The Manchester School Supplement 1998
0025–2034 39–61

THE EFFECTS OF GOODS AND FINANCIAL MARKET INTEGRATION ON MACROECONOMIC VOLATILITY

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The aim of this work is to determine whether increasing goods and financial market integration raises or lowers macroeconomic volatility. Shocks to money, government expenditure, and labour supply are analysed under different degrees of goods and financial market integration in a dynamic general equilibrium framework. Simulations show that the effects of the different shocks on economic volatility change significantly depending on the presence of incompletely integrated goods and/or financial markets. However, the results suggest that the effect of integration in one market is largely independent of the extent of integration in the other market.

1 Introduction

Given the importance of market integration in Europe and the concern for macroeconomic stabilization, it is important to determine whether integration raises or lowers macroeconomic volatility in the face of economic disturbances. In this paper goods and financial market integration are modelled and changes in the stabilizing roles played by different macroeconomic variables in response to disturbances to the economy under different degrees of goods and financial market integration are investigated.

The paper will extend theoretical models of intertemporal consumption smoothing to incorporate incomplete integration in goods and financial markets within a setting where nominal rigidities and imperfect competition exist. The theoretical framework of the model is based on the work of Obstfeld and Rogoff (1995) which incorporates nominal rigidities and imperfect competition into an intertemporal optimizing framework. Obstfeld and Rogoff assume purchasing power parity (PPP) and no impediments to trade in goods markets and integrated world capital markets. The basic objective of this paper is to extend this framework by

† I would like to thank two anonymous referees, Alan Sutherland, Huw Dixon, Peter N. Smith and participants at seminars at York, Warwick, the Money, Macro and Finance Conference (Durham) and the METU Conference on Economics (Ankara) for helpful comments and suggestions. I am grateful to the European Commission Jean Monnet Programme and Middle East Technical University, Ankara, for financial support. Any remaining errors are mine.

Published by Blackwell Publishers Ltd, 108 Cowley Road, Oxford OX4 1JF, UK, and 350 Main Street, Malden, MA 02148, USA.

introducing impediments to trade in goods and financial markets, thus looking at a model with imperfectly integrated markets. Several market imperfections exist simultaneously in the model. Whilst imperfect competition and nominal rigidities are more incidental to the analysis, since they constitute two main features of what is deemed to be a realistic model, the assumption of market imperfections preventing perfect integration in goods and financial markets is the central focus.

Real exchange rates feature large, persistent and systematic departures from the law of one price.[1] Accordingly, international trade theory has recently shifted emphasis to applications of imperfect competition and incomplete integration of markets. The issue of pricing-to-market (PTM), i.e. price discrimination across export markets correlated with exchange rate movements, has received widespread interest. The presence of PTM means that the forces enabling spatial arbitrage are absent and thus the price of the same good can diverge across markets. PTM therefore indicates incomplete goods market integration. Betts and Devereux (1996) develop a dynamic general equilibrium model combining PTM with imperfectly competitive firms and sticky prices. They show that PTM coupled with sticky nominal prices limits the degree of pass-through from changes in exchange rates to prices and mitigates the expenditure switching role of exchange rate changes.

Recent literature has also begun to consider the effects of imperfections in financial markets. The intertemporal approach regards the current account as a channel through which a country optimally modifies the time path of its absorption relative to its production in response to various types of shocks. So quantity adjustments can be regarded as being reflected in changes in capital flows. Financial markets enable intertemporal substitution of consumption and leisure and the sharing of risks, so capital flows play an important stabilizing role in response to external disturbances. The degree to which financial markets allow countries to deal effectively with shocks depends on the extent of financial market integration and capital mobility. Sutherland (1996a) investigates the effects of financial market integration on the volatility of macroeconomic variables treating financial market integration as the reduction of trading frictions between national financial markets. Increasing financial market integration decreases short-run volatility except in the case of monetary shocks where integration increases short-run volatility of nominal exchange rates and output while diminishing volatility of interest rates and consumption.

The presence of imperfect financial market integration coupled with

[1]Froot and Rogoff's (1995) survey of PPP shows that the law of one price fails quite notably even for goods that are commonly traded in international markets. Other studies also show failure of the law of one price in practice: see Isard (1977), Mann (1986), Knetter (1989, 1993), Engel (1993).

incomplete goods market integration could lead to interesting results in terms of its effects on the volatility of the economy. Intertemporally optimizing agents faced with imperfect goods market integration, manifested in the practice of PTM by imperfectly competitive firms operating under sticky prices, and incompletely integrated financial markets may face difficulties dealing with shocks.

