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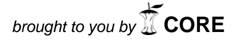

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Expenditure Switching and Exchange-Rate Policy

1. *Introduction*

Exchange-rate flexibility, it has been argued, is useful because it facilitates relative price adjustment among countries. Currency depreciation is a quick and painless way to lower domestic prices relative to foreign prices. Much attention has been paid recently to the benefits of exchange-rate stability in emerging economies. That literature has focused on the potential for greater monetary and financial stability from either fixing exchange rates or taking more extreme measures such as adopting a currency board or dollarizing. But that analysis is not directly applicable to the choices facing many advanced countries—such as the decision to adopt the euro for some European countries. These countries uniformly have stable monetary policies (at least as stable as the policy conducted by the European Central Bank) and have deep, well-regulated financial markets. The economic benefit of adopting the euro lies in the increased efficiency of transactions and the elimination of uninsurable exchange-rate risk. On the other hand, a country adopting the euro cedes its monetary policy to the European Central Bank, and no longer has the option of using monetary policy to respond to local conditions. Furthermore, adopting the euro eliminates one possible avenue for adjustment between countries—the relative price changes induced by exchange-rate movements. It is this latter effect that is the focus of this study.

Recent evidence has found that consumer prices in rich countries are

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not much affected by nominal exchange-rate changes in the short run.[1] This finding may imply that nominal-exchange-rate changes do not play much of a role in changing relative prices of goods. If consumer prices are not responsive to exchange rates, then a depreciation of the home currency, for example, does not increase much the price that consumers pay for imported goods. However, there are other interpretations of the evidence on exchange rates and consumer prices. For example, there might be important relative price effects but not for final consumer goods. One possibility is that intermediate firms substitute between domestic and foreign goods according to relative price changes, but set prices for consumers in a way that is unresponsive to exchange-rate changes.

The extent to which exchange rates alter relative prices may be important for determining the desirability of exchange-rate flexibility among advanced nations. Milton Friedman (1953), an early advocate of flexible exchange rates, argued that one advantage of floating rates is that they could allow rapid change in relative prices between countries (p. 162):

> A rise in the exchange rate . . . makes foreign goods cheaper in terms of domestic currency, even though their prices are unchanged in terms of their own currency, and domestic goods more expensive in terms of foreign currency, even though their prices are unchanged in terms of domestic currency. This tends to increase imports [and] reduce exports.

This passage makes two assumptions: that goods prices are unchanged in the currency of the producer of the good, and that there is significant passthrough of the exchange-rate change to the buyer of the good. On the nominal-price stickiness, Friedman argues that the choice of exchange-rate regime would matter little if nominal goods prices adjusted quickly to shocks (p. 165):

> If internal prices were as flexible as exchange rates, it would make little economic difference whether adjustments were brought about by changes in exchange rates or by equivalent changes in internal prices. But this condition is clearly not fulfilled. . . . At least in the modern world, internal prices are highly inflexible.

In assessing this relative-price effect and its significance for the choice of exchange-rate regime, Friedman is certainly correct to emphasize the

1. I have been the perpetrator of some of this literature: for example, Engel (1993, 1999) and Engel and Rogers (1996, 2001). Other works include Rogers and Jenkins (1995), Obstfeld and Taylor (1997), Parsley and Wei (2001a, 2001b), and Crucini, Telmer, and Zachariadis (2001). Mussa's (1986) classic paper stimulated much of this research.

importance of nominal-goods-price stickiness. As Buiter (1999) has forcefully emphasized, the decision to join a monetary union, or the choice of an exchange-rate regime, is a monetary issue. Relative-price behavior is usually independent of monetary regime in a world of perfect goods-price flexibility. The choice of monetary regime in this case only matters for short-run adjustment problems—the period during which nominal prices are adjusting.

The pioneering work of Obstfeld and Rogoff (1995, 1998, 2000a) has assumed that nominal prices are fixed in the producers' currencies, so that prices for consumers change one for one in the short run with changes in the nominal exchange rate. This is exactly the assumption of Friedman. I shall call this the PCP (for "producer-currency pricing") model. The Obstfeld–Rogoff (hereinafter, OR) models offer a sound analytical foundation for the claim that flexibility of exchange rates is desirable in this setting.[2] They derive three important results: (1) Exchange-rate flexibility achieves relative-price adjustment under PCP pricing. Indeed, in their models, flexible exchange rates are a perfect substitute for flexible nominal prices. That is, the flexible nominal-price allocations are achieved with PCP pricing but flexible exchange rates. (2) The policy that achieves the flexible price allocation is a constrained Pareto optimum. The monetary authorities can do no better. (3) This optimal policy is completely self-oriented. No policy coordination across countries is required or desirable. In this sense, perfectly flexible exchange rates are optimal.

The key role of nominal-exchange-rate flexibility in these models is that it allows for *expenditure switching*. That is, in the presence of real shocks that are specific to one country (productivity shocks, labor supply shocks, government spending shocks, etc.), nominal-exchange-rate changes allow adjustment of relative prices of goods across countries. These changes in relative prices can replicate the changes in relative prices that occur in flexible-price economies. For example, a country that experiences a productivity increase should experience a decline in the price of its output that induces a switch in expenditures toward the domestic product. In the PCP framework, even though nominal prices are sticky in the producers' currencies, this relative-price decline can be accomplished by nominal currency depreciation.

A number of recent papers [Betts and Devereux (1996, 2000), Chari, Kehoe, and McGrattan (2000), and others] have examined OR-style models in which nominal prices are set in advance in the currency of consumers. In that case, nominal-exchange-rate changes do not, in the short run, change any prices—nominal or real—faced by consumers. I shall call this

2. See Lane (2001) for an excellent general survey of the work stimulated by OR.

the LCP (for "local-currency pricing") model. Devereux and Engel (2001) have examined monetary policy in this setting, and have concluded that there is no case for nominal-exchange-rate flexibility—indeed, fixed exchange rates are preferred.

The size of the expenditure-switching effect is important in international macroeconomics not only for how it might influence optimal monetary policy. The literature, dating back to Mundell (1968) and earlier,[3] has emphasized the expenditure-switching role of nominal-exchange-rate changes in transmitting business-cycle fluctuations between countries. On the other hand, Krugman (1989) has argued that nominal-exchange-rate volatility might be accentuated if the expenditure-switching effect is small. The smaller the effect of exchange-rate changes on relative prices, and hence on relative demands, the larger the exchange-rate change that is required to reach equilibrium.[4]

Sections 2, 3, 4, and 5 of this paper lay out the framework of the new open-economy macroeconomics. I discuss why floating exchange rates are desirable under PCP, but fixed exchange rates may be optimal under LCP. Empirical evidence supports the notion that consumer prices are not very responsive in the short run to nominal-exchange-rate changes. Section 6 reviews some of that empirical evidence, and adds some new supporting evidence.

But the apparent small response of consumer prices to exchange-rate changes in the short run does not necessarily imply that nominal prices are sticky in consumers' currencies, or that the expenditure-switching effect is small. In OR (2000b), transportation costs and distribution costs increase the cost of imported goods, and serve to segment national markets. Even if imported goods are nearly perfect substitutes for domestically produced goods, they may not be consumed in great quantity because their cost is higher. In that case, an exchange-rate change will have only a small effect on the consumer price index.

A related approach observes that the actual physical good is only a small part of what the consumer buys. The consumer also pays for the nontraded marketing, distribution, and retailing services that bring the good to the buyer. Perhaps these costs are quite large, and dominate the cost of the physical good. If so, the influence of exchange-rate changes on real allocations is likely to be small, since the exchange-rate change only affects a small part of the cost of the good cum service purchased by the consumer. This is the approach taken by McCallum and Nelson (2000).

3. See Obstfeld (2001) for a survey of pre-Mundellian literature.

4. Devereux and Engel (2002) explore this argument and its limitations in the context of new open-economy macro models.

In both of these models, nominal consumer prices of imported goods are not sticky. But some new evidence will be presented in Sections 7 and 8 that suggests these models are, at best, only a small part of the explanation for the lack of responsiveness of consumer prices to exchange-rate changes. It seems likely that there is a significant degree of nominal-consumer-price stickiness. However, sticky consumer prices in themselves do not necessarily rule out an important expenditure-switching effect.

Obstfeld (2001) and Devereux, Engel, and Tille (1999) model imported goods as intermediates in the production of final consumer goods. In Obstfeld, there are domestic substitutes for the import, while in Devereux, Engel, and Tille there are not. When there are substitutes, the importer might switch between the imported intermediate and the locally produced alternative when the exchange rate changes. Obstfeld argues that in this type of economy, there may indeed be a significant expenditure-switching effect. It is not consumers who switch between imports and locally produced goods, but rather local producers who combine intermediate goods to make the final consumer product. It is both the degree of passthrough and the amount of substitutability that determine the strength of the expenditure-switching effect. Section 9 explores these models, and Section 10 sets out some directions for future research.

2. *Models of Exchange Rates and Relative Prices*

In this and the next three sections, I examine some simple new-open-economy macroeconomic models. These models are fully integrated equilibrium models in which households and firms make optimal choices, but in which some nominal prices are not completely responsive to shocks.

There are two countries in the general model. I will assume that there is a single period, though most of the results I discuss carry over to a multiperiod framework. I assume households in the home country maximize

$$U = \frac{1}{1-\rho}C^{1-\rho} + \chi \ln\left(\frac{M^D}{P}\right) - \psi L.$$

C is a consumption aggregate. Households consume goods produced in the home country and in the foreign country. Assume preferences are homothetic (so consumption aggregates and price indexes are defined.)

Real balances, M^D/P, appear in the utility function, where P is the optimal price index. Households get disutility from work, L.

Foreign households are assumed to have similar utility functions:

$$U^* = \frac{1}{1-\rho} C^{*1-\rho} + \chi \ln\left(\frac{M^{D*}}{P^*}\right) - \psi L^*.$$

Starred (*) variables are the foreign counterparts to the home-country variables.

Money is supplied exogenously through transfers. In equilibrium we have money supply equals money demand in each country $M = M^D$ and $M^* = M^{D*}$. The money supplies are random (as are productivity shocks to be introduced shortly.)

I will assume there are financial markets of the type discussed in Devereux and Engel (2001). Specifically, there are nominal bonds, traded prior to the realization of the state, that have payoffs specific to each possible state of the world. Most of the models we consider have home and foreign consumers facing different prices for the same good on spot markets. That is, the markets are segmented. We assume that it is impossible to make state-contingent trades that allow payoffs in physical goods, as that would allow households to get around paying the price set in their market. Instead, payoffs are specified in nominal terms. Optimal contracts ensure that the marginal utility from an additional unit of currency is proportional between home and foreign consumers in all states (where I have assumed the constant of proportionality is 1):

$$\frac{C^{-\rho}}{P} = \frac{C^{*-\rho}}{SP^*}.$$

S is the nominal exchange rate, expressed as the home-currency price of foreign currency.

Even though there is a nominal bond traded for each state of the world, markets are not complete, because the goods markets are segmented nationally. If the same good sells for different prices in different markets, households cannot arbitrage the goods market. As a result, risk sharing is not perfect unless purchasing-power parity (PPP) holds ($P = SP^*$).

The assumption that so many nominal assets are traded is, of course, unrealistic. It is a useful benchmark, and here it allows us to arrive at a simple flexible model that can be used to analyze relative-price effects in general equilibrium. We can reproduce Friedman's claim that nominal-exchange-rate flexibility allows desirable relative price adjustments to occur rapidly under his assumption of nominal prices fixed in producer's currencies, but we can also analyze other assumptions about how prices are set.

The following equilibrium conditions emerge using the first-order conditions for the household optimization problem:

$$M = \chi P C^{\rho}, \qquad M^* = \chi P^* C^{*\rho},$$

$$W = \psi P C^{\rho}, \qquad W^* = \psi P^* C^{*\rho}.$$

Here, W and W^* are the home and foreign wage, respectively.

This framework, while making very specific assumptions about preferences, has the advantage that it is easy to analyze under a variety of assumptions about goods pricing and about preferences over goods. We can derive a solution for the nominal exchange rate that does not depend on any assumptions about the production side of the economy or about how nominal prices are set, without making any further assumptions about consumption utility:

$$S = \frac{M}{M^*}.$$

Now we turn to the production side of the economy. There are a large number of goods produced in each country, each by a monopolist. We will initially consider models in which output for each firm i is produced using only a labor input: $Y_i = \eta L_i$ and $Y_i^* = \eta^* L_i^*$.[5] Here η (η^*) is a productivity shock that is common to all home (foreign) firms. We will consider a variety of possible assumptions about how prices are set. Prices may be flexible—that is, set with full information about the state. Or, in the new open-economy models, firms must set nominal prices in some currency prior to knowledge about the state.

3. *Flexible Nominal Prices*

It is helpful first to examine some of the properties of this model under completely flexible nominal prices. We shall assume home and foreign households have identical CES preferences over home and foreign aggregates. Each of these aggregates is in turn a CES function over the individual goods produced in the home and the foreign country, respectively. Firms face constant-elasticity demand curves, and therefore set prices as a constant markup over unit costs. We allow firms to discriminate across home and foreign markets. But under our assumptions about preferences

5. One of the models we examine later will have an iceberg transportation cost for shipping goods overseas. We will also consider models in which intermediate goods are used as inputs into final-goods production.

and about financial markets, when PPP holds (under flexible prices or under PCP), firms choose the same price for home and foreign consumers.

Aggregating across all home firms, we get

$$P_H = \mu W / \eta,$$

where P_H is the home currency price of home goods, and $\mu > 1$ is the markup. We have also $P_H = SP_H^*$, where P_H^* is the foreign-currency price of home goods. Likewise,

$$P_F^* = \mu W^* / \eta^*,$$

and $P_F = SP_F^*$.

We can also derive these equations for nominal wages in equilibrium:

$$W = \frac{\Psi}{\chi} M, \qquad W^* = \frac{\Psi}{\chi} M^*.$$

It follows from the equilibrium conditions that

$$\frac{P_H}{P_F} = \frac{P_H^*}{P_F^*} = \frac{\eta^*}{\eta}.$$

The relative price of home goods falls when there is an increase in η. When productivity in home firms increases, the cost per unit of home goods declines. Those costs savings are passed on to consumers in the form of lower prices.

I will not undertake a formal welfare analysis of the models presented here. Instead, I will focus on what turns out to be a critical aspect of the welfare analysis: the extent to which an exchange-rate regime is beneficial in achieving the adjustment of the price of home goods relative to foreign goods. Under the Friedman framework, exchange-rate flexibility allows immediate adjustment of that relative price in response to real shocks. But, as we shall see, that finding is a special case that depends critically on how Friedman assumes nominal goods prices are set.

4. *Sticky Nominal Prices: PCP Case*

Now consider the model when firms must set nominal prices in advance. In the one-period framework here, this means that prices are set in advance of knowledge of the preference shocks and money-supply realiza-

tions. Perhaps there are menu costs or some other sorts of costs that make it more profitable to set a non-state-contingent nominal price. First we take up the case in which firms set prices in their own currencies. That is, home firms set prices in the home currency, whether for sale to home or foreign households. We call this the PCP case. The law of one price holds for goods sold at home and in the foreign country, because, as we noted above, under our assumptions about preferences and financial markets, firms do not price-discriminate.

It follows that

$$\frac{P_H}{P_F} = \frac{P_H^*}{P_F^*} = \frac{P_H}{SP_F^*}.$$

Under the PCP assumption, both P_H and P_F^* are fixed ex ante and do not respond to shocks to demand or money supply. Define $\kappa \equiv P_H/P_F^*$. Because these nominal prices are set in advance of the realization of the state, κ does not depend on the outcomes of the random variables. Then the relative price of home to foreign goods varies inversely with the exchange rate:

$$\frac{P_H}{P_F} = \frac{\kappa}{S}.$$

Substituting in the expression for the equilibrium exchange rate, we get, under PCP pricing,

$$\frac{P_H}{P_F} = \kappa\frac{M^*}{M}.$$

Here we can see the gist of Friedman's argument for flexible exchange rates. If the exchange rate were fixed, there would be no channel to translate real demand shocks into a relative-price change. That is, if the exchange rate were held constant at a value of $\bar{S}$, the relative price of home to foreign goods would not depend on the shocks that hit the economy:

$$\frac{P_H}{P_F} = \frac{\kappa}{\bar{S}}.$$

But with exchange-rate flexibility and the correct monetary policy, the real productivity shocks can be translated precisely into the same relative-price effect that occurs under flexible prices. With the monetary policy

rules $M = (\chi\eta/\psi\mu)P_H$ and $M^* = (\chi\eta^*/\psi\mu)P_F^*$, the relative price will equal exactly its value under flexible prices:

$$\frac{P_H}{P_F} = \frac{P_H^*}{P_F^*} = \frac{\eta^*}{\eta}.$$

In fact, allocations are identical under PCP with these monetary rules, and under flexible prices. That is very much in accord with Friedman's intuition: flexible exchange rates are a perfect substitute for flexible goods prices in the presence of real shocks.

Moreover, in the models of OR (1998, 2000a), mimicking the flexible price allocation is the constrained globally efficient monetary policy. While the flexible-price equilibrium itself is not Pareto-efficient (because of the monopoly distortions), optimal monetary policy can do no better than to replicate the flexible-price allocation.

