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Owner-Used Capital Goods and the Exchange Rate Determination.

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Abstract:

Present paper addresses the issue of the short and long run determination of the exchange rates in the Redux model of Obstfeld and Rogoff (1995). Current extension of the Redux model includes the investment projects that simultaneously can serve as investment allocation subject to the capital gains, as well as a regular consumption good. In contrast to the standard theoretical results, our model produces the exchange rate overshooting both in presence and in absence of price rigidities in the markets for final goods. This effect depends on the size of the owner-used capital goods expenditure relative to the total consumption expenditure, as well as the initial level of inflation at home. Depending on parameter values, and the initial conditions, the model supports possibility for exchange rate dynamics that include either overshooting or undershooting..

JEL Classification:
Key Words: Exchange Rates, Overshooting, Capital, Owner-Occupied Housing.

Introduction.

The recent models of the exchange rate determination have been based on the Redux model originally developed in the Obstfeld and Rogoff (1995) paper. One of the major problems with the Redux framework is that in the traditional set up, the model generates no short run deviations in the exchange rate from the steady state value. In response to the exogenous money supply shock, the mainstream Redux model must rely on the presence of tradable and nontradable goods together with nominal price rigidity in order to produce the exchange rate overshooting.

Such specification is open to the criticism that nominal price rigidity in the nontradable sector is hard to justify in general setting of an open economy. In addition, even when the model is capable of generating overshooting, the assumptions employed in the model do not allow for it to capture the possibility of the exchange rate undershooting. The third source of criticism of the standard Redux model is that the exchange rate adjustments last only as long as the assumed period of nominal price rigidity. Thus, the Redux model does not allow, in its basic specification, for the persistent deviations in the exchange rate away from the long run equilibrium level.

On the other hand, a growing literature in economics considers the role that the cost of living price indices play in determining the consumer behaviour and the differences between the traditional price indices utilised in national accounting and the actual costs faced by the households[1]. Two dimensions of cost of living indices superiority over the traditional price index approach to inflation accounting are distinguished. First, cost of living (COL) indices take into account the effects that capital and asset markets have on

[1] See for example an extensive discussion of the CPI biases in Moulton (1996).

the cost of consumption and income of the agents. Second, COL indices allow for capturing quality changes and innovation in consumer goods.

Both of these distinctions remain outside the scope of the traditional price indices and subsequently outside the standard Redux model that uses standard CPI-type index for both tradable and nontraded goods. In the present model we propose to address at least the first distinction between the CPI and COL indices in the context of an open economy.

Most of the specifications for COL indices introduce an important possibility for the capital gains in the cost of consuming certain goods. The major distinction of these goods, which hereinafter we shall call the owner-used capital goods (OUCG), is that they represent simultaneously consumption good and capital good, subject to capital gains. The main example of such goods is found in the owner-occupied housing market. Other examples may include time-share real estate, holiday homes, motor vehicles, collectibles, antiques and even certain types of clothing.

Many of these categories, with exception of the owner-occupied housing, often either border or directly represent the broad category of luxury goods. Over the recent decades their share in household consumption expenditure has been steadily increasing within the OECD economies. For example in countries like the USA, UK, Japan, Ireland, Italy and France, housing costs account for between 20 and 40% of the total disposable income of the household. In the US, an average middle-class family has more than half its assets in the form of housing, according to Cambell and Cocco (2003). At the same time, in the UK, according to Miles (1993), the housing weight in total net worth of the households has increased twofold over the period of 1980 through 1990 to equal 40%.

As such, introducing these goods into the general macroeconomic model will yield at least the benefit of closer approximation of the real environments in which the consumers operate. In addition, owner occupied housing represents an important dimension to the analysis of the monetary policy in many OECD economies (see for example Iacoviello and Minetti (2000) and Fratantoni et al (2001)).

Likewise, broad arts and antiques markets which traditionally outperformed in the long run the stock market in the rates of return on the higher priced items in the recent decades have experienced rapid development of the secondary, more affordable markets. As such since the mid 1980's markets for prints and works on paper, with average items selling in the range between 1,000$ and 10,000$ have grown appreciably in breadth. Similar developments occurred in the designer goods and clothing markets, where a secondary resale market has been developed often with capital appreciation and in all cases with at least some store of value capacity.

In a parallel development, ageing of the OECD countries' population combined with increasing home ownership by the elderly that is not tied into housing consumption of the younger generations has created a strong market for re-mortgaging of the housing stock. This allows the elderly to continue residing in their homes while releasing at least partially the liquidity trapped in the real estate holdings for the purpose of financing higher rates of consumption. Thus, in addition to the stronger overall wealth effects on composition of consumption expenditure mentioned earlier, present economies can be characterised by the age effects in consumption cycle. These effects make the housing price fluctuations more salient in considering the household responses to price changes, and as such to the monetary policy overall.

In general, another aspect of such goods warrants their separate consideration in the general equilibrium open economy macroeconomic model: the relationship between the consumption expenditure on these OUCGs and the savings by the households. Browning and Lussardi (1996) point out that the treatment of durable goods, housing, and other items subject to capital gains or resale value, can distort the message of the aggregate savings rates. Accounting for these goods in the total household expenditure can explain, according to Skinner and Daniel (1990), more than doubling of the US nation savings rate over the period of 1983-1988 to 15% relative to the official savings rate estimates of 4.8-6%.

In the context of the open economy macroeconomic models, careful consideration shall be given to the separation of goods into tradable and nontraded categories. While the majority of the consumption items can be classified as tradables, housing is and will most likely remain largely a domestically produced and consumed good. In addition, as many examples from arts and antiques markets indicate, these goods carry a price premium both in level and growth terms that is localised within a given country or a region. Thus, for example, an Irish artist work sold at the auction can command up to 100% premium when it is traded in Dublin over the comparable sale in New York. As such, it makes sense to model it as a nontradable good.

The most fundamental distinction of the owner-used capital goods from traditional consumption goods is that these goods are subject to potential capital gains due to price appreciation. The consumers-owners of their housing therefore can benefit from this ownership in terms of both the immediate consumption utility and from the possibility to convert equity into the additional income by re-mortgaging.

As such the buyers of homes are concerned not primarily with the immediate price of their house, but with the relation between the current and future prices. In other words, they consider the cost of living index on the housing that accounts for potential capital gains/losses.

If the markets for OUCGs are closed to foreign competition, while by their nature being characterised by monopolistic competition amongst the producers, and/or limited nature of supply such as found in the art markets, the assumption of nominal price rigidity in the short run can be justified for these markets on the grounds other than the standard menu costs. Furthermore, nominal price rigidity at least in the case of housing markets can be replaced by time-to-build lags justified on the grounds of the regulatory climate of planning, development and approval.

