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No. 3540

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INTERNATIONAL MACROECONOMICS

Centre for Economic Policy Research

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ISSN 0265-8003

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Discussion Paper No. 3540
September 2002

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CEPR Discussion Paper No. 3540

September 2002

ABSTRACT

Dynamic General Equilibrium Analysis: The Open Economy Dimension*

This Paper discusses some key issues in the application of dynamic general equilibrium analysis to open economy modelling. In the context of the new open economy macroeconomics paradigm, we focus on: (i) the currency denomination of sticky prices; (ii) the role of the current account and net foreign assets; and (iii) the impact of fiscal policy.

JEL Classification: F30 and F40
Keywords: dynamic general equilibrium and new open economy macroeconomics

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*This Paper is produced as part of a CEPR Research Network on 'The Analysis of International Capital Markets: Understanding Europe's Role in the Global Economy', funded by the European Commission under the Research Training Network Programme (Contract No: HPRN-CT-1999-00067). A final version of this Paper will appear as part of a book *Dynamic Macroeconomic Analysis: - Theory and Policy in General Equilibrium* to be published by Cambridge University Press and Edited by S Altug, J S Chadha and C Nolan in 2003. We thank the two anonymous referees for comments.

Submitted 12 August 2002

1 Introduction

This chapter highlights some key topics in understanding the dynamic general equilibrium (DGE) behavior of open economies. In line with the evolution of best practice in closed-economy macroeconomic theory, DGE models are now the standard workhorse in the international macroeonomics literature. In addition, the incorporation of nominal rigidities and imperfect competition means that the current generation of open-economy DGE models is also able to address the concerns of policymakers regarding potential inefficiencies in adjusting to fundamental shocks. In this way, the "new open economy macroeconomics" (NOEM) is a direct descendant of the traditional Mundell-Fleming-Dornbusch model (Rogoff 2002). While respecting this lineage, the microfounded nature of the new generation of models means that much more can be done in terms of providing a rigorous welfare evaluation of alternative policy regimes.

An open-economy DGE model must contain a number of essential elements. Household preferences must be specified: this is more complex than in a closed-economy model since the elasticity of substitution between home- and foreign-produced goods must be specified. This also applies to the specification of production functions since imported intermediate goods represents a potentially important linkage across economies. The international dimension of asset trade must also be specified, detailing whether home and foreign households share risks via state-contingent assets or just engage in bond trade or face even more restricted opportunities for international financial transactions. Of course, the form of nominal rigidities must also be determined (sluggishness in goods prices versus wages; the duration of rigidities): in an open economy, the researcher faces the problem of deciding the currency denomination of these sticky goods or factor prices. Finally, the nature of monetary and fiscal policies must be incorporated. Again, policy formation in an open economy involves extra dimensions in fixing the domestic policy response to foreign disturbances and evaluating whether there are gains to international policy coordination.

Lane (2001) and Sarno (2001) provide broad surveys of this recent literature on "sticky" DGE (NOEM) models that was initiated by the seminal *Redux* model of Obstfeld and

Rogoff (1995). Our strategy in this chapter is to focus on some key issues that are at the core of current research on open-economy DGE modelling. In particular, we consider: the currency denomination of sticky prices; the role of the current account and net foreign assets in adjustment dynamics; and the analysis of fiscal policy in an open economy. As already noted, the first two topics raise issues that are by definition absent from closed-economy analysis; we also highlight the third topic, since it has received comparatively less attention than monetary analysis in the recent literature but represents a critical channel by which policymakers influence the behaviour of the international economy.

The structure of the rest of the chapter is as follows. Section 2 considers the currency denomination of sticky prices. The role of the current account and net foreign assets in the adjustment process is considered in section 3. We turn to the analysis of fiscal policy in NOEM models in section 4. Conclusions are offered in section 5.

2 The Currency Denomination of Sticky Prices

2.1 Optimal Exchange Rate and Monetary Policies

Obstfeld and Rogoff (1995, 1996a) assumed that prices were sticky in the currency denomination of the producer: US firms set prices in dollars, Japanese firms in yen and so on. Such producer currency pricing (PCP) implies an active expenditure-switching role for the nominal exchange rate: if the dollar depreciates, this implies a reduction in the euro-currency price of US exports which in turn should raise demand for these goods from eurozone purchasers.

Betts and Devereux (1996, 2000) and others have rather preferred an alternative specification under which firms set prices in the currency of the purchaser: such local currency pricing (LCP) of course requires that the firm is able to segment markets since prices to purchasers in different locations are potentially different under this scheme.[1] Under LCP,

[1]It is empirically well documented that deviations from the law of one price are widespread even for goods that are commonly traded in international markets (see, for example, Engel 1993, Froot and Rogoff

the exchange rate does not have a direct allocative role: a surprise nominal depreciation does not alter the prices facing purchasers and so does not induce substitution between domestic and imported goods. Rather, exchange rate movements just have income effects by altering the rate at which given foreign currency revenues convert into domestic currency and vice-versa.

In general, this "pass-through" debate concerns the elasticity

$$\frac{\partial p}{\partial e} = \lambda \tag{1}$$

where p is the (log) domestic-currency purchase price, e is the (log) nominal exchange rate and λ is the elasticity. Full PCP and LCP correspond to $\lambda = 1$ and $\lambda = 0$ respectively, with intermediate values representing partial degrees of pass through. As emphasized by Obstfeld (2001), p need not refer to a consumer price: intermediates comprise much of international trade. Moreover, it should be recognized that LCP is not the only source of a weak contemporaneous relation between exchange rates and consumer prices — as is surveyed by Engel (2002), shipping costs, nontraded distribution services and optimal price discrimination may also inhibit exchange rate pass through.

The recent literature has paid much attention to the comparison of PCP and LCP (ie differences in degree of pass through from exchange rates to the prices facing purchases) in terms of its implications for optimal monetary and exchange rate policies. Although the initial contributions in the NOEM field focused on certainty equivalence settings, the work that has followed Obstfeld and Rogoff (1998) has adopted an explicitly stochastic framework in evaluating policy regimes. This is important, since it highlights the role of uncertainty in determining the average levels of macroeconomic variables: risk-averse agents will typically build in risk premia into wages and prices in response to an uncertain environment. In turn, this implies that uncertainty has first-order effects on welfare.[2]

1995). Smets and Wouter (2002) find a significant amount of sticky import price behavior in their empirical model of the eurozone economy.

[2]Another literature — as laid out in Woodford (2002) — also emphasizes the role of uncertainty in affecting welfare. In the Woodford approach, staggered pricing means that shocks lead to a dispersion in

Under PCP, the standard finding is that a floating exchange rate system is optimal in allowing economies to adjust to asymmetric real shocks for standard Friedmanite reasons (see Obstfeld and Rogoff 2001, 2002). Under LCP, the gains to floating in adjusting to shocks are reduced, since the exchange rate does not facilitate stabilization in that case (Devereux and Engel 2001a).

Corsetti and Pesenti (2002a) make the point that LCP limits the desirability of exchange rate flexibility, even if output could be perfectly stabilized under a float. The reason is that exchange rate movements under LCP imply deviations from the law of one price. In turn, this increases the risk facing foreign exporters, who respond by incorporating a risk premium into prices that reduces the average real incomes of domestic households — in general, the optimal policy must trade off a larger output gap against lower import prices. However, Sutherland (2001a) shows that a flexible exchange rate may be desirable with even a low degree of pass through if the elasticity of labor supply is low.[3] The reason is that exchange rate volatility induces exporters to set high prices, which has the effect of improving the terms of trade.

