Exchange Rate Regimes and Relative Prices: An Industry-Level Empirical Investigation*

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Abstract

Using a post Bretton Wood dataset for three advanced countries, USA, UK and Japan, we try to see if there is any considerable expenditure-switching effect. In the theoretical backdrop of new open economy macroeconomics models, expenditure-switching effect is relevant for analyses assuming price-stickiness in terms of producer currencies. On the other hand, if we have price-stickiness in terms of consumers' currency, then expenditure-switching has no role to play. Based on these assumptions, flexible or fixed exchange rate regime choices are being debated. We try to analyze from the industry-level data on domestic consumer and producer prices as well as import and export prices, whether, exchange rate fluctuations have any effect on determining the relative prices. The results so far argue for flexibility of the exchange rates as it supports expenditure-switching, thus providing expost evidence for price stickiness in terms of producers' prices.

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1 Introduction

The choice of an "optimal" exchange rate regime depends on whether there is sufficient exchange rate pass-through or not. Exchange rate pass-through effect is defined as the percentage change in local currency import prices resulting from a one percent change in the nominal exchange rate. As nominal exchange rate changes may not be fully passed through to goods prices, consumer prices may not be very responsive to such changes. This implies that there will be less "expenditure-switching", i.e., a change in the exchange rate might not lead to much substitution between domestically-produced goods and imports. Under the pricing to market (PTM, see Krugman (1987)) or local currency pricing (LCP, see Devereux (1997)) mechanism, firms either price discriminate or set a price in their own currency for sale to households located in their country, but set a price in foreign currency for sales to foreign households. Therefore, even if there is currency depreciation at the exporting home country, higher import prices in the importing foreign country may not be reflected in the foreign country's domestic price level (measured in terms of the CPI) leading to low pass-through due to LCP and, therefore, less expenditure-switching. In this case, a fixed exchange rate regime would be preferable, because a sudden shortage in foreign goods supply due to some exogenous shock will lead to a large and undesirable currency depreciation under a flexible-rate regime.

On the other hand, if importables are priced in exporters' (or producers') currencies as producer currency pricing (PCP) models assume, then currency depreciation in the destination country will lead to higher import prices in the destination country. In this case, if the nominal exchange rate is flexible, then it will have a full "expenditure-switching" effect on relative price changes, based on the presumption of nominal price stickiness in exporters' currencies.

These two contradicting views regarding exchange rate regimes are intensely debated in the new open economy macroeconomics literature. Engel (2002) surveys new theoretical models that support a fixed exchange rate regime based on the assumption of domestic price rigidity. Previous empirical work (see, for example, Engel (1999)) found that prices are indeed sticky in consumers' currencies. Obstfeld (2002), however, argues against this view of exchange rate pessimism. In his empirical investigation, he shows that a nominal exchange rate depreciation drives down relative export prices and increase relative import prices. Therefore, we get the celebrated Keynesian-type short-run results. However, both Engel (2002) and Obstfeld (2002) point out that more detailed empirical evidence is needed and call for more careful interpretation of the existing empirical record. Our study tries to provide a comprehensive empirical analysis of the two contesting hypotheses. We look at three developed countries (USA, UK, and Japan) to see the dynamics of prices and exchange rates based on monthly industry level data. Our analysis has two parts. In the first part, we look at import prices, the PPI and the CPI and see how the exchange rate dynamics affect these prices. In the process, we differentiate exchange rate pass-through effects to import prices, producer prices and consumer prices as well as the intermediate effects that come from import prices to producer or consumer prices. The final expenditure-switching effect comes out from the interaction of all these exchange rate and price effects. We build a framework taking into account how the exchange rate affects traded and non-traded intermediate and final goods prices. Using a comprehensive econometric methodology that starts by investigating probabilistic properties of the data, we build a VAR model and suitably adjust that to get the required triangular system as predicted by our framework. Based on the correctly specified model, we then get the short run and long run effects of exchange rate fluctuations as well as intermediate effects from the import prices after estimating them with the Seemingly Unrelated Regression method. We can then see how industry level prices are affected in these countries and how these determine the extent of expenditure-switching. Suggestions for the choice of exchange rate regime are made on the basis of these expenditure-switching effects. In the second part we concentrate on relative export prices and their relationship with exchange rate fluctuations. Our results from both parts provide some support to Obstfeld (2002)'s view, which favors exchange rate flexibility.

The paper is organized as follows. In section 2, we provide an overview of previous theoretical and empirical work. In section 3, we describe the empirical analysis for import prices and export prices. Results from the empirical exercise and comments on possible long run and short run adjustments are discussed in section 4. Section 5 concludes. All the results are reported in tabular form in the first appendix. The second appendix provides industry details in the data.

2 Review of literature

In this part, we report two strands of literature. The first subsection describes studies dealing with the impact of the exchange rate on import and domestic prices and the second subsection reports past analyses of exchange rate's effect on export prices. If traditional Keynesian arguments are true, then we expect that an exchange rate depreciation in the domestic country will lead to higher import prices and lower export prices in the domestic country. The sticky prices assumption in exporters' currency and maintaining invoicing in exporters' currency give us this result. On the other hand, there will be no impact on the imported goods prices in the domestic country, if we have invoicing in importers' currency.

2.1 Exchange rate pass-through to import and domestic prices : Past evidence

In the new open economy macroeconomics, imperfect market structure and intertemporal modeling approach play important roles to determine ultimate price-setting decisions using a stochastic general equilibrium setup. Lane (2001) provides an excellent survey of this growing literature. Based on the assumption of output price stickiness in terms of producer prices or consumer prices, the new models argue for either flexible exchange rate or fixed exchange rate regime. The choice of hard peg or flexibility essentially focuses on the relative price adjustments of the exchange rates. If we subscribe to PCP mechanism, an exchange rate change can achieve the relative price adjustment between home and foreign goods, as there is complete exchange rate pass-through to final users of the goods. Therefore, we experience the "expenditure-switching" effect, as was first proposed by the classic study of Friedman (1953), which in turn calls for exchange rate flexibility. On the other hand, consumer price stickiness, manifested by LCP-PTM mechanism, argues for fixed exchange rate because there is no full pass-through effect of exchange rate changes and as a result, there is no relative price difference. In this case, nominal exchange rate fluctuations are undesirable as they deviate from law of one price also.

Among the theoretical studies that support LCP-PTM mechanism, Engel (2000) points out that the extent of LCP among European countries undermine Feldstein's (1992, 1997) view that the single currency of the European Monetary System will hinder adjustments that might have occurred through real exchange rate movements under a more flexible exchange rate regime. In this case, a fixed exchange rate or a single currency regime would be preferable, as is supported also by Corsetti and Pesenti (2002) finding. Devereux and Engel (2001) examine monetary policy in this setup and argue against nominal exchange rate flexibility. Other analyses, like, Betts and Devereux (1996, 2000) and Chari *et. al* (2000) find that nominal exchange rate changes do not affect nominal or real prices faced by the consumers in the short run. These claims are validated by empirical studies supporting LCP-PTM mechanisms, as these show incomplete exchange rate pass-through to consumer prices and import prices. Starting with the classic study of Mussa (1986), there is a large evidence in the empirical literature against PCP argument, which report that exchange rate pass-through to consumer prices is virtually zero.[1]

Country and industry specific studies point to LCP-PTM mechanisms also. These analyses find low exchange rate pass-through to import prices and propose a number of explanations for these evidences. For example, Kardasz and Stollery (2001) examine the pass-through effect into the real prices of domestically produced and imported goods in Canadian manufacturing industries through industry estimates of the pass-through elasticities and find that the extent of elasticity of substitution between imports and domestic goods determine the level of pass-through effects. Based on two equation systems built with import prices, exchange rates, world market and domestic prices, Adolfson (1997) reports a limited pass-through for Swedish import prices. Other studies like Gross and Schmitt (2000) and Bernhofen and Xu (2000) also support the findings of limited exchange rate pass-through in automobile industry in Switzerland and petrochemicals industry in USA. Reasons for these evidences include oligopolistic rivalry among source producers and non-

[1]see, for example, Engel (1993, 2000), Rogers and Jenkins (1995) and Parsley and Wei (2001).

competitive conduct by foreign firms. Exchange rate pass-through in US manufacturing industries and its cross-sectional variation is investigated by Yang (1997) and he finds that it is neither complete nor uniform across industries because of the degree of product differentiation and elasticity of marginal cost with respect to output. Goldberg and Knetter (1997) provide a comprehensive empirical review of PTM behavior in manufacturing trade among OECD countries. They show that the median exchange pass-through to manufacturing import prices hovers around fifty percent over a one-year period. These evidences, therefore, follow classic studies like Dornbusch (1987) and Feenstra *et. al* (1996) which use industrial organization models to explain pass-through in terms of market concentration, import penetration and the substitutability of imported and domestic products. Apart from these findings, we have previous works focusing on exchange rate pass-through at various industry-level prices and conclude that the extent is partial.[2]

The above findings, though lend some support towards LCP-PTM type arrangements, suffer from at least two potential shortcomings, according to Obstfeld (2002):

(1) Import prices paid at the entry point to a country is different from the CPI prices of imported goods. Therefore, factors affecting CPI real exchange rates may not explain the import price behavior. So even if we have evidence of LCP in the import prices, we may not find any of that towards the domestic prices. As a result, we need to separate the pass-through effects directed towards the import prices and domestic prices and their interaction will finally determine the extent of expenditure-switching effect.