Betts and Devereux (1996) consider a goods market imperfection while assuming that financial markets are perfectly integrated. Sutherland (1996a, 1996b) considers imperfectly integrated financial markets while assuming that goods markets are perfectly integrated. The distinguishing feature of the present paper is that both types of imperfect integration are combined in one model. Imperfectly integrated goods markets are represented by PTM and, as in Sutherland, imperfect financial market integration is represented by adjustment costs in asset stocks. Section 2 describes the model, Section 3 presents dynamic solution paths, Section 4 summarizes the results and Section 5 concludes the paper.

2 The Model

There are two countries of equal size, home and foreign. Foreign country variables are denoted with an asterisk. They are inhabited by a continuum of infinitely lived individual consumers and producers. Households consume a group of differentiated, perishable goods of total measure unity. These goods, produced by firms, are indexed by z on the unit interval. Home country firms produce a fraction n of goods and foreign firms produce $1-n$ goods.

Imperfect goods market integration is represented by the degree of PTM in the economy. The model assumes that each PTM good is sold exclusively by an individual firm in an imperfectly competitive setting where all firms are price setters. This rules out the possibility of individuals engaging in trade in PTM goods and arbitraging away price differentials between the two countries. The explicit presence of such barriers to trade is what represents incomplete goods market integration in this framework. A fraction s of firms price discriminate across countries and set prices independently for the home and foreign country; these are called PTM firms. The remaining $1-s$ of firms produce non-PTM goods which are traded freely by consumers in both countries. Price differences in non-PTM goods may be arbitraged away so firms set a single international price. The share of PTM and non-PTM firms is identical in both countries. The degree of non-PTM firms in the economy is taken to represent the degree of goods market integration achieved by the two countries. Complete PTM ($s=1$) implies that goods markets are totally segregated. When $s=0$ (there are no PTM goods) there is no market segmentation according to destination, goods markets are completely integrated and PPP holds.

2.1 Households

2.1.1 Preferences and Pricing Structure. Consumers in both countries have the same preferences, defined over a consumption index, real money balances and labour supply. A representative home resident maximizes a utility function that depends on consumption C, real money balances M/P and labour supplied N:

$$U_t = \sum_{s=t}^{\infty} \beta^{s-t} \left[\frac{\sigma}{\sigma - 1} C_s^{(\sigma-1)/\sigma} + \frac{\chi}{1-\epsilon} \left(\frac{M_s}{P_s} \right)^{1-\epsilon} - \frac{\kappa_s}{\mu} N_s^{\mu} \right] \tag{1}$$

with $0 < \beta < 1$, $\sigma > 0$, $\epsilon > 0$ and $\mu > 1$; κ is a shock variable indicating the effects of changes in labour effort on household utility. Letting $c(z)$ be a home individual's consumption of good z and θ be the elasticity of demand for consumption goods, the consumption index C is

$$C = \left[\int_0^1 c(z)^{(\theta-1)/\theta} \, \mathrm{d}z \right]^{\theta/(\theta-1)} \tag{2}$$

Domestic consumers face a consumer price index defined as

$$P_t = \left\{ \int_0^n p_t(z)^{1-\theta} \, \mathrm{d}z + \int_n^{n+(1-n)s} p_t^*(z)^{1-\theta} \, \mathrm{d}z + \int_{n+(1-n)s}^1 [E_t q_t^*(z)]^{1-\theta} \, \mathrm{d}z \right\}^{1/(1-\theta)} \tag{3}$$

The home country's consumer price index is made up of a combination of the home currency price $p_t(z)$ of the domestically produced good, the domestic currency price $p_t^*(z)$ of a foreign PTM good and the foreign currency price $q_t^*(z)$ of a foreign non-PTM good. So, p represents home currency prices and q represents foreign currency prices. Prices without asterisks are for home goods and those with asterisks are for foreign goods. E_t is the exchange rate in terms of the domestic unit cost of foreign currency.

2.1.2 Households' Interaction with Financial Markets. World capital markets are assumed to be imperfectly integrated, so individuals cannot trade freely in foreign financial assets. Individuals divide their wealth holdings between holdings of domestic currency, domestic real bonds and foreign real bonds. Home consumers have free access to domestic financial markets and may trade domestic bonds freely without incurring any costs of adjustment. Holdings of foreign bonds, however, are subject to adjustment costs. This paper adopts Sutherland's (1996a) approach of assuming the presence of adjustment costs for foreign asset holdings. Adjustment costs represent imperfect financial integration and the reduction of these costs signifies increasing integration of financial markets.