Devereux and Lane (2001a) provide a quantitative exploration for a small open economy. Their setup involves a competitive export sector that faces exogenously-determined world prices and a monopolistic nontraded sector that displays Calvo-style nominal price stickiness. The consumption good is imported. Two scenarios for the degree of pass-through for import prices are considered: complete pass through; and partial pass through, set at the same degree of rigidity as shown by prices in the nontradable sector. Shocks to world interest rates and the terms of trade are considered. The results of the numerical simulations are shown in Table 1 for three monetary rules: the targeting of nontradables inflation; CPI targeting; and an exchange rate peg.[4]

prices in the economy and variable production effort across firms, which is welfare-decreasing. Sutherland (2001a) shows that there are basic equivalences between the two approaches.

[3]The other papers in this literature typically assume an infinitely elastic labor supply.

[4]See Devereux and Lane (2001a) for details concerning the calibration of the model. This paper also considers the impact of financial frictions and liability dollarization, as is discussed below. Gali and Monacelli (2002) provide a related analysis but only for the case of complete pass-through and their model

The findings in the upper panel of Table 1 show that the first regime is easily dominant in the case of full pass through. By allowing the nominal and real exchange rate to vary in response to shocks, targeting nontradables inflation achieves much lower volatility in output and investment, even if CPI inflation is less stable. For an open economy with full pass through, targeting CPI inflation is much closer to a pegged regime, since exchange rate movements must be suppressed in order to maintain a stable CPI. In contrast, the lower panel of Table 1 shows that partial/delayed pass through sharply improves the relative performance of the CPI targeting regime. With partial pass through, a tight link between the nominal exchange rate and the CPI is broken, permitting exchange rate adjustment without sacrificing overall price stability. In this case, the CPI rule is actually preferable to targeting nontradables inflation: although aggregate output and investment volatility are higher, CPI inflation is stabilized and the lower amount of exchange rate volatility limits excessive reallocations between traded and nontraded sectors. Overall, the results in Table 1 indicate that a low degree of pass through may be a prerequisite for CPI inflation targeting to be a desirable monetary regime for a small open economy.

Another recent strand of the literature has focused on the currency denomination of asset contracts, instead of product prices. In particular, the effects of foreign-currency debt are considered. The typical finding is that such liability dollarization reduces the net gain to exchange rate flexibility: depreciation raises the real domestic value of foreign-currency debt and this tends to depress investment and production in models exhibiting financial constraints. Some authors have emphasized that this mechanism can give rise to multiple equilibria and crisis episodes: depreciation depresses investment, which in turn justifies depreciation (Aghion et al 2001). Others have incorporated this channel into otherwise standard DGE models and found that it does not alter the usual ranking of alternative exchange rate regimes: with pass through, flexible exchange rates are still preferable despite the negative net worth effect (Cespedes et al 2001, Devereux and Lane 2001a, Gertler et al 2001). However, Devereux and Lane (2001b) show that a fixed exchange rate may be

does not have a nontradables sector. See also Smets and Wouter (2002).

preferable if a trade financing constraint means that a fall in net worth raises the cost of imported intermediates — in this case, the combination of foreign-currency debt and depreciation directly depresses output by raising production costs.

Finally, Devereux and Engel (2002) show that LCP is helpful in reconciling high exchange rate volatility with exchange rate "disconnect": the fact that volatile nominal exchange rates appear to have little impact on overall macroeconomic behavior. In particular, Devereux and Engel (2002) achieve this result by combining LCP with other market imperfections: incomplete international financial markets; a particular structure of international distribution systems; and stochastic deviations from uncovered interest rate parity (UIP) that are driven by noise trader activity in financial markets. In related fashion, by eliminating offsetting expenditure responses, LCP raises the sensitivity of the exchange rate to disturbances. A further implication is that international consumption correlations are lowered (since real exchange rate movements are larger), while international output correlations are raised (since the expanding country raises demand for imports from overseas).

2.2 Endogeneity of PCP versus LCP

The preceding discussion begs the question of the endogenous determination of the currency denomination of sticky prices. A DGE approach highlights that firms should take into account the covariance between exchange rates and the marginal utility of consumption of its household shareholders in setting prices. In contrast, the partial equilibrium literature typically assumes a risk-neutral firm, which rules out consideration of such general equilibrium effects.

Devereux and Engel (2001b) study this problem in a general equilibrium setting in which money supplies are subject to random variability and households are risk averse.[5] These authors find that only relative monetary volatility matters under full risk-sharing: all firms will set prices in the most stable currency, in order to minimize uncertainty. If the home country has the more stable monetary regime, this means that home firms practice PCP but

[5] See also the numerical simulations in Bacchetta and van Wincoop (2001a).

foreign firms follow LCP vis-a-vis home consumers, with foreign consumers facing uncertain prices. If financial markets are incomplete, in contrast, a symmetric LCP equilibrium is feasible so long as absolute monetary variability is not too large in either country and the degree of risk aversion is not too low. However, a symmetric PCP equilibrium is only feasible in the knife-edge case when monetary variability is identical in the two countries.

Bacchetta and van Wincoop (2001b) provide an alternative approach and highlight that two key factors are the market share of home firms in the foreign market and the greater the market power of individual firms.[6] If home firms have a high market share and the elasticity of intrasectoral substitutability is low, then a PCP equilibrium is likely. This is reinforced by a strategic complementarity in price setting: PCP is more attractive, the more other home firms also pursue this strategy.[7]

Corsetti and Pesenti (2002b) make a useful contribution to this debate. Rather than focusing on monetary uncertainty, they allow monetary policies to be optimally determined. In addition, firms are free to choose any degree of pass-through. They show that there are two equilibria. In one equilibrium, exchange rates float and firms select PCP strategies; in the other, the exchange rate is fixed and an LCP equilibrium is feasible. In this way, a currency union can be self-validating, since fixed exchange rates are an optimal monetary policy response to LCP strategies, given that exchange rate shifts have no allocative role in that case. However, it is important to note that these equilibria are Pareto-rankable: the float/PCP equilibrium offers higher expected welfare compared to the fix/LCP alternative. The reason of course is that the former configuration allows the exchange rate to be a helpful adjustment mechanism in the face of asymmetric macroeconomic shocks.

Country size and, relatedly, the nature of the distribution process are also surely important. For instance, Devereux et al (1999) conjecture that the introduction of the euro will make it more likely that imports into the eurozone will be priced in euro rather than in foreign currency. Since such a switch insulates the eurozone price level from exchange rate

[6] Devereux and Engel (2001) consider a unit elasticity of substitution between home and foreign goods.

[7] Bacchetta and van Wincoop (2001b) also have an interesting discussion on the implications of allowing for wage rigidity in addition to price rigidity.

volatility, the welfare of European consumers is enhanced. Moreover, under international risk-sharing, foreign agents also benefit through an associated increase in European asset prices.

Undoubtedly, much remains to be done in terms of understanding the currency denomination of prices. The highest priority is surely the acquisition of improved empirical evidence on the price setting behavior: in this regard, the formation of EMU provides a natural experiment. In related fashion, a better understanding of the determination of the currency denomination of debt contracts is also an important desideratum.[8]

3 The Current Account and Net Foreign Assets in the Adjustment Process

A fundamental difference between a closed and open economy is that earned income and expenditure can diverge in the latter via access to international capital markets. With purchasing power parity (PPP), a full international risk-sharing equilibrium implies that domestic consumption depends only on global output, with full insulation from idiosyncratic domestic shocks. Of course, by the same token, this exposes domestic consumption to external disturbances that shift global output, even if domestic production is unchanged. As a modelling strategy, the assumption of complete international financial markets is attractive, since asymmetric shocks do not alter the international wealth distribution.[9]

Even if PPP does not hold (as under LCP, for instance), this assumption also provides an extremely simple relation between relative consumption and the real exchange rate

$$\left(\frac{C}{C^*}\right)^{-\rho} = \frac{P}{EP^*} \tag{2}$$

[8] See Chamon (2001) for one recent contribution on this problem.

