreciations influence prices: it is shown that deviations from LoOP, when export prices are denominated in foreign currency, include both *ex-ante* price discrimination and exchange rate surprise effect. After a theoretical demonstration, an empirical test is conducted to show actual correspondence to formal derivations: collected data refer to monthly domestic and export prices for ball bearings, screws, nuts and bolts produced by Japanese firms. Two criteria have been used in choosing presented data: the first is that price should be taken from a narrowly defined sector; the second is that geographical dispersion of exports should be minimal. Results further confirm the idea of failure of LoOP. With his analysis, Giovannini tried to achieve two further conclusions: isolate the *ex-ante* price discrimination policies effect, and determine whether failures of LoOP are forecasTable or not. The first objective is gained through a model which assumes a geometric distribution of prices, used in Calvo (1983), summing up contributions from Phelps (1978) and Taylor (1980): drawn conclusions are based on the strong rejection of the hypothesis that *ex-ante* discrimination does not exist. The second objective is pursued following Hansen (1982) and Cumby-Huizinga-Obstfeld (1983): using an estimator of the covariance matrix of parameters which allows us to account for autocorrelation and heteroskedasticity for the disturbance term. After running four regressions, Giovannini demonstrated that deviations from LoOP are forecasTable, but the lag is not always the same. In fact, for ball bearings and screws, tests indicated a longer lag than for nuts and bolts (12 months against 3).

A similar result is obtained by Knetter (1989). He dealt with mark-up determination strategy for international exporters in relation to the exchange rate dynamics. Knetter underlines that incomplete pass-through is consistent with two alternative theoretical frameworks: the competitive equilibrium (which implies LoOP), and an imperfectly competitive model where exporters can discriminate prices across destination markets. The author pursues his analysis through an econometric model which studies the effects of time and country-specific term on prices. He considered that exporters maximize profit in their own home currency terms, whilst import demand function depends on the local price in the destination market (and therefore expressed in local currency units). For any given price in the exporter's currency, a depreciation of the importer's currency pulls up the price effectively paid by the importer in his own home market. Therefore, demand function elasticity ultimately determines the strength of the linkage between prices and exchange rates, no matter which market model is hypothesized. The optimal mark-up is unchanged for the exporter only when demand has constant elasticity with respect to price. Even in this case, however, nothing implies that mark-up determination leads to the same price in different locations. Thus, Knetter found that when demand function, as perceived by the firm, appears to be more elastic as price increases, then the mark-up charged by the exporter must fall consequently as the buyer's currency depreciates. The author then collected monthly data (from 1978 to 1986 for American market, and from 1977 to 1985 for the German market) to investigate differences in price discrimination policies. He found that German enterprises adjusted export prices to nominal exchange rates more than American firms did. In a successive paper, Knetter (1993) found the same results with reference to export prices for goods from US, UK, Japan and Germany to selected countries.

Using the empirical framework proposed by Knetter, Gil-Pareja (2002), studied the pricing to market (PTM) behaviour of firms on European Union exports to OECD countries. Starting from the idea that exchange rate movements affect costs and mark-ups of firms selling in different international markets, Gil-Pareja estimated a fixed-effects model whose main advantage is basically that it allows to account for two very relevant effects: firstly, it considers the effect of marginal costs changes on export prices through the time dummy variables, and secondly, it captures destination-specific price movements caused by exchange rate variations through β_i coefficients. Positive values of β_i represent circumstances when mark-up variations are associated with stabilization in local buyer's currency (this kind of 'local currency pricing' will also be referred to by, among others, Engel and Rogers 1999, as reported below), whilst negative β_i represent situations when the effect of bilateral exchange rate variation on destination price of exports is boosted by destination-specific mark-up adjustments. Finally, $\beta_i = 0$ would mean that mark-up determination in a destination is not influenced by the bilateral exchange rate fluctuations at all. Results derived by Gil-Pareja offer evidence of pricing-to-market strategies of many exporter countries in the European Union. Their behaviour is homogeneous everywhere, but in the UK. The hypothesis by Rangan-Lawrence (1993), about presence of multinational firms whose agreements could justify exports to their foreign affiliates at constant prices, does not seem to find empirical confirmation.