The monetary policy I set out above is not only the policy that would be set by a global central planner. It is, as OR (2000a) show, the policy that self-interested national economic planners would follow. That is, there is no gain to international monetary coordination. Central banks following policies that maximize their own country's welfare can achieve the constrained globally efficient outcome. Thus, a system in which central bankers do not cooperate at all and allow the exchange rate to float freely is optimal, as Friedman claimed.[6]

This model, however, has implications that seem counterfactual: that exchange-rate changes are passed through one for one into consumer prices, and that the law of one price holds for all goods. It is this characteristic of the model that has led some researchers to consider the local-currency pricing version of the sticky-nominal-price model.

5. *Sticky Prices: LCP Case*

An alternative model for price setting is that firms set prices in the currency of consumers of the product. That is, when a home firm sells in the home market, it sets prices in the home currency, but for sales to the foreign market it sets prices in the foreign currency. We call this the LCP (for "local-currency pricing") case.

It follows immediately in this case that a flexible nominal exchange rate cannot achieve the optimal relative-price adjustment. P_h and P_f are both

6. OR (1998, 2000a) have delicate sets of assumptions on preferences and market structure that ensure that markets are actually complete. But OR (2001) show that these basic conclusions are, to first order, robust to market incompleteness.

set in the domestic currency and do not respond to contemporaneous shocks. We cannot replicate the flexible-price solution $P_H/P_F = P_H^*/P_F^* = \eta^*/\eta$ with flexible exchange rates, no matter what the monetary policy. In fact, Devereux and Engel (2001) go further and demonstrate that the optimal monetary policy in this case delivers fixed exchange rates.[7] Or, put another way, if the foreign country is following optimal monetary policy while the home country is using the exchange rate as its policy instrument, the optimal exchange-rate policy is to fix.

There is a simple way to understand the striking difference in optimal policy in the PCP world vs. the LCP world. There are two types of deviations from efficiency which monetary policy might be able to rectify in a sticky-price world. One is that relative prices might not respond in the correct way to real shocks, so that we might not achieve $P_H/P_F = P_H^*/P_F^* = \eta^*/\eta$. In the absence of optimal relative-price changes, consumers do not receive the correct signals and do not alter their demand for goods in the appropriate way when real shocks hit. As a consequence, resources will not be allocated efficiently.

The other type of inefficiency comes because deviations from PPP lead to incomplete risk sharing. As noted above, with a complete set of nominal contingent claims traded, in equilibrium $C^{-\rho}/P = C^{*-\rho}/SP^*$. Asset markets do not deliver complete risk sharing unless PPP holds ($P = SP^*$).

When prices are set in producers' currencies (PCP), PPP does hold, so asset markets do deliver complete risk sharing. In that case, monetary policy can be devoted entirely to ensuring that relative prices respond in the appropriate way to real shocks. But, of course, exchange-rate flexibility is needed to deliver the relative-price response.

Under local-currency pricing, relative prices simply cannot change in the short run in response to real shocks. It is useless for monetary-policy makers to devote any effort to achieving an efficient relative-price response. But, under LCP pricing, both P and P^* are predetermined and not affected by real shocks. If the nominal exchange rate is fixed so that PPP holds ($S = P/P^*$), then asset markets will achieve complete risk sharing.

This model is designed to highlight the role of expenditure switching and deviations from the law of one price for determining optimal monetary policy. The conclusion that fixed exchange rates are optimal, though, arises from some special features of the model: identical preferences, all goods traded, and a nominal state-contingent bond traded for every state

7. Bacchetta and van Wincoop (2000) and Devereux and Engel (1998) also examine exchange-rate rules with local-currency pricing. However, those analyses do not examine the real shocks that are at the heart of the issues we discuss here.

of the world. Under these assumptions, it is optimal to target world output and, with fixed exchange rates, allow financial markets to share the risk that arises from idiosyncratic shocks.

More generally, there might be a trade-off between the objective of monetary independence and that of minimizing deviations from the law of one price. Suppose that in each economy there is a sector that produces nontraded goods, and there are productivity shocks arising in the nontraded sector. On the one hand, it might be desirable to use monetary policy in this case to target local shocks. But such independent monetary policy will lead to nominal-exchange-rate changes that imply deviations from the law of one price for traded goods. These deviations would induce idiosyncratic risk in traded goods consumption.

Corsetti and Pesenti (2001) develop a model of "partial" passthrough of exchange rates to final consumer prices. Ex ante, firms may pass through only a fraction λ (taken to be exogenous) of any exchange-rate change to consumer prices. The PCP model is one extreme, in which $\lambda = 1$, and the LCP is the other extreme, in which $\lambda = 0$. They examine optimal monetary policy and the optimal degree of exchange-rate flexibility in this framework. Since Corsetti and Pesenti assume goods are sold directly to consumers (as do OR, and Devereux and Engel), it seems as though the empirically relevant case is the one in which λ is nearly zero, since passthrough to consumer prices is very small in the short run.

Corsetti and Pesenti show in their model that optimal policy minimizes a function of the *output gap* and deviations from the law of one price. The output gap is "the distance between actual and equilibrium employment levels." It is not always the case that eliminating the output gap is the optimal feasible policy. Corsetti and Pesenti's theorem implies that policymakers can improve welfare by using monetary policy to help eliminate deviations from the law of one price. Sometimes there is tension between that goal and the goal of eliminating the output gap.

6. Empirical Evidence on Deviations from the Law of One Price

The PCP model and the LCP model differ clearly in one empirical prediction. The PCP model predicts that the law of one price holds for consumer goods, while the LCP model predicts that it fails. Under the LCP model the (log) price of good i in the home country relative to the foreign country, $p_i - s - p_i^*$, varies as the nominal exchange rate changes, while in the PCP model this relative price is unaffected by nominal-exchange-rate movements.

That the law of one price (which I shall abbreviate as LOOP in this and

subsequent sections) fails for traded-goods prices is a well-established empirical fact. [See, for example, Isard (1977) and Kravis and Lipsey (1978). The recent pricing-to-market literature, surveyed by Goldberg and Knetter (1997), has documented the lack of full response of import prices to exchange-rate changes.] This literature has focused on import and export prices, not on the price of consumer goods. That distinction is important, as will become apparent in subsequent sections of this paper.

Some more recent work has focused on the failure of LOOP for consumer goods. That literature has documented not only that LOOP fails, but that its failure is large.

To say that the failure is "large" requires some metric for judging the size of the deviations from LOOP. One approach, in Engel (1993), was to compare the variance of deviations from LOOP [that is, $\mathrm{Var}(\Delta(p_i - s - p_i^*))$, where Δ is the time difference] with the variance of relative price changes between goods within a single country [$\mathrm{Var}(\Delta(p_i - p_j))$, where i and j are different products]. The idea is to understand what causes the observed large movements in real exchange rates between industrialized nations. One possibility is that real-exchange-rate movements are due largely to deviations from LOOP. But there are major competing theories that assume LOOP holds and attribute real-exchange-rate changes to relative-price changes among different goods. The most prominent of those theories posits that the real exchange rate changes between two countries as the price of nontraded goods relative to traded goods changes. So, if $p_N - p_T$ rises relative to $p_N^* - p_T^*$ [home-country (log) price of nontraded goods relative to traded goods rises relative to the foreign-country (log) relative price], the home-country price level will rise relative to the foreign-country level. That is, there will be a home real appreciation. Another, somewhat less prominent theory is that real exchange rates fluctuate because CPIs weight goods differently in different countries. Even if all goods are traded and LOOP holds for all goods, real exchange rates fluctuate as relative prices change. For example, if the French weight wine heavily in their CPI, then their CPI will rise relative to CPIs in other countries when the price of wine relative to other goods increases.

Engel (1993) compares $\mathrm{Var}(\Delta(p_i - s - p_i^*))$ with $\mathrm{Var}(\Delta(p_i - p_j))$ in some industrialized countries, looking at 1-, 3-, 6-, and 12-month horizons. For some measures, the consumer goods are fairly narrowly defined (potatoes, televisions, wine), although for some other measures the goods are quite aggregated (food, services, energy, rent). That paper simply tabulates $\mathrm{Var}(\Delta(p_i - s - p_i^*))$ for all goods and countries, and $\mathrm{Var}(\Delta(p_i - p_j))$ for all goods and countries, and compares their sizes. In general, the measures of $\mathrm{Var}(\Delta(p_i - s - p_i^*))$ tend to be much larger than $\mathrm{Var}(\Delta(p_i - p_j))$

at all horizons. The median value of $\mathrm{Var}(\Delta(p_i - s - p_i^*))$ is about 6 or 7 times as large as the median value of $\mathrm{Var}(\Delta(p_i - p_j))$ for all measures at all horizons.

Rogers and Jenkins (1995) extend this analysis, with a focus on U.S.–Canadian consumer prices. They confirm the large deviations from LOOP, and in addition find the deviations are very persistent.

Engel (1999) decomposes real-exchange-rate variation into a component attributable to deviations from LOOP and a component attributable to changes in the relative price of nontraded goods. Consider a price index for a country that is a weighted geometric average of traded- and nontraded-goods prices:

$$p_t = (1 - \alpha)p_t^T + \alpha p_t^N.$$

We can also write

$$p_t^* = (1 - \beta)p_t^{T*} + \beta p_t^{N*}.$$

Then the real exchange rate is given by

$$q_t = x_t + y_t, \qquad (1)$$

where $q_t \equiv s_t + p_t^* - p_t$, $x_t \equiv s_t + p_t^{T*} - p_t^T$, and $y_t \equiv \beta(p_t^{N*} - p_t^{T*}) - \alpha(p_t^N - p_t^T)$.

The log of the real exchange rate is composed of two parts: the relative price of traded goods between the countries, x_t; and a component that is a weighted difference of the relative price of nontraded- to traded-goods prices in each country, y_t. Engel (1999) then decomposes the mean squared error of changes in U.S. real exchange rates into parts attributable to x_t and y_t (and a part attributed to their comovement, which is small) at different horizons. That study uses four separate measures of prices, and finds that the deviations from LOOP account for over 90% of movements in U.S. real exchange rates relative to almost all countries at all horizons for all measures.

Here I replicate and extend some of that analysis, using consumer-price data from the OECD Main Economic Indicators (available from Datastream). Data are monthly (from 1973:12 to 2001:1) on four components of the consumer price index: food, all commodities less food, rent, and all services less rent, for eleven OECD countries.[8] The first two goods are

8. The United States, Canada, Japan, France, Italy, Switzerland, Belgium, Norway, Spain, Denmark, and the Netherlands.

tradables, and the last two are nontradables. I construct price indexes for a consumer that has Cobb–Douglas preferences and weights these items with the same weights they receive in the 2001 U.S. consumer price index.[9] In terms of the formula above, the weights α and β are set equal to 0.587 for all countries. In practice, the U.S. weight for nontraded goods is higher than for almost all OECD countries, but this should only bias the results in favor of finding a significant role for the relative price of nontraded goods (the y_t-component).

The constructed q_t, x_t, and y_t are all very persistent. Even though there are 27 years of monthly data, an augmented Dickey–Fuller (ADF) test is able to reject a unit root at the 5% level for only 9 of the 55 q_t-series, 9 of the 55 x_t-series, and 8 of the 55 y_t-series. At the 1% level, there are rejections only in one case for each of the three series.[10] All of the series had first-order serial correlation over 0.90 and, except in a few cases, over 0.96. So, in examining movements in these series, it makes sense to look at changes rather than levels.

Figure 1 plots

$$\frac{\mathrm{MSE}(x_t - x_{t-j})}{\mathrm{MSE}(x_t - x_{t-j}) + \mathrm{MSE}(y_t - y_{t-j})} \quad \text{for} \quad j = 1, 2, \ldots, 18,$$

where MSE stands for mean squared error. These statistics were calculated for 55 real exchange rates, but plots for only 10 are included because of space considerations.[11] Engel (1999) presents similar plots using these data, but only for five countries, and only for U.S. real exchange rates. Any variance or mean-squared-error decomposition must find a way to deal with comovements. Here, we leave the comovements of x_t and y_t out of both the numerator and denominator of the MSE ratios. In practice the comovements account for very little of the mean squared error of real-exchange-rate changes. The correlation of the series generally was highest in absolute value at short horizons, but at those horizons the correlation was almost always negative—so the sum of the variances of x_t and y_t is greater than the variance of q_t.

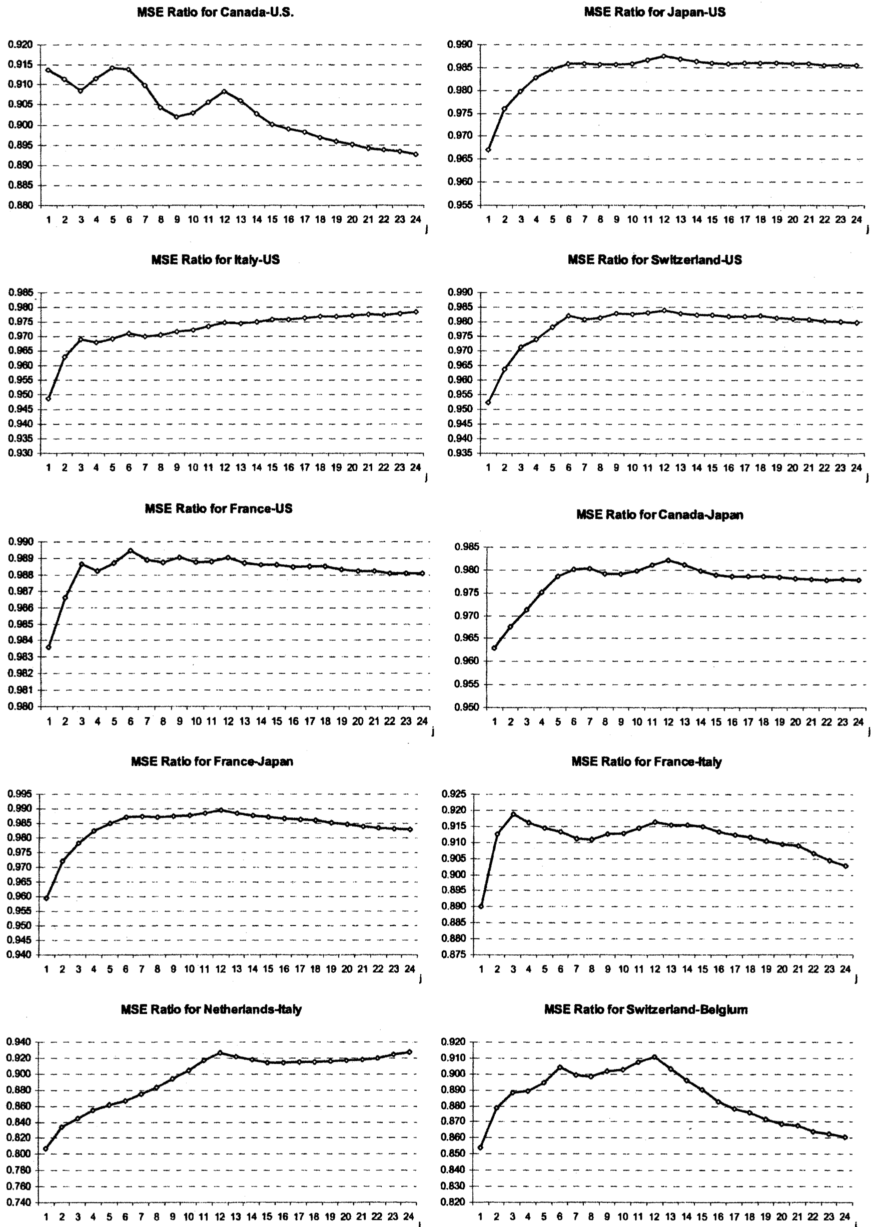
The decompositions shown in Figure 1 for the U.S. real-exchange-rate series confirm the findings of Engel (1999). Nearly all of the movements in real exchange rates are attributed to x_t, the component that measures deviations from LOOP. For all but the U.S.–Canada rate, x_t's share of the

9. Weights: 0.157 for food; 0.256 for commodities less food; 0.312 for rent; 0.275 for services less rent.

10. All of the ADF tests included a constant, no time trend, and three lags.

11. The NBER working paper version, Engel (2002), includes all 55 plots.

Figure 1 MSE DECOMPOSITION OF REAL-EXCHANGE-RATE CHANGES



Horizontal axis: horizon (in months). Vertical axis: MSE share due to LOOP violations.

mean squared error is above 0.90 at all horizons. Usually it is above 0.95. Only for the U.S.–Canada rate does it dip below 0.90 at the longer horizons, and then only to 0.893 for 18-month changes.

A similar finding holds for cross-continental real exchange rates—that is, Japanese (relative to North America and Europe) and Canadian (relative to Europe). The x_t-component accounts for over 90% of the MSE share for all real exchange rates at all horizons.[12] Usually the share is well over 95%.

The story for within-Europe real exchange rates is only slightly different. While x_t's share is often less than 90%, for 19 of the 28 European country pairs it is never less than 80% at any horizon. The nine pairs where x_t's share falls below 0.80, and the range at all horizons for x_t's share for those country pairs, are: Spain–Italy, 0.75–0.86; Denmark–France, 0.68–0.87; Norway–Netherlands, 0.73–0.88; Belgium–Netherlands, 0.67–0.89; Switzerland–Netherlands, 0.74–0.89; Denmark–Netherlands, 0.59–0.71; Denmark–Norway, 0.73–0.89; Denmark–Belgium, 0.63–0.71; and Denmark–Switzerland, 0.77–0.89.