[9] Tille (2000) points out that moving from autarky to complete financial integration is not necessarily welfare-improving for all countries. Consider two countries with differing levels of domestic monetary volatility. Financial integration raises the volatility of the exchange rate and induces the high-volatility country to restrict production — on net, the low-volatility country may lose out via a decline in its terms of trade.

where ρ is the coefficient of relative risk aversion, P and P^* are the home and foreign consumer price levels respectively and E is the level of the nominal exchange rate. Here, we have assumed that complete insurance extends to nominal incomes: at an optimum, transferring a dollar between home and foreign agents cannot be a Pareto improvement. Of course, however elegant, the tight link between the real exchange rate and relative consumption in equation [2] is profoundly rejected in the data (Ravn 2001).

As is emphasized by Corsetti and Pesenti (2001, 2002a), another way to eliminate international wealth redistributions is to restrict consumption preferences in a particular way.[10] Suppose initial non-monetary wealth is zero and utility from consumption is given by

$$U = \sum_{s=t}^{s=\infty} \beta^{s-t} \left[\ln C_s\right] \qquad 0 < \beta < 1 \tag{3}$$

where C_s is an unitary-elasticity aggregate over home and foreign goods

$$C_s = C_{Hs}^{\gamma} C_{Fs}^{1-\gamma} \tag{4}$$

and the corresponding consumer price index is

$$P_s = \frac{1}{\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}} P_{Hs}^{\gamma} P_{Fs}^{1-\gamma} \tag{5}$$

with the same preferences applying also to foreign households. Then, it can be shown that households just spend their income each period

$$P_s C_s = R_s \tag{6}$$

where R_s is the revenue from sales to domestic and export markets. Under PCP, this result applies even for a non-unitary intertemporal elasticity of substitution: it is sufficient that the elasticity of intratemporal substitution is one. The intuition is straightforward: current account imbalances will tend not to arise if there is limited substitutability between home and foreign products in consumption.

[10] See also Svensson and van Wijnbergen (1989), Cole and Obstsfeld (1991), Obstfeld and Rogoff (1998) and Tille (2001).

Although it promotes model tractability, ruling out current account and net foreign asset dynamics by either approach is quite limiting. The original *Redux* model emphasized that a monetary shock could be non-neutral even in the long-run, since it generates a short-run current account surplus and a corresponding long-run improvement in the net foreign asset position. In turn, this generates permanent wealth effects that alter the long-run patterns of consumption, work effort and the terms of trade.

The *Redux* model adopted a certainty-equivalence framework and just considered a one-time unanticipated monetary shock. In a more general stochastic DGE setting, permanent changes in the net foreign asset position provide technical problems since solution techniques typically rely on the existence of a stationary steady-state: a unit root in the net foreign asset position is obviously inconsistent with model stationarity. However, it is not difficult to ensure stationarity and the speed of convergence can be set at any desired rate. For instance, Schmitt-Grohé and Uribe (2001) consider several alternatives: an endogenous discount factor; a debt-elastic interest rate premium; convex portfolio adjustment costs; and, of course, completeness of international asset markets.[11] Alternatively, Ghironi (2002) and Cavallo and Ghironi (2002) achieve stationarity by imposing an overlapping generations (OLG) structure, although this imposes a lot of additional structure on the standard NOEM model.[12]

At an empirical level, net foreign asset positions tend to be quite persistent (Lane

[11] Benigno (2001) and Kollmann (2002) provide examples of employing a debt-elastic interest rate premium to ensure stationarity. Lane and Milesi-Ferretti (2002a) document some suggestive evidence in support of such a "portfolio balance" effect: there is a positive correlation between the ratio of net external liabilities to exports and real interest rate differentials.

[12] These authors find very slow convergence back to steady-state. In part, this is because they follow Weil (1989) and assume households are infinitely-lived but population growth means that new cohorts are born each period, rather than adopting the finite-horizon formulation as in Blanchard (1985). Ghironi (2002) argues that slow convergence is attractive since univariate tests indicate that it is hard to reject nonstationarity of the net foreign asset position. However, a unit root in the net foreign asset position could be consistent with rapid adjustment to business cycle shocks if the stochastic trend is driven by other persistent factors (eg demographic variables). See also the discussion in the next paragraph.

and Milesi-Ferretti 2001, 2002a), suggesting that current account innovations can be an important source of dynamics in open-economy DGE models. Moreover, the net foreign asset position has an important influence on the long-run values of real exchange rates and potentially also real interest rate differentials and country risk premia (Lane and Milesi-Ferretti 2000, 2002a, 2002b).[13]

At an empirical level, there is evidence that the current account does respond to monetary shocks. Lane (2001b) studies a variety of identified VAR models for the US economy and finds that a monetary shock, after an initial lag, moves the current account into surplus. That said, as is also emphasized by earlier work in the RBC tradition, productivity and terms of trade shocks may represent more important sources of cyclical fluctuations in the current account (Cardia 1991, Mendoza 1991).

It is important to recognize that the long-run wealth effects induced by such cyclical current account shocks are likely to be quantitatively minor. For instance, for an infinitely-lived household, a real interest rate of 4 percent means that a 1 percent of GDP improvement in the net foreign asset position implies only a relatively trivial 0.04 percent increase in the long-run level of consumption.[14]

In contrast, significant net foreign asset positions may also be accumulated as the the result of long-term trend differences in savings and investment behavior rather than business-cycle shocks. Lane and Milesi-Ferretti (2002a) show that relative income levels, public debt and demographic patterns play important in the evolution of net foreign asset positions. For business-cycle analysis, these accumulated imbalances — regardless of their origin — may be important, since exchange rate and asset price fluctuations then also operate via a revaluation channel on the value of foreign assets and liabilities. For instance, Benigno (2001) shows that the business cycle response to shocks is quantitatively quite different if

[13]Lane and Milesi-Ferretti (2000, 2002b) emphasize the relative price of nontradables as an important component of the real exchange rate that endogenously responds to the net foreign asset position. The real exchange rate effect obviously varies with country size. Lane and Milesi-Ferretti (2002a) document a strong inverse correlation between net foreign asset positions and real interest rate differentials.

[14]The increase in consumption will be somewhat higher if there is mean-reversion in the net foreign asset position, for instance if the model is set up to generate stationarity of the steady-state.

the initial net foreign asset position is say 30-50 percent of GDP rather than zero as is assumed in most of the literature.

Moreover, the asymmetry created by non-zero net foreign asset positions (if the home country is a net debtor, the rest of the world by definition is a net creditor) also implies potentially large gains to international policy coordination. In this model, for zero initial net foreign asset positions, the first best can be well approximated a policy of targeting domestic producer price inflation.[15] However, such a policy induces excessive volatility in interest rates and hence inefficient cross-country wealth redistributions if initial net foreign asset positions are non-zero and policy coordination in this case can substantially improve welfare. As Benigno (2001) puts it: "A producer-price stability policy is a symmetric policy in an asymmetric world."