Aw-Batra-Roberts (1997) showed substantial differences between average domestic and export prices of Taiwanese electronic producers, accounting for the heterogeneity of firms' strategies, reporting domestic prices which were always higher than the export prices. Their data, collected directly from firms, referred to the period 1986-1991 and have been measured at the production source without costs for transportation, insurance, and custom charges. Thus, authors can represent exactly the revenue actually received by the firm. The exposition of their data allowed them to underline the presence of strong differentials in prices between domestic and export markets. Considering that price differences between domestic and export prices can arise as a result of several factors, the authors proceeded to explain which reasons fit Taiwanese firms' behaviour: heterogeneity and differentiation explained strong domestic/export price differentials. Segmentation strategies are the core reason which can explain why the same good is not sold at the same conditions everywhere. Goldberg-Knetter (1997) define a market as integrated if geographical or national elements have no effects on prices. Therefore, the segmentation of a market relies on the ability to price discriminate: segmentation implies market power. This kind of approach has been deepened by Kasa (1992), who links with Krugman (1987), starting from the positive correlation between the value of a country's currency and the relative price of its imports: when a nation's currency appreciates, prices of its imports tend to raise (and respectively to fall in case of currency depreciation), compared to the price of same goods in other countries' markets. In his model, Kasa took into account both demand-side and supply-side previous contributions, like respectively Froot-Klemperer (1989, where dynamics is incorporated by assuming that in period 1 firm's demand depends on period 0 firm's market share), and Baldwin (1988, where dynamics is incorporated by linking different periods by sunk costs due to barriers to enter/exit a market). Then, Kasa built up a dynamic model of a German exporter, selling goods just abroad, in US and Canada; this model is useful to examine how a firm can use its profit margin to compensate temporary fluctuations in the exchange rate. As a first result, the model shows that systematic deviations from LoOP derive from adjustment costs caused by differences in marginal costs paid by the firm in the two markets; price differentiation is explained as pricing to market strategy, but the model highlights that a significant part of this strategy is generated by the transitory component of exchange rate movements. The second conclusion that Kasa presented is the construction of a data set which has been used to test the model, giving expected results in rejecting LoOP theory. Coherently with this rejection, see also Feenstra-Kendall (1997), Hooper-Mann (1989), and Gagnon-Knetter (1995).

4. National borders and the Law of One Price

Failures of LoOP have been also linked to the presence of a national border between two locations. In this literature stream, one of the most well-known contribution is Engel-Rogers (1996, ER1 henceforth), which tried to answer the question of the weight of the border on price differentials. The authors' work led to many other papers: one about relative price volatility (Engel-Rogers, 1998, ER2 henceforth), one about the welfare costs of deviations from LoOP (Engel-Rogers, 1999, ER3 henceforth) and one about price differentials of similar goods in different US cities, but from a composite point of view, investigating for several causes, such as nominal price stickiness, segmentation of markets, and tradability of goods (Engel-Rogers, 2001, henceforth ER4, reported in the next Section).

In ER1, authors demonstrate that the existence of a national border between two places widens the difference between prices. In order to obtain this result, they consider 14 disaggregated price indices from 23

North American cities referred to more than 16 years. Their choice of US and Canada for comparison, builds on the following reasons: first of all, they share a border; then, both countries are big enough (this aspect is particularly important to compare prices between distant places, to check whether cities in the same country reveal smaller price differentials than equally distant cities in different countries); thirdly, they have no trade restrictions between each other; and last but not least, they are both English-speaking countries and have similar context. Price volatility is expressed as function of distance between two places and a dummy variable for the presence of a national border is added. After reporting evidence that distance significantly affects price dispersion among cities in the same country, the authors find that the presence of the border influences differences in prices as well. This result is shown on the basis of the sign of coefficients on the dummy variable for the border, which are highly significant for all of the goods in the sample: distance does affect price dispersion, border widens it. The authors then tried several extensions to their basic investigations: they adjusted the sample, considering at first data from 1985 only, then splitting the sample at 1990 (in order to account for NAFTA effects); in all of these cases, results were still consistent with previously described conclusions. In the second part of their paper, Engel-Rogers tried to expound the economic significance of the border, once its relevance had been demonstrated: results highlighted that a border between cities has the same impact on price volatility as a distance of 1780 miles. They also highlighted that the 'size' of the border coefficient did not diminish after the trade agreement between USA and Canada was established.