(2) These expenditure-switching effects can be better explained by firm level decision making than consumption choices. Import prices at the point of entry will therefore affect economic decisions. Specifically, if firms have transnational operations, then the critical relative price for expenditure-switching will be the real exchange rate measured with respect to relative nominal unit labor costs.

Therefore, any empirical study to determine the extent of expenditure-switching will have to

[2]see references within Yang (1997).

take care of the above mentioned points. But the new empirical studies do not provide much attention to these issues. The existing approach to evaluate new open economy models employ unrestricted or structural VAR framework and judge the performances of impulse-response functions based on these VARs to conclude about the validity of pricing assumptions. For example, Eichenbaum and Evans (1995) use unrestricted VARs to show that predictions of sticky-price models are consistent with the movements of real exchange rates due to monetary shocks. Clarida and Gali (1994) use Blanchard and Quah (1989)'s structural VAR methodology to support this conclusion. McCarthy (2000) builds a VAR incorporating a distribution chain of pricing and finds that exchange rates have a modest effect on domestic price inflation while import prices have a stronger effect. Other studies build and test small open economy models to see the effect of stickiness assumptions. Bergin (2003) estimates and tests an intertemporal model using maximum likelihood and finds that price stickiness assumption in buyers' currency provides good estimates of the model in terms of prices and output. However, the model does not perform well in terms of explaining exchange rate movements.

The results we get so far from all of LCP-PTM type or general equilibrium models do not separate out the pass-through effects, which according to our discussion above may be important to determine the expenditure-switching effect. As it is related to the choice of exchange rates from a policy perspective, therefore, a comprehensive framework is needed to address the issue of expenditure-switching after incorporating both the pass-through effects directed towards domestic as well as import prices. Our study tries to take care of this issue after looking at the pass-through evidences coming from the other modeling assumption, PCP, also. In what follows, we discuss some studies based on PCP type arguments.

Existing analyses proposing flexible exchange rate regime rely on sticky prices assumption in terms of producers' or sellers' currency. Therefore, these models assume full exchange rate pass-through as opposed to the LCP-PTM type models. In a number of influential papers, Obstfeld and Rogoff (1995, 1998 and 2000) show that changes in consumer price in short run can be explained with changes in nominal exchange rate assuming PCP type models. So, we expect complete exchange rate pass-through to consumer prices and absence of that may be treated as evidence against PCP. In the theoretical framework, however, a number of explanations are put forward to counter this argument of low pass-through. For example, McCallum and Nelson (1999) emphasize that with higher proportion of non-tradable component in consumer prices, the influence of exchange rate changes on real allocations is likely to be small as the change may reflect a negligible part of the cost of the good and service purchased by the consumer. Obstfeld and Rogoff (2000) point out that in presence of high domestic transportation and distribution costs for imported goods, exchange rate pass-through to CPI will be smaller. In fact, Corsetti and Dedola (2001) build a framework in which incomplete pass-through arises because of the differential distribution costs in home and foreign markets. Obstfeld (2001) proposes another interesting argument to explain the low pass-through effect. It involves intermediate imported goods for which there are domestic substitutes and local producers use these imported goods to make a final good for consumers. The intermediate import prices may be sticky in terms of producers' currency, but the price for consumers may be rigid in terms of local currency. In this scenario, when the exchange rate changes, the importer might switch between imported intermediate and locally produced alternative goods. Therefore, we can experience significant expenditure-switching effect.

We try to empirically analyze these expenditure-switching effects, as proposed by Obstfeld (2001). In doing that, we address the pass-through separation effects which are not being explored till now. Taking industry level import prices, producer and consumer prices for USA, UK and Japan, we see how the exchange rate changes affect each of these prices. Our analysis point out that there is a separation between the pass-through effects, with one going to the import prices and the other going towards the domestic prices. This kind of potential separating effect is proposed by Obstfeld (2002) in (1) above and he also points out the policy implications with respect to separations : (i) Keeping other things equal, more extensive and rapid pass-through to import prices will enhance the expenditure-switching effects of an exchange rate change and (ii) on the other hand, fuller and faster pass-through to domestic prices will reduce the expenditure-switching effects. If we assume that there is purchasing power parity, then rapid pass-through to the entire range of goods in the

CPI nullifies the exchange rate's potential expenditure-switching role.[3] Obstfeld's explanation for these differences goes this way : "Because wage costs are a major component in production, and the wages are both nominally sticky and (in normal conditions) very sluggish. Given this sluggishness in domestic-currency costs, output prices will inherit a tendency to respond sluggishly to monetary impulses, whereas exporters will face corresponding pressures to maintain the domestic-currency prices of their exports so as to maintain profit margins." As a result, there will be relative price difference between domestic goods and imported goods which causes higher expenditure-switching. Apart from these two channels of exchange rate pass-through effects, we also get another effect that originates from import price fluctuations and affect domestic prices. Based on these interactive effects, we argue for higher or lower extent of expenditure-switching. The traditional argument on expenditure-switching look at the exchange rate's effect on consumer prices and import prices. But with import prices also affecting the consumer prices separately, the extent of expenditure-switching will be different. The industry level prices separate out the differences. The policy prescription on "optimal" exchange rate regime depends on this expenditure-switching. Our study do not provide precise explanations for the reasons of these price fluctuations across industries per se, but it gives us a new evidence towards expenditure-switching argument. According to Lane (2001), assumptions concerning the currency denomination of preset prices remain important in this new open economy macroeconomics literature and the extent of PTM behavior in the real data has not been explored thoroughly so far. Our study may be judged as a pointer towards looking at this aspect also. The industry-wise studies cited above argue for the extent of pass-through effect for particular industries like manufacturing, petroleum and automobile. But in our case, we cover a broad spectrum of SITC level of industries (see Appendix 2 for reference) and therefore, it is far more comprehensive and advanced. It, therefore, tries to look at the empirical issues after incorporating a lot of little explored or unexplored topics in the existing literature.

[3]see, Calvo and Reinhart (2002) for evidence from a number of developing countries.

2.2 Exchange rate pass-through to export prices : Past evidence

Obstfeld (2002) points out that if LCP types of models are true, then one would not observe the traditional effects of exchange rate changes for the *export prices*. By "traditional effects" one understands the Keynesian approach, which assumes that the prices are rigid only in exporters' currencies and not in importers' currencies. This is nothing but the PCP mechanism we have noticed earlier. Thus, with a currency depreciation in home country, their export prices will decline relative to the foreign export prices. An LCP-PTM type mechanism, may however yield a positive effect. PCP based arguments therefore place a greater emphasis on flexible exchange rates as playing a pivotal role in the international transmission of monetary disturbances. Obstfeld and Rogoff (2000) report aggregate monthly data for fifteen bilateral pairings of industrial countries relative export prices and exchange rates which support the traditional argument that exporters largely invoice in home currency and that nominal exchange rate changes thus have significant short-run effects on international competitiveness. In their dynamic time-series study of German, Japanese and US automobile exports to seven industrial-country destinations, Gagnon and Knetter (1995) finds that PTM is greater in the long run than in short run. These results are consistent with invoicing in the exporters' currency and show that pass-through to export prices is not zero, implying that LCP towards export prices may not be true. In what follows, we use an econometric model with the monthly growth rates of relative export prices and trade-weighted exchange rates based on SITC level prices on exports. Our results support the PCP argument as we find that pass-through effects are not zero.