The fact that the deviations from LOOP are a slightly smaller share of real-exchange-rate movements for intra-European country pairs suggests that perhaps the deviations from LOOP are not really attributable to sticky consumer prices. Perhaps they arise because transportation costs cause imperfect integration of markets. The somewhat smaller failures of LOOP for the European pairs might reflect the fact that transportation costs are lower for within-European trade than for cross-continental trade. On the other hand, during 1974–2001, intra-European nominal exchange rates have been less volatile than the cross-continental exchange rates. So, the fact that deviations from LOOP are smaller within Europe is consistent with sticky nominal consumer prices and deviations arising from nominal-exchange-rate fluctuations. The next section helps to shed some light on this question.

Betts and Kehoe (2001) recently have performed similar decompositions for a large number of countries, finding somewhat more evidence that the relative price of nontraded goods drives real exchange rates. However, there are two reasons why their results should be treated with a bit of caution. They measure q_t, the real exchange rate, using relative consumer price indexes in essentially the same way as I do.[13] But their

12. Except for the Danish–Canadian share at the 1-month horizon, which is 0.893.

13. One difference is that I construct real exchange rates for consumers who weight the four main components with equal weights in all countries, while they simply used published CPIs. Thus, their real-exchange-rate changes may reflect changes in relative prices that get reflected in real exchange rates because goods receive different weights across national CPIs.

measure of x_t is not a CPI measure of traded goods. Instead they take x_t to be the relative producer price indexes across countries (that is, s + log PPI* − log PPI). This measure of x_t might vary over time even if LOOP held for all traded goods and CPI weights for traded goods were identical. That is because it measures x_t using output weights rather than consumption weights. Output weights can be very different across countries even when CPI weights are not. A more substantial reason why Betts and Kehoe attribute more of real-exchange-rate movements to y_t is that they measure y_t as simply $q_t - x_t$. As I argued in Engel (1999), where I also employed this measure of y_t (as one of the four measures of y_t I considered), a serious bias is introduced by measurement error in this case. Since x_t and q_t are measured from different pricing surveys (PPI and CPI), where no effort is made to reconcile the pricing errors there will be largely uncorrelated measurement errors in the two series. This in turn implies there will be a potentially large negative correlation between the measure of x_t and the measure of y_t (= $q_t - x_t$). Indeed, in Engel (1999), I found that x_t and y_t measured in this way were highly negatively correlated. Decomposing the real exchange rate into x_t and y_t components is problematic because one must find a way to deal with the negative correlation. Although their results are similar to mine, Betts and Kehoe do attribute a larger share of the variance of annual changes in real exchange rates to the nontraded goods (y_t), even for the countries that I consider here. I do not find that the difference in our findings is attributable to differences in methodology, and so I must conclude that they arise from the difference in the way we measure the price of tradable goods.

In essence, Devereux and Engel (2001) take the evidence against LOOP for consumer goods as support for the position that nominal-exchange-rate changes are not passed through to consumer prices because of local-currency pricing. But there are other ways to interpret the evidence that do not rely on LCP behavior. We turn to a few of these alternatives.

7. *Shipping Costs*

One explanation for why LOOP fails is that home and foreign consumers are consuming slightly different products. That is, suppose a given product can be produced in both the home and the foreign country. Let the per-unit iceberg transport cost for exported goods be δ, as in OR (2000b). Let P_H be the domestic-currency price of the good in the home country, and P_F^* be the foreign-currency price of the good in the foreign country. The two goods are perfect substitutes for households. Then,

$$\frac{1}{1+\delta}SP_F^* \leq P_H \leq (1+\delta)SP_F^*.$$

If the home price is within this band, there is no passthrough of exchange rates to domestic prices. On the edges of the band, passthrough is complete. But this model has the untenable implication that zero passthrough occurs only because there is no trade.

A more satisfactory version of the transportation-cost theory is that there are two varieties of the good, one produced in the home country and the other produced in the foreign country. Assume CES utility (and no differences in tastes between home and foreign residents) and an elasticity of substitution between varieties greater than 1. If the elasticity and the per-unit transport costs are high enough, foreign varieties may constitute a small share of overall consumption and thus a small share in the measured price of home-country consumption. The reverse will be true of the foreign country. LOOP may fail grossly for the price index of these two goods.

Let P_i be the price of a particular good. However, P_i is itself an index over the price of two varieties of the good—one produced at home and one in the foreign country. Suppose home and foreign households have the same preferences for the good:

$$C_i = [\alpha C_{iH}^{(\lambda-1)/\lambda} + (1 - \alpha) C_{iF}^{(\lambda-1)/\lambda}]^{\lambda/(\lambda-1)},$$

where the subscript i is for the good, of which there are two types: H for home and F for foreign. Let the per-unit iceberg transport cost for exported goods be δ. The home-country producer is the only producer of the home variety, and the foreign producer the only producer of the foreign variety. LOOP holds exclusive of transport costs. We have $P_{iH}^* = (1 + \delta)P_{iH}/S$ and $P_{iF} = (1 + \delta)SP_{iF}^*$. The rest of the macro model is the same as specified above.

Under flexible nominal prices, P_{iH}/P_{iF} and P_{iH}^*/P_{iF}^* respond to real shocks. If nominal prices are sticky as in the Friedman framework of PCP, it is clear that a flexible exchange rate is necessary to achieve a desirable response of P_{iH}/P_{iF} (or P_{iH}^*/P_{iF}^*) to real shocks. This framework potentially is also consistent with the observation that measured consumer prices do not respond much to exchange-rate changes. We have:

$$\begin{aligned} P_i &= [\alpha^\lambda P_{iH}^{1-\lambda} + (1 - \alpha)^\lambda P_{iF}^{1-\lambda}]^{1/(1-\lambda)} \\ &= [\alpha^\lambda P_{iH}^{1-\lambda} + (1 - \alpha)^\lambda (1 + \delta)^{1-\lambda} S^{1-\lambda} P_{iF}^{*1-\lambda}]^{1/(1-\lambda)}. \end{aligned}$$

The passthrough elasticity for the home country, for example, is

$$\varepsilon = \frac{(1 - \alpha)^\lambda (1 + \delta)^{1-\lambda} S^{1-\lambda} P_{iF}^{*1-\lambda}}{\alpha^\lambda P_{iH}^{1-\lambda} + (1 - \alpha)^\lambda (1 + \delta)^{1-\lambda} S^{1-\lambda} P_{iF}^{*1-\lambda}}.$$

For $\lambda > 1$, we have $\varepsilon \to 0$ as $\delta \to \infty$. If the cost of the foreign good is high enough, there will not be much effect of exchange rates on home consumer prices if the foreign good is a sufficiently high substitute for the domestic good. For foreign prices (in domestic-currency terms);

$$SP_i^* = S[\alpha^\lambda P_{iH}^{*1-\lambda} + (1 - \alpha)^\lambda P_{iF}^{*1-\lambda}]^{1/(1-\lambda)}$$
$$= [\alpha^\lambda(1 + \delta)^{1-\lambda} P_{iH}^{1-\lambda} + (1 - \alpha)^\lambda S^{1-\lambda} P_{iF}^{*1-\lambda}]^{1/(1-\lambda)}.$$

If shipping costs were zero, so $\delta = 0$, LOOP would hold for good i. That is, we would have $P_i/SP_i^* = 1$. But as δ increases above zero, deviations from LOOP for good i (that is, for the index of the price of varieties H and F) increase. Taking a Taylor series expansion, the variance of $\ln(P_i/SP_i^*) = p_i - s - p_i^*$ equals approximately

$$\left(\frac{1}{\lambda - 1}\right)^2 \left(\frac{z - 1}{z + 1}\right)^2 \mathrm{Var}(X), \qquad \text{where} \quad z = (1 + \delta)^{\lambda - 1}$$
$$\text{and } X = \left(\frac{1 - \alpha}{\alpha}\right)^\lambda \left(\frac{P_{iH}}{SP_{iF}^*}\right)^{\lambda - 1}.$$

As the shipping costs increase, the variance of $p_i - s - p_i^*$ increases (holding the variance of X constant.)

Several studies have examined how the variations of deviations from LOOP are related to distance, which is taken to be a proxy for shipping costs. Engel and Rogers (1996) posit that the standard deviation of changes in $p_i - s - p_i^*$ is related to distance. Their comparison is made for 14 disaggregated CPI categories (food at home, food away from home, men's and boy's apparel, etc.) and for 23 cities in North America—9 Canadian cities and 14 U.S. cities. They found that deviations from LOOP were significantly related to distance between locations. But they also found that, even taking into account the distance effect, the deviations from LOOP were much larger when comparing goods prices between U.S. and Canadian cities than when comparing prices for city pairs within the United States or Canada. That is, there is a large *border effect.*

Similar findings have been confirmed for U.S.–Japanese prices (Parsley and Wei 2001a), and intra-European prices (Engel and Rogers, 2001; Parsley and Wei, 2001b). Parsley and Wei's studies used data on very narrowly defined consumer goods (for example, boxes of facial tissues, men's jeans, imported whiskey). Each of these studies confirms that distance between locations is a significant explanatory variable for the standard deviation of $p_i - s - p_i^*$. But these studies go further, and find that volatil-

ity of nominal exchange rates plays a much greater role in accounting for the volatility of deviations from LOOP.

Here I shall present some evidence that is similar in spirit to the evidence presented in those papers. My traded-goods price data are not nearly as disaggregated as the data in the other studies: I will use the OECD data on consumer prices for food and for all commodities excluding food that I described in the previous section.

In Table 1, I report cross-section regressions, in which the dependent variable is the standard deviation of changes in $p_i - s - p_i^*$ (for food, and for commodities less food), so there are 55 observations in each cross-section regression, representing the standard deviation of $p_i - s - p_i^*$ for each of the 55 country pairs. The top panel reports regressions for 1-month changes, and the bottom panel for 12-month changes. The shipping costs are captured by DIST, which measures the log of the distance between the capital cities. It is difficult to gauge the correct form of the nonlinear relationship between distance and shipping costs, especially over large intercontinental distances. So the regressions also include a dummy variable that takes on a value of 1 if one of the countries in the country pair is Japan (JADUM), and another dummy that is 1 if the country pair has one country in North America and another in Europe (ATLDUM).

For both food and nonfood goods, the coefficient on log distance is positive and highly significant for both 1-month and 12-month changes. This is in accord with the transportation-cost theory of deviations from LOOP.

Another approach is to take bilateral trade volumes as a measure of integration between two countries. Table 1 reports regressions that use the log of bilateral trade volumes instead of the log of distance as an explanatory variable.[14] Two sets of regressions are reported. The first are OLS in which the bilateral trade volumes are deflated by the product of GDPs of the trading pairs. The second are IV regressions in which the undeflated bilateral trade volumes are explained in a first stage by a gravity model—using the log of distance and the log of the product of GDPs as instruments. For both food and nonfood goods, the coefficient on log of trade is positive and significant for both 1-month and 12-month changes.

However, as was noted in the previous section, countries that are closer together, or that have higher (scaled) bilateral trade volumes, also tend to have lower nominal-exchange-rate volatility. So the transportation-cost effects that Table 1 reports may be overstating the value of distance or trade. In Table 2, the same regressions are run, but also using the standard

14. These data were taken from Andrew Rose's Web site, http://haas.berkeley.edu/~arose/RecRes.htm. They are the data used in Frankel and Rose (2002). I take the average of the log of bilateral trade for 1975, 1980, 1985, 1990, and 1995.

Table 1 REGRESSIONS OF RELATIVE PRICE VOLATILITY ON DISTANCE OR TRADE VOLUMES

Standard deviation of relative price of	*No.*	*Estimation method*	*Log of distance*	*Log of volume of bilateral trade*	*Constant*	*JADUM*	*ATLDUM*	R^2
			One-Month Differences					
Food	1	OLS	0.41		−0.87	0.58	0.34	0.89
			(5.32)		(−1.78)	(2.85)	(2.04)	
	2	OLS		−0.17	−2.04	1.17	0.76	0.85
				(−3.48)	(−1.88)	(7.88)	(5.65)	
	3	IV		−0.09	3.18	1.56	1.09	0.84
				(−2.94)	(6.37)	(14.69)	(11.99)	
Nonfood commodities	4	OLS	0.37		−0.42	0.25	0.27	0.82
			(4.57)		(−0.82)	(1.18)	(1.58)	
	5	OLS		−0.13	−1.12	0.81	0.68	0.78
				(−2.71)	(−1.00)	(5.30)	(4.92)	
	6	IV		−0.13	3.98	1.12	0.92	0.82
				(−4.71)	(8.94)	(11.91)	(11.44)	

Twelve-Month Differences								
Food	7	OLS	0.018		−0.051	0.027	0.024	0.87
			(4.43)		(−1.92)	(2.43)	(2.65)	
	8	OLS		−0.0098	−0.16	0.048	0.038	0.86
				(−4.19)	(−2.95)	(6.62)	(5.74)	
	9	IV		−0.0024	0.10	0.070	0.058	0.81
				(−1.39)	(3.84)	(12.44)	(11.98)	
Nonfood commodities	10	OLS	0.022		−0.069	0.020	0.025	0.88
			(5.28)		(−2.64)	(1.84)	(2.86)	
	11	OLS		−0.013	−0.23	0.041	0.038	0.84
				(−6.25)	(−4.82)	(6.22)	(6.35)	
	12	IV		−0.0029	0.11	0.071	0.065	0.83
				(−1.71)	(4.21)	(12.41)	(13.33)	

t-statistics in parentheses. All regressions use 55 country-pair observations.
Dependent variable in regression is specified in leftmost column. Standard deviations are calculated from monthly data, 1973:12–2001:1. IV estimation uses log of distance and log of products of GDP as instruments.

Table 2 REGRESSIONS OF RELATIVE PRICE VOLATILITY ON DISTANCE OR TRADE VOLUMES AND ON VOLATILITY OF NOMINAL EXCHANGE RATES

Std. dev. of relative price of	*No.*	*Est. method*	*Log of distance*	*Log of volume of bilateral trade*	*Standard deviation of nominal exchange rate*	*Constant*	*JADUM*	*ATLDUM*	R^2
One-Month Differences									
Food	13	OLS	0.041		0.83	0.28	0.33	0.016	0.98
			(1.07)		(16.25)	(1.33)	(3.90)	(0.23)	
	14	OLS		0.029	0.89	1.09	0.40	0.072	0.98
				(18.76)	(18.76)	(2.61)	(5.87)	(1.20)	
	15	IV		−0.055	0.82	1.42	0.44	0.088	0.99
				(−6.07)	(24.16)	(8.85)	(8.02)	(1.80)	
Nonfood commod.	16	OLS	0.17		0.44	0.20	0.11	0.10	0.86
			(1.91)		(3.80)	(0.41)	(0.59)	(0.62)	
	17	OLS		−0.011	0.56	0.85	0.33	0.25	0.84
				(−0.23)	(4.91)	(0.85)	(2.01)	(1.73)	
	18	IV		−0.11	0.49	2.91	0.45	0.32	0.89
				(−4.97)	(5.98)	(7.49)	(3.39)	(2.74)	

Twelve-Month Differences

Food	19	OLS	0.026		0.86	−0.0006	0.0014	−0.0030	0.99
			(1.67)		(20.62)	(−0.71)	(0.37)	(−0.93)	
	20	OLS		−0.0005	0.88	−0.002	0.0049	−0.0005	0.98
				(−0.51)	(20.40)	(−0.09)	(1.52)	(−0.17)	
	21	IV		−0.0005	0.88	0.017	0.0058	0.0002	0.98
				(−1.04)	(23.17)	(1.90)	(1.78)	(0.05)	
Nonfood commod.	22	OLS	0.0083		0.72	−0.031	−0.0014	0.0027	0.96
			(2.98)		(9.77)	(−1.97)	(−0.21)	(0.48)	
	23	OLS		−0.0060	0.68	−0.11	0.0075	0.0082	0.96
				(−4.09)	(9.73)	(−3.60)	(1.42)	(1.74)	
	24	IV		−0.0012	0.81	0.033	0.012	0.012	0.95
				(−1.29)	(11.74)	(2.11)	(2.01)	(2.36)	

t-statistics in parentheses. All regressions use 55 observations.
Dependent variable in regression is specified in leftmost column. Standard deviations are calculated from monthly data, 1973:12–2001:1. IV estimation uses log of distance and log of products of GDP as instruments.

deviation of the nominal exchange rate as an explanatory variable. In all cases, the standard deviation of the nominal exchange rate is highly significant. In comparison with Table 1, the absolute values of the coefficients on the trade and distance variables fall greatly, and their statistical significance also falls.

Table 3 reports an analysis of variance for each of the regressions reported in Table 2. The purpose of Table 3 is to show how much of the "explained" variance of the dependent variable is attributable to the standard deviation of nominal exchange rates, the integration variable (distance or trade volume), the dummy variables, and their interaction. Table 3 reveals that distance or trade volume accounts for a small fraction of the explained variance in all of the reported regressions. In eight of the twelve regressions, it accounts for 1% or less of the explained variance. In one regression it accounts for 16.4%, and in the remaining three for less than 10%. In contrast, in all of the regressions, the standard deviation of the nominal exchange rate accounts for a large fraction of the explained variance. In all but one case it is over 50%, and in most cases it is over 80%. So, even though distances or trade volumes are sometimes significant in explaining the standard deviation of $p_i - s - p_i^*$, they do not carry much of the load in explaining it.