Cavallo and Ghironi (2002) consider the impact of current account dynamics in a setting in which central banks follow Taylor-style interest rate rules of the form

$$i_{t+1} = \alpha_1 y_t + \alpha_2 \pi_t^{CPI} + \xi_t \tag{7}$$

where y_t and π_t^{CPI} are the deviation of output and CPI inflation from their steady-state (trend) values.[16] This particular monetary policy rule leads to some interesting dynamics. For instance, consider the impact of an accumulation of net foreign assets. Since this generates a positive wealth effect that leads to a reduction in work effort, domestic output falls even though domestic consumption is raised.

The Taylor rule in equation (7) instructs the central bank to reduce interest rates whenever it observes a fall in output below its steady-state value (regardless of its source): the positive accumulated net foreign asset position is thereby associated with a depreciation of the nominal exchange rate. Another implication of this rule is that there is a forecastable component to the nominal exchange rate: the accumulated net foreign asset position pre-

[15] This is the optimal policy under complete financial integration. If initial net foreign asset positions are zero, it is also not far from the optimum with bond-only international asset trade.

[16] See also Lane (2002).

dictably influences the interest rate under equation (7), through the wealth effect on labor supply and thereby on the level of output.[17]

This example highlights the importance of carefully specifying the loss function for the central bank in an open economy. Obstfeld and Rogoff (1995) strongly emphasized that the behavior of output is not a good welfare indicator in an open economy, since real income and output can diverge due to investment income flows and terms of trade movements and the value of leisure time needs also to be incorporated into an overall welfare evaluation. Since a monetary policy rule like equation (7) appears suboptimal from a normative perspective in an open economy, it would be interesting to also study optimizing monetary policy strategies.[18] At an empirical level, it would be interesting to compare the fit of a welfare-maximizing rule relative to the "positive" rule embodied in equation (7).

It should be recognized that a significant net external liability position also leaves a country vulnerable to a financing crisis, which can in itself be a source of business cycle volatility. In turn, a sharp turnaround in the trade balance may require a large real depreciation, especially in the presence of nominal rigidities. Such "sudden stops" in capital inflows have been a recurrent problem for emerging market economies in recent years but are also potentially relevant for major debtor nations such as the US (Obstfeld and Rogoff 2000).

Integrating the macroeconomic impact of dramatic shifts in international financial market sentiment into the NOEM framework appears to be a useful direction for future research.[19] Of course, understanding the sources of these market swings is a primary concern in assessing the net gains to international financial integration. A related issue is that allowing non-fundamental financial market shocks (in conjunction with incomplete risk sharing) can help improve the empirical performance of NOEM models. For instance, Devereux and

[17] The strength of this mechanism is the larger, the higher the degree of substitutability between domestic and foreign goods in consumption. This model maintains the PCP assumption.

[18] Examining the behavior of such rules for the flexible-price case also seems to be a digression, since such monetary policy rules only make sense if there is some degree of nominal rigidity.

[19] Cook and Devereux (2001) provide an interesting application of such a model to the Asian crisis .

Engel (2002) and Kollmann (2002) both allow for stochastic deviations from UIP in their calibration models and find that it is helpful in improving the fit to the data.[20]

Finally, a complete treatment of the net foreign asset position requires the introduction of capital accumulation into the model: investment dynamics are central to understanding current account behavior. In this regard, Betts and Devereux (1999), Chari et al (1998) and Kollmann (2001) provide interesting numerical analysis of the impact of introducing capital into NOEM models. It would be desirable to also allow for international trade in equities in addition to trade in bonds, especially if one objective to capture the unusual behavior of the US net foreign asset position since the mid-1990s (Ventura 2001). In related fashion, reintroducing portfolio balance considerations in modelling current account dynamics may add an interesting dimension to the role played by the net foreign asset position as a key state variable in NOEM models.

4 Fiscal policy in NOEM models

In this section we survey how NOEM models have been used to analyze fiscal issues. Despite the fact that this framework is equipped to study the effects of fiscal shocks, relatively few authors focus on them. We start by illustrating how government spending can be introduced into the *Redux* model, and we subsequently look at the effects of fiscal shocks in variants of the basic model that incorporate various features such as LCP strategies; financial frictions; perfect risk sharing; home-bias; non-separability between private and public consumption; fixed exchange rates; and deviations from Ricardian Equivalence.

4.1 Government spending in the Redux model

Government spending is introduced in the basic *Redux* model by Obstfeld and Rogoff (1995) in the form of a composite of public consumption that aggregates across the differentiated

[20] Kollmann (2002) studies a small open economy. He argues that shocks to UIP actually improve welfare, since the country will hold higher net foreign assets in response and hence enjoy a greater mean level of consumption.

goods produced by the individual agents in the same way as for private consumption, with the same elasticity of substitution. Accordingly, domestic government spending is given by

$$G = [\int_0^1 g(z)^{\frac{\theta-1}{\theta}} dz]^{\frac{\theta}{\theta-1}} \tag{8}$$

where $[0,1]$ is the continuum of goods produced in the domestic and foreign countries and θ is the elasticity of substitution between varieties. Formula (8) also illustrates the absence of home bias in government spending in the *Redux* model. In this framework world government spending G_t^w enters as an exogenous shock to the demand schedule faced by every agent for its product

$$y_t^d(z) = [\frac{p_t(z)}{P_t}]^{-\theta}(C_t^w + G_t^w) \tag{9}$$

where $[p_t(z)/P_t]$ is its relative price and C_t^w and G_t^w are global private and government consumption spending respectively. In the *Redux* model, a permanent balanced-budget increase in home government spending reduces short-run relative consumption and depreciates the exchange rate. The intuition for this result is that, with no home bias in government spending, such a policy increases the demand for both domestic and foreign goods, while the tax bill only falls on domestic residents. This implies a negative wealth effect for home agents, who react by reducing their consumption relative to foreigners. Because money demand is a positive function of consumption, the fall in relative consumption brings about a depreciation of the domestic currency.

A domestic balanced-budget increase in government spending also raises output in the home country and lowers it abroad. The positive effect on domestic output is consistent with results previously derived in the Real Business Cycle (RBC) tradition.[21] Under flexible prices, this can be explained by the fact that an increase in taxes reduces wealth, inducing agents to redce their consumption of leisure and increae labour supply. In contrast, under sticky prices, output is demand determined and so its positive response cannot be explained by supply-side factors. An intuition for the increase in domestic output can rather be found

[21] For example, Baxter and King (1993).

in the expenditure-switching effect that follows the depreciation of the domestic currency which raises demand for domestic goods.[22] Since both leisure and consumption provide utility in this framework, the above analysis suggests that a domestic fiscal expansion has *beggar-thyself* and *prosper-thy-neighbor* welfare implications.

The effects of permanent fiscal expansions on the current account and on the real interest rate are in stark contrast with the implications of flexible-price, representative agent models. If $\theta + 1$ is bigger than the elasticity of intertemporal substitution of real balances ϵ, the home country runs a current account surplus following a domestic expansion.[23] This is due to the fact that, unlike in flexible-price models, the presence of sticky prices means that an unanticipated permanent increase in government spending can tilt the time profile of output, thereby inducing current account effects.

A permanent fiscal policy shock reduces the short-run real interest rate.[24] The intuition is that the effect on output is larger in the short-run than in the long-run on account of the the temporary nominal rigidity. This implies a declining path of output available for private consumption. It follows that a decrease in the short-run real interest rate is required, in order to make the individual optimal consumption smoothing consistent with this dynamics.

While all the effects discussed above refer to an increase in government spending that is financed with lump-sum taxes, Obstfeld and Rogoff (1995) also consider the case of an income tax. When distortionary taxation is introduced, initial steady-state output is lower than in the case in which the only distortion is imperfect competition. It follows that both countries potentially gain more from an unanticipated increase in world demand than in the

[22] By the same token, we can explain the decrease in foreign output following a domestic expansion. Since the domestic effect is stronger in absolute value, world output increases.