With this in mind, we incorporate the aforementioned effects into the general equilibrium framework of the exchange rates determination along the lines of the Obstfeld and Rogoff (1995) Redux model with tradable and nontraded goods.

In Part 1 we discuss the issue of price indices and introduce a specific representation of the cost of living index with capital gains. In Part 2 we show that once incorporated into the Redux model, this representation yields stronger results than the traditional Redux model with tradables and notraded goods. In addition to this, the model also predicts a possibility for the exchange rate undershooting, depending on the starting level of inflation at home. Part 3 considers the variation in the Redux model whereby the nominal price rigidity assumption is relaxed. It is replaced instead by the assumption that there are time-to-build lags present in domestic productive sector. As this section of our paper shows, the model yields exchange rate overshooting even in the context of

flexible prices of domestic goods. Finally Part 4 of the paper concludes by considering the issue of PPP long run reversion in the model with COLI and owner-used capital goods.

Part 1. Price Index versus Cost of Living Measures: Does Inflation Bias Matter?

Ability to accurately represent the measure of prices and inflation is critical to most economic issues. In particular, in the context of a model studying the effects of money supply changes on the exchange rates, the effects of monetary policy are determined in large by the assumptions concerning the aggregate prices faced by the representative households. Therefore, it is instructive to consider briefly a topic of price index determination.

In 1995 the US Senate Finance Committee produced a study of the Consumer Price Index that concluded that current methods for calculating the CPI overstate the changes in cost of living by about 1.1 percentage points per year, with a range of plausible values for the bias between 0.8 and 1.6 percentage points. Using survey data, Nordhaus (1998), shows that CPI bias is upwardly statistically significant at 1.5 percentage points level, with standard error of 0.48. This bias, when compared in and by itself to the average rate of CPI inflation of about 3 percentage points is large enough. Compounded over time, its importance becomes even greater.

Not surprisingly, the Committee's recommendations began with an overarching suggestion that: "The Bureau of Labor Statistics should establish a cost-of-living index as its objective in measuring consumer prices" (US Senate, 1996). At the same time,

Nordhaus (1998) concludes that: “It is likely that changes in the distribution of income over life-cycle effects might account for some of the apparent bias” between CPI-measured and underlying true inflation. Following along the same lines of argument, several countries, such as the US, Sweden and Netherlands, adopted the COL index as a conceptual framework for the CPI.

Conventionally, the main question that we consider in comparing the CPI against other indices is: “ Which expenditures for the consumer are to be included in the index?” The CPI focuses on consumer expenditures on goods and services. As such it excludes asset markets activities, broad notions of quality of life and the relationship between current consumption and future consumption inherent in the goods and services that may yield capital gains and/or the possibility for future resale value. Overall, CPI approach fails entirely to consider the issue of savings that can be invested to finance future consumption. This implies that when a price of future consumption rises relative to current consumption no direct account of the potential capital gains is taken in the CPI.

Contrary to the CPI, cost-of-living index, COLI, is traditionally defined as the ratio of individual household’s minimum expenditure necessary to achieve a base period level of utility at the current period prices to the base period level of expenditure, i.e.:

$$COLI_i = \frac{X_i\left(P_t, U_0 \middle| T_i\right)}{X_i\left(P_0, U_0 \middle| T_i\right)}$$

where X_i is the expenditure of household *i*, P_t it the price levels in period *t*, U_0 is the reference level of utility in base period and T_i is a set of conditioning characteristics of household *i*. In general there are two approaches to measuring the COLI: one that uses

estimated systems of demand equations to make exact utility comparisons, and one that relies on mathematical formulae to calculate index numbers.

Overall, when the economists define the changes in the cost of living, the main question they attempt to answer is: “How much more income will the consumer need in order to achieve the previously attained level of utility under the new prices?” In this context consider the example of the differences between the elderly and the young. A greater percentage of the elderly own their homes relative to the average population (in the US: 75% to 55%). When the housing component of the CPI rises because of the increases in owner-equivalent rent, the homeowners are accruing capital gains. Thus if the purpose of a separate price index for the elderly is to adjust their retirement benefits to compensate for deterioration of the real incomes due to inflation, the home owning elderly should not enjoy an over-compensatory cost of living adjustments in their retirement income.

Pollak (1998) further suggests that the wage rate has a role to play in the COLI. Most COL indices assume that consumer preferences are separable across goods and leisure. If the law of one price holds, this separability assumption allows us to define a subindex for goods that depends only on goods prices and is independent of the wage rate. In return we can abstract away from the issue of the consumer search for lowest priced goods. Yet, if the separability assumption is relaxed, the wage rate earned by the agent becomes an opportunity cost of the search. In the context of the Redux model this may result in endogenising the price level into the agent’s work effort decisions and thus into the demand side of production.

As mentioned above, COLI provides a conceptual and practical framework for estimating various biases inherent in the CPI. As such the COLI theory addresses specific aspects of the price movements, such as quality differentiation and product innovation, outlet substitution and consumption-leisure inseparability. The latter can be of an importance in the context of the exchange rate determination model with endogenous labour, such as Redux.

One of the major issues considered in COLI yet omitted by the standard CPI is what we can term to be owner-utilised capital goods, i.e. such goods that simultaneously serve as consumption good and the store of value good. The most accessible examples of such goods is owner-occupied housing. This concept can be extended to those goods that may fail to generate capital gains, but do have a resale market, such as domestic appliances, furniture, some clothing, and other consumer goods. We shall consider the idea of applying COLI index to the consumer decision making process on the basis of the example of owner-occupied housing. Many empirical studies (see Fratantoni et al, 2001 for example) find strong cross-correlations between inflation and real housing appreciation. However, we also consider, if only in passim, the possibility for the resale markets in the broader category of goods. This is captured in the model within the simplifying assumption that capital losses account for partial liquidity recovery.

Overall, COLI approach focuses on pricing the flow of housing consumption over the time period, i.e. on a yearly or monthly cost of living in the house. As such the idea is that the household utility depends on the cost of housing, not on the purchasing price. Whenever the housing services are rented by the household, both price and quantity of services consumed are easy to measure. The only point of caution here is that the true

cost of housing must include depreciation of the fixed quality housing consumed by the renters. This exerts a small downward bias on the rent indices.

In the case of owner occupied housing due to a lack of transaction between the owner and the renter there is no directly observable price and thus no directly observable expenditure weight. In such cases, two approaches exist to estimating housing costs. First approach relies on estimating the change in the monthly cost for owner occupied housing by the changes in rental rates for the housing of similar type. The problems with this approach are manifold. Rent controls and subsidies may distort comparisons with the owner-occupied housing. Prices in owner-occupied housing and rental markets may fail to move together due to differences in demographic and market structures. The markets for rentals may be thin for the exact type of the owner-occupied housing.