In the transportation-cost model, the behavior of nominal exchange rates plays no role in explaining the deviations from the law of one price. The deviations result from a real trading cost. The models make no mention of these costs differing across nominal-exchange-rate regimes. In the LCP model, by contrast, deviations from LOOP are volatile precisely because nominal exchange rates are volatile. The empirical work cited above, and the new work reported here, shows there is a role for both models in explaining the deviations from LOOP. But the implication of the analysis of variance in Table 3 is that the proxies for trading costs account for a very small fraction of the variation in prices across countries compared to nominal-exchange-rate fluctuations.

These empirical studies certainly do not perfectly measure transportation costs, or their effects on deviations from LOOP. However, even if transportation costs were much more significant, this model actually would not support a strong expenditure-switching effect. The reason there is so little passthrough of exchange rates to consumer prices in the home country in the transportation-cost model is that foreign varieties are a small share of total consumption. In fact, ε measures not only the elasticity of consumer prices with respect to a change in the price of foreign goods; it also measures the share of foreign goods in expenditures. So passthrough can only be small in this model if the expenditure share on foreign varieties is small. The case for floating rates is weak in this

Table 3 ANALYSIS OF VARIANCE OF REGRESSIONS FROM TABLE 2

Regression no.	Variance of s.d. of exchange-rate component	Variance of distance or trade component	Covariance of ex. rate and trade or distance component	Variance of dummies	Covariance of dummies with nondummies
			1-month changes		
13	80.6	0.5	9.7	3.4	9.7
14	87.8	0.3	−4.5	4.5	12.0
15	77.8	1.0	1.4	5.9	13.8
16	46.1	16.4	25.4	1.2	10.9
17	67.9	0.1	2.1	8.3	21.7
18	50.6	7.4	3.0	14.6	24.4
			12-month changes		
19	92.8	0.8	7.7	0.2	−1.5
20	95.8	0.0	1.5	0.3	2.4
21	96.0	0.0	0.3	0.4	3.3
22	69.0	8.0	21.5	0.2	1.3
23	64.2	6.1	17.1	1.5	11.1
24	81.7	0.2	0.6	3.1	14.4

Cell entries are the percentage of total explained sum of squares from corresponding regressions in Table 2 that are explained by each component.

case. Floating rates might be needed to achieve optimal relative-price adjustments, but those adjustments are not very important to the functioning of the economy in this model.

In fact, OR (2000b) reason that the low passthrough to consumer prices cannot be fully explained by transportation costs, and that some other factors must be at play.

8. *Nontraded Distribution Services and PCP*

One possible explanation for the apparent nonresponsiveness of consumer prices to exchange-rate changes is that CPIs measure the price of a basket of both consumer goods and the distribution services that bring the goods to consumers. LOOP might very well hold for the actual physical good (as in PCP models), but the measured consumer price includes the price of the distribution service, which is nontraded and for which LOOP need not hold. Recent examples of papers that have adopted this type of model are McCallum and Nelson (2000), Burstein, Neves, and Rebelo (2000), and Burstein, Eichenbaum, and Rebelo (2002).[15] None of these papers provide direct evidence on the role of distribution costs in accounting for real-exchange-rate changes.

Let the home price of imported good i be a composite of a traded-goods price $\bar{P}_i$ for which LOOP holds ($\bar{P}_i = S\bar{P}_i^*$) and the price of a nontraded distribution service (P_{iS}). If output of the final consumer product is a CES function of the traded good and the distribution service (with elasticity equal to λ), the price of the final product can be written as

$$P_i = [\alpha^\lambda P_{iS}^{1-\lambda} + (1-\alpha)^\lambda \bar{P}_i^{1-\lambda}]^{1/(1-\lambda)} = [\alpha^\lambda P_{iS}^{1-\lambda} + (1-\alpha)^\lambda S^{1-\lambda} \bar{P}_i^{*1-\lambda}]^{1/(1-\lambda)}. \qquad (2)$$

If $\bar{P}_i^*$ is fixed in foreign-currency terms, the passthrough of exchange rates is given by:

$$\varepsilon = \frac{(1-\alpha)^\lambda S^{1-\lambda} \bar{P}_i^{*1-\lambda}}{\alpha^\lambda P_{iS}^{1-\lambda} + (1-\alpha)^\lambda S^{1-\lambda} \bar{P}_i^{*1-\lambda}}.$$

As $\alpha \to 1$, $\varepsilon \to 0$. That is, as the share of the nontraded distribution service increases toward unity, the passthrough elasticity falls toward zero.

We cannot usually observe $\bar{P}_i$ and $\bar{P}_i^*$ directly, but we might be able to examine this hypothesis using only measures of the consumer price and

15. The model of OR (2000a) could be interpreted this way. The final good in that type of model is a composite of a traded home-produced good, a traded foreign-produced good, and a nontraded distribution service.

a measure of the price of services. To simplify matters, let the production function be Cobb–Douglas [so $\lambda \to 1$ in (2)]. The price of good i in the home compared to the foreign country is

$$p - s - p^* = k + \alpha x + (1 - \alpha)u, \tag{3}$$

where lowercase letters mean logs, the subscripts i are dropped, k is a constant, α is the cost share of nontraded distribution services, $x \equiv p_s - s - p_s^*$ is the price of services in the home country relative to the foreign country, and $u \equiv \bar{p} - s - \bar{p}^*$ is the price deviation for the traded good. Under the null LOOP, u should in principle be zero, but the null might allow for a small i.i.d. error. So equation (3) could be estimated. It should have a good fit and yield a tight estimate of α if the distribution cost model is true.

But estimating this equation is not useful for distinguishing between the model in which prices are equalized for the traded good and the model in which there is local-currency pricing for the traded good. To allow for this alternative, let $u = -\gamma s + \varepsilon$. Under LOOP for the traded good, $\gamma = 0$. Under LCP, $\gamma = 1$. The quantity $1 - \gamma$ is the degree of pass-through. Assume that ε is uncorrelated with s and has a small variance. Also, define $v = p_s - p_s^*$, and assume for purposes of exposition that it is also uncorrelated with s. Then $x \equiv v - s$. Under these assumptions, the probability limit of the OLS estimate of α from equation (3) is given by

$$\alpha + \frac{(1 - \alpha)[\mathrm{Cov}(\varepsilon, v) + \gamma\,\mathrm{Var}(s)]}{\mathrm{Var}(v) + \mathrm{Var}(s)}.$$

Under the hypothesis that LOOP holds for the traded good ($\gamma = 0$), the asymptotic bias is small, since $\mathrm{Cov}(\varepsilon, v)/\mathrm{Var}(s)$ is likely to be small. But when $\gamma = 1$, the asymptotic bias of the estimate of α from this regression could be large. As $\mathrm{Var}(s)$ gets large, the probability limit of the estimate of α approaches $\alpha + (1 - \alpha) = 1$. Under the alternative of LCP, estimating equation (3) would return a large estimate of α. The equation would fit well and appear to attribute most of the variation of $p - s - p^*$ to the relative services component. Estimating (3) is not a good way to test for the model in which LOOP holds for the traded good (and the services component accounts for all of the deviations in the CPI prices across countries), vs. the LCP model.

Suppose, however, we could group u with x and estimate

$$p - s - p^* = k + \alpha(x - u) + u. \tag{4}$$

The probability limit of the estimate of α from this regression is given by

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

When $\gamma = 0$, the asymptotic bias is small because Var(s) is large relative to the other variances and covariances. The R^2 from the regression should be high, because $x - u = v - \varepsilon + s$ in this case, which has a high variance relative to the regression error, $u = \varepsilon$. But under LCP ($\gamma = 1$) the asymptotic bias is much higher, and likely to be negative if Cov(ε, v) is near zero. Moreover, the R^2 will be low, since $x - u = v - \varepsilon$ has small variance and the regression error $u = -s + \varepsilon$ has large variance. So, if LCP were important, the coefficient estimate and R^2 from this regression would be very different than if LOOP held for the traded good. This might be a useful approach to distinguish the models.

Fortunately, we can observe $x - u$ up to a constant of proportionality, because $x - u = [1/(1-\alpha)][p_s - p - (p_s^* - p^*)]$. Substituting into equation (8.3), we arrive at the equation we propose to estimate:

$$p - s - p^* = k + \frac{\alpha}{1-\alpha}[p_s - p - (p_s^* - p^*)] + u. \tag{5}$$

To sum up the previous discussion: Under the hypothesis that nontraded distribution services account for the observed deviations across countries in consumer prices, while LOOP holds well for the actual traded good, the slope coefficient in the regression should be strongly positive and the R^2 should be high. Alternatively, if there is LCP for the traded good, the slope coefficient is biased downward (and may be negative), and the R^2 will be low [especially if Var(s) is high].

We do not observe the cost of the distribution services, p_s, directly. But we can use as a proxy the OECD prices of services (excluding rent) described above in Section 6. We use as our measure of the observable traded-goods price, p, the traded-goods price that was constructed from the OECD data on food prices and prices of nonfood commodities.

As we noted above, the measures of $p - s - p^*$ are highly persistent for all 55 country pairs, and we fail to reject a unit root in almost all cases. Similarly, $p_s - p - (p_s^* - p^*)$ is persistent. We reject a unit root at the 5% level for only nine of the 55 country pairs, and at the 1% level for only two. So we will examine the relationship between changes in $p - s - p^*$ and changes in $p_s - p - (p_s^* - p^*)$. We regress 1-month (2-month, 3-month, . . . , 24-month) changes in $p - s - p^*$ on 1-month (2-month, 3-month, . . . , 24-month) changes in $p_s - p - (p_s^* - p^*)$.

Figure 2 presents plots of the estimated slope coefficient from the regressions for the 24 horizons, with one graph for 10 of the 55 country pairs. Figure 3 plots the R^2's from those regressions.[16]

The results indicate poor performance for the distribution-services model at the shortest horizons. For horizons less than 6 months, there are no cases in which the coefficient is positive and the R^2 is greater than 0.07. In many instances, the coefficient on the relative price of services is negative. For all of the intra-European country pairs, which have low nominal-exchange-rate volatility, the coefficient is negative at horizons of 1 to 6 months. In some cases the R^2 is high (in the range of 0.15 to 0.45) in these regressions. As we would expect under LCP, the lowest R^2's are for the country pairs that have the highest nominal-exchange-rate volatility—country pairs involving the U.S., Japan, and Canada with overseas partners.

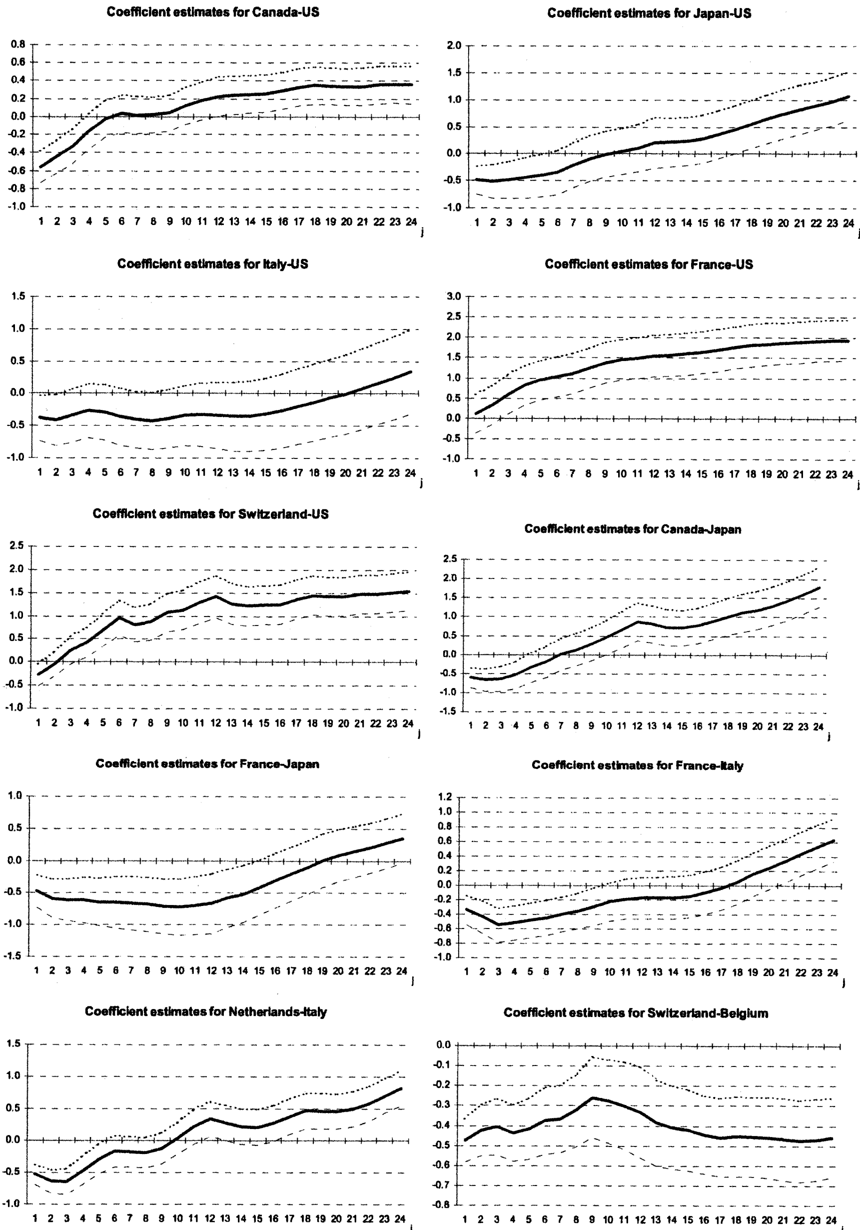
At the longest horizons, the distribution-services model fares only slightly better. It is still the case that the coefficient estimates is negative at the longer horizons for almost all of the European country pairs. Of the 28 European country pairs, only nine display positive coefficients at all of the horizons from 19 to 24 months. Two more have positive coefficients at the 23- and 24-month horizons. In only one of these eleven cases (Belgium–Norway) is the R^2 above 0.20. The distribution-services model appears to explain a bit more for the 27 country pairs that are not intra-European. In 14 cases, the regression coefficient is positive at all of the longer horizons (19 to 24 months), and in 2 additional cases it is positive for some of the longer horizons. Of these 16 country pairs with positive coefficient estimates at longer horizons, only 3 (Belgium–U.S., Belgium–Canada, and Netherlands–U.S.) have R^2's greater than 0.20.

Goldberg and Verboven (2001a) (hereinafter referred to as GV) have a related empirical study that appears to find much stronger evidence in favor of the distribution-services approach. GV use extremely detailed data for automobile prices sold in five European countries. They have prices of specific models for 15 years, data on characteristics of the automobiles (horsepower, size, luxury features, etc.), production location of each model, and some data on income of buyers. They use tax data, and make use of data on import restrictions. In short, their data are comprehensive and much better than the data used here.

In essence, GV estimate a version of equation (3). However, they do not simply allow the deviation from LOOP for the traded good to appear as an error term in the regression. They are not able to observe u. But they build a highly complex model of automobile demand and the pricing-

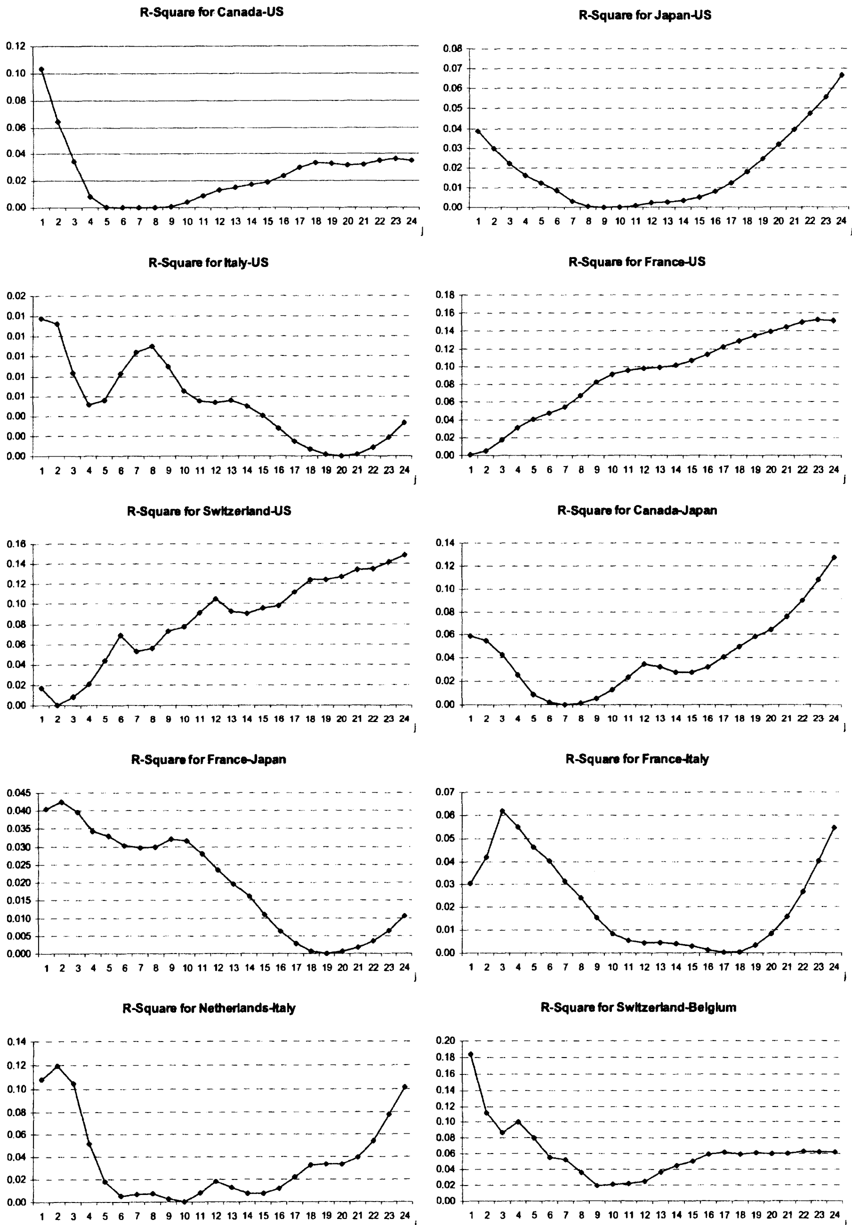
16. The NBER working paper version, Engel (2002), presents plots for all 55 country pairs.