Following Sutherland (1996a) adjustment costs are assumed to be convex in the form

$$Z_t = \frac{\phi}{2} I_t^2 \tag{4}$$

where I_t is the amount of funds transferred from the domestic to the foreign financial market.[2] The effects of financial integration are considered by looking at economic disturbances under different degrees of financial integration, represented as different values of ϕ in (4).

Given the above setting for their interactions with financial markets and that consumers receive income $w_t N_t$ from wages and profits Π_t on their ownership of domestic firms and pay T_t taxes, holdings of domestic and foreign bonds are governed by the flow budget constraints

$$D_t = (1 + i_{t-1})D_{t-1} + M_{t-1} - M_t + w_t N_t - P_t C_t - P_t I_t - P_t Z_t + \Pi_t - P_t T_t \tag{5}$$

$$F_t = (1 + i^*_{t-1})F_{t-1} + \frac{1}{E_t} P_t I_t \tag{6}$$

2.1.3 Households' Maximization Problem. Domestic households maximize lifetime utility (1) subject to their holdings of wealth in the forms of domestic currency, domestic bonds and foreign bonds. The first-order conditions are

$$C_{t+1} = C_t \left[\beta(1 + i_t) \frac{P_t}{P_{t+1}} \right]^{\sigma} \tag{7}$$

$$\frac{M_t}{P_t} = \left[\frac{\chi}{C_t^{-1/\sigma}} \left(\frac{1 + i_t}{i_t} \right) \right]^{1/\epsilon} \tag{8}$$

$$N_t = \left(\frac{C_t^{-1/\sigma}}{P_t} \frac{w_t}{\kappa_t} \right)^{1/(\mu-1)} \tag{9}$$

$$(1 + i_t)(1 + \phi I_t) = \frac{E_{t+1}}{E_t}(1 + \phi I_{t+1})(1 + i^*_t) \tag{10}$$

[2]It would perhaps be more realistic to assume that adjustment costs in financial markets are non-convex. However, given the objective of the present exercise, the differences between convex and non-convex adjustment costs are relatively unimportant. For sufficiently large costs both types of cost function will imply that the interest differential between national bond markets can vary over a large range without causing large financial flows. Convex costs have the advantage of analytical tractability. See Sutherland (1996a) for a further discussion of this point.

Equation (7) is the standard consumption Euler equation. The household's demand for each differentiated good of each type is

$$c_t(z) = \left[\frac{a_t(z)}{P_t}\right]^{-\theta} C_t \tag{11}$$

$a_t(z)$ can be $p_t(z)$, $p_t^*(z)$ or $E_t q_t^*(z)$ depending on the type of good demanded.

A household's optimal money demand schedule is given by (8) which equates the marginal rate of substitution of composite consumption for real money balances to the opportunity cost of holding real balances. A household's optimal labour supply decision is shown by (9); this equates the marginal disutility of labour effort to the marginal utility of the real wage. Labour markets are assumed to be completely segregated with real wages determined by market clearing in each labour market.

Equation (10) shows the household's optimal allocation of wealth between domestic and foreign bonds, taking into consideration the costs related to transferring wealth from one financial market to the other. With integrated capital markets, where there are no costs of adjustment ($\phi = 0$), equation (10) directly implies uncovered interest parity (UIP), as in Obstfeld and Rogoff (1995).

Introducing imperfections in financial and goods markets has not affected the household's optimal demand for real balances (8), nor its optimal labour supply decision (9). These and the consumption Euler equation (7) are in fact identical to those in Obstfeld and Rogoff (1995), Betts and Devereux (1996) and Sutherland (1996a). The main effect of introducing imperfect capital mobility is reflected in the household's wealth allocation between domestic and foreign bonds, which no longer implies UIP. Introducing imperfectly integrated goods markets, represented by price discrimination with respect to market destination, affects consumers' demand for specific goods, as is apparent in equation (11). But households' intertemporal consumption stream, given by (7), is unchanged since it is based on a composite consumption index of all goods.

2.2 Firms

2.2.1 Firms and Price Determination. Two types of firms exist, PTM firms which price discriminate according to market destination and non-PTM firms which set a single international price. Both types produce differentiated goods by using domestic labour as the only input. All firms have an identical linear production technology, $Y_t(z) = N_t(z)$ where $Y_t(z)$ is total output of the firm and $N_t(z)$ is total employment.