3 Expenditure switching : empirical analysis from Industry-level import and export prices

3.1 A simple model

We build a simple model based on the prices of products in terms of end uses in importing country. The purpose of this approach is two-fold. First, it follows the proposition put forward by Obstfeld (2002) as we separate out the pass-through effects towards import prices and domestic consumers' prices or producer prices. Second, it addresses the issue of expenditure-switching in a clear way, after incorporating the potential effect of changes in import prices to domestic prices. We can also see the extent of expenditure-switching for consumer and producer prices. Based on the theoretical arguments in Obstfeld and Rogoff (2000) and Obstfeld (2001), we try to separate out the goods in terms of end uses. The data we have include consumer prices (CPI), which reflect final products or final goods' prices. We also collect import prices (IMP) for final goods, intermediate goods as well as crude materials. Finally, we take prices for domestic producers (PPI), which can be categorized in terms of final goods, intermediate goods and crude materials. The ability to separate in terms of end uses provides a better understanding in terms of price movements. The setup we use is a partial equilibrium: the exchange rate is exogenously determined and the model focuses on the impact of an exchange rate depreciation. Therefore, we deviate from the traditional exchange rate pass-through estimation literature, as they include other "control" variables, like a measure of exporters' cost or cost from tariff barriers in the destination country.[4] Our treatment assumes that there is perfectly competitive conditions in the exporting country and international trade with the world is costless, thus nullifying the effects of controls. Within this framework, we build three different kinds of reduced-form systems in the following to see the impact of exchange rate depreciation on import prices, producer prices as well as consumer prices.

System I : In the destination country, domestic consumer prices (CPI) reflect prices for both

[4] see, Goldberg and Knetter (1997) for a general review of pass-through studies.

tradeables and non-tradeables. With higher proportion of tradeables in final goods prices, we expect that exchange rate depreciation will affect the CPI. Assuming PCP, the effect will be full. On the other hand, under an LCP-PTM mechanism, the extent of CPI change will be closer to zero. We may of course get a change in CPI closer to zero if there is a small proportion of tradeables in CPI itself. As a result, one has to be careful from the empirical perspective in judging the effects of pass-through to CPI, as pointed out by our earlier discussion. The nontradeables part of CPI is influenced by PPI, and it can be due to any components of it. In this case, we assume that CPI is being affected by final goods' PPI. This can be interpreted as putting some restrictions on domestic producers, here we maintain that producers' sell only finished goods to the consumers, which is being reflected in the CPI for final goods. Apart from these two potential effects that can justify CPI hike, we may also get another effect from import prices to consumer prices. This is based on the separation in terms of potential importers. If domestic importers are different from domestic producers, then we expect that change in imported final goods prices will also lead to a change in CPI, as these importers charge some positive markups. This effect can be termed as the "carry-over effect", and we can define it as a percentage change in CPI due a proportional change in imported final goods prices. If the extent of the change is the same, then we say that the carry-over effect is complete. This can be linked to the PTM argument in the following way. With higher level of PTM evidence, we expect negligible carry-over effect, as domestic importers' try to maintain their market share by not increasing the domestic prices of the imported goods proportionately. Based on this scenario, the CPI is influenced by three factors: exchange rate, PPI for finished goods and IMP for finished goods. Consider the (long-run) equilibrium relationship between CPI inflation (denoted by y), PPI inflation from finished goods (denoted by x_1), growth rate of imported finished goods prices (denoted by x_2) and growth rate of exchange rate (denoted by x_3). According to the previous analysis, we will get a functional relationship like the following:

$$y = f(x_1, x_2, x_3) \tag{1}$$

Assuming domestic producers use tradeables or imported components in final goods' production, PPI final goods' prices will also be influenced by exchange rates as well as import prices for those intermediate inputs. First effect can be termed again as the pass-through effect towards PPI and we expect the extent to be fuller or lesser based on the assumption of PCP or LCP-PTM type of pricing argument. The second effect can be interpreted as another carry-over effect, this time from import prices to producer prices. In terms of functional form, we will get:

$$x_1 = g(x_{2,}x_3) \tag{2}$$

The import prices are influenced only by exchange rate directly at the point of entry in our analysis. In this case, final goods import prices will be increased as a result of exchange rate depreciation. Based on PCP mechanism, say a 10 percent depreciation of exchange rate will lead to a 10 percent hike in the import prices. On the other hand, we expect a marginal increase or zero increase in the imported final goods prices relying on LCP-PTM type of arguments. In equational terms, this can be depicted as:

$$x_2 = h(x_3) \tag{3}$$

From the above analysis, we have a reduced-form system, where the price effects and the explanatory components are depicted clearly. Based on this system, we argue for the extent of expenditure-switching in the following way. If there is evidence of PCP in imported final goods prices, then there is a proportional increase in those prices as a result of exchange rate depreciation. For CPI, our earlier discussion points out that it is also influenced by exchange rate and imported goods prices. Assuming PCP also towards CPI, an exchange rate depreciation will cause the import prices as well as domestic prices for final goods to rise proportionately. Therefore, there is no relative price difference between domestic and imported goods. So, the extent of expenditure-switching will be much less and exchange rate will have no role to play in terms of stabilizing domestic prices and consumption. As a result, flexible exchange rate regime is not the best option here. On the other hand, if there is evidence of LCP towards CPI and PCP towards imported final goods prices, then, definitely, there is a relative price difference between the domestic goods and imported final goods. In this scenario, we may get higher extent of expenditure-switching. This magnitude will be further aggravated with the evidence of lower carry-over effect from the imported final goods prices to consumer prices. Low carry-over effect can be justified with a domestic competitive market where there are a large number of importers trying to hold on their existing profit margin by not charging any higher markup on domestic prices. Our final conclusion on the magnitude of expenditure-switching depends on the evidence of the extent of pass-through effect towards these different prices as well as the carry-over effect from import prices to CPI. Higher level of expenditure-switching, according to above analysis will call for PCP towards IMP for final goods, LCP-PTM towards CPI and lower level of carry-over effect. Flexible exchange rate mechanism in this scenario has a relative price stabilizing effect as well as higher terms of trade effect. LCP towards imported final goods prices, PCP for CPI and higher level of carry-over effect, on the other hand, will lead to lower expenditure-switching effect or no expenditure-switching at all. In this case, fixed exchange regime will be optimal.

So far, in the literature, arguments against higher level of expenditure-switching are based on either LCP mechanism towards import prices or LCP type arguments for consumer prices. Our simple analysis show that we need to look beyond those to get a complete picture of the expenditure-switching effect. In fact, evidence of LCP on CPI serves as an incentive for expenditure-switching in our framework, as it helps to maintain relative price differential. We are not considering any feedback effects from the consumers prices to producer prices or to import prices in this static framework so far. However, the effect of expenditure-switching may be dampened if these kinds of dynamic feedbacks are present from CPI and PPI to IMP or exchange rates. Our dynamic empirical framework addresses this issue in a greater detail in the next section. From the three equation setup, we can build a static system and identify all the short run and long run effects. As PCP type arguments are based on Keynesian perspective, so the short run adjustments are also emphasized in the literature to support the proponents of flexible exchange rate regimes. Long run equilibrium effects essentially look at the whole process of adjustments after taking care of all the potential effects of both international adjustments coming from a fluctuation in the exchange rate as well as from the import prices to domestic prices.

We have system I comprising of above three equations. The following gives us all the short run and long run adjustments. After solving for a change in the exchange rate as well as other prices, the final long term average effect will be:

$$\frac{dy}{dx_3} = f_1(g_1 h_1 + g_2) + f_2 h_1 + f_3 \tag{4}$$

where f_j, for $j = 1, 2, 3$, denotes the partial derivative $f_j \stackrel{\text{def}}{=} \partial y / \partial x_j$. These partial derivatives denote the direct average responses of CPI inflation to a change in each variable. For example, f_3 will denote the direct average response of a exchange rate change on the CPI inflation. In our empirical analysis, we will add the time dimension and, therefore, short run adjustments will be reflected by the smaller lagged effects of the explanatory variables, which are x_i's for the first equation. We can interpret $f_2 h_1$ as the cumulative carry-over effect and f_2 as the direct (or, short run) carry-over effect and the magnitude of these will also influence the ultimate expenditure-switching effect. $f_1 g_1 h_1$ can be termed as the long run inflationary effect, which is being guided by the short run inflationary effect denoted by f_1. g_1 can also be termed as a carry-over effect of imported finished goods' prices to domestically produced finished goods' prices. Therefore, from this triangular system, we can actually differentiate between the extent of each effect and then can argue for the expenditure-switching determined by the overall long run impact.