Figure 2 COEFFICIENT ESTIMATES FOR REGRESSION OF TRADED PRICES ON SERVICE PRICES



Horizontal axis: horizon (in months). Plotted is slope coefficient of regression of relative traded prices on service price, and 95% confidence interval.

Figure 3 R^2 FROM REGRESSIONS REPORTED IN FIGURE 2



to-market behavior of automobile producers. Combining these, they use sophisticated nonlinear methods to come up with a measure of the desired degree of price discrimination by firms. Although this does not do justice to GV's work, in essence their empirical model could be expressed as an extension of (3):

$$p - s - p^* = k + \alpha x + y + \eta.$$

Relative to (3), the term y represents the sophisticated estimate of desired price discrimination by firms. The error term η represents all the elements not captured by y, so $\eta \equiv (1 - \alpha)u - y$.

GV's approach is a reasonable and very admirable attempt to deal with the unobservability of u. My hunch—and this obviously deserves further study—is that GV still do not capture the full degree of price discrimination. In fact, if producers are simply setting prices in local currencies (because, say, of menu costs), the model of GV will certainly underpredict the degree of desired local-currency price stability for the imported good. So the residual remaining in the GV regression will still be highly negatively correlated with s, and therefore highly positively correlated with x. As a result, GV will tend to attribute too much to the distribution services component x.

GV believe they rule out the possibility of transitory price stickiness by estimating their equation in levels over a 15-year period—to capture the long-run pricing equation. However, real exchange rates are extremely persistent (see Rogoff, 1996). Chari, Kehoe, and McGrattan (2000) show that when price setting is asynchronized, the adjustment can be very slow. Rogoff cites a half-life for the real exchange rate of 3–5 years. With such slow adjustment of prices, the 15-year sample that GV use may not be sufficient to capture only long-run pricing behavior.

Even if the distribution-services hypothesis is correct, it might imply that the role for nominal-exchange-rate flexibility is small. In this approach, the reason that nominal exchange rates have low passthrough to consumer prices is that the distribution services are a large component of the cost of consumer goods. As in the model with transportation costs, if the nontraded marketing services are such a large component of the cost of consumer goods that we barely observe any effect of exchange-rate passthrough, then the physical import must not be a very important component of our consumer basket. Exchange-rate flexibility is desirable for achieving relative price adjustments, but these relative price adjustments may not be very significant. The cost of the physical traded good is a small component of the overall cost of consumer goods, so achieving

the optimal relative-price change for this component may not influence welfare much.

9. Imports as Intermediate Goods

Obstfeld (2001) models imported goods as intermediate products. They are combined with products produced locally to make final consumer goods (which are nontraded). There is complete passthrough of exchange rates to imported-goods prices in this framework. That is, the price of imported goods is set in the producers' currencies, so the imported price varies one for one with the exchange rate. But imported goods are not sold directly to consumers. The price of the final good is set in the consumers' currencies.

This model, then, is completely consistent with the observation that consumer prices do not respond much to exchange-rate changes in the short run. But there is still an important role for exchange-rate flexibility in changing relative prices. The final-goods producer faces a *sourcing* decision—to use imported intermediates or locally produced intermediates. There is not perfect substitutability between the two, but there is some.[17] So a nominal-exchange-rate adjustment can change the price of imported relative to locally produced intermediates.

There is a single final consumer good, sold by a monopolist that buys intermediate inputs in competitive markets. The price of the final good in the home country is P, and it is fixed in home currency.

The cost of producing the good is not fixed ex ante. The cost is given by

$$\Gamma = [\alpha^{\lambda} P_H^{1-\lambda} + (1-\alpha)^{\lambda} S^{1-\lambda} P_F^{*1-\lambda}]^{1/(1-\lambda)}.$$

Here, P_H is the price of the home-produced intermediate good. That good is produced using a variety of labor inputs. In the Obstfeld setup, each household is a monopoly supplier of a unique type of labor. Nominal wages are fixed ex ante. The intermediate-goods market is competitive with free entry. The price P_H is in principle flexible, but under competitive conditions it is equal to the ex ante fixed nominal wage. (In Obstfeld's model, there are no productivity shocks, but there are labor-supply shocks. The labor input per unit of output is fixed at unity.)

Likewise, P_F^* is the price of the foreign-produced intermediate in the foreign currency. The structure of the foreign intermediate market is the same as that of the home market, which implies that P_F^* is fixed ex ante

17. Specifically, in Obstfeld's framework there is unit elasticity of substitution.

in the foreign currency. The home-currency price, $P_F = SP_F^*$, changes with the exchange rate.

Under flexible nominal prices, using the general model of Section 2, we find

$$\frac{P_H}{P_F} = \frac{P_H^*}{P_F^*} = \frac{\eta^*}{\eta}.$$

(Here, an increase in η represents an increase in home labor supply, which would reduce the wage and cost per unit of the home product under flexible prices and wages.)

With fixed nominal wages, we have for example in the home country $P_H/P_F = P_H/SP_F^*$. Since P_H and P_F^* will be fixed under the market conditions described, we need exchange-rate flexibility to allow relative price adjustment. Indeed, since $S = M/M^*$, with a suitably designed monetary policy of the form $M = k\eta$ and $M^* = k^*\eta^*$ the flexible price equilibrium can be mimicked. Indeed, Obstfeld demonstrates that prices and allocations are the same under flexible prices as under sticky nominal wages with this inward-looking monetary policy that has exchange-rate flexibility.[18]

OR (2000) present evidence that shows there is much more passthrough of exchange rates to imported-goods prices than to final-consumer prices. While the passthrough is certainly not 100% (as in the model just described), there appears to be a sufficient degree of passthrough to allow for a significant expenditure-switching effect following from nominal-exchange-rate changes. Goldberg and Knetter (1997) and Goldberg and Campa (2001) offer evidence that while passthrough to import prices is far from complete, it is significantly greater than passthrough to final-consumer prices.

An important aspect of the Obstfeld (2001) model is the idea that there are final-goods producers or distributors who can substitute between locally produced and imported intermediates. Devereux, Engel, and Tille (1999) take an approach that is quite similar to Obstfeld (2001). However, they take the limiting case of the cost function in which the elasticity of substitution is zero. That is, their model can be interpreted as one in which the distributor combines imported goods and locally produced goods in fixed proportion.[19] In that case, of course, there is no possibility of substi-

18. In fact, in terms of real variables and prices of output, the model is isomorphic to the PCP model of OR (2000a).

19. That is not exactly the set-up in Devereux, Engel, and Tille, but there is little difference in substance between the model I describe here and theirs.

tution between imported goods and local goods when the exchange rate changes, even though there is complete passthrough of the exchange rate to imported prices.

Potentially there are wealth effects from exchange-rate changes in this case. The demand for imported goods is fixed, because their price is fixed in consumers' currencies and the distributor cannot substitute toward locally produced goods. When the home currency depreciates, it raises the price that local distributors must pay for imported goods and lowers their profits. Foreign distributors have a windfall gain. In Devereux, Engel, and Tille (1999), these profit effects are not consequential, because of their assumption that there are state-contingent nominal bonds traded for each possible state. But Tille (2000) investigates the importance of these wealth effects for equilibrium demands when only non-state-contingent bonds can be traded. These wealth effects are a completely different channel through which exchange rates affect equilibrium than the relative price effects that are so important to the Friedman analysis.

The model of Devereux, Engel, and Tille (1999) is best described as one in which imports are primarily branded final goods. The distributor cannot substitute any local product for that brand. For example, a Toyota dealer cannot substitute a Chevrolet Lumina for a Camry if the yen becomes too expensive. The Obstfeld (2001) model is best thought of as a model in which the consumer cannot differentiate between local and imported sources of inputs. Perhaps the typical product in this setup is auto parts. The automobile may itself be assembled in the country in which it is consumed (in fact, many Toyota Camrys purchased in the United States are manufactured there), but using parts that may be imported or produced locally.

The empirical question is to what extent substitution occurs at some stage before the good reaches the consumer. For the question of exchange-rate flexibility, the key is whether substitution can occur between imported and local products. For example, if the United Kingdom is considering adopting the euro vs. keeping an independent pound, the question is whether in response to a pound depreciation the British can substitute toward British goods. Let me clarify what this means by way of an example. Suppose the imported good is wine. If the euro appreciates relative to the pound and dollar and thereby raises the pound price of French wine (as in the PCP specification), then the British might substitute away from French wine toward American wine. But for that margin of substitution, the flexibility of the pound–euro rate does not matter at all. Even if the pound–euro rate were fixed, the price of French wine would rise relative to that of American wine. The question is the degree to which a euro appreciation leads U.K. distributors to substitute away from goods

produced on the continent toward U.K.-produced goods. If a large degree of such substitution occurs (as in the Obstfeld (2001) model), then exchange-rate flexibility is desirable. If little such substitution occurs (as in Devereux, Engel, and Tille (1999)), then there is not so strong a case for an independent currency with freely floating rates.

10. Conclusions

The famous case for flexible exchange rates advanced by Friedman (1953) is based on a view that appears at odds with empirical evidence. Friedman's approach assumes that nominal prices are set in producers' currencies and exchange-rate changes are passed through completely to final users of the goods. Thus an exchange-rate change delivers a relative price adjustment between foreign and domestically produced goods.

Recent theoretical papers confirm Friedman's policy prescription under his assumption about goods pricing. Empirical evidence, however, appears to contradict this assumption, because consumer prices are not very responsive to exchange rates. If there is no effect of exchange rates on prices that are paid by demanders of goods, then the exchange rate does not play the role in adjusting relative prices that Friedman posits. The jury is still out on whether we can reconcile the evidence of low exchange-rate pass-through to consumer prices with a significant expenditure-switching effect.

Even for advanced countries that have credible monetary policies and stable financial markets, expenditure switching is only one of several factors that are important in the choice of fixed vs. floating. As has been noted, one traditional argument in favor of floating exchange rates is that countries are able to follow independent monetary policies that allow monetary policy to react to local conditions. In the model of Devereux and Engel (2001), independent monetary policies are strictly suboptimal—they lead to undesirable deviations from LOOP, and do not yield any gains. But the structure of their model rules out possible gains from monetary policy, because it assumes a full set of nominal state-contingent claims, identical preferences for home and foreign households, and that all goods are traded.

On the other hand, there is evidence that fixed exchange rates, or currency unions, confer gains that are not addressed in the models discussed here. Rose (2000) and Frankel and Rose (2002) find empirical evidence that joining currency unions will increase the volume of trade between union members, and the increased trade will stimulate growth. These papers do not explain why currency unions increase trade, but presumably the unions somehow foster more tightly integrated markets. Indeed, Parsley and Wei (2001b), Rogers (2001), and GV (2001b) find that deviations

from LOOP are small for currency-union members—even smaller than for countries that have fixed exchange rates but separate currencies. So the choice of exchange-rate regime, and particularly the choice to join a currency union, might influence how prices are set.

The models discussed here assume that the exchange rate is driven by monetary and real factors, and there is no significant role for speculative bubbles. If bubbles are important in determining exchange rates, then perhaps a stronger case for fixed exchange rates or currency union can be made. Jeanne and Rose (2002) advance the view that fixed exchange rates are desirable on the grounds that they help reduce the role of pure noise in exchange rates.

Missing from my survey of empirical work has been evidence concerning quantities: trade flows or employment, for example. Integrating such evidence is important, but beyond the scope of this paper. Microeconomic studies that examine how imports of particular types of goods, or how employment in specific industries, are affected by changes in import prices must be applied with a dollop of caution. That is because there is a missing link that must be supplied before one can use these studies to judge the quantitative significance of the expenditure-switching effect: the degree of passthrough. Import demand may be fairly elastic with respect to price changes, but if the import price is inelastic with respect to the nominal exchange rate, the overall effect on import demand may be small.

Aggregate studies that link employment or aggregate imports or sectoral employment to real exchange rates suffer less from this problem, because we know that for advanced countries the real exchange rate moves closely with the nominal exchange rate. Hooper, Johnson, and Marquez (2000) estimate short-run aggregate import and export elasticities for the G-7 countries. They find these elasticities are uniformly small, and generally statistically indistinguishable from zero. They conclude, "The evidence suggests that . . . changes in relative prices play a lesser role as a short-run international conduit."

On the other hand, studies of the effects of real exchange rates on employment, such as Gourinchas (1998, 1999) and Goldberg and Tracy (2000), do find statistically significant effects. It is difficult to judge, however, the economic significance of their findings for the importance of the expenditure-switching effect without placing them in the context of a general equilibrium model. For example, Gourinchas (1998) finds "an average 0.27% contraction in tradable employment over the 3 quarters following a mild 10% appreciation of the real exchange rate." Gourinchas (1999) finds "a 1 percent appreciation of the real exchange rate destroys 0.95 percent of tradable jobs over the next two years." It is difficult to judge whether such changes imply that nominal-exchange-rate flexibility

has large or small effects on welfare unless these findings can be integrated into a full general equilibrium model.

The new open-economy macroeconomics has given us a structured way to think about the issues that are important when considering the desirability of floating exchange rates vs. currency union. Unfortunately for policymakers facing a near-term deadline for choosing an exchange-rate system, our knowledge has not advanced far enough to offer a firm recommendation backed up by appropriate theory.

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Comment

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1. Introduction

This paper by Charles Engel is a very useful survey on what the new-open-economy literature and empirical evidence on real-exchange-rate behavior have to say about Milton Friedman's (1953) case for floating exchange rates. Friedman argued that when prices are sticky, floating exchange rates are preferable to fixed exchange rates because the nominal exchange rate can move to bring the real exchange rate in line with the equilibrium relative price between domestic and foreign goods. As Engel demonstrates, however, this question hinges upon the degree to which

exchange-rate changes are passed through into imported-goods prices in domestic currencies. After describing this result, Engel examines the current empirical literature on real-exchange-rate behavior. The evidence suggests that domestic prices are rather unresponsive to exchange rates. Engel argues that fixed, not flexible, exchange rates are optimal in this case. Engel also looks at other explanations for the insensitivity of domestic prices to exchange-rate changes and concludes that more research needs to be done to arrive at a definitive answer.

As a status report on the literature, this paper fills an important niche in emphasizing what we have learned so far. However, the paper also highlights some issues that remain on the table to understand the significance of both the specific arguments in the paper and how they bear on the literature as a whole. Some of these issues are described by Engel. Therefore, I focus below on some of the issues not mentioned in the paper. I divide my comments into two broad categories: first, issues arising from the argument in the paper itself; and second, issues that remain for the literature to confront in the future.

2. *Issues Arising from the Paper*

The basic premise of this paper is derived in Devereux and Engel (2001). The model is a *new-open-economy macro* model with two countries populated by monopolistic competitors facing constant markups and representative consumers. In the basic model, consumers have the same utility function, although generalizations are described later in the paper. Importantly, markets are incomplete, so that agents cannot undo the effects of sticky prices, a critical factor in Friedman's case for floating exchange rates. The nature of market incompleteness assumed here is that state-contingent assets have nominal, not real, payouts. This assumption turns out to be key to the welfare implications, as I describe below.

With this model, Engel examines three regimes with different exchange-rate passthrough assumptions. First, it is assumed that prices are completely flexible. In this case, it is shown that whether the exchange rate is fixed or flexible, the constrained optimum can be achieved. In this optimum, relative prices of home to foreign goods are equal to the ratio of endowment supplies, so that

$$P_H/P_F = P_H^*/P_F^* = \eta^*/\eta. \tag{1}$$

The second regime Engel examines is the *producer currency pricing* (PCP) regime, in which there is 100% passthrough. The price is set in the exporting country's currency, and under floating exchange rates any change

in exchange rates is completely passed through into changes in the importing country's price of the imported good. Purchasing-power parity (PPP) holds for each individual good. In this case, the same constrained optimum can be achieved, since relative prices change with the exchange rate. It is this channel that generates the optimum under both the flexible goods and the PCP case. This is a version of Friedman's argument for flexible exchange rates under sticky prices.