The second approach is to estimate the cost of owner-occupied housing via the capital theory considerations. The latter relates the price of housing, depreciation of the physical stock (*d*) and the opportunity cost of housing purchase (*r*) to the stream of housing costs. The following functional form, provided in Triplett (2001), is often accepted in this case. Define user-cost of living index accounting for the capital gains as: $\tilde{P}_{Kt} = a_1 P_{Kt} + P_{Kt-1}$ (1)

where $a_1 = d + r - 1$ is the scalar capturing, the capital gains from the new price realisation, less depreciation, and the opportunity cost of using capital[2].

Consider a case of the price increase. For owners this has two effects. On the one hand, the cost of housing rises more than in traditional CPI approach as the current period

[2] Note that our assumption of constant depreciation rate is consistent with the general literatrure on owner-occupied housing (see for example Miles (1993)).

price is increased by the multiple of the interest rate and depreciation. Yet, on the other hand, capital gains accrue to the owner. As such the specification above helps to explain why the home owners prefer the environment of rapid prices increases in the real estate, while the renters prefer the environment of falling housing prices.

Once again, we want to point out the nontrivial nature of the owner-utilised capital goods. If the resale markets exist for cars, furniture, consumer durables and homes, one cannot fail to consider the expected capital gains or partial future expenditure recovery through the resale value for the broad and extremely important category of goods. For example in 1996 sample from 29 US cities, Engel and Rogers (2001) find that homeowners costs represented 19.825% of the total average consumer expenditure, while food away from home, the second largest expenditure component, accounted only for 6.189% share.

Overall, the distinction between the purchase of durable asset and current consumption is often hard to make. Goodhart (2001) provides evidence on the role that the real estate markets play in financial intermediation, real output and CPI movements. In fact, Goodhart (2001) shows that the linkages between housing prices and both output and CPI measure of inflation are much stronger than the links between equity prices and output/inflation. If anything, this points out that if one is to accept a model of exchange rates in presence of investment project, it shall be of no lesser importance to consider the model with owner-utilised forms of capital in it as well.

In recognising this, the International Labour Organisation (ILO) manual lists three approaches to how the housing purchases and services shall be treated in the price index context.

The first approach, according to Goodhart (2001) is an asset-based measure, by which the change in the price of newly purchased owner-occupied dwellings is weighted by the net purchase of the reference population. Countries such as Australia and New Zealand have used this approach, and it is reported to be the main contender for the Euro-area Harmonised Index of Consumer Prices (HICP), which currently excludes any measure of housing price changes.

The second method is a measure of actual cash outflows on housing purchase. For the purpose of this paper, this approach is similar to the first one, insofar as it captures the capital gains.

The third approach assumes that all housing is rented and the implicit rental rate is then charged as a price of housing. This is the approach discussed earlier, and its shortcomings include the fact that it disregards the savings/asset nature of the housing purchases in presence of capital gains. It is worth mentioning that a mixed method between approaches one and two that does capture depreciation and opportunity cost of the interest payments, is currently employed in RPI computations in the UK, Canada, Finland and Sweden.

Due to the limited nature of the present study, we want to restrict our attention on the capital-goods nature of OUCGs. Thus we omit consideration of the rental markets – an implication further discussed below.

Part 2. Theoretical Model.

As argued in part 1 above, we define user-cost of living index by equation (1). This specification captures, together with the capital gains, the effects of physical stock depreciation, *d*, and the opportunity cost of using capital, *r*. Note, condition that $a_1 < 0$ corresponds to the case of 'normal' interest rate / depreciation rate environment.

$\tilde{P}_{Kt} > 0$ allows for capital gains as long as $cap.gain = \frac{P_{K,t} - P_{K,t-1}}{P_{K,t}} < r + d$ [3].

Further note that our assumption that the opportunity cost of OUCGs is the rate of return to bonds is consistent with the law of one price, but violates the Lucas tree investment technology constraint that implies that the opportunity cost of OUCG,

$r_{OUCG} = d + r - 1 << r$.

We, thus, abstract from considering the linkage between the utility derived by households from consumption of OUCGs and the rate of return to these goods in over and above the capital gains.

As in the standard Redux model, we assume that non-traded OUC goods are

a) homogeneous and divisible;

b) produced by the firms facing the downward sloping demand curves;

c) pricing decisions of the firms take into account the realised capital gains.

It is worth noting that assumption (a) is standard in the theoretical models of art markets and owner-occupied housing, as discussed in Stein (1995), Brown, Song and

[3] Note that in our specification, capital gains have a positive effect on demand for OUCGs (as given by equation (2)). This in turn implies that the rate of return to OUCGs is positively correlated with the changes

McGillivray (1997), as well as Miles (1993). Furthermore, this assumption is supported by the environment of perfect capital markets. In absence of liquidity constraints it is equally straightforward to model services flows from the ownership of OUCGs along the lines of viewing ownership of OUCGs as a stream of one period purchases of services and investments as well.

Assumption (b) is the standard production assumption in the Redux model, while assumption (c) makes the Redux model approach consistent with the presence of the effects of depreciation and opportunity costs on investment decisions with respect to OUC goods.

It is important to specify more precisely what we mean by production of OUC goods in this model. Here we abstract away from considering secondary and rental markets for OUC investment goods. This assumption is common to the literature on owner-occupied housing, as for example in Brown, Song and McGillivray (1997) and Miles (1993). A firm can improve existent unit of OUC (as would be the case with home improvements) or produce an entirely new unit, using labour as the sole input into production. In this scenario a firm operates in a fashion similar to that of the non-traded goods markets in the standard Redux model. The only deviation in it decision making allowed is the inclusion of depreciation and opportunity cost of production into the pricing decision.

Under the assumptions (a)-(c) we have the following demand function for OUC goods:

$$y_K^d(j) = \left[\frac{p_K(j)}{\tilde{P}_K}\right]^{-\theta} C_K^A$$

in consumption growth in OUCG component of consumption. This result is supported by the evidence given in Yogo (2003).

This function implies that the demand for OUC goods is positively related to the depreciation rate (*d*) and the interest rate on alternative investment (*r*). As depreciation rate or the interest rate rise, $\tilde{P}_K$, or cost-of-living adjusted price of OUC goods rises as well in the current period relative to the previous period. This implies an increase in the capital gains, making OUC goods more attractive to the households[4].

From equation (1) and demand function above, we can define a standard price index accounting for the presence of the owner-utilised COL index as:

$$\tilde{P}_t = \frac{P_{Tt}^{\gamma}\tilde{P}_{Kt}^{1-\gamma}}{\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}} \tag{2}$$

where $0<\gamma<1$ is the share of tradable goods in consumption.