System II : This system takes care of further segmentation in the price effects. Here, we assume that final goods are produced domestically with the help of tradeable and non-tradeable intermediate inputs. We further assume that these intermediate inputs themselves have some imported components. As a result, final goods PPI will be influenced by changes in exchange rate, domestically produced intermediate inputs' prices as well as prices of imported intermediate inputs. We will again get a three equation setup like System I here, with the second equation depicting how the domestically produced intermediate inputs' prices being influenced by changing price level of imported intermediate inputs as well as the exchange rate. The third equation in the system will show interactions between imported intermediate inputs' prices and exchange rates. All the usual mechanism of LCP-PTM or PCP remain valid in this case also. As a result, the expenditure-switching magnitude will be influenced by the evidence of LCP-PTM or PCP. Bacchetta and Wincoop (2002) builds a theoretical model similar to the one set up above and shows that foreign exporters will resort to PCP if there is sufficient competition in the domestic market faced by the domestic firms who use imported intermediate goods to produce final goods in this market.

System III : This is a two equation system, where the first equation depicts a change in the producer prices as a result of a change in the import prices, with the goods can be for final use or intermediate use. In the second equation, we have the imported goods' prices influenced by changes in the exchange rate. Maintaining the same notations as described earlier, i.e, depicting PPI inflation by x_1, growth rate of imported goods prices by x_2 and growth rate of exchange rate by x_3, this system will be denoted by the following equations

$$x_1 = g(x_{2,}x_3) \tag{5}$$

and

$$x_2 = h(x_3) \tag{6}$$

As like the three-equation system, in this case also, we can get the long run and short run average impacts by the following expression

$$\frac{dx_1}{dx_3} = g_1 h_1 + g_2 \tag{7}$$

where g_j, for $j = 1, 2$, denotes again partial derivative. Here, g_2 denotes the direct average response of a exchange rate change on the PPI inflation. g_1 is the carry-over effect and h_1 reflects the direct average impact of exchange rate change on the import prices.

All of these systems show the separation in the pass-through effects towards domestic prices, measured either in terms of consumer prices (system I) or in terms of producer prices (system II and system III). The equations also help to identify the carry-over effect and we can clearly see the interaction between all these effects to finally calculate the extent of expenditure-switching effect.

3.2 Empirical framework

3.2.1 Related to Import Prices

The above conceptual framework can be converted into an econometric framework, which can be used both for testing the implied triangularity of the three-equation system we propose and for estimating short and long-run effects. All our analysis is conducted in growth rates. Standard unit root and cointegration tests were performed for the levels, but we found no strong evidence of cointegration for almost all our systems. These tests are not presented here but are available on request. In what follows we describe the empirical implementation of system I.

Consider a (3×1) vector with CPI inflation, PPI inflation and growth rate of import prices, say $\boldsymbol{z}_t \stackrel{\text{def}}{=} (y_t, x_{t1}, x_{t2})'$, and redefine the growth rate of the exchange rate as $x_{t3} \equiv w_t$.[5] We assume that $\boldsymbol{z}_t$ can be adequately modeled by a vector autoregression with an exogenous input variable (VARX) as:

$$\boldsymbol{z}_t \stackrel{\text{def}}{=} \sum_{i=1}^{p} \boldsymbol{\Pi}_i \boldsymbol{z}_{t-i} + \sum_{j=1}^{q} \boldsymbol{\beta}_j w_{t-j} + \boldsymbol{u}_t \tag{8}$$

where $\{\boldsymbol{\Pi}_i\}_{i=1}^{p}$ are (3×3) parameter matrices and $\{\boldsymbol{\beta}\}_{j=1}^{q}$ are (3×1) parameter vectors. The error vector $\boldsymbol{u}_t$ is assumed to be multivariate white noise with variance-covariance matrix $\boldsymbol{\Sigma}$. The model in the above equation will be our broadest, unrestricted model (U-model).[6] The implied triangularity of the conceptual model of the previous section is now testable using this model. Consider the restrictions implied by the following null hypothesis and corresponding to our first restricted model (R1-model):

$$H_0 : \left\{\pi_{ab}^{i} = 0 \;\mid \text{for } a > b \text{ and } a, b = 1, 2, 3\right\} \quad \forall i \tag{9}$$

where π_{ab}^{i} is the (a, b) coefficient of $\boldsymbol{\Pi}_i$. These restrictions imply absence of feedback from CPI inflation to PPI inflation and from CPI and PPI inflation to growth of import prices; they are immediately testable using a Wald-type test applied to the U-model.

[5] All variables are taken as deviations from their respective sample means.

[6] The U-model was estimated using conditional least squares with the orders chosen by the Schwarz (BIC) criterion.

If the above null hypothesis is rejected we proceed by eliminating the insignificant coefficients from the U-model and re-estimate the remaining parameters by seemingly unrelated regression (SUR). This is our second restricted model (R2-model), which we then compare to the U-model using a likelihood ratio (LR) test. If the R2-model is rejected in favor of the U-model we use the estimates from the U-model to compute the long-run effects; if the R2-model is not rejected we use its estimates to compute the long-run effects. Similarly, if the null hypothesis of triangularity is not rejected, we proceed by eliminating the insignificant coefficients from the R1-model and re-estimate the remaining parameters using SUR. This is our third restricted model (R3-model), which we now compare to the R1-model using a LR test. Depending on whether the R3-model is rejected or not we use the estimates from either the R1-model or the R3-model to calculate the long-run effects.

To illustrate the computation of the long-run effects, consider the U-model and re-write it using lag operator notation as:

$$\mathbf{\Pi}(L)\boldsymbol{z}_t = \boldsymbol{\beta}(L)w_t + \boldsymbol{u}_t \tag{10}$$

where $\mathbf{\Pi}(L) \stackrel{\text{def}}{=} \boldsymbol{I}_3 - \sum_{i=1}^{p} \mathbf{\Pi}_i L^i$ and $\boldsymbol{\beta}(L) \stackrel{\text{def}}{=} \sum_{j=1}^{q} \boldsymbol{\beta}_j L^j$. When the system is in long-run equilibrium we expect that the variables do not deviate substantially from some fixed values, say their respective means $\boldsymbol{z}^* \stackrel{\text{def}}{=} \mathsf{E}[\boldsymbol{z}_t]$, $w^* \stackrel{\text{def}}{=} \mathsf{E}[w_t]$ and $\boldsymbol{u}^* \stackrel{\text{def}}{=} \mathsf{E}[\boldsymbol{u}_t] = 0$. Therefore, we have the representation:

$$\mathbf{\Pi}(1)\boldsymbol{z}^* = \boldsymbol{\beta}(1)w^* \tag{11}$$

from which all long-run effects can be easily computed by summing the estimates of the $\mathbf{\Pi}_i$'s and the $\boldsymbol{\beta}_i$'s. For example, the long-run effects of the exchange rate growth on CPI inflation, PPI inflation and growth of import prices are given by the estimate of the vector $\partial \boldsymbol{z}^*/\partial w^* \stackrel{\text{def}}{=} [\mathbf{\Pi}(1)]^{-1}\, \boldsymbol{\beta}(1)$.

3.2.2 Related to Export prices

Let p_t denote the export price of the domestic country, p_t^* denote the respective price of the foreign country and e_t denote the trade-weighted exchange rate (in units of domestic currency per unit of weighted index of foreign currencies). The dependent variable is the monthly growth in relative export prices $\Delta y_t = (1-B)y_t$ (B being the lag operator). The explanatory variable is the monthly growth of the exchange rate x_{t3}. The model we consider is a regression in monthly growth rates, namely:

$$\pi(B)\Delta y_t = c + \delta(B)x_{t3} + z_t(\theta) \tag{12}$$

where $\pi(B) = 1 - \sum_{i=1}^{r} \pi_i B^i$ and $\delta(B) = \delta_0 + \sum_{i=1}^{s} \delta_i B^i$ are polynomials in the lag operator B and where the term $z_t(\theta)$ captures the regression error dynamics of the equation and depends on the auxiliary parameter vector θ. For example, if the equation includes the first lag of Δy_t and x_{t3} and the regression error follows a seasonal autoregression of orders one and twelve then $\pi(B) = 1 - \pi_1 B$, $\delta(B) = \delta_0 + \delta_1 B$ and $z_t(\theta) = u_t$, with $(1-\phi_1 B)(1-\phi_{12}B^{12})u_t = \varepsilon_t$, $\varepsilon_t \sim iid(0, \sigma_\varepsilon^2)$ and $\theta = (\phi_1, \phi_{12}, \sigma_\varepsilon^2)$. If no lagged dynamics of Δy_t and x_{t3} are explicitly included then $\delta^* = \delta_0$ gives us the long-run "equilibrium" effect of a change in monthly relative export prices from a change in the monthly trade-weighted exchange rate. If lagged terms are present, then the long-run effect is computed as $\delta^* = \delta(1)/\pi(1)$, i.e. as the equilibrium solution of the dynamic part of the model.