This result is reversed in the third case Engel examines, however. Under *local currency pricing* (LCP) the price is set in the importing country's currency. In this case, there is no passthrough. Since prices are unrelated to exchange-rate movements, there is no adjustment to changes in goods supplies even under flexible exchange rates. Therefore, it is not possible to achieve the constrained optimum. In fact, Engel argues that the optimal policy is to fix the exchange rate at the level implied by PPP.

The intuition for this result illustrates why the asset-markets assumption is so critical when there is no passthrough (LCP). First, the channel for relative prices to respond to real shocks is missing. Therefore, relative prices do not attain the constrained optimum, so that equation (1) does not hold, even under floating exchange rates.

Second, since PPP does not hold and since contingent claims pay out in nominal (not real) contracts, there is an additional source of distortion. In particular, nominal contingent contracts imply that asset markets achieve the following first-order condition:

$$U'(C)/P = U'(C)^*/SP^*, \tag{2}$$

where $U'(C)$ [$U'(C)^*$] is the marginal utility of consumption to the domestic [foreign] consumer, and P, P^*, and S are the domestic price, foreign price, and nominal exchange rate, respectively. As is well known, the standard complete-markets optimum would generate[1]

$$U'(C) = U'(C)^*. \tag{3}$$

Therefore, asset markets would achieve optimal risk sharing only if $P = SP^*$, since in this case the asset-market condition (2) also generates (3). In other words, the risk-sharing optimum holds only if PPP holds.

This distortion does not arise in the 100%-passthrough (PCP) regime,

1. In the standard model with isoelastic utility, the growth rates of marginal utilities are equalized. In this simple single-period model, parameters are normalized so that marginal-utility levels are equalized.

since PPP holds, resulting in the risk-sharing optimum automatically. However, in the no-passthrough (LCP) regime with nominal contingent contracts, there is an additional lack of risk-sharing distortion arising from deviations from PPP. In fact, in this regime the optimal policy is to give up on responding to supply shocks and instead target risk sharing by fixing the exchange rate at the level that will imply PPP.

While this policy is the best the authorities can accomplish under no passthrough (LCP), it is still Pareto-inferior to the optimum under 100% passthrough (PCP), since the economy is still left with the relative price distortion under no passthrough.

Given this background, I now describe questions arising from the argument.

2.1 WHAT TYPE OF ASSET MARKETS ARE THESE?

As explained above, the nature of the welfare hierarchy of the exchange-rate policies in the presence of different degrees of exchange-rate passthrough depends critically on the asset-market structure. However, there is little motivation for this market. Why are there state-contingent claims in nominal, but not real, payoffs? Many critics of the complete-markets assumption focus upon the state-contingent nature of the payoffs. Recent studies find that only a small proportion of risks measured by consumption outcomes are spanned by financial returns.[2] Given the substantial stickiness of prices documented by Engel, it seems unlikely that adjusting by the nominal price levels would affect this result. By contrast, it could be argued that liquid markets exist for real-index bonds for which assets pay out in real terms. Another approach that has been taken in the literature is to assume that state-contingent assets do not trade at all, but that risk-free bonds can be used to smooth consumption intertemporally.[3] It would be interesting to see how these more conventional assumptions about incomplete markets would affect the results from the analysis.

Whatever the result, it is clear that the assumed asset structure is key to the outcome in the paper. Therefore, it deserves more discussion. Why can't people trade at least some assets with real payouts if they can trade in what would seem like much more complex asset markets that pay off nominal returns in *all* states? What kind of market is this, and where do we see examples in the real world? How robust are the implications for fixed vs. floating exchange rates to the specific assumptions of the form of market incompleteness?

2. See for example Davis, Nalewaik, and Willen (2000).
3. See Heaton and Lucas (1995, 1996), and Baxter and Crucini (1995), to name a few.

2.2 HOW IMPORTANT QUANTITATIVELY ARE THESE INEFFICIENCIES?

Taking the asset market structure as given, the other question lurking behind the welfare hierarchy is: "How big are the welfare distortions?" Recall that under 100% passthrough the constrained optimum can be achieved where two potential distortions can be eliminated: (a) misallocation of relative goods supplies, and (b) inefficient sharing of risks across countries. Under the no-passthrough (LCP) regime, only the risk-sharing inefficiency (b) can be eliminated. Therefore, the obvious question is: how large is this inefficiency (b) compared to the inefficiency (a)?

If risk-sharing welfare costs (b) are large and the supply allocation welfare costs (a) are small, then it would seem that the difference between the optimal exchange-rate regimes under no passthrough and 100% passthrough would not be very great. Under no passthrough (LCP), the economy would be left with a small resource-allocation distortion after fixing exchange rates, but in either case, the risk-sharing costs are eliminated. This would imply that the welfare costs of having no passthrough are not large.

On the other hand, if risk-sharing welfare costs (b) are significantly smaller than supply allocation costs (a), then there is a significant welfare loss under fixed exchange rates arising from the exporters' practice of fixing prices in local currencies and not passing through exchange-rate changes. In this case, the choice of exchange-rate regime would be a less important policy issue than this practice by exporters and importers. This is because, whether exchange rates are fixed or floating, there is a large welfare loss from supply misallocation (a) that arises purely from the practice of not passing exchange-rate changes through to exporting prices. Therefore, a more important policy might be to encourage exporters and importers to pass exchange-rate changes through to local-currency prices, thereby getting the economy closer to a constrained optimum.

As this discussion makes clear, without some quantification, we cannot know how critical the degree of exchange-rate passthrough is to Friedman's argument for fixed vs. floating exchange rates.

2.3 IS THE FOCUS UPON THE FRIEDMAN ARGUMENT FOR FLOATING RATES TOO NARROW?

In this paper, Engel asks what this version of the new open-economy model has to say about Friedman's argument for floating exchange rates. Given the discussion above, it is clear that this leads to an argument not for fixed exchange rates necessarily, but for a *PPP rule*. Moreover, the rationale behind this PPP rule in the model is expressly to eliminate a distortion of international risk sharing.

On the other hand, countries that have adopted a PPP exchange-rate rule, such as Latin American countries and Israel, do not appear to have had international risk sharing as a major policy objective. Rather, the PPP rule seems to coincide with announced concerns about reducing inflation and generating credibility in financial markets.

Thus, it appears that by choosing to focus upon Friedman's argument, Engel has narrowed the discussion of fixed vs. floating rates to risk sharing. This particular consideration does not seem to be a major concern to policymakers faced with this decision, however.

3. *Issues Ahead for the Literature*

Above, I have restricted my comments to the specifics of the model and empirical evidence outlined by Engel in his paper. In this section, I describe some issues that lie ahead for the literature to confront if the new open-economy model is to be used to make welfare statements about Friedman's argument for fixed vs. floating rates.

3.1 HOMOGENEOUS PASSTHROUGH ACROSS INDUSTRIES

The model described in the paper relies upon fixed markups and passthrough across industries at the aggregate economy level. However, the empirical evidence on passthrough has found both assumptions to be counterfactual at the industry level. For example, Knetter (1993) finds significant differences in markups across industries. In fact, he finds that there is greater variation in markups across industries than across countries. Furthermore, Bodnar, Dumas, and Marston (2002) examine a duopoly model of domestic and foreign exporters in Japan in which the markups not only are time-varying, but depend upon the exchange rate. Table 1 reproduces some of the estimates of passthrough across indus-

Table 1 PASSTHROUGH ESTIMATES BY INDUSTRY FROM BODNAR, DUMAS, AND MARSTON (2002)

Industry	*Passthrough coefficient*
Construction machinery	0.806
Measuring equipment	0.750
Camera	0.471
Copies	0.294
Motor vehicles	0.262
Electronic parts	0.244
Magnetic recording	0.218
Film	0.148

Figure 1 MOTOR VEHICLE PRICES IN YEN

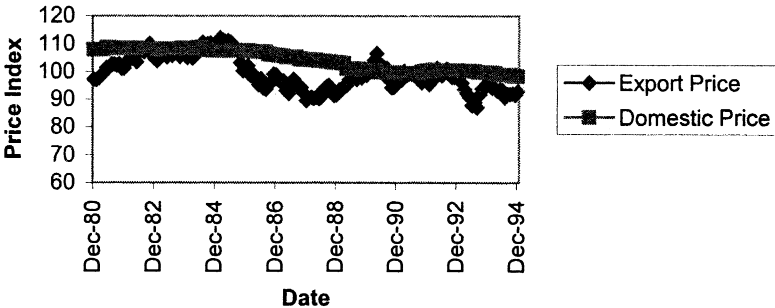
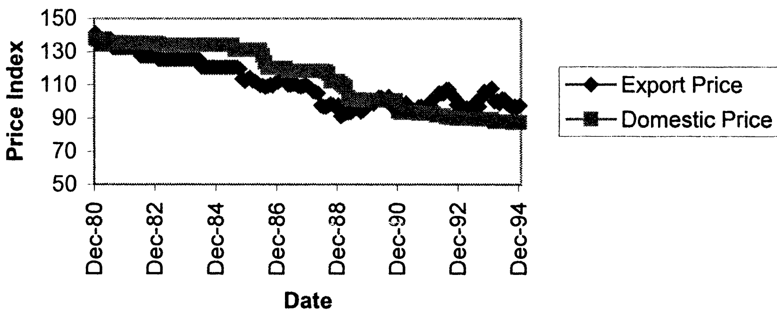


Figure 2 CAMERA PRICES IN YEN



tries. The passthrough coefficients of exchange rates to Japanese export goods differ from about 81% for construction machinery to about 15% for film. To illustrate the relationship between the domestic and foreign prices, Figures 1 and 2 show the domestic price index and the export price index, both in Japanese yen, for motor vehicles and cameras, respectively.[4] While these figures are not the most extreme differences in passthrough shown in Table 1, there are clearly differences in the amount of variability in the deviations from the law of one price in these goods.

Thus, before the model outlined in the paper can be used to make policy statements that hinge critically on the degree of passthrough, more research must be done to understand the behavior of aggregate passthrough. In particular, the literature must tackle the question of how differences in markups and / or passthrough at the industry level (perhaps

4. I thank Dick Marston for providing me with the data from the Bank of Japan to generate these figures.

even the firm level) aggregate up to the macroeconomic response of goods pricing.

3.2 CONSTANT PASSTHROUGH OVER TIME

In the literature, a standard assumption is that passthrough is constant over time. Accordingly, in the paper by Engel, passthrough is either 100% or zero all the time, although these extremes are clearly meant as benchmark assumptions. While this assumption makes for tractable analysis and results, it is at odds with standard business practice. Companies involved in international trade differ in their approaches to exchange-rate risk, but most international financial officers claim to use a variety of strategies to manage this risk. These strategies include a combination of hedging the risk with financial instruments and adjusting the local-currency price as the exchange rate changes.

Some evidence on these business practices is provided in a survey of 399 firms' use of derivatives (Bodnar, Marston, and Hayt (1998). These firms were from diverse industries coming from three different sectors: primary products, manufacturing, and services. Moreover, the firms ranged from small (sales less than $150 million) to large (sales more than $1.2 billion). Of the large firms, 83% responded that they used financial derivatives to hedge risk; of the medium-sized firms, 45%; of the small firms, 12%. This suggests that much of the international trade transactions at the macro level in the United States is hedged to some degree with derivatives.

What does hedging have to do with passthrough? Financial officers suggest that they often view hedging and adjusting their local-currency price as substitute strategies for protecting profits from adverse exchange-rate changes. When profits are protected from exchange-rate movements by existing hedges, exporters feel less need to adjust prices in local currency and tend not to pass through exchange-rate changes. On the other hand, when there are no hedges or existing hedges have expired, exchange-rate movements are felt more directly in profit lines and there is a more immediate need to consider a price change.

On this issue, the survey by Bodnar, Marston, and Hayt (1998) is again illuminating. Of the firms that use derivatives to hedge currency risk, 85% replied that they hedged anticipated transactions less than a year, and only 57% said that they hedge anticipated transactions more than a year. This evidence is consistent with anecdotal evidence that suggests firms hedge short-term exposures more actively than longer-term exposures. Moreover, 60% of the firms said that while they faced foreign-exchange exposure, the net exposure was only plus or minus 5% of net revenues.

This suggests that many firms have multiple exposures so that they are operationally hedged.

If firms are hedged with either derivatives or a mix of operations, then it is likely that many international financial officers do not alter local-currency prices in the near term. Therefore, short-term passthrough is likely to be low. However, as hedging instruments expire, these same international officers are forced to pass through the changes at least partially in order to preserve profit lines. Clearly, the degree of competition and the mix of operations are key factors in this decision.

Overall, it is difficult to envision a model that brings empirics on exchange-rate passthrough together with welfare analysis of Friedman's argument for fixed exchange rates without considering the passthrough decision as an endogenous variable to the firm.

4. Conclusions

This paper is an insightful survey of what the new-open-economy macro literature and empirical evidence on the real exchange rate jointly have to say about Friedman's argument for fixed vs. floating exchange rates. It should be useful to any researcher who wants to learn more about the area.

At the same time, I was left with the wish list of research items posed above. This list includes: (1) quantifying the importance of the welfare costs; and (2) analyzing the robustness of the results to (a) the asset market assumptions and (b) heterogeneity and time variation in passthrough across industries. I look forward to reading about such further research.

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Comment[1]

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1. Introduction

It is a pleasure to discuss this paper by Charles Engel. In recent years, Engel has been a major contributor to the new-open-economy macro (NOEM) literature. This literature, pioneered by Obstfeld and Rogoff (1995), aims to build models of the open economy in the New Keynesian tradition while retaining solid micro foundations and a rigorous intertemporal approach. Engel's empirical and theoretical papers have shaped and greatly influenced the direction that this research has taken.

This paper offers two contributions. The first part is a survey of recent developments in the literature, both theoretical and empirical. This is most welcome. The field is starting to look a lot like a restaurant menu with 150 different entrees, all made from the same 20 basic ingredients. In the end, and without a little clarification for the layman inside all of us, they all taste the same. The second part of the paper provides additional empirical evidence that prices are sticky in consumers' currency, evidence that is used to discriminate further between alternative models.

I like the first part. I am somewhat less convinced by the second one, as my comments will now explain.

2. A (Selective) Review of the Literature: What We Have Learned

A key issue is the impact of exchange-rate movements on relative prices and quantities. In the traditional Mundell–Fleming framework, domestic-currency prices of domestically produced goods are given, and the pass-through from exchange rates to prices is unitary. A depreciation of the domestic currency lowers the price of exports in the foreign currency and

1. Thanks to Richard Friberg, Helene Rey, and Lars Svensson for helpful discussions and comments.

increases the price of imports in the domestic currency. This relative-price change affects the allocation of expenditure—the *expenditure-switching mechanism*—which is at the heart of the adjustment process and is the key to the potency of monetary policy under flexible exchange rates.

2.1 EARLY NEW OPEN-ECONOMY MODELS: PRODUCER CURRENCY PRICING

The early NOEM models of Obstfeld and Rogoff (1995, 1998, 2000, 2002) have incorporated this mechanism by assuming that prices are fixed in the currency of the producer (*producer currency pricing*, or PCP). Not surprisingly, perhaps, these models retain the flavor of the old Mundell–Fleming framework. In contrast, though, one can now ask normative questions such as (1) "What are the optimal exchange-rate regime and monetary policy?" and (2) "Should there be monetary cooperation?" In Obstfeld and Rogoff (2002), the answers are (1) to float, and to set monetary policy to respond to domestic real shocks only, and (2) no.

This paper provides a nice intuition for these results: under a complete set of *nominal* claims, the marginal utility of a unit of domestic currency is proportional between domestic and foreign consumers. Full insurance—equating marginal utilities—requires that PPP hold. This happens when the exchange rate is flexible. On the other hand, country-specific shocks require an adjustment in relative prices. When prices are sticky in the producer's currency, this is achieved by a flexible exchange rate, provided monetary policy targets domestic real shocks. This is the rationale for flexible exchange rates in Mundell's classical analysis of optimum currency areas, and this also underlies Friedman's celebrated argument for flexible exchange rates. In the Obstfeld–Rogoff setup, therefore, Friedman meets Mundell, and they both conclude that flexible exchange rates do the trick. Together with an appropriately chosen monetary policy (one that focuses exclusively on the task at hand, i.e. stabilizing domestic fluctuations), this implements the constrained Pareto-efficient allocation and replicates the flexible price allocation.

It is useful to note that this result does not depend too much on the assumption that markets for nominal contingent claims are complete. Indeed, as Obstfeld and Rogoff (2002) have shown, even when markets are incomplete, the gains from cooperation are likely to be very small compared to the potential gains from stabilization of domestic disturbances. This is so because in this class of models the welfare gains from international risk sharing are not very large.

2.2 BUT THE LAW OF ONE PRICE DOES NOT HOLD

So, what more could we ask for?