These conclusions led Engel-Rogers (ER2) to deepen their analysis referring to market segmentation. They argue that if price differentials exist, then the reason might be that markets are not integrated. In fact, their main conclusion is that consumer markets are *national* markets, for several reasons: firstly, because the distribution network is nationally organized; secondly, because of barriers to movement of goods; finally, because tastes are differentiated across different countries. To analyze barriers to market integration, they updated their regression (done in ER1), accounting for distance, border, and different conditions in the labour market. Related literature deals with the definition of market integration based on the speed of convergence of prices (as in Parsley-Wei, 1996): within the US, it is lower the more distant the cities pairs, and in international cases of comparisons, in the presence of borders, still lower. Thus, as in ER1, the authors concluded again that the border matters significantly for at least two reasons: firstly, the segmentation of markets creates opportunities for pricing to market; secondly, hypothesizing nominal price stickiness, given that prices are set in customer's currencies, the nominal exchange rate may play a relevant role in creating divergence. Very interestingly, two further relevant reasons for prices inequality emerge: one is the level of mark-up that firms can exercise in markets; the other is that each commodity includes a 'non-tradable' part, whose price diverge across locations. In the next Section this aspect will help in distinction between tradable and non-tradable goods.

Borraz (2006) investigated the weight of the border ('the *width* of the border' in Engel and Rogers' words) between US and Mexico. Confirming expected results, also in keeping with findings by Rogers-Smith (2001), who conducted the analysis before him following ER1, Borraz demonstrated the existence of a large positive and significant border effect. He tried to pursue his analysis in an original fashion using disaggregated consumer price data, building indices in a different way (organizing similar categories of goods and not referring to the general consumer price index). Results which were still consistent with the above-depicted investigations. A further finding of this author is the reduction of the 'border effect' caused by the 'El Pacto Period' (May 1988 to Nov 1994).

Broda-Weinstein (2008) reported a strong border effect, referring to barcode data. According to them, borders give rise to flagrant violations of LoOp, distance affects these differences, and convergence to PPP is inconsistent with data, which report actual nominal price stickiness. LoOP is violated between cities in different countries, but it fails among cities within the same borders as well. Their analysis referred to micro datasets within and across 10 cities in USA and 6 regions in Canada, covering approximately 40 percent of all expenditure on goods in consumption. In order to support results by Engel-Rogers (1996), Broda and Weinstein investigated the 'width' of the border regressing a measure of the price dispersion on the log of distance and a dummy variable. The only difference, compared to Engel and Rogers, is that the authors here use two different measures of price dispersion, but their results are consistent with those presented earlier, even if the magnitude of the border itself is different.

In ER3, the main topic refers to the analysis of the importance of local currency pricing and flexible exchange rates in failure of LoOP. Under local currency pricing, nominal exchange rate volatility does not affect consumer prices directly in local markets (zero pass-through grade). If each firm's pricing policy is based on its own country's currency, this allows the nominal exchange rate variations to cause divergences in prices among countries. Inevitably, monetary unions are an instrument to reduce this volatility: this is the reason why Engel-

Rogers focused on an empirical exploration of LoOP in European cities, using consumer price data over the period 1981-1997. They find several conclusions. First of all, they identify that most of the border effects arise from local currency pricing within fluctuating exchange rate regimes. Secondly, they investigate the border effect that remains even if one accounts for nominal exchange rate variability, demonstrating that the border plays a significant role. Their opinion is that cross-country differences in national marketing and distribution systems may affect price structure. As a third result, they investigated welfare costs of LoOP failures. Under a floating exchange rate regime, if firms adopt local currency pricing policies, inefficiency arises because consumers pay different prices in different locations even when transport costs are zero. The adoption of a fixed exchange rate regime does not necessarily solve the inefficiency: in that case the welfare loss would arise from volatility in consumption, turning the focus on price stickiness, therefore reducing the relevance of the exchange rate regime in explaining the failure of LoOP.