Total output of a domestic PTM firm is made up of output sold domestically, y_t^{D}, and output for sales to the foreign country, y_t^{F}. With G_t the level of domestic government expenditures, total domestic demand for good z is

$$y_t^{\mathrm{D}}(z) = \left[\frac{p_t(z)}{P_t}\right]^{-\theta}(C_t + Z_t + G_t) \tag{12}$$

and there is a similar expression for $y_t^{\mathrm{F}}(z)$. Total output of the non-PTM firm is made up of output sold domestically, y_t^{D} as in (12), and output for sales to the foreign country, y_t^{N}. Total foreign demand for a domestically produced non-PTM good is given by

$$y_t^{\mathrm{N}}(z) = \left[\frac{p_t(z)}{P_t^* E_t}\right]^{-\theta}(C_t^* + Z_t^* + G_t^*) \tag{13}$$

In a monopolistically competitive goods market each firm, having some degree of monopoly power, sets prices of its good separately to maximize its profits. PTM firms separately choose $p_t(z)$, the nominal price of their good for the home market, and $q_t(z)$, the nominal price of their good in the foreign market. Non-PTM goods producers set a single international price since these goods can be traded by individuals and price differentials can thus be arbitraged away.

The presence of nominal rigidities which involve sluggish price adjustment makes the present dynamic optimizing open-economy model more realistic both theoretically and empirically. Prices are sticky in that some firms cannot immediately respond to economic disturbances by changing prices within the period under consideration. Instead these firms respond to disturbances by meeting market demand at preset prices. (This is profitable for firms since prices are above marginal cost.)

The specific form of sluggish price adjustment considered here is that described by Calvo (1983), which assumes that firms change their prices after time intervals of random length. In other words, the specific time period between price changes is a random variable.[3] Though Calvo's model is one of continuous time, following Rotemberg (1987), Sutherland (1996a) and Kollmann (1996) a discrete-time version of this model is presented. The probability that a given firm changes its price at any particular period is taken to be a constant, $1 - \gamma$. Accordingly the probability that a given firm will leave its price at the previous predetermined level is γ. Given the law of large numbers the proportion of firms leaving their price levels unchanged is therefore γ, and a proportion $1 - \gamma$ reset their prices at a new optimal level.

Prices of PTM goods are preset in the buyer's currency, so the foreign currency price of the seller's good will not automatically change with

[3]Although the underlying source of price stickiness is not explicitly modelled here, the rationalization for it could be that firms are bound by contracts which can only be renegotiated intermittently. Another rationalization for price stickiness is the presence of 'menu costs' which may deter producers from changing prices in the face of small demand shocks. The Calvo model is consistent with both interpretations of price stickiness.

movements in exchange rates. Foreign currency prices of non-PTM goods, set in seller's own currency, change with movements in exchange rate.

2.2.2 Firms' Maximization Problem. The specific nature of nominal rigidities assumed above coupled with imperfect goods market integration represented by the presence of PTM makes the profit maximizing problem of the firm more complicated. In the absence of nominal rigidities, PTM firm z would maximize

$$\Pi_t^{\mathrm{P}}(z) = \left[\frac{p_t(z)}{P_t}\right]^{-\theta}(C_t + G_t + Z_t)[p_t(z) - w_t] + \left[\frac{q_t(z)}{P_t^*}\right]^{-\theta} \times (C_t^* + G_t^* + Z_t^*)[E_t q_t(z) - w_t] \quad (14)$$

The first part of the above equation represents profits from domestic sales of good z, $\Pi_t^{\mathrm{D}}(z)$, and the second profits from sales of the good to the foreign country, $\Pi_t^{\mathrm{F}}(z)$. Total profits of firm z can thus be expressed as $\Pi_t^{\mathrm{P}}(z) = \Pi_t^{\mathrm{D}}(z) + \Pi_t^{\mathrm{F}}(z)$.

However, the presence of nominal rigidities in the form of Calvo price inertia introduces a dynamic dimension to the firm's optimization problem in the sense that prices chosen by the firm in one period may still be in force in further periods and thus have influences on the profits of the firm in future periods. In this case the firm must maximize the discounted value of all its current and future profits taking into account the probability of the current price being in force. This is done by weighting each future period by the probability that the firm will leave its price unchanged, namely γ. In this case an individual domestic firm z maximizes

$$V_t^{\mathrm{P}}(z) = \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} \Pi_s^{\mathrm{D}}(z) + \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} \Pi_s^{\mathrm{F}}(z) \quad (15)$$

where $R_{t,s}$ is the discount factor defined as $R_{t,s} = [1/(1 + r_t)][1/(1 + r_{t+1})] \ldots [1/(1 + r_s)]$. The first-order conditions of the domestic PTM firm z are

$$p_t(z)(\theta - 1) \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} \frac{C_t + G_t + Z_t}{P_s^{-\theta}} = \theta \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} \frac{C_t + G_t + Z_t}{P_s^{-\theta}} w_s \quad (16)$$

and

$$q_t(z)(\theta - 1) \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} \frac{C_t^* + G_t^* + Z_t^*}{P_s^{*-\theta}} E_t = \theta \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} \frac{C_t^* + G_t^* + Z_t^*}{P_s^{*-\theta}} w_s \quad (17)$$