Well, it turns out that a critical assumption in this class of models is the

PCP assumption and the associated expenditure-switching mechanism. In its simplest form, it implies that the law of one price (LOOP) holds for consumer prices. Yet, as Engel and others demonstrated in a series of very influential papers (Engel, 1993, 1999; Engel and Rogers, 1996, 2001; Parsley and Wei, 2001), and as he shows anew in this paper (see his Figure 1), domestic and foreign consumer markets are very segmented. Put simply, LOOP does not hold, and the passthrough to retail prices is closer to zero than to one. Engel (1999) demonstrates an even stronger result. He decomposes movements in the CPI real exchange rate into two components (up to some empirically small covariance term): the relative price of traded goods, and a weighted difference of the relative price of traded to nontraded goods at home and abroad. Under standard theories of exchange-rate determination, tradable goods satisfy LOOP, so movements in the real exchange rate should be accounted for by fluctuations in the relative price of traded to nontraded goods at home and abroad. Yet, Engel finds that up to 90% of the variability in real exchange rates, even at long horizons, is explained instead by deviations from LOOP.

This result is consistent with a combination of two assumptions. First, firms can price-discriminate across markets (*price to market*, or PTM). Second, they set prices in advance in local currency (*local currency pricing*, or LCP). As Devereux and Engel (1998) and this paper show, these assumptions deliver starkly different results. Since prices are now sticky in the importer's currency, relative-price adjustments do not take place, even with a flexible exchange rate. A flexible exchange rate just causes profit risk for exporters. A fixed exchange rate is therefore the optimal policy. In this framework, both Mundell and Friedman are wrong, the former because there is no expenditure-switching effect, the latter because there are no relative-price adjustments.

2.3 YET THERE IS EVIDENCE OF EXPENDITURE SWITCHING

Given the extensive evidence of the failures of LOOP, is the debate settled?

Not quite. Obstfeld and Rogoff (2000) and Obstfeld (2001) show that the LCP assumption has some implications for the comovements of the terms of trades and the nominal exchange rate that are rejected by the data. Suppose, as Devereux and Engel do, that prices are fixed in the importer's currency. Denote the domestic currency price of imported foreign goods by P_F. Denote the foreign currency price of exported domestic goods by P_H^*. Both are fixed. The terms of trade, the relative price of home imports in terms of home exports, is simply $P_F/\varepsilon P_H^*$, where ε denotes the nominal exchange rate quoted as units of domestic currency per unit of foreign currency. Under LCP, a currency depreciation—an increase in ε—*improves* the terms of trade.

Conversely, under PCP, the domestic price of imports, $P_F = \varepsilon P_F^*$, increases one for one with the exchange rate, while the domestic-currency price of domestic exports, P_H, remains unchanged. Hence the terms of trade are $\varepsilon P_F^* / P_H$ and *deteriorate* with a currency depreciation.

As Obstfeld and Rogoff show, terms-of-trade deteriorations are, if anything, positively correlated with nominal-exchange-rate depreciations. Figures 1 and 2 report scatterplots of the 12-month change in the relative price of exports—a proxy for P_F / P_H—against the 12-month change in the nominal exchange rate for Japan and Germany against the United States. The correlation is positive and very high in both cases (0.86 for Japan–U.S. and 0.95 for Germany–U.S.), indicating substantial deterioration in the terms of trade when the currency depreciates.

As Obstfeld (2001, p. 19) argues, "because the ultimate consumer is several steps removed from the port of entry of import goods, however, findings such as Engel's (1999) have only an indirect bearing on the height of barriers to international trade between firms, which accounts for most of international trade." Indeed, empirical studies of passthrough surveyed in Goldberg and Knetter (1997) indicate substantial but not 100% passthrough at the firm level.

To summarize, the overwhelming evidence assembled by Engel in this

Figure 1 YEN–DOLLAR RELATIVE EXPORT PRICES VS. NOMINAL EXCHANGE RATE (12-MONTH PERCENTAGE CHANGE), 1974–2002

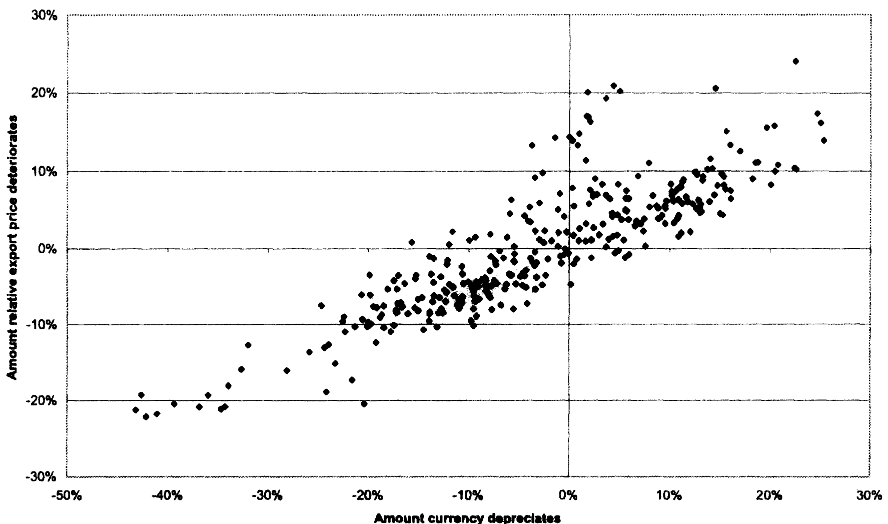
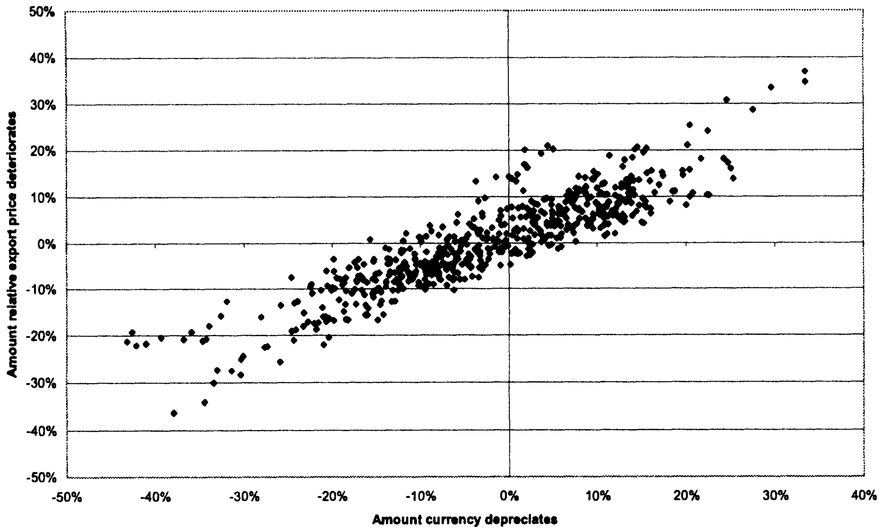


Figure 2 DEUTSCHE-MARK-DOLLAR RELATIVE EXPORT PRICE VS. NOMINAL EXCHANGE RATE (12-MONTH PERCENTAGE CHANGE), 1974–2002



and previous papers indicates that consumer markets are very segmented, even for tradable goods. Yet terms of trade and export prices do respond to exchange rates. This opens up the possibility that expenditure-switching channels are present at the importer level, yet do not affect the consumer level much.

3. *What Should Come Next*

What can account for the different behavior of import and consumer prices? The paper considers three possibilities. First, trading costs may lead domestic consumers to substitute for domestic alternatives (Obstfeld and Rogoff, 2000). If so, the share of foreign goods in the price index may be small, and fluctuations in the exchange rate may not affect the CPI much. Second, deviations of LOOP could arise from the nontraded component in each traded good—local production and distribution costs such as rent, advertising, etc. (McCallum and Nelson, 2000; Burstein, Neves, and Rabelo, 2000). Lastly, intermediate inputs represent the bulk of international trade between developed economies. If domestic and foreign intermediates are substitutes, a fluctuation in the exchange rate may not affect the overall CPI much, even with a high passthrough at the import level (Obstfeld, 2001).

The substantive part of the paper considers all three alternatives and argues that explanations based on trading costs and on nontradable services and distribution do not hold up to the data. Before I comment on this part, it is important to log a few remarks on the general research agenda.

3.1 INVOICING: PRACTICE AND THEORY

Clearly, price discrimination and invoicing practices can have a large effect on the transmission mechanism and optimal monetary policy. This raises two questions, one positive and one normative: What do we know about invoicing practices? In which currency should exporters set their prices?

3.1.1 Invoicing in Practice The empirical evidence is sparse. Obstfeld and Rogoff (2000), as well as most of the literature, refer to a 1995 Institute study concluding that most exports tend to be invoiced in the currency of the exporter. There is one notable exception: exports to the United States are generally invoiced in dollars.

Table 1 reports some more recent evidence on the currency of denomination of exports and imports of some industrialized countries between 1992 and 1996, from Tavlas (1997). The U.S. special status is still there:

Table 1 CURRENCY DENOMINATION OF SELECTED INDUSTRIAL COUNTRIES, 1992–1996

	Fraction (%)		
Country	*U.S. Dollar*	*DM*	*Yen*
	Exports		
United States	98.0	0.4	0.4
Germany	9.8	76.4	0.6
Japan	52.7	—	35.7
United Kingdom	22.0	5.0	0.7
France	18.6	10.6	1.0
Italy	23.0	18.0	—
	Imports		
United States	88.8	3.2	3.1
Germany	18.1	53.3	1.5
Japan	70.4	2.8	22.5
United Kingdom	22.0	11.9	2.4
France	23.1	10.1	1.0
Italy	28.0	13.0	—

Source: Tavlas (1997)

98% of exports and 88% of imports are invoiced in dollars. For other countries, the picture is more mixed. For instance, the U.S. dollar is used to invoice more than half of Japanese exports, and about 20% of French and Italian exports. Lastly, Germany is comparable to the United States, invoicing more than 50% of its imports in its own currency. This last fact does not fit well with either the PCP or the LCP assumption. Take the extreme case where all international transactions with the United States are invoiced in dollars, at set prices in the short run. Neither the U.S. terms of trade, $P_F/\varepsilon P_H^*$, nor the U.S. CPI responds to nominal exchange rates, and the exchange-rate risk falls squarely on foreigners.

Table 2 in Friberg (2001)—reproduced here as Table 2—provides some additional data for Sweden for 1968 and 1995. Less than 50% of exports is now invoiced in Swedish krona. In contrast, the fraction of imports invoiced in krona has increased from 26% to 33%.

One can conclude that the pattern of the ECU study has not remained stable over time, as more firms appear to rely on international currencies or the importing-country currency for international transactions. One may legitimately ask whether this change has been accompanied by similar changes in the passthrough or associated with some of the changes in

Table 2 CURRENCY DENOMINATION OF SWEDISH TRADE 1995 AND 1968

	Fraction (%)				
	Imports		*Exports*		*Share in Swedish exports (%)*
Currency	*1995*	*1968*	*1995*	*1968*	
SEK	33.1	25.8	43.8	66.1	—
USD	21.9	22	18.4	12.3	8
DEM	14.4	17.4	9.8	3.8	13.3
GBP	5.4	17.3	5.4	11.2	10.2
NLG	5.1	NA	3.2	NA	5.3
FRF	4.1	2.5	3.7	0.8	5.1
DKK	3	3.9	2.6	1.8	6.9
NOK	2	2.2	2.8	0.7	8.1
ITL	1.7	1.8	1.4	0.3	3.8
JPY	1.7	NA	1.4	NA	2.7
FIM	1.6	NA	1.7	NA	4.8
CHF	1.5	NA	NA	0.5	1.9
Other	4.3	4.7	4.6	2.5	29.9
Total	100	100	100	100	100

Source: Friberg (2001). Data from 1995 are taken from the settlement reports of Sveriges Riksbank—all payments for goods above a threshold of SEK 100,000 and going through Swedish banks are reported. The data from 1968 are from Grassman (1973). Data on exports are from 1994; source: Statistics Sweden.

the structure and patterns of international trade between developed countries (outsourcing, intrafirm trade, etc.), and of financial flows (globalization, international currencies, etc.). But more importantly, this evidence highlights the perils of assessing the merits of various monetary-policy and exchange-rate regimes if we do not have a clear understanding of the determinants of invoicing practices.

3.1.2 Invoicing in Theory At a theoretical level, the invoicing decision need not be neutral. The choice of currency can affect the variability of profits through exchange-rate risk. Consider for instance the case where an exporter sets its price P_H^* in the importer's currency. Assume that import demand depends only upon the import price $[Q(P_H^*)]$ and that forward markets are available and efficient. The exporter can hedge fully any fluctuation in future revenues by selling $P_H^* Q(P_H^*)$ of the foreign-currency forward. On the other hand, if a price P_H is set in the exporter's currency, the future demand $Q(P_H/\varepsilon)$ becomes uncertain and may be more difficult to hedge. This intuition underlies Friberg's (1998) result that invoicing in the importer's currency maximizes ex ante profits when the latter are concave in exchange-rate surpises.

But these results are obtained in partial equilibrium, and therefore somewhat unsatisfactory. After all, it is likely that the volatility of the exchange rate will depend upon the equilibrium currency invoicing that we observe. To paraphrase Krugman (1989), high exchange-rate volatility may be a telltale sign that exchange rates do not matter much, a situation that is much more likely when prices are set in the importer's currency. Further, a firm's decision to invoice in a given currency may not be independent of what other firms are doing. Strategic complementarities can be important.

One recent paper considers the invoicing question in a general-equilibrium framework: Bacchetta and Van Wincoop (2001). They show that exporters have a greater preference to invoice in their own currency the higher their market share and the lower the elasticity of substitution with competing products.

It is a bit early to tell whether these results are robust, or what optimal monetary policy would be like, and how it would depend upon the degree of market incompleteness. But this is clearly an area that deserves further investigation.

3.2 BEYOND EXPENDITURE SWITCHING

In modern economies, exchange-rate movements have complex effects that cannot be reduced to a simple expenditure-switching effect. Consider

Devereux and Engel's (2002) careful attempt at *disconnecting* the exchange rate from other macro fundamentals. Under LCP, relative export prices will not change. Yet external adjustment will come through at least two other channels. First, a depreciation of the domestic currency will reduce markups on foreign goods sold domestically. This decreases profits for local distributors and/or foreign producers, depending on the vertical pricing structure of the industry. As foreign goods become generally less profitable, one should expect a gradual improvement over time in the external accounts. Second, an *expected* depreciation leads to a compensating interest-rate differential. A higher domestic interest rate induces a higher growth rate of consumption, which can also increase current net exports. The general message from Devereux and Engel's paper is that it takes quite a bit of work, and a number of not so appealing assumptions, to disconnect the exchange rate.

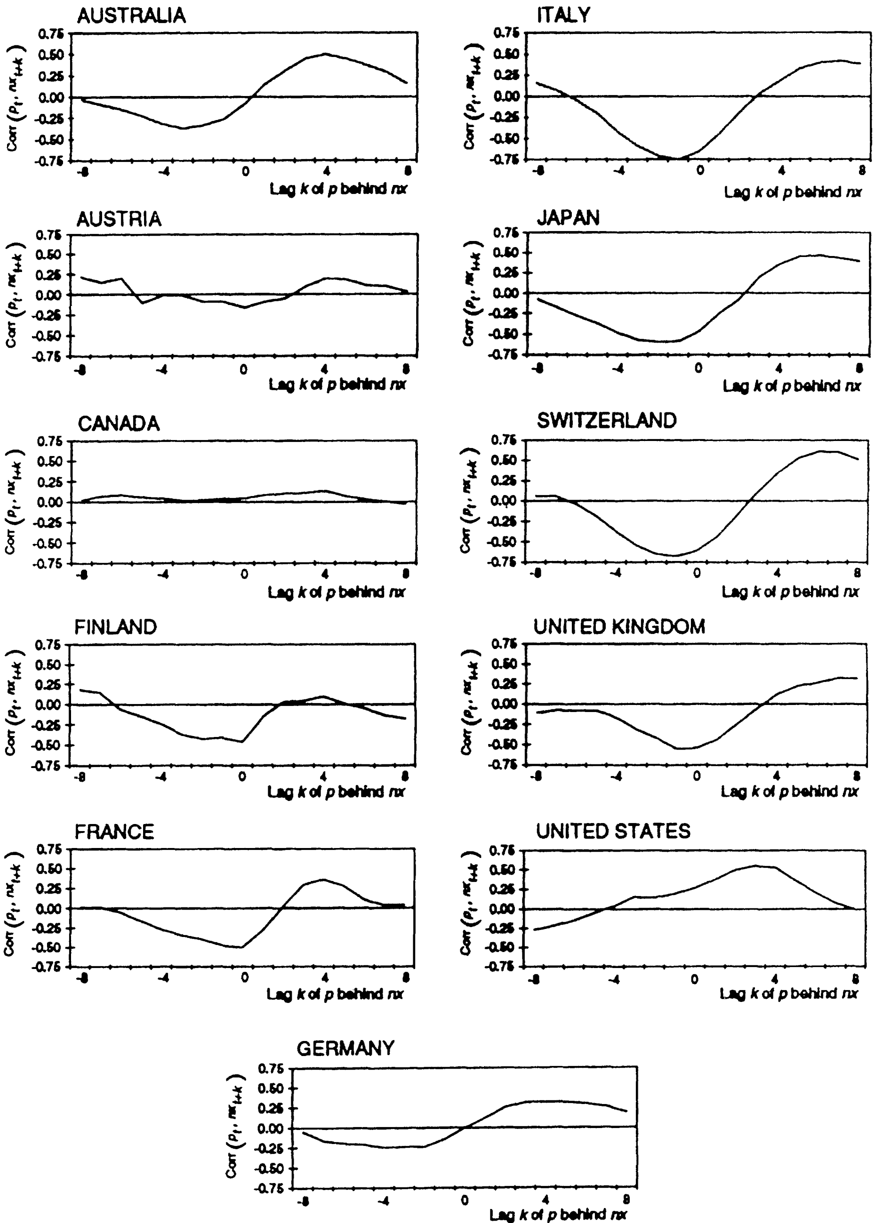
Given the empirical evidence on the disconnect, i.e. of "weak feedback links between the exchange rate and the rest of the economy" (Obstfeld and Rogoff, 2000), this may indicate that expenditure switching—and all the other channels—are not very operational. *A contrario*, this reinforces the view that the expenditure effect is not so crucial anyway.