[23] Note that this condition is always satisfied in the particular case of logarithmic preferences, in which $\epsilon = 1$. This follows from the fact that the elasticity of substitution between goods θ must be bigger than unity in order to have well defined demand functions. Note that the consumption elasticity of money demand in the model is given by $1/\varepsilon$.

[24] This is a novelty compared to the flexible-price textbook result of no effect on the interest rate (Barro 1993)

case of lump-sum taxes. In the case of a monetary shock, the overall benefit is redistributed towards the depreciating country, that can reduce the distortion due to income taxes at foreign expense.

A feature of the *Redux* model, as it is clear from equation (9), is a constant elasticity of demand, that implies a fixed mark-up of prices on marginal costs. While enhancing tractability, this rules out some interesting possibilities. Rotemberg and Woodford (1992), for example, show that allowing for intra-industry strategic collusion can generate a counter-cyclical mark-up following an unexpected fiscal shock. Gali (1994) and Dixon and Rankin (1994) make the point that changing the public-private spending mix also alters the elasticity of total demand if the elasticity of public spending is different from that of private spending.[25] In this way, endogenizing the degree of imperfect competition could improve our understanding of the effects of fiscal policy. The subsequent literature that has built on the *Redux* model has also highlighted some other limitations of the basic framework, as well as its flexibility in terms of introducing more realistic assumptions. In what follows, we illustrate how researchers have attempted to deal with some of these issues in relation to fiscal policy.

4.2 Fiscal policy: PCP versus LCP

As was discussed in section 2, a feature of the *Redux* model that has been deemed as unrealistic is the PCP assumption that requires the law of one price (LOOP) and PPP to always hold. Most of the contributions that deal with fiscal policy, however, use the PCP approach. This modelling choice can probably be considered less problematic when dealing with fiscal shocks than when dealing with monetary ones, in light of the results illustrated in Betts and Devereux (1999). Using calibration experiments, these authors show that deviations from the LOOP, although crucial in affecting the transmission mechanism of

[25] In empirical work, Lombardo (2001) finds a negative relationship between the government share and the mark-up.

monetary shocks, are relatively unimportant for the case of fiscal shocks.[26] The interdependence pattern following a tax-financed increase in government spending is essentially the same as in the *Redux* model regardless of the denomination of sticky prices.

A noteworthy exception is that with LCP the nominal exchange rate slightly overshoots in the short run. This difference with the *Redux* result of no overshooting is due to the fact that with LCP the foreign price level does not move immediately and the rise in the price level is smaller than in the PCP case. This in turn implies that the reduction in relative consumption is slightly reduced and hence an overshooting of the exchange rate is required to clear the money market.

Senay (1998) analyzes the impact of fiscal policy in a LCP framework that also incorporates financial frictions. Senay confirms, in a LCP framework, that financial integration reduces the volatility of consumption, output and the nominal exchange rate following an asymmetric fiscal shock.[27] However, she finds that the way in which financial integration operates does not significantly depend on the degree of LCP in the economy.

4.3 Fiscal policy and perfect risk sharing

Betts and Devereux (1999) also show that the asset market structure is crucial in affecting the results following a fiscal shock. When asset markets are complete, the wealth effects of financing the increased government spending are shared equally by the two countries. Domestic and foreign variables therefore react in the same way. Both home and foreign output increase, while consumption falls, and there are no exchange rate and current account effects.

In the *Redux* model, the degree of monopolistic competition and the elasticity of substitution between home and foreign goods are equal. As was discussed in section 2, Corsetti and Pesenti (2001) develop a model that sets a unitary elasticity of substitution between home and foreign goods. Under PCP, this formulation provides the same kind of risk

[26] On the other hand, the asset market structure is very important in the fiscal case (see below), and irrelevant in the monetary one.

[27] The same result is found by Sutherland (1996).

sharing implied by complete markets for the case of fiscal shocks. The fiscal results of these authors however differ from those of Betts and Devereux (1999), since they introduce complete home bias in government spending. When a domestic fiscal shock stimulates the demand for home goods only, foreign output, the nominal exchange rate, home and foreign consumption are unaffected in the short-run, while home output increases on a one-to-one basis.[28]

It follows that the welfare spillover of a fiscal expansion is determined solely by the long-run effects. A foreign increase in government spending affects the home economy through two channels. The first channel is a depreciation of the domestic real exchange rate, that reduces the domestic purchasing power parity and consumption. The welfare spillover of this channel is unambiguously negative. Since a fiscal expansion in the foreign country reduces the amount of foreign goods available to world consumers, the world demand for domestic goods increases if domestic and foreign goods are substitutes, and decreases if they are complements. The sign of the welfare spillover is negative when the two national goods are substitutes, because domestic production increases and domestic leisure falls. Corsetti and Pesenti (2001) conclude that the negative channel prevails for a wide range of parameters. In their model therefore, unlike in the *Redux*, fiscal spillovers are likely to be *beggar-thy-neighbor*.

A feature of the way Corsetti and Pesenti (2001) specify preferences is that solutions can be derived in closed form, without resorting to linearization. Their model is therefore well equipped to carry out a choice-theoretic analysis of policy coordination. In particular, they analyze the interplay between monetary and fiscal policy links, by deriving the optimal

[28] This property, which can be labelled "quasi-neutrality", is common in models with home bias in government spending (an early example is Rankin 1990). Ganelli (2000) argues that introducing home bias in government spending in the *Redux* model generates "quasi-neutrality" of fiscal shocks. Warnock (1998) introduces home bias in the *Redux* model in the form of idiosyncratic preferences, rather than in the composition of spending, finding that a higher degree of home bias increases the depreciation of the domestic currency and therefore increases the probability that the home country runs a surplus following a domestic fiscal expansion.

monetary policy as a function of the parameters of the model and of the other (domestic and foreign) policy variables. Since a home fiscal expansion increases domestic output in the short-run, bringing the domestic economy closer to potential output at unchanged terms of trade, the optimal monetary response is a contraction of domestic money supply. As noted above, domestic fiscal shocks have no impact on the foreign economy in the short-run. The foreign authorities therefore do not need to react directly too such a policy, but they will implement the optimal response to any monetary contraction of the home country caused by a domestic fiscal shock.

4.4 Useful government spending

Ganelli (2000) introduces utility enhancing government spending in the *Redux* model, by modelling private and public consumption as substitutes in private utility. The representative agent therefore maximizes the following utility function:

$$U_t^j = \sum_{s=t}^{\infty} \beta^{s-t} [\log(C_s^j + \gamma G_s) + \chi \log \frac{M_s^j}{P_s} - \frac{\kappa}{2} Y_s(j)^2] \tag{10}$$

where γ is the marginal rate of substitution between private and public consumption, M_s^j/P_s is the level of real balances and $Y_s(j)$ is the level of work effort. This formulation implies a direct crowding-out effect of government spending on private consumption, that tends to have a negative effect on the domestic and international consumption multipliers, both in the short and in the long run.

Ganelli (2000) also shows that introducing utility enhancing government spending increases home welfare, following a domestic expansion, compared to the *Redux* benchmark. This follows from the fact that the direct increase in utility caused by such an expansion more than offset the negative welfare effect arising from the reduction in consumption due to direct crowding out. The differential effect of introducing $\gamma > 0$ therefore moderates the *beggar-thyself* nature of fiscal policy highlighted by Obstfeld and Rogoff (1995).