Ascione (2003) evaluates two alternative explanations for incomplete pass-through. A first reason for the incomplete adjustment of import price to real exchange rate is the price discrimination policies of firms which decide retail prices on the basis of the destination market; the second reason for LoOP failure is based on the effect of distribution costs. Ascione shows that deviations from LoOP are greater under flexible exchange rate regimes than under fixed ones. A possible explanation for this conclusion is that under a fixed regime variations in the exchange rate are perceived by agents as more durable compared to a flexible context; in fact, if firms vary their prices only in the case of permanent exchange rates modifications, in a flexible exchange system elasticity of price with respect to the exchange rate will be lower and it will cause broader deviations from LoOP.

Earlier, Feenstra-Gagnon-Knetter (1996) studied the automobile industry to investigate the correlation between pass-through and market share of firms. They based their analysis on annual data from 1970 to 1988, looking cars from France, Germany, Sweden, and US, sold in twelve countries. The research showed that the pass-through behaved differently: inverse correlation to market share dynamic in cases of low market share; direct correlation to market share in cases of high market share.

LoOP validity is denied also by Asplund-Friberg (2001), who analyzed actual difference in prices of identical goods in a situation where none of the 'traditional' reasons of failure of the law can be invoked (transportation costs, trade barriers, imperfect information). These authors took their data sample from three Scandinavian duty-free outlets in two ferry boats companies between Sweden and Finland (data samples referred to years 1975 to 1998 for the first, and 1991 to 1997 for the second), and one airline company (data sample referred to years 1995 to 1998). Each good, in the same place, is priced in two currencies (at least), leaving the customer with the choice of paying in his preferred currency (thus choosing 'his' price). Percentage deviation from LoOP is calculated. Results of the analysis showed that relative price did not equal exchange rate (as it should do, if LoOP held). Persistence and magnitude of deviations from LoOP are insensible to product differentiation: the company maintained the same relative price for every product in every catalogue, and the reason is not due to the fixed cost to reprint catalogues, as the authors reported that between 1982 and 1988 five new catalogues were printed without changing relative prices. This indication is significant, because if LoOP were valid, catalogue updates should have occurred. On the basis of their statistically significant results, Asplund-Friberg concluded that LoOP validity must be rejected. Furthermore, they proceeded to test for a unit root in deviations from LoOP; this allowed them to conclude that relative price follows a random walk. Therefore, arbitrage did not exercise pressure to equalize prices, and this is consistent with the hypothesis that LoOP failures can also explain PPP deviations, (as in Engel, 1999, where rejection of the law of one price justifies a large part of exchange rate variability). Arbitrage takes place only after deviation from LoOP assumes significant magnitude: data showed that for minor deviations printing of a new catalogue is not necessary as arbitrage does not operate. A new catalogue is printed only when important variations in variables could justify arbitrage. Thus one can conclude, as in Obstfeld-Taylor (1997), that a sort of 'inaction band' operates.

5. Tradability of goods and LoOP

LoOP failures related to tradability of goods have been explored in literature. Tradability is usually linked to the relevance of transaction costs proportionally to the value of goods being sold. Following Heckscher (1916), some authors, for example Obstfeld-Taylor (1997) or Bec *et al.* (2004), considered the case in which arbitrage does not take place, when price differences between two places for the same good would be smaller than transaction costs (transport, taxes, tariffs, and so on).