3.2.1 Quantities and J-Curve What does the empirical evidence say? One way to make progress is to look at the evidence on the effect of exchange rates on quantities. After all, it is not enough to measure the effect of nominal exchange rate on relative prices or terms of trade. The ultimate importance of expenditure switching can only be measured by its effect on quantities: goods imported or exported, demand for factors of production, etc.

Engel correctly argues that "microeconomic studies that examine how imports of particular types of goods, or how employment in specific industries, are affected by changes in import prices must be applied with a dollop of caution. That is because there is a missing link that must be supplied before one can use these studies to judge the quantitative significance of the expenditure-switching effect: the degree of passthrough." But similarly, one should apply caution in interpreting studies that show a low degree of passthrough without looking at the effect on quantities. What if import demand is very elastic? Even with a low passthrough, adjustments may be substantial.

The first piece of evidence comes from Figure 3, from Backus, Kehoe, and Kydland's (1994) classic study on the J-curve. The cross-correlation function between terms of trade and the ratio of the trade balance to output indicates that the trade balance tends to improve following an improvement in competitiveness (a worsening in the terms of trade).

Figure 3 CROSS-CORRELATION FUNCTIONS FOR THE TRADE BALANCE AND THE TERMS OF TRADE IN 11 COUNTRIES.



From Backus, Kehoe, and Kydland (1994).

But these cross-correlations do not tell us how large is the effect of the exchange rate on the trade balance or factor demands. In Gourinchas (1998), I looked directly at the impact of exchange-rate movements on the labor market. An important methodological innovation in that paper was to focus on disaggregated data and to construct industry-specific exchange rates from bilateral real exchange rates based on the wholesale price index, using as weights the trade shares of the major trading partners. While changes in exchange rate appear to have little effect at the aggregate level, they have important effects on export-oriented and import-competing industries. Importantly for Engel's paper, these results do not look at the effect of changes in relative export or import prices. The reason for doing so is simple: export prices are choice variables for firms. Issues of simultaneity and exogeneity are thus likely to be important. On the other hand, most firms are likely to take the bilateral exchange rate as given and unlikely to be influenced by their individual production decisions.[2]

This has the important consequence that I am estimating a *net* exchange-rate effect on employment, after being filtered into import prices, markups, wealth and profits.[3] The results, reproduced in Table 3, indicate that a 10% depreciation of the exchange rate (a high value of λ) leads to an increase in tradable manufacturing employment of 0.27% over the next three quarters. The evidence indicates that these exchange-rate movements account for between 9% and 11% of the fluctuations of employment at the four-digit level, on average. While not a major source of fluctuation, they are nonetheless significant. Goldberg and Tracy (2002, 2000) and Campa and Goldberg (2001), in a series of papers, argue further that exchange-rate changes also affect wages significantly, especially for low-skill workers.

These results indicate that exchange rates do matter, although the evidence is not detailed enough to indicate whether it is through an expenditure-switching effect or any other channel.

4. *What We Cannot Conclude (Yet)*

With these comments made, let me return to the second part of the paper. Sections 7–9 consider three models that can potentially explain the low

2. The issue of simultaneity is more delicate to handle, since exchange rates could move in response to monetary and fiscal determinants that affect labor markets directly. I show in my paper that this is not likely to be a serious issue for the United States: in effect, the paper uses the disconnect to identify the response of employment to exchange-rate movements that are not connected with monetary or aggregate activity.
3. Since I also include direct controls for monetary policy, the effect of exchange rates does not include their indirect effect on domestic interest rates.

Table 3 EMPLOYMENT RESPONSE TO REAL-EXCHANGE-RATE DEVIATIONS

Sector:		Two-digit		Traded						Nontraded	
				All		*Exports*		*Import comp.*			
Regressor	*Timing*	*Coeff.*	*SE*	*Coeff.*	*SE*	*Coeff.*	*SE*	*Coeff.*	*SE*	*Coeff.*	*SE*
λ_t	Cont.	1.40	1.65	4.97	2.47	2.72	3.32	4.58	3.18	6.24	3.38
	1 lag	−0.64	2.29	5.47	3.40	2.60	4.70	8.24	4.32	−3.13	4.45
	2 lags	−0.37	1.76	−7.73	2.58	−4.28	3.49	−9.84	3.31	−0.92	3.49
	Sum:	0.39	0.76	2.71	1.13	1.03	1.38	2.96	1.03	2.18	1.88
$\hat{E}_t$	Cont.	0.68	0.03	0.66	0.06	0.48	0.07	0.77	0.08	0.52	0.08
	1 lag	0.01	0.04	0.08	0.06	0.12	0.08	0.03	0.08	0.02	0.08
	2 lags	0.17	0.03	0.28	0.05	0.37	0.07	0.18	0.07	0.06	0.07
	Sum:	0.85	0.04	1.02	0.07	0.98	0.10	0.98	0.10	0.60	0.10
i_t	Cont.	0.05	0.03	0.05	0.05	0.18	0.07	−0.08	0.07	−0.03	0.07
	1 lag	−0.12	0.03	−0.05	0.06	−0.10	0.08	0.01	0.08	−0.06	0.08
	2 lags	0.02	0.03	0.01	0.06	−0.07	0.07	0.04	0.08	0.07	0.07
	Sum:	−0.06	0.02	0.01	0.03	0.01	0.05	−0.03	0.04	−0.01	0.04

Source: Gourinchas (1998, Table 3).

passthrough to consumer prices, together with higher passthrough to import prices and a significant expenditure-switching effect. Among these models, Engel argues that the shipping costs and the nontradable component of tradable goods are not the full answer. I want to revisit his arguments and offer a few comments.

4.1 SHIPPING COSTS AND DISCONNECT

Shipping costs reduce the weight on foreign goods in the CPI, and if domestic and foreign goods are substitute, this lowers the passthrough to consumer prices. To measure the importance of the shipping-cost argument, Engel runs regressions of the volatility of the bilateral real exchange rates for food and for commodities less food against a measure of distance and the volatility of the nominal exchange rate. Distance proxies for shipping costs, as is traditional in the gravity-equation literature. When both variables are introduced in the regression, only the volatility of the nominal exchange rate comes in significantly, which the author interprets as a rejection of the shipping-cost theory.

Yet it is possible to interpret the results somewhat differently. High volatility of the nominal exchange rate could also be evidence of large transaction or shipping costs, as in Dumas (1992). In that model, deviations from LOOP reflect the presence of nonconvex adjustment costs. The larger the costs, the larger the zone of inaction. The argument does not require that prices be set in the currency of the importer.

In other words, we would expect more variability in the nominal and real exchange rates if shipping costs are higher. The endogenous variance of the nominal exchange rate implies that regressions reported in Table 1 of the paper do not allow a separation between the shipping cost theory and the LCP alternative. The volatility of the nominal exchange rate may be picking up those components of the costs that are not already captured by geographical distance.

One may be tempted to dummy exchange-rate regimes. After all, Mussa (1986) showed that there is much less nominal and real exchange-rate variability under fixed than under flexible exchange rates. However, this may fail for another reason: if indeed differences in shipping costs account for the difference in volatility, it is the long-run volatility that matters. A rigid fixed-exchange-rate regime may suffer an ignominious fate—and the ensuing bout of volatility—if the peg does not allow for adjustments in real exchange rates. Though in the short run volatility may be low, in the long run it may be substantially higher.

More generally, nominal-exchange-rate volatility is likely to reflect the volatility of the underlying monetary policy as well as the impediments to trade in goods and the degree of price stickiness. An alternative approach

would directly use measures of the volatility of the nonsystematic part of monetary policy—since the systematic part may also be geared to offset exchange-rate fluctuations, as in the case of fixed exchange rates.

As they stand, the empirical results from Section 7 do not provide a tight case that shipping costs are not an important part of the explanation.

4.2 NONTRADABLES AND LOCAL DISTRIBUTION COSTS

The paper argues that nontradables are relatively unimportant in explaining deviations from LOOP. Denote by p^* the foreign-currency price (in logs) of a good sold in the foreign country. If the good is produced at home, the price of exports in home currency is $e + p^*$. As a matter of decomposition, we can write

$$e + p^* = \mathrm{mc}(z, y^*, e) + \mu(x^*, e),$$

where $\mathrm{mc}(z, y^*, e)$ represents the marginal cost in domestic currency of production *and distribution*, and depends upon the domestic input costs z, as well as the foreign local costs y^* and the exchange rate e. The term $\mu(x^*, e)$ represents the markup and depends upon foreign demand x^* as well as the exchange rate e, if the firm is pricing to market. We observe that the exchange rate appears both in the marginal-cost term, reflecting the importance of the local nontradable component, and in the markup, reflecting pricing to market.

Similarly, let's write the price of the good in the source country as

$$p = \mathrm{mc}(z, y, 1) + \mu(x, 1),$$

where both the marginal cost and the markup depend only upon domestic factors, as emphasized by the 1 in both terms. The marginal costs differ to the extent that the distribution part differs as well. The relative price of the good is simply

$$e + p^* - p = [\mathrm{mc}(z, y^*, e) - \mathrm{mc}(z, y, 1)] + [\mu(x^*, e) - \mu(x, 1)]. \tag{1}$$

This expression contains two terms. The first one reflects the differences in marginal costs, expressed in a common currency. One can think of this term as measuring the importance of local costs. The second term reflects the fact that firms can price-discriminate and apply different markups to different countries. The exchange rate appears in both terms.

Equation (1) is what Goldberg and Verboven (2001) estimate in their study of the European car market. They first estimate a semistructural

demand system and use it to derive own- and cross-price derivatives that determine the optimal price markups. They then estimate a supply system similar to equation (1). They use their estimate to derive the relative importance of the exchange-rate component for the marginal cost and for the markup term. Their results indicate that roughly ⅔ of the deviations from LOOP arise from the local cost component.

By contrast, Engel writes the price of the good in the foreign market as

$$p^* = \alpha\, p_s^* + (1 - \alpha)\bar{p}^*,$$

where p_s^* represents the price of the local—nontradable—components and $\bar{p}^*$ the price of the tradable part. α represents the (constant) share of the costs arising from the local cost component. Using this decomposition, he obtains the following expression for the relative price:

$$e + p^* - p = \frac{\alpha}{1 - \alpha}\,[(p_s^* - p^*) - (p_s - p)] + [e + \bar{p}^* - \bar{p}]. \tag{2}$$

The first term represents the domestic-vs.-foreign relative price of services, or more generally the nontradable component. Engel interprets this term as capturing the local cost component. The second term represents the relative price of the tradable component. Under the PTM, it should be zero. Engel interprets this term as capturing the relative markup.

Using data on the relative price of services as a proxy for p_s and p_s^*, and data on the price of food and nonfood commodities as a proxy for the price of the tradable component, Engel concludes that most of the variation arises from deviations in the (unobserved) relative price of the tradable component, $e + \bar{p}^* - \bar{p}$. In other words, there is little evidence in the OECD sectoral price data that deviations from LOOP arise from the foreign vs. domestic price of services relative to tradable goods.

Should we conclude that local costs are unimportant, and unaffected by exchange rates, as the paper does?

At face value, this paper's approach has a number of advantages: it relies on a simple decomposition, and does not require the potentially costly auxiliary assumptions on the market structure or the shape of the demand system that Goldberg and Verboven must make. However, it is also unclear that one can map equation (2) simply into equation (1). Ultimately, it is equation (1) that we are interested in, and equation (2) may have little to say about it.

Consider the following counterexample. Suppose there is perfect competition both at home and abroad, so that $\mu(x^*, e) = \mu(x, 1) = 0$. All varia-

tions in the relative price must come from the local cost component and relative marginal costs. Assume further that input prices are constant in their own currency. If there is substitution between local and home inputs, and marginal costs are not constant, a fluctuation in the exchange rate will affect the price of the tradable component less or more than one for one, leading to a fluctuation in $e + \bar{p}^* - \bar{p}$. Yet, by construction, this would simply reflect the effect of the exchange rate on relative marginal costs $mc(z, y^*, e) - mc(z, y, 1)$. It would be incorrect to attribute the variation to markup fluctuations.

5. Conclusions and Suggestions

This is a stimulating paper written by an expert in the field. It asks an important question, one that has gathered substantial attention of late: Is there an expenditure-switching effect, and if so, through which channels? In so doing, it provides a very valuable and insightful survey of recent developments on new open economy macro models. It then offers some new empirical evidence aimed at discriminating amongst the recent models that feature both low passthrough at the consumer level and higher passthrough at the import level. I find that part of the paper somewhat less convincing. The empirical evidence is exciting and will undoubtedly provoke further rounds. But I do not think that it addresses squarely the empirical questions raised by the models. The field has matured considerably in the past few years, and I believe it is now ripe for a careful look at the sort of microeconomic evidence that will deliver the next set of stylized facts. I am quite certain that Engel will be among the major contributors to this endeavor.

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Discussion

Alan Stockman remarked that the literature tends to focus on the details of price stickiness and price setting, and pays less attention to the consequences for quantities. He felt that micro-level work on this issue would be interesting, though it should not violate the Flood–Rose disconnect puzzle. He suggested that the disconnect puzzle may be connected with the fact that a fraction of trade is intrafirm trade, which involves transfer pricing for tax purposes. This implies that many prices do not have any economic content. He also questioned whether prices matter for quantities when trade takes place under implicit long-term contracts between firms. He noted that in his work on J-curves, he had found that in the longer term, the J-curve exists, but that it does not have the standard consequences for GDP. Rather than exchange-rate depreciation leading to higher net exports and an increase in GDP, depreciation leads to a statistically significant decrease in GDP.

Ken Rogoff noted that Engel's work provides strong evidence that consumer prices don't respond to exchange-rate changes. He added that Goldberg and Knetter show that passthrough is much greater into wholesale prices, but that recent work by Giovanni Olivei shows that passthrough into wholesale prices has declined both in the developed world and in the developing world. He commented that this is a mystery, and suggested that it might be connected with the fact that intrafirm trade is growing as a share of total trade. He pointed out that intrafirm trade is now over 50% of trade for many countries. He also cited work by Jim Rauch showing that interfirm trade often takes place as part of a network. However, he remarked that while the importance of intrafirm trade might suggest how exchange-rate risk is shared, how firms react to exchange-rate changes is still a puzzle. He noted that some firms, such as Ikea, seem to be good at matching sourcing behavior to exchange-rate changes, but that expenditure switching on a large scale doesn't seem to result.

Ariel Burstein mentioned that in exploring the links between passthrough and expenditure switching, it might be instructive to look at large devaluations, where nominal rigidities are unlikely to play a major role. He noted that in work where he looked at nine large devaluations in the 1990s, import prices move closely with the exchange rate, but consumer prices do not.

Charles Engel noted that the international setting demonstrates that menu costs cannot be the only explanation for nominal price stickiness, as menu costs are incurred no matter which currency prices are set in. Following up on this point, Ken Rogoff remarked that this literature could

be very useful for closed-economy macroeconomics. He said that international data confirm what Kimball, Barro, and Hall said in relation to the closed economy: Wage stickiness is not enough; prices also have to be a bit sticky.

Lars Svensson was troubled by the fact that the currency in which firms set prices is taken as exogenous in the paper, and asked Charles Engel whether he had considered endogenizing this choice. On a related point, Bob Hall pointed out that in many cases, particularly in intermediate-product markets, pricing is not the unilateral decision of the seller, but the result of an interaction between buyer and seller. He suggested that the literature should take this into account.

Lars Svensson also asked whether there is evidence of different responses of prices to transitory and permanent changes to the exchange rate, and suggested that VAR evidence might be informative on this point. Engel replied that the evidence suggests that the behavior of real exchange rates and deviations from the law of one price is remarkably similar at short and long horizons. On this point, Alan Stockman remarked that work on the differences across countries in the extent of exchange-rate passthrough would be desirable. He agreed with Karen Lewis that cross-country differences could be due to differences across industries in passthrough and differences across countries in industrial composition. However, he noted that the implications for expenditure switching do not depend on where cross-country heterogeneity in passthrough comes from.

Charles Engel summed up the thrust of his paper as a rejection of the simple Devereux–Engel zero-expenditure-switching local-currency-pricing approach. He noted that the evidence favors considerable consumer price stickiness, except in high-inflation emerging markets as mentioned by Ariel Burstein. But it also favors considerable passthrough to import prices, and he saw the determination of the resulting magnitude of expenditure switching as the next challenge for the literature.