The optimisation program for the household is the standard Redux model adjusted to account for the possibility that non-traded sector consists of the owner-utilised capital goods[5]. It is given by:

$$\left\{B_{t+1}, M_t, C_{Kt}, y_{Kt} \middle| \overline{C}_{Kt}^{A}\right\}$$
$$= \arg\max \sum_{s=t}^{\infty} \beta^{s-t}\left[\gamma \log C_{Ts}^{j} + \left(1-\gamma\right)\log C_{Ks}^{j} + \frac{\chi}{1-\varepsilon}\left(\frac{M_s}{\tilde{P}_s}\right)^{1-\varepsilon} - \frac{k}{2}y_{Ks}^{2}\left(j\right)\right] \tag{3}$$

subject to the within-period budget constraint:

$$C_{T,s} = RB_s + \frac{M_{s-1}}{P_{Ts}} - \frac{M_s}{P_{Ts}} - B_{s+1} + \frac{P_{Ks}}{P_{Ts}} y_{Ks}\left(j\right)^{\frac{\theta-1}{\theta}} C_K^{A\frac{1}{\theta}} + \overline{y}_T - \tau_s - \frac{\tilde{P}_{Ks}}{P_{Ts}} C_{Ks} \tag{4}$$

[4] This specification of demand function is consistent with the derivations in Vigdor (2004) under the assumption of perfect capital markets and in absence of rental markets for housing.

[5] Note that our assumption that OUCGs are nontraded is consistent with the discussion of the effects of market restrictions on price indices, presented in Diewert (1995). Specifically, Diewert (1995) argues that some of the standard CPI biases can be accounted for by assuming that the goods sold at different locations are not perfectly substitutable even when they share in physical characteristics (see footnote 51, page 45). In our context, lack of substitutability of these goods naturally translates into an assumption that OUCG goods are non-traded. In addition, since OUCG goods may involve owner-occupied housing, arts and collectibles,

Note that according to the above budget constraint, households value consumption of the owner-used capital goods while accounting for the potential capital gains. The output of this domestic nontradable sector is valued only in terms of current price levels. This allows capital gains to be fully distributed to the investor-user of these goods, abstracting away from the possibility that a producer can capture a share of these gains. Likewise, the money component of the instantaneous utility function in equation (3) is deflated by the COL index instead of the straightforward price index. This is due to the assumption that owner utilised capital goods are sufficiently liquid to allow within the period conversion of the equity held in these goods. Thus in equation (3) we have complete markets for liquidity[6].

The former aspect of the new specification determines a new relationship between the traded goods and owner-used capital goods sectors, whereby the first order condition for consumption of owner-used capital goods is:

$$C_{Kt} = \frac{1-\gamma}{\gamma}\frac{P_{Tt}}{\tilde{P}_{Kt}}C_{Tt} \qquad (5)$$

which implies for the case of capital gains that a rise in the interest rate, *r* or a rise in the depreciation factor, *d* will have the same effect on the relative consumption of non-traded goods to traded as the fall in the absolute price of non-tradables over time, namely: C_{Kt} will fall relative to C_{Tt}. This is consistent with the interpretation of the rate of return on OUCGs given in equation (2) above.

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the assumption that the international markets for such goods are not significant relative to domestic ones is perfectly reasonable.

[6] This result is consistent with assumption (a) above and the presence of perfect markets for liquidity that jointly guarantee existence and frictionless operations of the markets for fractional resale of the OUCGs.

As expected, consumption of owner-used capital goods will rise period on period whenever the relative price of owner-used capital goods falls compared to the price of tradables, within the same period of time. However, whenever the capital gains are insufficient to offset the negative effects of depreciation and opportunity costs, consumption of OUCGs will fall relative to tradables whenever their price rises relative to tradables in the same time period.

Overall, controlling for all other variables, the long run level of nontradable output and consumption will be higher in case when the OUCGs are present in the economy, than in case of Redux model. This result holds, as long as $r+d<1$, solely due to the capital gains sensitivity of both demand and supply of the nontradables in the model.

Denote by the lower case variable $x = \frac{dX_t}{X_0}$, by $\bar{x} = \frac{dX_{SS}}{X_0}$ the new steady state values that prevail after the shock, and by $x_0 = \frac{dX_0}{X_0}$ the initial steady state variables preceding the shock. The first order conditions to the problem in the log-linear form are:

$$c_T = \bar{c}_T \tag{6}$$

$$\begin{aligned} \varepsilon m &= (\varepsilon - 1)\tilde{p} + p_T + \frac{\beta}{1-\beta}\left[p_T - \bar{p}_T\right] = \\ &= \frac{1}{1-\beta}\left(p_T - \bar{p}_T\right) + (\varepsilon - 1)\left[\gamma p_T + \frac{1-\gamma}{r+d}\left(a_1 p_K + p_{K0}\right)\right] \end{aligned} \tag{7}$$

$$c_K = c_T + p_T(1-\gamma) - \frac{1-\gamma}{r+d}\left(a_1 p_K + p_{K0}\right) \tag{8}$$

$$\frac{\theta+1}{\theta} y_K = -\left(\frac{\theta-1}{\theta}\right) c_K + \frac{p_K - p_{K0}}{r+d} \tag{9}$$

where by equation (2):

$$\tilde{p}_t = \gamma p_{Tt} + (1-\gamma)(a_1 p_{Kt} + p_{K0}). \quad (10)$$

Equation (10) provides the relationship between the COLI-measured index of price changes and the individual price components. Specifically, COLI inflation is measured as a weighted average of the traded goods price inflation and the OUCGs price inflation net of the capital gains and financial depreciation, $r+d$, that captures physical loss of the owner-utilised capital stock and the opportunity cost of OUCGs in terms of financial assets, namely bonds.

Note that equation (8) corresponds to the similar condition in Brown et al (1997) and can be re-written as:

$$c_K - c_T = p_T(1-\gamma) - \frac{1-\gamma}{r+d}(a_1 p_K + p_{K0})$$

so that the difference in growth rate in consumption of OUCGs relative to the traded goods consumption is an increasing function of traded goods inflation and a decreasing function of the OUCG inflation net of capital gains. This is precisely the intuition behind equation (1) in Brown et al (1997). Furthermore, under our utility function specification and assumed absence of rental markets for property, equation (8) above fully corresponds to the standard definition of the real cost of housing given by Breedon et al (1993) in their equation (1).

In what follows we make a simplifying assumption that although as standard, $R\beta = 1$, we also have: $r = d = \delta$.

We first attempt to replicate the results of the benchmark Redux model with traded and non-traded goods and nominal price stickiness in the non-traded sector. Due to neutrality of money in the long run, and assuming that in the short run price of owner-used capital goods is fixed,

$$p_K = 0$$

and

$$\overline{p}_T = \overline{m} = m$$

so that

$e = p_T$.