4.5 Fiscal policy under fixed exchange rates

Caselli (2001) develops a fixed exchange rate version of the *Redux* model. Her main interest is to evaluate the welfare effects of fiscal contractions under two alternative global monetary arrangements. In the first regime, the foreign country pursues its own monetary policy aimed at long-run price stability, and the home country is unilaterally responsible for pegging the exchange rate. In the second regime, the home and foreign countries cooperate to maintain fixed exchange rates at unchanged world money supply. Caselli (2001) interprets the first regime as a proxy of the situation faced by several EU countries that have carried out fiscal contractions in the 1980s and 1990s, while pegging their currencies to the Deutsche Mark.

Symmetrically to what happens in the *Redux* model following a fiscal expansion, a home contraction in public spending in this framework increases private relative consumption, therefore increasing home money demand. Unlike in the *Redux*, with fixed exchange rates the equilibrium cannot be restored by a nominal appreciation. An implication is that, contrary to the conventional wisdom dictated by the Mundell-Fleming approach, monetary policy under unilateral pegging has to become more expansionary in order to stabilize the exchange rate in the face of a fiscal contraction.

Caselli (2001) also tests empirically some implications of the model using EU data. A panel regression shows that, in line with the theoretical analysis, the differential (home minus foreign) in private consumption growth rates is negatively affected by a domestic fiscal expansionary policy and positively affected by a foreign expansion.

4.6 Macroeconomic effects of government debt

A common feature of all the policy experiments considered so far is that they are balanced-budget expansions or contractions. This follows from the fact that, with infinitely lived agents, Ricardian equivalence holds and there is no role for government debt. Ganelli (2002) departs from Ricardian equivalence by introducing overlapping generations of the Blanchard type (1985) in a NOEM framework. This enables a nontrivial analysis of the

real effects of government debt.

In this framework, each agent faces in every period a constant probability of death $1-q$. Unlike in the infinitely lived models previously described, it is here necessary to differentiate agents by age. The representative domestic agent of age a at time t therefore maximizes the expected utility function:

$$E(U_t) = \sum_{s=t}^{\infty}(\beta q)^{s-t}[\log(C_{a+s-t,s}) + \chi \log \frac{M_{a+s-t,s}}{P_s} + \\ +\psi \log(1 - L_{a+s-t,s})] \tag{11}$$

where q is the probability of surviving to next period. $C_{a+s-t,s}$ denotes consumption of an agent of age $a+s-t$ at time s, and an analogous notation holds for the other variables. L denotes the amount of labor supplied in a perfectly competitive labor market.[29] Since the endowment of time in each period is normalized to 1, $1-L$ denotes leisure. It is possible to derive per-capita macroeconomic variables, by solving the optimization problem of the representative agent, aggregating across ages and dividing by the size of the population. Ganelli (2002) evaluates the short-run and long-run effects on per-capita macroeconomics variables of a debt-financed temporary reduction in taxes, with long-run taxes increasing endogenously to meet the increased interest payment.

If such a policy is carried out by the domestic country, short-run relative (domestic minus foreign) consumption increases. This is achieved by means of an increase in the domestic level of consumption, while the effect on foreign consumption is ambiguous but likely to be positive as well. The fact that relative and absolute home consumption increase following a domestic fiscal shock illustrates the existence of a wealth effect that is not at work in the Ricardian models previously considered. Because of the deviation from Ricardian Equivalence, home agents are aware of the fact that there is a positive probability that they will not be alive next period, and therefore they will not have to pay the future tax-bill implied by the increase in debt. This explains why short-run domestic consumption

[29] The departure form the yeoman-farmer model used in the *Redux*, where agents are both consumers and producers, is necessary to make aggregation across ages possible.

increases. The latter result in consistent with some recent empirical evidence regarding the effects of fiscal policy.[30]

The fact that short-run relative consumption increases implies an appreciation of the exchange rate and a decrease in relative output. The short-run international output spillover is unambiguously positive. In contrast to the *Redux* model, introducing deviations from Ricardian equivalence can thereby make the NOEM paradigm more consistent with the predictions of the traditional Mundell-Fleming-Dornbusch framework.

The long-run movements of output and consumption depend on the effect on net foreign assets. Ganelli shows that net foreign assets are a positive function of the short-run nominal exchange rate and a negative function of short-run relative consumption.[31] It follows that net foreign assets unambiguously decrease following a temporary debt-financed tax cut. Since there is an inverse steady-state relation between net foreign assets and the trade balance, long-run relative consumption and leisure must fall to offset the reduction in net foreign assets.

This discussion illustrates that is clearly possible to attribute real macroeconomic effects to government debt policies once the NOEM framework is suitably adapted to allow for deviations from Ricardian Equivalence. The analysis of Evans (1991) does suggest that the impact of simply moving from the representative-agent infinite-horizon case is quantitatively limited. However, Faruqee and Laxton (2000) show that the public debt can have larger effects if combined with non-flat age-earnings profiles and a low intertemporal elasticity of substitution. At an empirical level, Lane and Milesi-Ferretti (2002a) document that the level of government debt is an important driver of the net foreign asset position for both industrial and developing countries. The magnitude of the elasticity is larger for the latter group, which is in line with the view that departures from Ricardian Equivalence are

[30] Fatas and Mihov (2001), using a VAR approach to study the effects of fiscal policy shocks in the US, stress the contrast between the positive effect on consumption that is in the data and the negative impact in their standard RBC theoretical model. They conclude that one important item in the agenda of research on fiscal policy is to develop theoretical models that bring theory closer to reality.

[31] The net foreign asset position is also a negative function of relative government spending, that is kept constant in the policy under consideration.

likely to be larger for developing countries that are characterized by more severe financial constraints on household and corporate borrowing.

4.7 Fiscal Policy: Other Dimensions

One direction for future research is to incorporate the stylized fact that a substantial proportion of government spending is used not for public consumption of privately-produced goods but rather to pay for employment in the public sector. None of the models that we have surveyed incorporates this feature. Finn (1998), using a flexible-price RBC model, shows how failing to distinguish between these two different sub-aggregates of government expenditure can lead to overestimation of the government's impact on the economic cycle. Lane and Perotti (2002) in a reduced-form sticky-wage sticky-price model show how the composition of government spending interacts with the exchange rate regime and empirically matters for macroeconomic outcomes. Incorporating this distinction into a micro-founded NOEM model could provide a better understanding of the role of fiscal policy. In addition, embedding the concerns of the "fiscal theory of the price level" literature into a NOEM setting may also be a useful direction for new theoretical work.

Since the econometric analysis of fiscal policy still in its infancy, it is also obvious that more empirical work aimed at testing the fiscal implications of these models would be welcome. Here, extending the recent techniques of Blanchard and Perotti (2001) and Fatas and Mihov (2001) to an open economy setting would be a welcome innovation: it would be extremely helpful to have evidence concerning the impact of fiscal policy on the exchange rate, the current account and interest rate differentials. As is illustrated by Favero (2002), it is also important to study the joint impact of monetary and fiscal policies by allowing for interdependencies between the two instruments of macroeconomic policy management.

5 Conclusions

This chapter has discussed some key elements in DGE analysis of open economies and, along the way, has also signalled key issues to be addressed by future researchers.[32] One contribution of the NOEM literature has been to highlight the wide range of possible choices that exist in the specification of microfounded international DGE models: the fixed assumptions in the Mundell-Fleming-Dornbusch model concerning the relation between exchange rates and prices and the role played by the current account have been challenged, with myriad alternatives being offered. In terms of modelling strategy, we have emphasized that the choices required to obtain closed-form solutions may be potentially misleading in terms of identifying quantitatively-relevant specifications.