The structure of pricing behaviour by firms implies that firms who do change their price in period t will all change it to the same levels p_t and q_t in domestic and foreign currency respectively. The number of firms who last set their prices at period $t-1$, $(1-\gamma)\gamma$, again will have set it at the same levels p_{t-1} and q_{t-1}. Redefining the general price index (3) for the domestic economy yields

$$P_t = \left(n(b_t^{\mathrm{D}})^{1-\theta} + [(1-n)s](b_t^{*\mathrm{D}})^{1-\theta} + \{1-[n+(1-n)s]\}E_t^{1-\theta}(b_t^{*\mathrm{F}})^{1-\theta}\right)^{1/(1-\theta)} \tag{18}$$

where to simplify notation the price indices are defined as

$$b_t^{\mathrm{D}} = \left[(1-\gamma)\sum_{s=0}^{\infty}\gamma^s p_{t-s}^{1-\theta}\right]^{1/(1-\theta)} \tag{19}$$

$$b_t^{*\mathrm{D}} = \left[(1-\gamma)\sum_{s=0}^{\infty}\gamma^s p_{t-s}^{*1-\theta}\right]^{1/(1-\theta)} \tag{20}$$

$$b_t^{*\mathrm{F}} = \left[(1-\gamma)\sum_{s=0}^{\infty}\gamma^s q_{t-s}^{*1-\theta}\right]^{1/(1-\theta)} \tag{21}$$

Equation (19) is a price index for the domestic currency price of domestically produced goods, (20) is a price index for domestic currency prices of foreign-produced PTM goods sold in the domestic market and (21) is an index of foreign-produced non-PTM goods for sale in the domestic country priced in foreign currency.

A non-PTM firm's maximization problem is very similar to the PTM firm's. Non-PTM firms determine a single price for their good to be charged in both the domestic and foreign country. In the absence of nominal rigidities, non-PTM firm z maximizes

$$\begin{aligned}\Pi_t^{\mathrm{NP}}(z) = \left[\frac{p_t(z)}{P_t}\right]^{-\theta}(C_t + G_t + Z_t)[p_t(z) - w_t] + \left[\frac{p_t(z)}{P_t^* E_t}\right]^{-\theta} \\ \times (C_t^* + G_t^* + Z_t^*)[p_t(z) - w_t]\end{aligned} \tag{22}$$

The first part of (22) represents profits from domestic sales of good z, $\Pi_t^{\mathrm{D}}(z)$, and the second profits from sales of the good in the foreign country, $\Pi_t^{\mathrm{N}}(z)$. Total profits of non-PTM firm z are $\Pi_t^{\mathrm{NP}}(z) = \Pi_t^{\mathrm{D}}(z) + \Pi_t^{\mathrm{N}}(z)$. Introducing nominal rigidities in the form of Calvo price inertia leads to the following profit equation, i.e. the non-PTM counterpart of equation (15):

$$V_t^{\mathrm{NP}}(z) = \sum_{s=t}^{\infty}\gamma^{s-t}R_{t,s}\Pi_s^{\mathrm{D}}(z) + \sum_{s=t}^{\infty}\gamma^{s-t}R_{t,s}\Pi_s^{\mathrm{N}}(z) \tag{23}$$

Since non-PTM firms set a single international price for their good, the first-order condition of non-PTM firm z leads to a price-setting condition for $p_t(z)$ which is exactly the same as (16).

2.3 Government

Government in each country prints money and collects taxes to finance G_t which is a composite of domestic and foreign goods defined in the same way as households' consumption. Purchases are financed totally by lump sum taxes and money printing. The domestic government budget constraint is

$$P_t G_t = P_t T_t + M_t - M_{t-1} \tag{24}$$

2.4 Equilibrium Conditions

Equilibrium in the world economy is a set of consumption, output, exchange rate, prices and wages enabling market clearing in goods, labour, money and bond markets, i.e. a set of variables that

(i) satisfy the optimal evolution of intertemporal consumption given by the Euler equation in each country;
(ii) clear the money market in both countries at each period with the level of domestic money supply determined exogenously by the government;
(iii) clear labour markets at each period;
(iv) satisfy conditions for optimal wealth allocation between domestic and foreign bonds;
(v) satisfy conditions for optimal price setting by domestic and foreign firms at each time period for both PTM and non-PTM goods;
(vi) satisfy the intertemporal budget constraint for each country, with present discounted values of total consumption, government expenditure and adjustment costs in each country being equal to the present discounted values of total labour and profit income.