These costs may then help distinguishing between tradable and non-tradable goods; as Dixon-Griffiths-Lawson (2004) point out, goods and services which enter international trade and satisfy the law of one price, or at an appropriate relative price that could satisfy the law of one price, can be defined as tradable. All other goods

and services will be defined as non-tradable. The most notable work done for the distinction between tradables and non-tradables was undertaken by Dwyer (1992) and elaborated further by Knight-Johnson (1997).

To the best of my knowledge, literature does not offer investigations which specifically test LoOP validity for non-tradable goods. Some relevant work has been instead released in order to study relationships among productivity, the Balassa-Samuelson effect, public expenditure, and the real exchange rate. Examples of this stream of literature can be found in Hsieh (1982), Marston (1990b), Froot-Rogoff (1991), Asea-Mendoza (1994a, 1994b), De Gregorio-Wolf (1994), De Gregorio, Giovannini-Wolf (1994), Micossi-Milesi-Ferretti (1994), Strauss (1996), Faruqee (1995), Chinn (1996), Chinn-Johnston (1997), Canzonieri *et al.* (1996), MacDonald (1997), and Alberola-Tyrväinen (1998). The Balassa-Samuelson effect-related literature has almost always been referred to the purchasing power parity debate, more that to LoOP validity, pointing mostly to debate about exchange rate dynamics. Exactly in this stream, the iceberg model by Sercu *et al.* (1995), tries to analyse the width of a band around the nominal PPP value, due to presence of transaction costs. Other examples are traceable in Dumas (1992), O'Connell-Wei (1997), Obstfeld-Rogoff (2000), Betts-Kehoe (2001), and Crucini-Lee (2004). This literature will not be surveyed here, as this review has been expressly dedicated to the debate about the Law of One Price, given the availability of well-recognized surveys of literature about PPP (see for example, Papell-Prodan, 2003, or Taylor-Taylor, 2004).

Engel-Rogers (2001, ER4), referring to the tradability of goods, proposed a test on a new version of LoOP, which is introduced as the 'proportional law of one price', using monthly price indices for 43 goods from 29 US cities, over the period 1986-1996. The difference between the normal LoOP (named the 'absolute law of one price') is that now they measured the standard deviation of changes in the log of the relative price index of goods across locations. Whether this deviation is low, it indicates that prices are either equal or proportional, and, perhaps surprisingly, they found that deviations are larger for traded goods. Such a result, appears to be in contrast with the traditional trade theory, which assumes that LoOP holds for tradable goods, but not for non-tradable ones.

This problem is considered in Koren (2004), giving support to the conclusion gained by Engel-Rogers (2001): hypothesizing costly trade as a transportation sector which uses resources with different factor intensities compared to the production sector, the author demonstrated that transport and distribution factors cause 10-20 per cent deviation from LoOP across US cities. This empirical investigation (using data set from Parsley-Wei 1996, ER4, and additional data which include pairwise driving distances between cities and the per-barrel price of oil) explains why if trading is costly, LoOP fails. This generates Koren's 'law of two prices'.

Parsley-Wei (1996) studied the speed of convergence to LoOP, with quarterly data, looking for the effect of transport costs. Using distance between cities as a proxy variable of transport costs, they also included in their analysis the impact of tariffs. Their results show unambiguously that distance can make prices differ very much; furthermore, the speed of convergence to LoOP is decreasing as the distance between two cities increases.