Regarding the current state of the literature, there are encouraging signs that new technical progress is being made. In particular, developing second-order solutions to DGE models promises to be very helpful in improving welfare evaluation and the analysis of international policy coordination issues in open-economy DGE models (Kollmann 2002, Sutherland 2001b). In addition, more research on fiscal policy would counter-balance the predominance allocated to the analysis of monetary shocks in the literature to date.

Empirical implementation of the NOEM paradigm is also getting started. Bergin (2002b) and Ghironi (1999) provide interesting systems-based estimation and tests. From another angle, Smets and Wouters (2002) represents an innovative attempt to calibrate a NOEM model for the eurozone, in part deriving parameter values from an estimated VAR for the eurozone economy. In addition to such macroeconometric studies, more microeconomic evidence on international price setting and international financial trade is highly desirable.

[32] For reasons of space, this chapter has comparatively neglected the use of NOEM models for the analysis of international policy coordination issues. This is an exciting current branch of the literature: Bergin (2002a) provides an accessible introduction.

References

[1] Aghion, P., P. Bacchetta and A. Banerjee (2001), "Currency Crises and Monetary Policy in an Economy with Credit Constraints," European Economic Review 47, 1121-1150.

[2] Bacchetta, P. and E. van Wincoop (2001a), "A Theory of the Currency Denomination of International Trade," mimeo, University of Virginia.

[3] Bacchetta, P. and E. van Wincoop (2001b), "Trade Flows, Prices and the Exchange Rate Regime," mimeo, University of Virginia.

[4] Barro, R. J. (1993), Macroeconomics, 4th ed. New York: Wiley.

[5] Baxter M., and R. King (1993), "Fiscal Policy in General Equilibrium", American Economic Review 83, 315-334.

[6] Benigno, P. (2001), "Price Stability and Imperfect Financial Integration," mimeo, New York University.

[7] Bergin, P. (2002a), "Is There a Role for International Policy Coordination?," Federal Reserve Bank of San Francisco Economic Letter No. 2002-03.

[8] Bergin, P. (2002b), "Putting the New Open Economy Macroeconomics to a Test," Journal of International Economics, forthcoming.

[9] Betts, C. and Devereux, M. (1996), "The Exchange Rate in a Model of Pricing to Market," European Economic Review 40, 1007-1021.

[10] Betts, C. and Devereux, M. (1999), "The International Effects of Monetary and Fiscal Policy in a Two-Country Model", mimeo, University of British Columbia.

[11] Betts, C. and Devereux, M. (2000), "Exchange Rate Dynamics in a Model of Pricing-to-Market," Journal of International Economics 50, 215-244.

[12] Blanchard, O.J., (1985), "Debt, Deficits and Finite Horizons," Journal of Political Economy 93, 223-247.

[13] Blanchard, O.J. and R. Perotti (2001), "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output," mimeo, MIT.

[14] Cardia, E. (1991), "The Dynamics of a Small Open Economy in Response to Monetary, Fiscal, and Productivity Shocks," Journal of Monetary Economics 28, 411-434.

[15] Caselli, P. (2001), "Fiscal Consolidation under Fixed Exchange Rates," European Economic Review 45, 425-450.

[16] Cavallo, M. and F. Ghironi (2002), "Net Foreign Assets and the Exchange Rate: Redux Revived," Journal of Monetary Economics, forthcoming.

[17] Cespedes, L., R. Chang and A. Velasco (2001), "Balance Sheets and Exchange Rate Policy," mimeo, Harvard University.

[18] Chamon, M. (2001), "Why Don't We Observe Foreign Lending to Developing Countries In Their Currency, Even When Indexation To Inflation Is available?," mimeo, Harvard University.

[19] Chari, V.V., P. Kehoe and E. McGrattan (1998), "Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates," Federal Reserve Bank of Minneapolis Staff Report No. 223.

[20] Cole, H. and M. Obstfeld (1991), "Commodity Trade and International Risk Sharing: How Much Do Financial Markets Matter?," Journal of Monetary Economics 28, 3-24.

[21] Cook, D. and M. Devereux (2001), "The Macroeconomic Effects of International Financial Panics," mimeo, University of British Columbia.

[22] Corsetti, G. and Pesenti, P. (2001), "Welfare and Macroeconomic Interdependence", Quarterly Journal of Economics, 421-445.

[23] Corsetti, G. and Pesenti, P. (2002a), "International Dimensions of Optimal Monetary Policy," mimeo, University of Rome III.

[24] Corsetti, G. and Pesenti, P. (2002b), "Self-Validating Optimum Currency Areas," NBER Working Paper No. 8783.

[25] Devereux, M., C. Engel and C. Tille (1999), "Exchange Rate Pass-Through and the Welfare Effects of the Euro," NBER Working Paper No. 7382.

[26] Devereux, M. and C. Engel (2001a), "Monetary Policy in the Open Economy Revisited: Exchange Rate Flexibility and Price Setting Behavior," mimeo, University of British Columbia.

[27] Devereux, M. and C. Engel (2001b), "Endogenous Currency of Price Setting in a Dynamic Open Economy Model," NBER Working Paper No. 8559.

[28] Devereux, M. and C. Engel (2002), "Exchange Rate Pass Through, Exchange Rate Volatility and Exchange Rate Disconnect," Journal of Monetary Economics, forthcoming.

[29] Devereux, M. and P.R. Lane (2001a), "Exchange Rates and Monetary Policy in Emerging Market Economies," CEPR Discussion Paper No. 2874.

[30] Devereux, M. and P.R. Lane (2001b), "Understanding Bilateral Exchange Rate Volatility," CEPR Discussion Paper No. XXXX, forthcoming.

[31] Dixon, H., and Rankin, N.(1994), "Imperfect Competition and Macroeconomics: A Survey," Oxford Economics Papers 46, 171-199

[32] Engel, C. (1993), "Real Exchange Rates and Relative Prices: an Empirical Investigation", Journal of Monetary Economics 32, 35-50.

[33] Engel, C. (2002), "The Responsiveness of Consumer Prices to Exchange Rates and the Implications for Exchange-Rate Policy: A Survey of a Few Recent New Open-Economy Macro Models," NBER Working Paper No. 8725.

[34] Evans, P. (1991), "Is Ricardian Equivalence a Good Approximation?," Economic Inquiry 29, 626-644.

[35] Faruqee, H. and D. Laxton (2000), "Life Cycles, Dynasties, and Saving: Implications for Closed and Small Open Economies," IMF Working Paper WP/00/126.

[36] Fatas, A. and Mihov, I. (2001), "The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence", mimeo, INSEAD.

[37] Favero, C. (2002), "How Do European Monetary and Fiscal Authorities Behave?," mimeo, Bocconi University.

[38] Finn, M.G. (1998), "Cyclical Effects of Government's Employment and Goods Purchases," *International Economic Review* 39, 635-657.

[39] Froot, K.A. and Rogoff, K. (1995), "Perspectives on PPP and Long-run Real Exchange Rates" in G.M. Grossman and K. Rogoff (eds), *Handbook of International Economics,* Vol. 3, Amsterdam, North-Holland, pp. 1647-1688.

[40] Gali, J., (1994), "Monopolistic Competition, Business Cycles and the Composition of Aggregate Demand," Journal of Economic Theory 63, 73-96.

[41] Gali, J. and T. Monacelli (2002), "Monetary Policy and Exchange Rate Volatility in a Small Open Economy," mimeo, Universitat Pompeu Fabra.