3.3 Data

3.3.1 For Import prices

The requisite data for USA come from the Bureau of Labor Statistics's web site. Import prices are taken from SITC classification, PPIs are taken both for Industry-wise and Commodity-wise classifications. We use the CPI for urban consumers as our sample CPI series in the study. For import prices from Food and Beverages, Mineral Fuels and Lubricants and Textiles industries, we have used the corresponding CPI for these industries in our analysis. In every case of our data for USA, the end point is December, 2002. But the starting point varies across industries. For example, the sample range of import prices for Food and Beverages begins from January, 1989, for Textiles, Organic chemicals, Furnitures and Metalworking machinery, it starts from January, 1994 and for the rest of the industries, it is from January, 1993. We are looking for industry-wise import prices with the imports coming from all over the world, so nominal exchange rate series may not give us the required effects as it reflects the bilateral currency prices. Therefore, we are taking the trade-weighted exchange rates for all the countries in our sample. We have taken the US currency vis-a-vis weighted average of twenty-seven major trading countries currencies as the trade-weighted exchange rate for USA from Federal Reserve Bank of St. Louise's web site. For import prices, the base is 2000 = 100 and for consumer and producer prices the base is 1982-84 = 100. In our analysis, we change all the series base to an uniform base of average of 1995 = 100. We have done the analysis for fourteen industries for USA, which includes broad as well as subcategories of SITC level industries.

In case of UK, the data for SITC level import prices and PPIs come from the National Statistics Online. The trade-weighted exchange rate data is available from Bank of England's web site. In all of these cases, we have the sample range from January, 1991 to December, 2002. For import prices and PPI, we have the same base of average of 1995 = 100. We are looking at eleven industries in our analysis.

For Japan, the wholesale price index (WPI), domestic producer price index (PPI), import prices (IMP) and trade-weighted exchange rates are obtained from the Bank of Japan's web site. Our sample ranges from January, 1971 to December, 2002 and we have seven broad SITC industries for our study.

3.3.2 For Export prices

In case of USA, SITC level data for export prices are obtained from the Bureau of Labor Statistics's web site. In all, we have sixteen industries including subcategories of broad SITC level industries. Most of the monthly data starts from January, 1993 and we have taken observations till December, 2002 in our analysis. The reported base for all the prices' in the sample is 2000 = 100. We have changed the base to an uniform base of average of 1995 = 100 for the present analysis.

For UK, we have sixteen SITC level industries' export prices, which includes prices for subcategories of industries also. The reported base in this case is 1995 = 100. The sample period in our analysis is from January, 1983 to December, 2002.

Japanese export prices are taken from Bank of Japan's web site. In this country's case, we have six industries with the monthly data starting from January, 1983 and ending at December, 2002. We have converted the data from the base of 2000 = 100 to average of 1995 = 100.

When we analyze relative export prices, we have constructed relative prices by dividing export price of one industry in one country with that of the corresponding industry's export price in another country. For some of the countries in our sample, the industries do not match one to one. Therefore, we get a small number of relative export prices, especially in case of analyses involving Japan. For example, USA and Japan and UK and Japan analyses involve only five relative prices, whereas, for USA and UK analysis, we have fifteen cases of relative export prices.

4 Empirical results

4.1 Results from analysis of Import prices

4.1.1 Results from system I : Case of Japan and USA

Looking at Table 2, for all the seven industries in Japan and three industries in USA, we see that there is evidence of feedback from CPI inflation to PPI inflation as well as from CPI and PPI inflation to growth of import prices. As a result, we go with the R2-model and estimate that with SUR. Table 1 has all the estimation results from this model, because the statistical test (LR test) in these cases tell us that R2-model is correct (except for Food, where we reject the R2-model in favor of the U-model, and therefore, calculate the short and long run coefficients from the U-model for this industry). Short run results give us the direct effects of exchange rate depreciation on import prices (denoted by h_1), on wholesale price indices for Japan or CPI for USA, (denoted by f_3) and the carry-over effect from import prices to either wholesale prices or CPI (denoted by f_2). In the short run, for three out of ten industries in our sample (see Table 1 for reference), we do not have any evidence of carry-over effect. This does not necessarily mean that our conceptual system or model is wrong, it just points out that for these kind of particular data, we do not find any significant effects. For the rest of the industries, however, there are significant carry-over effects. Evidence of higher level of expenditure-switching is supported by at least sixty percent of the tabulated cases, with Mineral fuel and lubricants industry in USA providing the highest magnitude of expenditure-switching. This is achieved with PCP for import prices in all of these industries, evidence of LCP towards wholesale prices or CPI for fifty percent of the cases and with low carry-over effect in forty percent of the cases. Concentrating on the long run impact (also denoted by the notations established earlier), for sixty percent of industrial prices in our sample, we can say that there is evidence of PCP with the pass-through coefficients varying from seven percent (in case of Machinery and Equipment for Japan) to more than hundred percent (in case of Wood and lumber in Japan). Forty percent of the sampled industries provide evidence of LCP towards domestic prices for these two countries with the extent of it varying from close to one percent (in case of Textiles for Japan) to forty-five percent (in case of Mineral fuels and lubricants for USA). Higher level of expenditure-switching is pointed by these forty percent of the sampled industries. Our results from Japan are similar to Obstfeld's (2002) USA-Canada findings, which show that in Machinery and Equipment and Textiles industries an effective depreciation of Japanese Yen raises import prices of these industries. Negative coefficients in the tables can be explained by higher extent of export price declines for these industrial products than the exchange rate depreciation. We have verified this from the corresponding data with export prices but are not reported in the analysis. These results are available on request.

4.1.2 Results from system II : Case of UK

Tables 3 and 4 report the estimation and model testing results from system II. We have done the analysis for UK only, mainly because of the data availability. In both of the industries, we get low level of exchange rate pass-through to domestic producer prices for intermediate goods as well as low level of carry-over effect both in the short run and long run. These therefore suggest a greater level of expenditure-switching provided we get PCP for imported goods prices. But both industries findings show negative coefficients of the import goods prices. As a result, magnitudes of export price decline in both of these industries are much higher than the extent of exchange rate depreciation. In this case, the long run and short run coefficients are calculated from the U-model for Chemicals and Organic chemicals industry and from the R2-model for Machinery and Electrical equipment industry. The first one implies that there is feedback from CPI and PPI to import prices and the second one points out that there is no such feedbacks, thus supporting triangularity.

4.1.3 Results from system III : Case of UK and USA

Estimation and model testing results for system III are presented in tables 5 to 8. As is depicted earlier in the simple model part, this is a two equation system, with the first equation of producer prices being influenced by import prices fluctuations (measured in terms of g_1) and changes in exchange rate (measured by g_2). The second equation looks at the exchange rate pass-through effect to import prices (denoted by h_1). Tables 5 and 6 summarize UK findings and USA results are reported in Tables 7 and 8. Looking at Table 6, in case of UK, for four out of thirteen industrial categories, we go with the R2-model and calculate both short and long-run effects from these models. Remaining industries support R3-model, showing that the null hypothesis of triangularity is not rejected. For these industries, we have calculated the short and long-run coefficients from R3-model, except for Organic chemicals' industry, which supports R1-model. From the estimation results (see Table 5), evidence from three industrial prices (Pulp, Wood and Medicinal products) show that there is no carry-over effect from import prices to producer prices both in the short and long-run. Seventy percent of remaining industries, however, depict that there is significant carry-over effect in the short run. We get the highest carry-over effect in Iron and steel industry with a magnitude of fifty seven percent. In the short run, forty-six percent of the sampled industries support positive significant effect in terms of import price increase as a result of depreciation in trade-weighted exchange rate. Tobacco prices report the highest (more than one hundred percent) and Iron and steel prices report the lowest (close to fifteen percent) pass-through effects in the short run. Negative coefficients are justified in terms of greater increase in export prices of these industrial products than the extent of exchange rate depreciation. As compared to pass-through towards import prices, the extent of pass-through towards producer prices is less in four out of thirteen industries in the short run. These four industries, viz., Tobacco, Metal ores, Plastics and Iron and steel, therefore support the higher extent of expenditure-switching in the short run, though the effect is dampened in case of Iron and steel and Plastics' prices because of higher magnitude of carry-over effect. The results are similar from the long run calculations also. In all, we get mixed support towards higher level of expenditure-switching.