3 Analysis of Dynamic Solution Paths

The effects of exogenous shocks to money supply, government expenditure and labour supply on the volatility of macroeconomic variables such as consumption, output, the nominal exchange rate, real interest rates and foreign bond holdings are analysed under four different combinations of goods and financial market integration. The analysis seeks to understand how different degrees of integration in goods and financial markets affect the volatility of these variables and thus the stabilizing role to be played by them in response to economic disturbances.

Since no closed-form solution to the model may be obtained, numerical simulations of the model in its calibrated and log-linearized form are presented. The dynamics of the model are analysed in terms of deterministic solution paths. These enable an easier interpretation of the interrelationships between variables compared with stochastic simulations.

The shocks considered are permanent,[4] and asymmetric in that the domestic and foreign country are both affected by the same type of shock but in opposing ways.[5] Three types of shocks, to the money supply, to government expenditures and to labour supply, are considered. Each shock affects domestic variables positively through a 1 per cent permanent increase while their foreign counterparts undergo a permanent 1 per cent decrease.

The effects of goods market integration (GMI) will be analysed by looking at different degrees of PTM, i.e. by varying the share s of PTM firms in the economy. For expository purposes only two extreme cases of PTM are considered, the case of complete GMI when $s = 0$ implying full PPP, and the case of incomplete GMI when $s = 1$ implying full PTM. The effects of financial market integration (FMI) are analysed by changing the value of ϕ in the cost function. Complete FMI is represented by $\phi = 0$ and incomplete FMI by $\phi = 5$. The following four cases are considered:

Case 1: Complete GMI, complete FMI, $s = 0, \phi = 0$
Case 2: Incomplete GMI, complete FMI, $s = 1, \phi = 0$
Case 3: Complete GMI, incomplete FMI, $s = 0, \phi = 5$
Case 4: Incomplete GMI, incomplete FMI, $s = 1, \phi = 5$

The parameter values used in the simulations are taken from Hairault and Portier (1993) and Sutherland (1996a, 1996b) and are

$$\beta = 1/1.05 \quad \epsilon = 9.0 \quad \chi = 1.0 \quad \mu = 1.4 \quad \sigma = 0.75 \quad \theta = 6.0 \quad \gamma = 0.5$$

Dynamic adjustment paths of domestic macroeconomic variables are presented in Figs 1–3. In each part of each figure there are four plots illustrating the above four cases. Case 1 of complete GMI and FMI is represented by the plot marked with dots, case 2 of incomplete GMI and complete FMI by the plot of empty circles, case 3 of complete GMI and incomplete FMI by the plot of squares and case 4 with incomplete GMI and FMI by the plot of triangles.

[4]Looking at permanent shocks is equivalent to looking at random walk shocks in a stochastic model. An interesting (and arguably more empirically relevant) alternative to this would be to consider mean reversion in shocks.

[5]Shocks which hit each country equally (i.e. symmetric shocks) do not give rise to flows of goods or funds between countries. The degree of goods and/or financial market integration is therefore irrelevant to the effects of symmetric shocks. It is possible that integration in itself will reduce the importance of asymmetric shocks. This possibility is not considered in this analysis.

3.1 Money Supply Shocks

This section presents the effects of an asymmetric, permanent money supply shock on variables such as consumption, output, real interest rates and foreign bond holdings under different degrees of GMI and FMI. The domestic money supply is increased by 1 per cent and the foreign money supply decreased by 1 per cent. Figure 1 presents the dynamic response of domestic country variables only.[6]

To provide a benchmark consider first the case of complete GMI and complete FMI, i.e. case 1. Complete GMI implies the presence of full PPP, so the nominal exchange rate and domestic and foreign price levels will adjust to maintain domestic/foreign PPP across the two countries. Complete FMI implies that UIP holds. UIP implies equality of expected returns. The combination of UIP and PPP implies equality of real interest rates in the two countries.

The perfect asymmetry of the shock combined with a unified world financial market implies that interest rates are unaffected by the shock. This is apparent in Figs 1(c) and 1(d). As one would expect, the exchange rate depreciates by approximately 2 per cent in the long run. For reasons described in detail in Obstfeld and Rogoff (1995), the exchange rate jumps to its new long-run equilibrium immediately. Sluggish goods price adjustment implies that the nominal depreciation is also a fall in the relative price of home goods. This implies a demand-induced increase in domestic output in the short run. As nominal contracts are redrawn, output declines towards its long-run level. The short-run rise in output allows domestic consumers to increase consumption. Consumers use their free access to world financial markets to smooth this increase perfectly over all future periods. This implies some asset accumulation in the short run.