Local distribution services are the core of the paper written by Baba (2007), who considered that even whether LoOP held at producer/importer level, consumer prices could however differ for local firms' mark-ups associated to distribution costs, which heavily influence final good prices as also reported by Burnstein *et al.* (2003) and Campa-Goldberg (2004). In order to expound this idea, Baba analysed two addends of the final retail price of goods, named 'cost effect' and 'price discrimination effect'. These two effects interact in two ways: the first simply internalize into the final price the set of costs paid by the seller to produce the good being sold, whilst the second is decided by the seller accounting for tastes and demand function characteristics of the local market. The first effect has been analysed by MacDonald-Ricci (2003) for ten OECD countries using CPI data and by Goldberg-Verboven (2001) for European countries using car prices. Both of these contributions conclude that a significant role in differentiating prices is attributable to local wage difference, as in Alessandria-Kabosky (2004). The second effect has been studied by Goldberg-Verboven (2001) and Hellerstein (2004, for the beer industry) by modelling the impact of local inputs on retail prices of differentiated goods, thus explaining important source of differences in prices. In particular, both Goldberg-Verboven (2001) and Hellerstein (2004) are based on demand functions characterized by the Almost Ideal Demand System (AIDS), firstly proposed by Deaton-Muellenbauer (1980). Differently form other contributes, Baba conducted his analysis (dealing with monthly data for about 350 goods from 47 cities, referred to years 2000-2005) on price differentials only among Japanese cities: this allowed him to preserve his conclusion from problems which can affect all international price comparisons, such as, for example, sticky prices/wages, variations in nominal exchange rates. These analyses confirm LoOP failure.

Tradability is not always an exogenous characteristic of goods. Indeed, Bergin-Glick (2003) proposed a new way of thinking about non-tradedness, as an endogenous decision. Their model develops a simple method

for analysing a continuum of goods with heterogeneous trade costs, which explores whether and how a seller decides to trade a good internationally. Given this endogeneity, the good on the margin assumes a key-role in linking prices of traded and non traded goods, preventing the two price indices from moving too far apart. This point of view confirms that trade costs (tariffs, non-tariff barriers, shipping costs, and marketing and distribution costs) act dramatically in influencing trade decisions, as emphasized by Hummels (1999) in his empirical work. Collecting detailed data for individual goods, he finds that freight costs alone can range from more than 30 percent of value for raw materials down to 4 percent for some manufactures. The model by Bergin-Glick considers a small open economy with a continuum of home goods with a distribution of trade costs. The country tends to export those goods with low trade costs, once considered internal demand: this is the reason why the cut-off between traded and non-traded may shift over time. This is, in a sense, an extension of Obstfeld-Rogoff (2000), because they consider only one home good that switches between traded and non-traded status. Other empirical work found support for the idea that tradability of goods may change over time: Bernard and Jensen (2001) show that from a panel of US manufacturing plants from 1987 to 1997, on average, 13.9% of non-exporters begin to export in any given year during the sample, and 12.6% of exporters stop. Final results by Bergin and Glick report two surprising conclusions about the Balassa-Samuelson effect: the first is that there is little to no support for it as of the mid-20th century, contrary to the general conception; the second is that this effect has grown over time to rather large values in the most recent years. Productivity shocks that are heterogeneous among goods not only induce a response in relative prices, as usually conceived in the standard Balassa-Samuelson model, they also induce a response in the relative tradability of goods.

Naknoi (2008) developed a stochastic dynamic general equilibrium model to explain variance decompositions of real exchange rates. As empirical literature on real exchange rate has often found (see, among others, Engel 1999, Betts-Kehoe 2001, Chari *et al.* 2002), some real exchange rates are driven by the relative price of traded goods and some by the relative price of non-traded to traded goods. The way relative price dominates the real exchange rate is significant for implications about international shock transmissions. In order to investigate this topic, Naknoi focuses on trade costs, heterogeneous productivity, and sticky wages to underline how the dynamics of comparative advantage amplify expenditure switching. Thus, he presents an alternative theory with an emphasis on endogenous tradability and exchange rate regimes. This analysis is consistent with Mendoza (2000), who highlighted the role of exchange rate regimes, reporting that the contribution of relative price of non-traded to the variance of Mexico-US real exchange rate is over 30 percent higher in the period of fixed than in the period of flexible exchange rates. Naknoi analytically showed that the contribution of the relative price of traded goods is increasing in the covariance between terms of trade and productivity differentials in the non-traded and export sectors. If the covariance is large, it means that wage inflation is offset by productivity gain more in the non-traded than in the export sector. The covariance, therefore, measures the degree to which shocks are transmitted to prices in the export sector relative to those in the non-traded sector. The difference in the covariance across exchange rate regimes is essentially the expenditure-switching effect of exchange rates generated by endogenous tradability. The importance of endogenous tradability emerges as Naknoi shows that the correlation between the relative price of traded and non-traded goods is perfect in the absence of endogenous tradability, because shocks are transmitted only through terms of trade when the trade pattern is exogenous.