[42] Ganelli, G. (2000), "Useful Government Spending, Direct Crowding-Out and Fiscal Policy Interdependence", Warwick Working Paper in Economics n. 547. Forthcoming in the Journal of International Money and Finance.

[43] Ganelli, G. (2002), "The New Open Economy Macroeconomics of Government Debt", mimeo, Trinity College Dublin.

[44] Gertler, M., S. Gilchrist and F. Natalucci (2001), "External Constraints on Monetary Policy and the Financial Accelerator," mimeo, New York University.

[45] Ghironi, F. (1999), "Towards New Open Economy Macroeconometrics," mimeo, Boston College.

[46] Ghironi, F. (2002), "Macroeconomic Interdependence Under Incomplete Markets," mimeo, Boston College.

[47] Kollmann, R. (2001), "The Exchange Rate in a Dynamic-Optimizing Business Cycle Model with Nominal Rigidities," Journal of International Economics 55, 243-262.

[48] Kollmann, R. (2002), "Monetary Policy Rules in the Open Economy: Effects on Welfare and Business Cycles," CEPR Discussion Paper No. 3279.

[49] Lane, P.R. (2001a), "The New Open Economy Macroeconomics: A Survey," Journal of International Economics 54, 235-266.

[50] Lane, P.R. (2001b), "Money Shocks and the Current Account," in in Money, Factor Mobility and Trade: Essays in Honor of Robert Mundell (G. Calvo, R. Dornbusch and M. Obstfeld, eds.), Cambridge, MA: MIT Press, 385-412.

[51] Lane, P.R. (2002), "Comment on *Net Foreign Assets and the Exchange Rate: Redux Revived*," Journal of Monetary Economics, forthcoming.

[52] Lane, P.R. and G.M. Milesi-Ferretti (2000), "The transfer problem revisited: Real exchange rates and net foreign assets," CEPR Discussion Paper No. 2511.

[53] Lane, P.R. and G.M. Milesi-Ferretti (2002a), "Long-Term Capital Movements," NBER Macroeconomics Annual 16, forthcoming.

[54] Lane, P.R. and G.M. Milesi-Ferretti (2002b), "External Wealth, the Trade Balance and the Real Exchange Rate," European Economic Review, forthcoming.

[55] Lane, P.R. and R. Perotti (2001), "The Importance of Composition of Fiscal Policy: Evidence from Different Exchange Rate Regimes," Journal of Public Economics, forthcoming.

[56] Lombardo, G. (2001), "Sticky Prices, Markups and the Business Cycle: Some Evidence," mimeo, Deutsche Bundesbank.

[57] Mendoza, E. (1991), "Real Business Cycles in a Small Open Economy," American Economic Review 81, 797-818.

[58] Obstfeld, M. (2001), "International Macroeconomics: Beyond the Mundell-Fleming Model," International Monetary Fund Staff Papers 47S, 1-39.

[59] Obstfeld, M. and K. Rogoff (1995), "Exchange Rate Dynamics Redux," Journal of Political Economy 103, 624-660.

[60] Obstfeld, M. and K. Rogoff (1996), Foundations of International Macroeconomics, The MIT Press, Cambridge, MA.

[61] Obstfeld, M. and K. Rogoff (1998), "Risk and Exchange Rates," NBER Working Paper No. 6694.

[62] Obstfeld, M. and K. Rogoff (2000), "Perspectives on OECD Economic Integration: Implications for US Current Account Adjustment," in Global Economic Integration: Opportunities and Challenges, Federal Reserve Bank of Kansas City.

[63] Obstfeld, M. and K. Rogoff, (2001), "New Directions for Stochastic Open Economy Models," Journal of International Economics, 50, 117-153.

[64] Obstfeld, M. and K. Rogoff, (2002), "Global Implications of Self-Oriented National Monetary Rules," Quarterly Journal of Economics, forthcoming.

[65] Rankin, N. (1990), "Macroeconomic Interdependence, Floating Exchange Rates, and Product Substitutability," in Private Behavior and Government Policy in Interdependent Economies, A.S. Courakis and M.P. Taylor (Eds.), Oxford University Press.

[66] Ravn, M. (2001), "Consumption Dynamics and Real Exchange Rates," CEPR Discussion Paper No. 2940.

[67] Rogoff, K. (2002), "Dornbusch's Overshooting Model After Twenty-Five Years," International Monetary Fund Working Paper No. 02/39.

[68] Rotemberg, J. and Woodford, M. (1992), "Oligopolistic Pricing and the Effects of Aggregate Demand on Economic Activity," Journal of Political Economy Vol. 100, pp. 1153-1207

[69] Sarno, L. (2001), "Toward a New Paradigm in Open Economy Modeling: Where Do We Stand?," Federal Reserve Bank of St. Louis Review, 83(3), 21-36.

[70] Schmitt-Grohé, S. and M. Uribe, 2001, "Closing Small Open Economy Models," mimeo, University of Pennsylvania.

[71] Senay, O. (1998), "The Effects of Goods and Financial Market Integration on Macroeconomic Volatility," The Manchester School Supplement 66, 39-61.

[72] Smets, F. and R. Wouters (2002), "Openness, Imperfect Exchange Rate Pass-Through and Monetary Policy," Journal of Monetary Economics, forthcoming.

[73] Sutherland, A. (1996), "Financial Market Integration and Macroeconomic Volatility," Scandinavian Journal of Economics 98, 521-539.

[74] Sutherland, A. (2001a), "Incomplete Pass Through and the Welfare Effects of Exchange Rate Volatility," mimeo, University of St Andrews.

[75] Sutherland, A. (2001b), "A Simple Second-Order Solution Method for Dynamic General Equilibrium Models," mimeo, University of St Andrews.

[76] Svensson, L. and S. van Wijnbergen (1989), "Excess Capacity, Monopolistic Competition and International Transmission of Monetary Disturbances," Economic Journal 99, 785-805.

[77] Tille, C. (2000), "Is the Integration of World Asset Markets Necessarily Beneficial In the Presence of Monetary Shocks?," mimeo, Federal Reserve Bank of New York.

[78] Tille, C. (2001), "The Role of Consumption Substitutability in the International Transmission of Shocks," Journal of International Economics, ...

[79] Ventura, J. (2001), "A Portfolio View of the US Current Account Deficit," Brookings Papers on Economic Activity 1, 241-253.

[80] Warnock, F.E. (1998), "Idiosyncratic Tastes in a Two-Country Optimizing Model: Implications of a Standard Presumption" International Finance Discussion Paper No. 631, Board of Governors of the Federal Reserve System. Forthcoming in the Journal of International Money and Finance.

[81] Woodford, M. (2002), Interest and Prices: Foundations of a Theory of Monetary Policy, Princeton University Press, forthcoming.

Table 1: Macroeconomic Volatility and Pass Through

PT					
	Output	Investment	RER	NER	Inflation
NT	0.14	3.9	1.22	2.43	1.76
Pstab	0.99	6.29	0.45	0.51	0
Peg	1.11	6.65	0.34	0	0.3
DPT					
	Output	Investment	RER	NER	Inflation
NT	0.1	1.74	2.66	2.88	0.25
Pstab	0.4	3.42	1.69	1.71	0
Peg	1.1	6.62	0.35	0	0.3

PT is full pass through case; DPT is partial/delayed pass through case. NT, Pstab and Peg refer to the policy rules of targeting nontradables inflation; CPI inflation; and fixing the exchange respectively. Standard deviations reported where shocks to terms of trade and world interest rate are jointly estimated from a VAR using Asian data. For more details, see Devereux and Lane (2001).