In case of USA, we accept triangularity from the R1-model and then use R3-model for our estimation in ten out of eleven industries in our sample (see Table 8 for reference). For Chemicals, we go with the R2-model as the null hypothesis of triangularity is rejected from the first step. Long and short run coefficients are estimated from R2-model for Chemicals and from R3-model for all other industries, except Metal-working machinery industry. All these results, therefore, support the proposed triangularity. Looking at the estimation results from Table 7, there are no carry-over effects in case of Meat, Rubber and Non-metallic minerals industries both in the short and long-run. There are no pass-through effects (both in short run and long run) to producer prices also for Fruit, Inorganic chemicals and Electrical machinery industry. This is perfectly consistent with the data for PPI, as these do not include imported components. In our analysis, for forty-six percent of cases in the short run, we get positive pass-through effect towards import prices with the magnitude varying from ten percentage points (for Furnitures) to fifty-three percentage points (for Fruit). These, therefore, show that the exchange rate pass-through effects to import prices are not close to zero, as is expected under the LCP-PTM mechanism. However, we get very low level of pass-through estimates towards producer prices in the short run for almost thirty-six percent of sampled industries with the extent varying between two to nine percent. The reason for this occurence is again the non-inclusion of imported goods' in the producer prices, as a result, exchange rate changes have limited role to play explaining these fluctuations. In view of this, for the higher level of expenditure-switching argument to be valid, we expect higher level of pass-through to import prices. This is supported by almost forty-six percentage of sampled industries with the effect significant and most prominent in the Metal-working machinery industry (thirty percent) and the least in Furniture (ten percent). Relatively low pass-through to Furnitures, which is a part of broad SITC category, Miscellaneous manufactured articles, provide some support to Yang (1997)'s earlier findings for manufacturing industry in USA. Across industry comparisons from the table show considerable variations. These results are also in line with Knetter (1993), which shows substantial variations in pass-through coefficients across industries. Negative coefficients in the table depict lower magnitude of exchange rate depreciation as compared with higher magnitude of export price decline for these industries.

4.2 Results from analysis of export prices

Estimation results from relative export prices are presented in Table 9. Last three columns tabulate estimated values of the coefficients associated with trade-weighted exchange rates. Negative coefficients provide support for theoretical justification of the absence of zero or very less extent of exchange rate pass-through towards relative export prices. Out of the total seventeen industries in our sample, we get the significant desired effect in fifteen industries, thus providing almost ninety percent of cases some evidence of apparent pass-through. Within USA and UK comparison, the pass-through extent is the largest in Textile fiber industry (forty-seven percent) and lowest in Road vehicles industry (ten percent). For these two country analyses, at least sixty percent of sampled industries cases, there are some amount of pass-through towards export prices. Comparison with USA and Japan gives us evidence towards pass-through for eighty percent of sampled industries with Road vehicles' industry showing the largest amount (almost sixty-seven percent) of pass-through among all the industries in the sample. Relative price comparison among UK and Japan show us the highest level of pass-through in Miscellaneous Manufacturing industry (nearly thirty-five percent). Eighty percent of the sampled industries in this case provide significant support to traditional Keynesian type arguments and therefore show the validity of PCP mechanism in these cases. Our results, overall, are quite similar to that of Obstfeld and Rogoff (2000) and Obstfeld

(2002). Within cross-country estimates, Chemicals industry's relative export prices pass-through effects are relatively comparable, as the estimates range from eighteen percentage to twenty-nine percentage points. It shows that PCP mechanism is prevalent within these countries as far as setting the export price of this industry. Miscellaneous manufactures' industry estimates also point out the same with the exception of USA and UK estimate. Except for USA and Japan estimate, we see that the Road vehicles' industry prices give us the lowest evidence of exchange rate pass-through among all the industries and countries in the analysis. This may be due to higher extent of local currency pricing that are being practiced in USA and UK automobile markets.

From both the import and export prices evidence in our analysis, we can see that the PCP mechanism is supported by a large number of industrial categories. As we have discussed earlier, this will therefore point out towards traditional Keynesian type results: with a depreciation of nominal exchange rate in the domestic country, the export prices will go down and the import prices will go up for domestic country, leading to a decline in the terms of trade and more consumption of domestic goods in the world market. Comparing all the estimation results from different tables, we get the following.

Beverages and Tobacco prices decline from export analysis is consistent with USA and UK findings from corresponding import prices increase as a result of the exchange rate depreciation. Chemical prices change due exchange rate depreciation is also consistent with the PCP argument if we look at corresponding export prices and import prices in case of Japan and USA. Within this broad SITC category, we get support for PCP from Organic chemicals price movement in case of UK also. Textile fabrics, which is a sub-category of SITC level Manufactures' industry, provide support to PCP mechanism if we compare the values from Table 9 and Table 1 for Japan. Non-ferrous metals' industry prices also point to stickiness in terms of producer currency, though the coefficient is not very much significant when we look at the export prices. Machinery and Transport equipment prices provide partial support for PCP with a subcategory, Metal-working machinery import prices in case of USA moving in tandem with the traditional argument and Japanese Machinery and Equipment industry moving in correspondence to the theoretical prediction. Miscellaneous manufactures industry prices from all three categories of country-wise export estimates get corresponding support from US Furnitures' industry and Japan's Wood industry import prices with an exchange rate depreciation showing predictable movements as under PCP type mechanism. Though these later two industries are subcategories of Miscellaneous manufactures' industries, but still these can be judged as support for producer currency type adjustments. Obstfeld (2002) also compares the co-movements of USA and Canadian SITC level export prices and import prices and finds similar results. Our empirical analysis, therefore, points out the validity of traditional argument and the PCP mechanism.

5 Conclusion

The new open economy macro models by Obstfeld and Rogoff (1995) argue for flexible exchange rates based on the assumed strength of Keynesian-type expenditure-switching. Our empirical evidence from thirty-four industries across three countries show that there is some justification in that. Using post Bretton Wood period high-frequency industrial-level monthly price data, we find indirect support for the sticky-wages-and-prices argument in exporting producers' currencies. This, in turn, points out to the prevalence of the PCP mechanism in import prices. For both export and import prices, we find that, there is traditional Keynesian-type responses in response to an exchange rate depreciation. Though preliminary, as we find significantly high expenditure-switching effects, these results provide some support for the adoption of a flexible exchange rate regime. We also try to separate the pass-through effects towards import prices and domestic prices, and argue that Obstfeld's (2002) proposed hypotheses can be empirically explored using a consistent econometric framework.