Using this, from equation (7) we can solve for the exchange rate changes in the short run as a function of money shock and the initial level of inflation:

$$e = \frac{\varepsilon\delta + 1 + \delta}{1 + \delta + \gamma\delta(\varepsilon - 1)} m - \frac{(1-\gamma)(\varepsilon - 1)}{1 + \delta + \gamma\delta(\varepsilon - 1)} \frac{p_{K0}}{2} \tag{11}$$

Using equations (7)-(9) we can solve for:

$$p_{K0} = \frac{\delta}{(1-\gamma)(1-\delta)} m$$

Using this in eqaution (11) and subtracting a long run version of equation (11) from the resulting equation we obtain:

$$e - \overline{e} = \frac{\varepsilon - \gamma(\varepsilon - 1)}{1 + \delta + \gamma\delta(\varepsilon - 1)} \frac{m}{2} - \frac{(1-\gamma)(\varepsilon - 1)}{1 + \delta + \gamma\delta(\varepsilon - 1)} \frac{p_{K0}}{2} \tag{12}$$

Note that if $\varepsilon = 1$, we still obtain overshooting contrary to the traditional Redux[7].

However, for any $\varepsilon > 1$, the exchange rate will either overshoot or undershoot the new long run equilibrium rate. If prior to the shock the economy experienced either a period of owner-used capital price deflation, or stagnation, so that $p_{K0} \leq 0$, overshooting will result. The cause for this effect is that in case of deflation or stagnation in owner-used capital prices, capital losses result from holding owner-used equity, so that households will demand less of the capital goods and more of the international bonds. Bond

[7] In the standard Redux model, in the presence of tradable and non-tradable sectors, overshooting result depends on condition that $\varepsilon \neq 1$.

holdings increase and the exchange rate appreciates in the short run.[8] Thus in our model we have explicit substitution effect between the OUCGs and the financial assets.

For the case of low inflation in owner-used capital prices, households have low incentives to hold these assets relative to international bonds. Hence, as before, overshooting will result for $0 < p_{K0} < \frac{\varepsilon - \gamma(\varepsilon - 1)}{(\varepsilon - 1)(1-\gamma)} m$.

Finally, for the case of strong capital gains, so that $p_{K0} > \frac{\varepsilon - \gamma(\varepsilon - 1)}{(\varepsilon - 1)(1-\gamma)} m$, the households will increase their stock of OUCGs and decrease their holdings of foreign bonds. As the result, the demand for foreign currency will fall relative to the money supply and the exchange rate will undershoot the target in the short run.

Furthermore, in dealing with the economies experiencing deflation in the period preceding the shock, expansionary monetary policy will result in stronger overshooting in our model than in traditional Redux model extended to the case of tradables and nontraded goods.

Part 3. Planning and Building Lags as a Substitute for Menu-Cost Driven Price Rigidity.

In the following we shall consider the possibility for dropping the assumption of the short-run rigidity of the capital goods. Suppose that due to a time lag between the planning stage of development and the time when the OUCGs arrive into the market, the

[8] In the context of this paper it is counter intuitive to consider the possibility of $p_{K0} = 0$, since in this case only opportunity costs and depreciation term provide any divergence between the CPI and the COLI.

short run supply of nontraded goods is fixed, $y_N = 0$. In this case, from equation (9), short run changes in nontradables prices are driven by demand alone, so that

$$c_K = \frac{\theta p_{K0}}{2\delta(1-\theta)} \tag{13}$$

Since in the short run by equation (6), $c_T = 0 = \overline{c}_T$, then equation (8) yields:

$$c_K = p_T(1-\gamma) - \frac{1-\gamma}{2\delta}(a_1 p_K + p_{K0})$$

Combining these equations, we can solve for the changes in the price of tradable goods as a function of the OUCGs inflation and our model fundamentals:

$$p_T = \frac{\left[\theta + (1-\theta)(1-\gamma)\right]}{2\delta(1-\theta)(1-\gamma)} p_{K0} - \frac{\left[\theta - (1-\theta)(1-\gamma)(2\delta-1)\right]}{2\delta(1-\theta)(1-\gamma)} p_K \tag{14}$$

3.1. The case of long run monetary policy neutrality.

Assuming that resale markets exist for the short run fixed stock of the OUCGs, $p_K \neq 0 = \overline{p}_K = \overline{p}_{K0}$, where the last equality signs are consistent with assumption of no long run real effects of monetary policy. Then the short-run and the long-run changes in the exchange rate are given by:

$$e = \gamma p_T + (1-\gamma)\left[(2\delta-1) p_K + p_{K0}\right] \tag{15}$$

$$\overline{e} = \gamma \overline{p}_T + (1-\gamma) 2\delta \overline{p}_K \tag{16}$$

By equations (14)-(16) and assumption on the growth rate in tradable goods consumption, we have:

$$\left[\varepsilon-1+\frac{1+\delta}{\gamma\delta}\right]\left(e-\bar{e}\right)= \\ =\left[\varepsilon+\frac{1+\delta}{\gamma\delta}\right]\bar{m}+\left(1-\gamma\right)\left\{\frac{1+\delta}{\gamma\delta}-\left(\varepsilon-1\right)\left(2\delta-2+\frac{1}{2\delta}\right)\right\}p_K \tag{17}$$

The term in curved brackets in equation (17) is positive whenever

$$\varepsilon<\frac{2\left(1+\delta\right)}{\gamma\left(2\delta-1\right)^2}+1 \tag{17a}$$

This restriction implies that $\left(e-\bar{e}\right)>0$[9]. Hence, in the model with production lags, the exchange rate overshoots its target in the short run. The reason is that in absence of the new homes coming on the market, whenever ε is relatively small (condition (17a) holds), consumers who experience capital gains will spend their higher money holdings on foreign bonds and will therefore bid up the exchange rate in the short run. Note that ε is the intertemporal elasticity of substitution in real balances, so that relatively low values of ε are associated with lower willingness of the households to adjust their money balances over time and subsequently with higher propensity to hold foreing bonds.

Undershooting results arise when condition (17a) is not satisfied and the intertemporal elasticity of substitution in real balances is sufficiently high[10].

[9] Note that under our standard assumptions, δ is small, while $\varepsilon\geq 1$, which implies that under standard parameterisation, γ is always smaller than $2(1+\delta)/(2\delta-1)^2>1$. Thus, condition (17a) is satisfied for the range of ε.

3.2. The case of long run monetary policy effectiveness.

Next we want to consider the case where there are real changes in the long run steady state consumption and production of the owner-used capital goods. Thus, we relax the assumption that $\overline{p}_K = 0$.