6. Conclusive remarks: is LoOP just a theoretical myth?

The reviewed literature builds upon the rejection of LoOP. This rejection is driven by the analysis of empirical aspects of its applicability.

Differences in prices may have several sources. A strongly different approach to explain differences in price between domestic- and export- destined goods is suggested by Ravn-Schmitt-Grohé-Uribe (2007), referring to deep habits. According to these authors, when habits are formed at the level of individual goods, firms can have the incentive to differentiate their mark-up (through price) accordingly with demand structure in each market they operate. This 'pricing to habit' formulation is inserted in the stream of literature about pricing to market referred to customer switching costs, as in Froot-Klemperer (1989), and allows the analysis to account for demand-shift-induced price variations. Demand shocks in markets can be the source of divergences in prices, which makes LoOP fail. In order to underline the impact of habits on the pricing policies of firms, Ravn, Schmitt-Grohé, and Uribe built a two-country dynamic general equilibrium model which focused on the presence of habits as a strong factor of influence for each variety of goods, exogenously determined, inside the inter-temporal utility function. This implies that demand structure for any individual variety of goods will be decreasing in the relative price, increasing in the level of habit-adjusted consumption, and increasing in the 'weight' of habit. The aggregate

demand function that each firm will face is depicted as the sum of private, public, domestic, and foreign components: the structure of this demand is constituted of a price-elastic component and a price-inelastic component. The latter is the deep-habits-influenced term. This leads the authors to conclude that given that, in principle, demand elasticity can differ domestically and abroad, and considering the possible difference in public expenditure decisions, price would differ internationally because demand functions would differ and thus firms can have the incentive to differentiate their mark-up accordingly.

At this stage, one can question whether LoOP ever failed in the past as it fails nowadays. This topic is the core of the paper by Froot-Kim-Rogoff (1995). They showed that deviations from LoOP have been remarkably present in time. They held furthermore that these deviations do not refer just to cross-country relative prices of individual goods, but to broad indices. They collected annual data of agricultural commodities from England and Holland: wheat, oats, barley, butter, eggs, cheese, peas, and silver. The first result obtained, is that volatility of LoOP deviations is very wide. The augmented Dickey-Fuller test showed that those deviations appear stationary, and after a Chow test on ARMA specifications, the estimation supported the conclusion that the rate of convergence during the XX century is not significantly different from the one referring to earlier centuries. Thus these authors demonstrated that deviations from LoOP have almost always been the same in both magnitude and persistence.

This survey tried to show evidence of empirical failure of LoOP. Results show the lack of actual support for the famous 'second law of economics'. Pippenger-Phillips (2006) tried to defend it, arguing that a common mistake in analyses rejecting LoOP is to ignore implications of arbitrage. LoOP does work correctly, in their opinion, and adverse ideas are, in their words, wrong because they do not consider, as they should, relevant conditions, such as transaction costs, timing of arbitrage, non-perfectly identical products, and resale opportunities.

The question appears to be methodological: only a Walrasian perfectly competitive world would accept LoOP without exceptions. In true markets, even identical goods can be sold at different prices, as documented by Elzinga-Hogarty (1978) or by Asplund-Friberg (2001), just to mention two examples: the same bituminous coal was sold in two zones of same country with different prices; the same good was sold at two different prices on the same boat. Why?

Only restrictive and hypothetic conditions preserve validity of the law. Looking for a theory which fits reality, many try to redefine reality to enslave it to comfortable theories but, as Keynes (1923, p. 92) pointed out, 'if we restrict ourselves […] we should find that the theory is always in accordance with the facts. In fact, the theory, stated thus, is a truism, and as nearly as possible jejune'.

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