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Appendix 1 : Tables

Table 1. Estimation Results from System I

Country	Industry	$h_1(SR)$	$f_3(SR)$	$f_2(SR)$	$h_1(LR)$	$f_3(LR)$	$f_2(LR)$
Japan	Chemicals	0.088	0.021	na	0.123	0.351	na
	p-value	0.048	0.009	na	0.048	0.643	na
Japan	Food	0.143	0.042	0.171	0.386	1.251	5.13
	p-value	0.034	0.022	0.000	0.104	0.854	0.85
Japan	Mach. and Equip.	0.053	0.027	0.036	0.071	0.022	0.029
	p-value	0.081	0.002	0.072	0.089	0.002	0.049
Japan	Metal	0.025	0.032	0.085	0.051	-0.165	-0.443
	p-value	0.764	0.057	0.000	0.767	0.399	0.354
Japan	Petrol and fuel	-0.221	-0.124	0.382	-0.421	-0.076	0.234
	p-value	0.027	0.002	0.000	0.012	0.003	0.000
Japan	Textiles	0.071	0.027	0.048	0.078	0.019	0.035
	p-value	0.028	0.087	0.163	0.030	0.085	0.144
Japan	Wood	0.401	0.221	0.161	1.257	0.904	0.658
	p-value	0.000	0.000	0.000	0.006	0.549	0.515
USA	Food and beve.	0.354	-0.082	na	0.291	-0.084	na
	p-value	0.004	0.002	na	0.006	0.005	na
USA	Mineral fuels and lubri.	0.522	0.450	0.154	0.522	0.450	0.154
	p-value	0.175	0.037	0.000	0.175	0.037	0.000
USA	Textiles and apparels	-0.254	0.158	na	-0.256	0.060	na
	p-value	0.000	0.005	na	0.000	0.005	na

Table 2. Nested Model Testing for System I

Country	Industry	$R1$ is correct	$R2$ is correct	$R3$ is correct
Japan	Chemicals	52.788	93.992	na
	p-value	0.002	0.567	na
Japan	Food	54.057	129.918	na
	p-value	0.002	0.002	na
Japan	Mach. and Equip.	46.112	72.193	na
	p-value	0.064	0.999	na
Japan	Metal	70.017	33.745	na
	p-value	0.000	0.999	na
Japan	Petrol and fuel	55.121	61.439	na
	p-value	0.001	0.997	na
Japan	Textiles	165.985	115.564	na
	p-value	0.000	0.969	na
Japan	Wood	63.177	69.462	na
	p-value	0.000	0.995	na
USA	Food and Beve.	338.499	6.053	na
	p-value	0.000	0.999	na
USA	Mineral fuels and lubri.	404.010	89.932	na
	p-value	0.000	0.999	na
USA	Textiles	67.792	77.684	na
	p-value	0.000	0.888	na

Table 3. Estimation Results from System II

Country	Industry	$h_1(SR)$	$f_3(SR)$	$f_2(SR)$	$h_1(LR)$	$f_3(LR)$	$f_2(LR)$
UK	Chemicals and Organic chemicals	-0.344	0.054	0.021	-0.344	0.054	0.021
	p-value	0.000	0.003	0.079	0.000	0.003	0.079
UK	Machinery and Electrical equipment	-0.461	0.018	0.028	-0.571	0.018	0.029
	p-value	0.000	0.075	0.013	0.000	0.085	0.016

Table 4. Nested Model Testing for System II

Country	Industry	$R1$ is correct	$R2$ is correct	$R3$ is correct
UK	Chemicals and Organic chemicals	50.762	139.908	na
	p-value	0.010	0.015	na
UK	Machinery and Electrical equipment	74.055	101.359	na
	p-value	0.000	0.236	na

Table 5. Estimation Results from System III

Country	Industry	$h_1(SR)$	$g_2(SR)$	$g_1(SR)$	$h_1(LR)$	$g_2(LR)$	$g_1(LR)$
UK	Tobacco	1.655	0.522	-0.354	1.117	0.401	-0.272
	p-value	0.000	0.000	0.000	0.000	0.000	0.000
UK	Pulp	0.276	0.299	na	0.161	0.622	na
	p-value	0.025	0.009	na	0.028	0.015	na
UK	Wood	-0.722	-0.262	na	-0.722	-0.394	na
	p-value	0.000	0.000	na	0.000	0.001	na
UK	Metal ores	0.546	0.324	-0.145	0.258	0.487	-0.218
	p-value	0.088	0.004	0.004	0.089	0.007	0.012
UK	Chemicals	-0.536	na	0.036	-0.397	na	0.075
	p-value	0.000	na	0.247	0.000	na	0.219
UK	Organic chemicals	0.215	0.332	0.163	0.231	0.323	0.159
	p-value	0.116	0.002	0.153	0.133	0.002	0.129
UK	Medicinal products	-0.313	-0.332	na	-0.241	-0.332	na
	p-value	0.000	0.005	na	0.000	0.005	na
UK	Plastics	0.085	-0.079	0.459	0.187	-0.089	0.518
	p-value	0.191	0.271	0.002	0.214	0.282	0.000
UK	Textile fabrics	-0.243	0.028	0.086	-0.359	0.057	0.177
	p-value	0.000	0.028	0.001	0.002	0.042	0.002
UK	Iron and Steel	0.145	0.131	0.573	0.146	0.093	0.409
	p-value	0.042	0.039	0.000	0.047	0.042	0.000
UK	Non-ferrous metals	0.251	0.425	0.058	0.146	0.600	0.082
	p-value	0.002	0.001	0.239	0.001	0.002	0.240
UK	Machinery and Trans.	-0.487	0.024	0.066	-0.391	0.024	0.067
	p-value	0.000	0.041	0.003	0.000	0.047	0.005
UK	Electrical machinery	-0.479	0.047	0.050	-0.511	0.091	0.096
	p-value	0.000	0.009	0.063	0.000	0.022	0.052

Table 6. Nested Model Testing for System III

Country	Industry	$R1$ is correct	$R2$ is correct	$R3$ is correct
UK	Tobacco	51.146	na	50.419
	p-value	0.351	na	0.999
UK	Pulp	64.107	46.194	na
	p-value	0.000	0.464	na
UK	Wood	19.018	na	10.727
	p-value	0.088	na	0.978
UK	Metal ores	24.510	23.351	na
	p-value	0.017	0.612	na
UK	Chemicals	38.741	49.647	na
	p-value	0.003	0.258	na
UK	Organic chemicals	18.275	na	37.008
	p-value	0.107	na	0.012
UK	Medicinal products	18.946	na	19.563
	p-value	0.395	na	0.994
UK	Plastics	27.529	na	40.591
	p-value	0.069	na	0.237
UK	Textile fabrics	16.874	na	26.804
	p-value	0.531	na	0.838
UK	Iron & Steel	24.781	na	39.093
	p-value	0.131	na	0.252
UK	Non-ferrous metals	22.944	20.027	na
	p-value	0.028	0.829	na
UK	Machinery and Tran.	11.898	na	39.744
	p-value	0.852	na	0.194
UK	Electrical machinery	32.678	na	45.650
	p-value	0.111	na	0.528

Table 7. Estimation Results from System III

Country	Industry	$h_1(SR)$	$g_2(SR)$	$g_1(SR)$	$h_1(LR)$	$g_2(LR)$	$g_1(LR)$
USA	Meat	-0.316	-0.133	na	-0.309	-0.174	na
	p-value	0.068	0.125	na	0.074	0.143	na
USA	Fruit	0.525	na	0.019	0.228	na	0.025
	p-value	0.147	na	0.013	0.148	na	0.017
USA	Beverages	-0.046	-0.164	0.319	-0.033	-0.164	0.319
	p-value	0.093	0.009	0.002	0.095	0.009	0.002
USA	Chemicals	0.105	0.094	0.237	0.105	0.121	0.306
	p-value	0.006	0.006	0.041	0.006	0.013	0.018
USA	Organic chemicals	-0.174	-0.284	0.535	-0.161	-0.298	0.564
	p-value	0.091	0.013	0.001	0.090	0.014	0.002
USA	Inorganic chemicals	-0.125	na	0.485	-0.171	na	0.382
	p-value	0.313	na	0.000	0.300	na	0.000
USA	Rubber	0.038	-0.005	na	0.063	-0.014	na
	p-value	0.559	0.844	na	0.573	0.842	na
USA	Non-metallic minerals	-0.111	0.028	na	-0.134	0.035	na
	p-value	0.009	0.102	na	0.009	0.107	na
USA	Metal working machinery	0.303	0.077	0.101	0.431	0.811	1.067
	p-value	0.007	0.001	0.052	0.024	0.585	0.583
USA	Electrical machinery	-0.118	na	0.078	-0.189	na	0.145
	p-value	0.060	na	0.001	0.078	na	0.003
USA	Furnitures	0.100	0.027	0.016	0.124	0.081	0.048
	p-value	0.019	0.023	0.551	0.025	0.107	0.548

Table 8. Nested Model Testing for System III

Country	Industry	$R1$ is correct	$R2$ is correct	$R3$ is correct
USA	Meat	21.825	na	21.802
	p-value	0.351	na	0.995
USA	Fruit	13.735	na	41.308
	p-value	0.746	na	0.287
USA	Beverages	12.212	na	23.810
	p-value	0.836	na	0.973
USA	Chemicals	44.851	66.422	na
	p-value	0.001	0.059	na
USA	Organic chemicals	17.283	na	47.863
	p-value	0.635	na	0.214
USA	Inorganic chemicals	21.748	na	18.696
	p-value	0.243	na	0.992
USA	Rubber	21.686	na	27.366
	p-value	0.357	na	0.949
USA	Non-metallic minerals	9.220	na	27.155
	p-value	0.980	na	0.983
USA	Metal working machinery	7.252	na	68.739
	p-value	0.995	na	0.001
USA	Electrical machinery	9.271	na	30.111
	p-value	0.979	na	0.914
USA	Furnitures	8.299	na	42.688
	p-value	0.989	na	0.398