By equation (8) both consumption and production of the owner-used capital goods will change in response to money shock to adjust to a new long run level. Using this assumption the model can be re-written as:

$$\overline{c}_K = \overline{p}_K \frac{\theta}{2\delta(\theta-1)} \tag{18}$$

Equation (17) and it's long run version yield:

$$p_T = p_K \left\{ \frac{\theta + (2\delta-1)(\theta-1)(1-\gamma)}{2\delta(\theta-1)(1-\gamma)} \right\} \tag{19}$$

by equation (19) growth rates in prices of tradable goods and owner-used capital goods countermove[11]. Since equation (15) applies also in the case of effective monetary policy,

$$p_K = e \left\{ \frac{2\delta}{(2\delta-1)\left[(1-\gamma)2\delta + \theta\gamma + \gamma\right]} \right\} \tag{20}$$

By equation (20), OUCGs' inflation countermoves with the changes in the exchange rate. This is consistent with model intuition, since in presence of the possible capital gains, increase in growth rate of the OUCGs' price will result in domestic agents substituting away from foreign bonds and in favour of the domestically produced capital

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[10] The discussion above hinges, in case of overshooting, on the assumption that in the long-run $\overline{m} \geq 0$. This implies that in the case of $\overline{m} < 0$ for the case of overshooting, and in the case of undershooting result, the exchange rate indeterminacy holds for some values of $\overline{m}$.

[11] This is so since for any $\theta > 1$, we have $(2\delta-1)(1-\gamma) / \left[\gamma + 2\delta(1-\gamma)\right] < 1 < \theta$.

goods. The resulting lower demand for foreign currency will lead to negative growth rate in the exchange rate. Likewise, the price of tradables growth rate is negatively related to the exchange rate changes, due to the same substitution effect as above.

By equation (17) and its long-run barred version, together with maintained assumptions that in the short run $c_K = c_{K0} = 0$ and corresponding short-run assumption that $p_K = p_{K0} = 0$, we have:

$$\left(e-\bar{e}\right)\underbrace{\left(\frac{1+\delta}{\gamma\delta}+\varepsilon-1\right)}_{(+)}=\left(1-\gamma\right)\left\{\frac{1+\delta}{\gamma\delta}-\left(\varepsilon-1\right)\left(2\delta-2+\frac{1}{2\delta}\right)\right\}\underbrace{\left(\frac{2\delta\left(1-\theta\right)}{\theta}\right)}_{(-)}\bar{c}_K \tag{21}$$

Hence, the deviation of the exchange rate from its long run equilibrium level is, in sign, determined by the last term in equation (21). This is exactly the same result as in equation (17), so that condition (17a) still guarantees either overshooting or undershooting result depending on the relative size of the intertemporal elasticity of substitution in real balances, ε.

Parameterisation on the grid of values obtains the following results.

Grid: $\gamma = \{0.6, 0.7, 0.8, 0.9\}$ $\delta = \{0.2, 0.1, 0.05, 0.03\}$ $\varepsilon = \{2, 3, ..., 12\}$

Results:

For $\gamma = 0.6$, which corresponds to the 40% share of OUCGs in total expenditure, we have:

a) Undershooting occurs for all ε if $\delta = 0.2$, for all $\varepsilon \leq 6$ if $\delta = 0.1$, and for all $\varepsilon \leq 4$ if $\delta \leq 0.05$.

b) Overshooting occurs for all $\varepsilon > 6$ if $\delta = 0.1$, and for all $\varepsilon > 4$ if $\delta \leq 0.05$.

For $\gamma = 0.8$, which corresponds to the share of owner-used capital goods in total expenditure of 20%, we have:

c) Undershooting occurs for all $\varepsilon \leq 9$ if $\delta = 0.2$, for all $\varepsilon \leq 5$ if $\delta = 0.1$, and for all $\varepsilon \leq 3$ if $\delta \leq 0.05$.

d) Overshooting occurs for all $\varepsilon > 9$ if $\delta = 0.1$, and for all $\varepsilon > 5$ if $\delta \leq 0.05$, and for all $\varepsilon > 3$ if $\delta \leq 0.05$.

Hence, overall we can distinguish 8 regimes.

Regime A: γ small (high share of owner-used capital goods in total expenditure)

Regime A.1 (ε, δ) small: the elasticity of substitution in real balances across time is large, while the opportunity cost of purchasing the OUCGs is low. In response to the rise in money supply, households adjust their growth rate of tradables consumption instantaneously, generating an upward demand in the foreign exchange. The exchange rate appreciates. However, with low opportunity cost of OUCGs, households realise capital gains and use these proceeds to increase the money holdings in order to raise their future stock of the capital goods. The reason for this is that with low δ, the returns to international bonds are lower as well, so that agents substitute away from bonds. Low ε implies that households are more willing to vary their real balances over time. This generates demand for domestic currency, alleviating the pressure on the exchange rate to rise immediately to the new steady state level. Overtime, this substitution stops and the exchange rate reaches its new, higher steady state.

Regime A.2 ε **small,** δ **large:** elasticity of substitution for real balances and the opportunity cost of holding the owner-used capital are both large. In this case undershooting occurs in the short run, albeit on the lower scale than in Regime A1. The reasons for this is that once again the elasticity of intertemporal substitution for the real balances is large, the agents will adjust their holdings of OUCGs by decreasing their holdings of real balances in the long run. However, this substitution will be lower in this case than in Regime 1A since international bonds are now more attractive than before, relative to the OUC due to high rate of return on the bonds and high opportunity cost of the owner-used capital. Hence, tas money balances rise in the short run, the bond holdings will rise as well, generating an opposite effect on demand for foreign currency.

Regime A.3 ε **large,** δ **small:** implies that households are unwilling to substitute the real balances over time, and the opportunity cost of OUCGs being low, home agents are willing to increase their holdings of capital at the expense of international bonds in the long run. The result is that demand for home currency falls, as the households lower real balances and increase bond holdings, while the demand for foreign currency rise due to tradables consumption adjustment. The overshooting arises.

Regime A.4 (ε, δ) **large:** with low substitutability of real balances and high opportunity cost of OUCGs, the overshooting effects in Regime A3 are ameliorated by the lower willingness of the households to adjust their holdings of international bonds in favour of the capital goods in the long run.

Regime B: γ large (low share of owner-used goods in total expenditure)

Regime B.1: (ε, δ) small: undershooting results. However, relative to the Regime A.1, undershooting requires higher elasticity of substitution between real balances. The reason for this is that with lower share of the OUCGs in total expenditure of the households, the savings portfolio of the agents is more loaded in the direction of foreign bonds. The capital gains realisation is lower relative to Regime 1.A, and thus the increase in money holdings is lower.