In case 2, where incomplete GMI is introduced, all firms are PTM so the PPP condition breaks down. This has two direct impacts on the effects of a money shock. First, the breakdown in PPP implies that real interest rates can diverge. Figure 1(d) shows that domestic real interest rates fall in the short run. Second, PTM implies that changes in the nominal exchange rate are not reflected in changes in relative goods prices. This has important implications for the transmission effects of the shock onto the movements of other variables. With full PTM, any money market disequilibrium induced by a shock has to be corrected by changes in nominal interest rates since the presence of PTM hinders pass-through effects from exchange rate changes to nominal prices.[7] The

[6]Foreign counterparts are simply mirror images of domestic ones, so they are not shown.
[7]This mechanism is relevant for all cases with full PTM not only with the money shock but also under government expenditure and labour supply shocks.

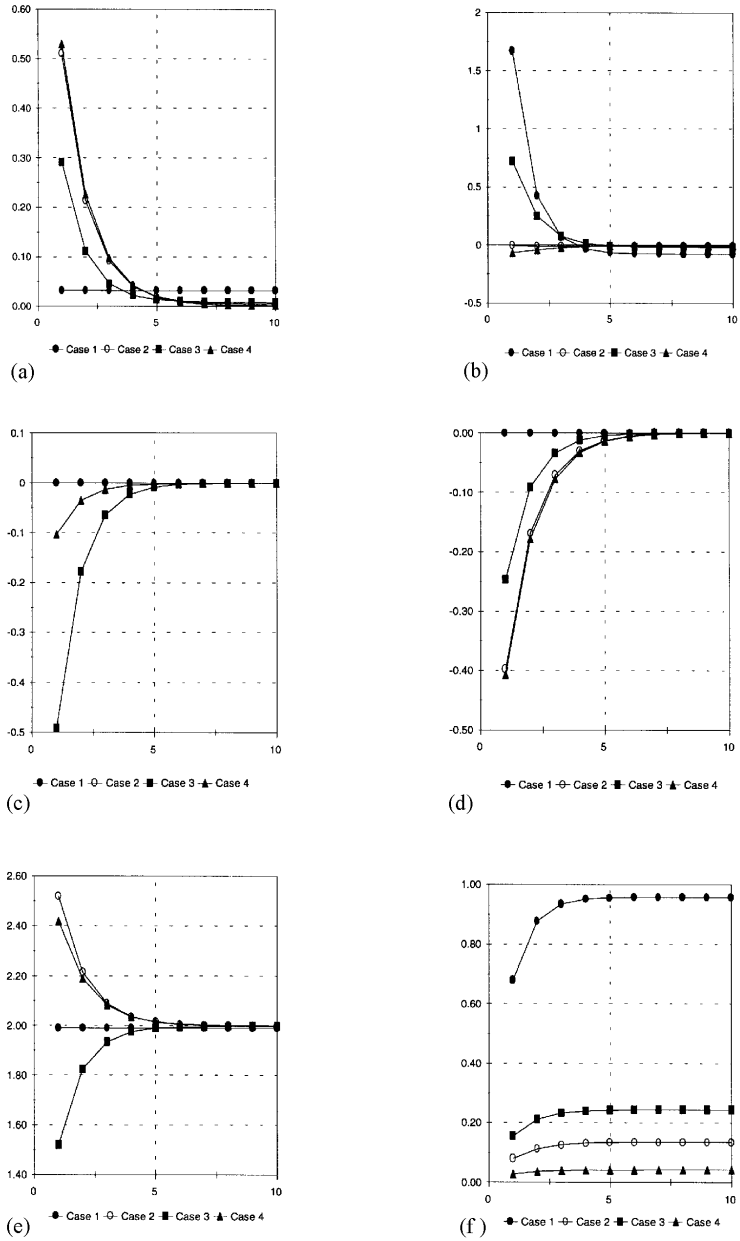

FIG. 1 Money Supply Shock: (a) Consumption; (b) Output; (c) Yield Differential; (d) Real Interest Rate; (e) Nominal Exchange Rate; (f) Foreign Bond Holdings

Note: Units of measurement: C_t, Y_t and E_t, percentage deviation from initial equilibrium; r_t, percentage point deviation from initial equilibrium; D_t, deviation as a percentage of the initial consumption level.

absence of pass-through effects also means that the nominal exchange rate depreciation does not induce any short-run changes in output. The short-run fall in real interest rates induces a short-run rise in consumption (see Fig. 1(a)). As shown by Betts and Devereux (1996), PTM implies some short-run overshooting of the nominal exchange rate (see Fig. 1(e)).