Table 9. Estimation Results from Relative Export Prices

Industry	US-UK Estimates	US-JAPAN Estimates	UK-JAPAN Estimates
Meat	-0.637	na	na
p-value	0.137	na	na
Fruit	-0.507	na	na
p-value	0.129	na	na
Beve. and Tobacco	-0.243	na	na
p-value	0.004	na	na
Crude mate., except fuel	0.328	na	na
p-value	0.038	na	na
Textile fibers	-0.472	na	na
p-value	0.042	na	na
Metalliferous ores etc.	0.269	na	na
p-value	0.269	na	na
Chemicals	-0.259	-0.283	-0.179
p-value	0.004	0.179	0.015
Organic chemicals	-0.431	na	na
p-value	0.003	na	na
Inorganic chemicals	-0.168	na	na
p-value	0.132	na	na
Medicinal products etc	-0.208	na	na
p-value	0.050	na	na
Uncoated paper	-0.327	na	na
p-value	0.017	na	na
Textile fabrics	na	na	-0.304
p-value	na	na	0.000
Non-ferrous metals	-0.203	na	na
p-value	0.280	na	na
Manu. of metals	na	-0.436	na
p-value	na	0.028	na

Table 9A. Estimation Results from Relative Export Prices(contd.)

Industry	US-UK Estimates	US-JAPAN Estimates	UK-JAPAN Estimates
Machinery and Trans.	na	-0.283	-0.249
p-value	na	0.007	0.000
Road vehicles	-0.095	-0.667	-0.090
p-value	0.082	0.002	0.269
Misc. Manufactures	-0.101	-0.374	-0.347
p-value	0.115	0.036	0.000

Appendix 2 : Industry-wise data description

USA: Import prices are taken for the following industries, numbers on left correspond to SITC

01 Meat and meat preparations (denoted by 'Meat' in the tables; subcategory of SITC category "Food and live animals")

05 Vegetables, fruit and nuts, fresh or dried (denoted by 'Fruit' in the tables; subcategory of SITC category "Food and live animals")

11 Beverages (denoted by 'Beverages' in the tables; subcategory of SITC category "Beverages and Tobacco")

5 Chemicals and related products, n.e.s (denoted by 'Chemicals' in the tables)

51 Organic chemicals (denoted by 'Organic chemicals' in the tables; subcategory of SITC category "Chemicals and related products")

52 Inorganic chemicals (denoted by 'Inorganic chemicals' in the tables; subcategory of SITC category "Chemicals and related products")

62 Rubber manufactures, n.e.s (denoted by 'Rubber' in the tables; subcategory of SITC category "Manufactured goods classified chiefly by materials")

66 Non-metallic mineral manufactures (denoted by 'Non-metallic minerals' in the tables; subcategory of SITC category "Manufactured goods classified chiefly by materials")

73 Metalworking machinery (denoted by 'Metal working machinery' in the tables; subcategory of SITC category "Machinery and Transport Equipment")

77 Electrical machinery and equipment (denoted by 'Electrical machinery' in the tables; subcategory of SITC category "Machinery and Transport Equipment")

82 Furniture and parts thereof (denoted by 'Furnitures' in the tables; subcategory of SITC category "Miscellaneous manufactured articles")

UK: Import prices are taken for the following industries, numbers on left correspond to SITC

12 Tobacco (denoted by 'Tobacco' in the tables; subcategory of SITC category "Beverages and Tobacco")

25 Pulp and waste paper (denoted by 'Pulp' in the tables; subcategory of SITC category "Crude Materials")

24 Wood and cork (denoted by 'Wood' in the tables; subcategory of SITC category "Crude Materials")

27 Metal ores (denoted by 'Metal ores' in the tables; subcategory of SITC category "Crude Materials")

5 Chemicals (denoted by 'Chemicals' in the tables)

51 Organic chemicals (denoted by 'Organic chemicals' in the tables; subcategory of SITC category "Chemicals")

54 Medicinal products (denoted by 'Medicinal products' in the tables; subcategory of SITC category "Chemicals")

57+58 Plastics (denoted by 'Plastics' in the tables; subcategory of SITC category "Chemicals")

65 Textile fabrics (denoted by 'Textile fabrics' in the tables; subcategory of SITC category "Manufactures")

67 Iron and Steel (denoted by 'Iron and Steel' in the tables; subcategory of SITC category "Manufactures")

68 Non-ferrous metals (denoted by 'Non-ferrous metals' in the tables; subcategory of SITC category "Manufactures")

7 Machinery and Transport Equipment (denoted by 'Machinery and Tran.' in the tables)

716+75+76+77 Electrical machinery (denoted by 'Electrical machinery' in the tables; subcategory of SITC category "Machinery and Transport Equipment")

Japan: Import prices are taken for the following industries

Chemicals (denoted by 'Chemicals' in the tables)

Foodstuffs and Feedstuff (denoted by 'Food' in the tables)

Machinery and Equipment (denoted by 'Mach. and Equip.' in the tables)

Metals and Related Products (denoted by 'Metal' in the tables)

Petroleum, Coal and Natural Gas (denoted by 'Petrol and fuel' in the tables)

Textiles (denoted by 'Textiles' in the tables)

Wood, Lumber and Related Products (denoted by 'Wood' in the tables)

USA and UK: Export prices are taken for the following industries, numbers on left correspond to SITC

01 Meat and meat preparations (relative export prices denoted by 'Meat' in the table; subcategory of SITC category "Food and live animals")

05 Vegetables, fruit and nuts, fresh or dried (relative export prices denoted by 'Fruit' in the table; subcategory of SITC category "Food and live animals")

1 Beverages and Tobacco (relative export prices denoted by 'Beve. and Tobacco' in the table)

2 Crude materials, inedible, except fuels (relative export prices denoted by 'Crude mate., except fuel' in the table)

26 Textile fibers and their waste (relative export prices denoted by 'Textile fibers' in the table; subcategory of SITC category "Crude materials, inedible, except fuels")

28 Metalliferous ores and metal scrap (relative export prices denoted by 'Metalliferous ores etc.' in the table; subcategory of SITC category "Crude materials, inedible, except fuels")

5 Chemicals and related products, n.e.s (relative export prices denoted by 'Chemicals' in the table)

51 Organic chemicals (relative export prices denoted by 'Organic chemicals' in the table; subcategory of SITC category "Chemicals and related products")

52 Inorganic chemicals (relative export prices denoted by 'Inorganic chemicals' in the table; subcategory of SITC category "Chemicals and related products")

54 Medicinal and pharmaceutical products (relative export prices denoted by 'Medicinal products etc.' in the tables; subcategory of SITC category "Chemicals and related products")

64 Uncoated paper or paperboard, and linearboard (relative export prices denoted by 'Uncoated paper' in the table; subcategory of SITC category "Manufactured goods classified chiefly by materials")

68 Nonferrous metals (relative export prices denoted by 'Non-ferrous metals' in the table; subcategory of SITC category "Manufactured goods classified chiefly by materials")

78 Road vehicles (relative export prices denoted by 'Road vehicles' in the table; subcategory of SITC category

“Machinery and Transport Equipment”)

77 Electrical machinery and equipment (relative export prices denoted by ‘Electrical machinery’ in the table; subcategory of SITC category “Machinery and Transport Equipment”)

8 Miscellaneous manufactured articles (relative export prices denoted by ‘Misc. Manufactures’ in the table)

Japan: Export prices are taken for the following industries

Chemicals and Related Products (relative export prices denoted by ‘Chemicals’ in the table)

Textiles (relative export prices denoted by ‘Textile fabrics’ in the table)

Metals and Related Products (relative export prices denoted by ‘Manu. of metals’ in the table)

General Machinery and Equipment (relative export prices denoted by ‘Machinery and Trans.’ in the table)

Transportation Equipment (relative export prices denoted by ‘Road vehicles’ in the table)

Other Manufacturing Industry Products (relative export prices denoted by ‘Misc. Manufactures’ in the table)