Regime B.2: ε small, δ large: again undershooting arises, ameliorated relative to Regime A.1 by the smaller share of the owner-used capital goods.

Regime B.3 ε large, δ small, and **Regime B.4 (ε, δ) large**. In both cases overshooting results.

Overall, an increase in the share of owner-used capital goods in total household expenditure acts to increase the likelihood of overshooting case. Only for low the implausibly high level of time preference discount rate (and thus implausibly high levels of interest and depreciation rates) will the undershooting be an issue at the acceptable levels of the elasticity of substitution for real money balances.

Part 4. Implications of the COLI extension to PPP.

In the context of previous discussion of the role that the COLI plays in correcting for the overestimation of inflation rates by CPI, it is of interest to consider the model in relation to the Purchasing Power Parity (PPP) theory. PPP theory establishes a long run

equilibrium relationship between national prices across two countries and the real exchange rate, q_t . In particular, classical PPP identity states that

$$q_t = s_t + p_t^* - p_t \tag{22}$$

where p_t^*, p_t are logs of foreign and domestic price indices, and s_t is the log spot exchange rate. By equations (1) and (2) this relationship can be expressed as:

$$\begin{aligned} q_t &= b_0 - b_0^* + s_t + \gamma^* p_{Tt}^* + \left(1-\gamma^*\right)\log\left(a_1 P_{Kt}^* + P_{Kt-1}^*\right) - \gamma p_{Tt} - \left(1-\gamma\right)\log\left(a_1 P_{Kt} + P_{Kt-1}\right) \\ b_0 &= \gamma\log\left(\gamma\right) + \left(1-\gamma\right)\log\left(1-\gamma\right) \\ b_0^* &= \gamma^*\log\left(\gamma^*\right) + \left(1-\gamma^*\right)\log\left(1-\gamma^*\right) \end{aligned} \tag{23}$$

Suppose that goods arbitrage conditions hold, so that $s_t + p_{T,t}^* - p_{T,t}$ is stationary. Cheung and Lai (1999) show that when the price ratio of tradables to nontradables is non stationary, the long run PPP can be rejected. Extending the CPI to COLI, as done in equation (23) yields stronger result.

Consider the following two cases:

Case 1: $r = d = \delta \approx 1/2$ which corresponds to the economic environment with high opportunity cost of capital;

Case 2: $r = d = \delta < 1/2$ which corresponds to the environment with low capital cost.

In Case 1, $\log\left(a_1 P_{Kt} + P_{Kt-1}\right) \approx p_{K,t-1}$ in which case reversion to PPP is simply delayed. The delay is an increasing function of the share of OUCGs in total expenditure. However, if the price ratio of tradable to nontradable goods remains stationary, PPP reversion will occur.

$$q_t = b_0 - b_0^* + s_t + \gamma^* p_{Tt}^* - \gamma p_{Tt} + \left(1-\gamma^*\right) p_{K,t-1}^* - \left(1-\gamma\right) p_{K,t-1} \tag{24}$$

Note that environment of high opportunity cost of capital may include the case of the high foreign bond yields. As mentioned earlier, this can also include the case where utility component of the owner-occupied housing at home is small. In the latter case, Lucas tree model will imply that the opportunity cost of domestic housing is large, even if the foreign bond yields are low. In both cases, long-run reversion is driven by the fact that the OUCGs are not significantly different from the bonds in their utility generating capacity, and they are relatively expensive compared to the bonds. The near equivalence of the bonds and the OUCGs here is driven by the fact that as OUCGs face high opportunity costs, direct utility share of OUCGs falls relative to the income effect of OUCGs on budget constraint. At the same time, bonds enter household choices via budget constraint alone. Thus adjustment to the new equilibrium in response to exogenous shocks takes place largely in form of bond holdings changes, and not via changes in the stock of OUCGs.

In Case 2, we distinguish two sub-cases associated with capital gains or losses in the markets for OUCGs.

Consider the case of $P_{K,t-1} / P_{K,t} = \left(1+\varepsilon_t\right)^{-1}$, where ε_t is positive in case of capital gains. Whenever capital gains or losses are small, so that ε_t is small in mode, then $\log\left(P_{Kt} + P_{Kt-1}\right) \approx p_{K,t} + \log\left(\frac{2\delta}{1-2\delta} + \varepsilon_t - 1\right)$ corresponding to small capital loss or gain respectively. As long as $\varepsilon_t < \frac{2\delta}{1-2\delta}$, PPP reversion will occur for ε_t constant.

This implies that

$$q_t = s_t + \gamma^* p^*_{Tt} - \gamma p_{Tt} + (1-\gamma^*)\left[p^*_{K,t} + \log\log\left(\frac{2\delta}{1-2\delta} + \varepsilon^*_t - 1 \right) \right] - \\ -(1-\gamma)\left[p_{K,t} + \log\left(\frac{2\delta}{1-2\delta} + \varepsilon_t - 1 \right) \right] + (b_0 - b^*_0) \quad (25)$$

However, as long as $\varepsilon^*_t, \varepsilon_t$ are different and time dependent, PPP reversion may not take place.

Second, consider the case of strong capital gains environment, so that $\varepsilon_t > \frac{2\delta}{1-2\delta}$. In this case, equation (24) is not defined, so that PPP fails to hold even in the long run.

Hence, overall in the model with COLI mechanism, we can expect the mean reversion to occur in the sample of countries with high opportunity cost of capital[12]. In addition, in the case of normal and low opportunity cost of capital, PPP reversion can be expected only in the case of combining moderate capital gains/losses and constant growth rate in the price of owner-utilised capital goods across two countries. If the price of OUC goods grow at time-dependent rate in at least one of the countries, PPP will fail to revert to the long run equilibrium. Furthermore, PPP will fail to apply to the countries experiencing strong capital gains or losses in the capital goods markets.

These conclusions relate to the proposition by Froot and Rogoff (1995) concerning the difficulty of capturing the reversion effects in case of the countries experiencing strong income growth. In both, equations (25) and (26) above, assuming that the price ratio of tradables to OUCG capital is stationary, term $P_{K,t} >, < \frac{P_{K,t-1}}{1-2\delta}$ drives the deviation from

[12] High rate of return to bonds relative to domestic owner-utilised capital investment, or low utility component of the owner-used capital goods relative to tradables.

the PPP. Thus, the deviation in PPP will be observed in the case where the countries substantially differ in the shares of owner-used capital goods in total expenditure[13].

Conclusions.

Current paper proposes an extension of the Redux model to incorporate the distinction between the tradable consumption goods and the nontraded owner-used capital goods. The latter category of goods is distinguished from the traditional nontradables by the assumption that these capital goods are subject to capital gains/losses and depreciation, in addition to serving as a component of the utility function. As the result of this, we model the aggregate price index over the consumption goods to include the capital gains term and depreciation. Thus the traditional CPI-type structure of prices employed in the Redux model is replaced by the COLI-type of price process.

The dynamic nature of COLI is then shown to generate the set of interesting results that match broadly stylised facts not replicated in the original Redux model. In particular we show that in presence of capital gains, exchange rate overshoots or undershoots its long run target. This occurs even in the case when the intertemporal substitution parameter on money demand, ε can be set at unity.

In general Redux model with tradable and nontradable goods, log-utility specification in money balances yields no overshooting. Thus standard Redux model requires that the intertemporal elasticity of substitution in money demand be set above unity in order to

[13] Considering that capital gains in housing were persistently stronger in the US relative to Germany, as well as adding the effect of higher rate of re-financing of real estate assets in the US than in Germany, this result may help to explain why the stationarity is harder to detect in the dollar-based exchange rates than in the German-mark-based rates (Fisher and Park (1991) and Papell (1997)).

generate short-run dynamics in the exchange rate that last only for the period of price stickiness.

In our model, depending on the direction of prices for the capital goods in the period preceding the monetary expansion, the exchange rate overshoots or undershoots its target. Thus in the environment with the owner-utilised capital goods price deflation or stagnation, the exchange rate overshoots its target. Same holds for the case of low inflation in the owner-used capital. However, if the capital gains are large, the undershooting may result.

Moving the Redux model away from the assumption of the nominal price rigidity in nontraded owner-used capital, we develop a variation of the model with building lags. If we are to interpret the nontraded capital goods as housing, this is a natural assumption, provided that planning and permission process do take relatively long period of time between the purchase contracting and the completion of the housing. In the environment with time to build lag of one period, both over and undershooting may arise. The exact adjustment path depends on the size of the share of owner-used capital goods in the total expenditure, the size of the opportunity cost of investing in the owner-used capital and the depreciation of the physical stock of capital.

Finally, in light of the observed dynamics of the exchange rate, we consider briefly the relationship between COLI and the long run PPP. The model generates interesting results that also match some empirical facts. In particular we show that in the environment of the strong capital gains in the owner-used capital markets in at least one of the countries, the PPP does not hold even in the long run. Furthermore, we show that in the economies with reasonably low interest rates and depreciation, even modest

capital gains/losses differences between the two countries may cause the situation in which the PPP fails to revert to its long run equilibrium.

The above results provide an interesting departing point for the future studies. For example, the relationship between the long run reversion of the PPP and the presence and magnitude of the owner-used capital goods in the expenditure of the household can be examined and tested empirically. Secondly, the empirical investigation of the importance of the COLI in exchange rate movements in response to the monetary policy can be developed along the lines of this paper.

References.

Breedon, F.J., MAS Joyce *Housing prices, arrears and possession: A three equation model for the UK*, Bank of England, Working Paper No.14, June 1993.

Brown, J.P., Song, H. and A. McGillivray *Forecasting UK Housing Prices: a time varying coefficient approach*, Economic Modelling, 14 (1997), pages 529-548.

Browning, M., and Lussardi, A. *Household Savings: Micro Theories and Micro Facts?* The Journal of Economic Literature, Volume XXXIV, Number 4, December 1996, pages 1797-1855

Campbell, J. Y. and Cocco, J. F. *Household Risk Management and Optimal Mortgage Choice*, NBER Working Paper 9759, June 2003.

Cheung, Y. and K. Lai *On Cross-Country Differences in the Persistence of Real Exchange Rates.* CESifo, Working Paper 218, December 1999.

Diewert, W.E. *Axiomatic and Economic Approaches to Elementary Price Indexes.* NBER Working Paper series, WPNo 5104, May 1995.

Engel, C. and J. Rogers *Violating the Law of One Price: Should we make a federal case out of it?* Journal Of Money, Credit and Banking, February 2001, Vol.33, Number 1, pages 1-15.

Fisher, E. and J. Park *Testing Purchasing Power Parity under the Null Hypothesis of Cointegration* The Economic Journal Vol. 101, 1991, pages 1476-1484

Fratantoni, M, S. Schuh, *Monetary Policy, Housing and Heterogeneous Regional Markets,* Mimeo, Federal Reserve Bank of Boston, September 2001.

Froot, K.A. and K. Rogoff, *The EMS, the EMU, and the transition to a Common Currency* in O.Blanchard and S. Fisher "1995 NBER Macroeconomic Annual" The MIT Press, Cambridge, MA, 1995, pages 269-317.

Goodhart, C. *What Weights Should Be Given to Asset Prices in the Measurement of Inflation?* The Economic Journal, June 2001, pages F335-F356.

Iacoviello, M. and Minetti, R. *The Credit Channel of Monetary Policy and Housing Markets: International Empirical Evidence*, Bank of Finland, Discussion Paper 14/2000.

Miles, D. *House Prices, Personal Sector Wealth and Consumption: some conceptual and empirical issues,* in *Papers in Money, Macroeconomics and Finance*, supplement to The Manchester School, Proceedings of the Money, Macroeconomics and Finance Group, 1992. Volume LXI, 1993, page 35.

Moulton, B. R. *Bias in the Consumer Price Index: What Is the Evidence?*, Journal of Economic perspectives, Vol.10, Number 4, Fall, 1996, pages 159-177.

Nordhaus, W. D. *Quality Change in Price Indexes?* The Journal of Economic Perspectives, Vol. 12, Number 1, Winter 1998, pages 59-68.

Papell, D. *Searching for Stationarity. Purchasing Power Parity under the current float,* Journal Of International Economics, Vol.43, 1997 pages 313-332.

Pollak, R. *The Consumer Price Index: A Research Agenda and Three Proposals.* Journal of Economic Perspectives, Vol. 12, Number 1, Winter 1998, pages 69-78.

Skinner, J. and Daniel F. *The Impact of the 1986 Tax Reform Act on Personal Saving*, in Do Taxes Matter? The Impact of the Tax Reform Act of 1986, MA:MIT Press, 1996, pages 50-79.

Triplett, J. *Should the Cost-Of-Living Index Provide the Conceptual Framework for the Consumer Price Index?* The Economic Journal, June 2001, pages F311-F334.

US Senate Committee on Finance, *Final Report of the Advisory Commission to Study the Consumer Price Index*. Washington DC, Congress 104, 2 session, Government Printing Office, 1996, page 2.

Vigdor, J. L. *Liquidity Constraints and Housing Prices: Theory and Evidence from the VA Mortgage Program*, NBER Working Paper 10611, June 2004.

Yogo, M. *A Consumption-Based Explanation of Expected Stock Returns*, Department of Economics, Harvard University, manuscript, March 2003.

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