In case 3, where incomplete FMI is introduced, UIP breaks down. The main direct impact of this is to allow yields on domestic and foreign bonds to diverge. This is apparent in Fig. 1(c). The tendency for the money supply shock to induce asset accumulation in the domestic economy implies that domestic yields fall. This implies a fall in domestic real interest rates and a short-run increase in consumption. In this case the nominal exchange rate undershoots its long-run equilibrium. (For a detailed explanation see Sutherland (1996a).)

Finally, consider case 4 where there is both incomplete GMI and incomplete FMI. Case 2 introduced incomplete GMI with full PTM leading to the breakdown of the PPP condition. In case 4 imperfections in financial markets are introduced, thereby leading to the breakdown of the UIP condition too. The fact that UIP no longer holds in the short run has certain additional effects on real interest rates. As the analysis of case 2 showed, with perfect capital mobility the money shock did not lead to any yield differential. But it can also be seen in Fig. 1(f) that bond accumulation is not significantly large in case 2. So introducing imperfect capital mobility in combination with incomplete GMI does not place too much pressure on the yield differential and domestic real interest rates therefore do not fall very significantly relative to case 2. Accordingly current consumption is initially marginally higher in case 4 than in case 2.

It can be seen that the presence of imperfect capital mobility does not significantly alter the volatility of any of the macro variables shown in Fig. 1 compared with case 2. This is mainly because (as seen in case 2) full PTM almost eliminates financial flows resulting from the money shock, so the degree of FMI becomes relatively unimportant.

To summarize, moving from case 4 to case 2, financial integration with full PTM leads to slightly less volatility in consumption, output, real interest rate and foreign bond holdings, while leading to greater volatility in the nominal exchange rate. However, it could be concluded that financial integration with incomplete GMI does not lead to significant changes induced by an asymmetric money supply shock. Moving from case 3 to case 1, financial integration induces less volatility in interest rates and consumption, but increases volatility in the nominal exchange rate, output and foreign bond holdings.

When imperfect capital mobility exists, GMI (i.e. moving from case 4 to case 3) leads to less volatility in consumption, nominal exchange rates and real interest rates, whereas it leads to greater volatility in output and foreign bond holdings. GMI with imperfect capital mobility does lead to significant changes in the volatility and levels of these macro variables in response to a money shock. GMI when financial markets are perfectly integrated (i.e. moving from case 2 to case 1) leads to less volatility in nominal exchange rate, real interest rate and foreign bond holdings, though it creates more volatility in consumption and output.

3.2 Government Expenditure Shocks

This section describes the effects of an asymmetric, permanent shock to goods demand on the volatility of macro variables. Domestic government expenditure increases by 1 per cent with a corresponding decrease in foreign government expenditure. The increase in domestic spending is financed by an increase in domestic lump sum taxes. Figure 2 presents the dynamic response of domestic macro variables to the shock.

In case 1 of complete GMI and FMI, PPP and UIP conditions hold and government expenditure increases do not lead to changes in real interest rates. This is seen in Figs 2(c) and 2(d). The nominal exchange rate responds by depreciating to its new long-run equilibrium of around 0.1 per cent as seen in Fig. 2(e). Since tax increases cause a fall in the consumption of leisure, i.e. an increase in labour supply, domestic output rises in the long run. This requires a change in relative prices. Sluggish price adjustment implies that output rises by less in the short run than the long run. Higher tax payments of domestic agents cause their consumption levels to drop by nearly 0.34 per cent as seen in Fig. 2(a). With lower output in the short run and a flat consumption profile, domestic agents accumulate debt.

In case 2 where full PTM coexists with perfect capital mobility, the PPP condition breaks down and domestic and foreign real interest rates diverge. The government expenditure shock reduces consumption and therefore money demand and domestic nominal interest rates. As explained in the previous section PTM coupled with sluggish price adjustment implies that money market disequilibria are corrected by changes in the nominal interest rate. This results in a fall in domestic real interest rates as seen in Fig. 2(d). Falling real interest rates in the short run induce agents to bring consumption to the present as seen in Fig. 2(a). The fall in nominal interest rates leads to overshooting of the nominal exchange rate. Unlike case 1, in case 2 the depreciation of the exchange rate has no effect on output so the short-run expansionary effect is lower than in case 1. Increasing output and decreasing consumption profiles imply debt accumulation in the short run.

In case 3, introducing imperfect capital mobility leads to the

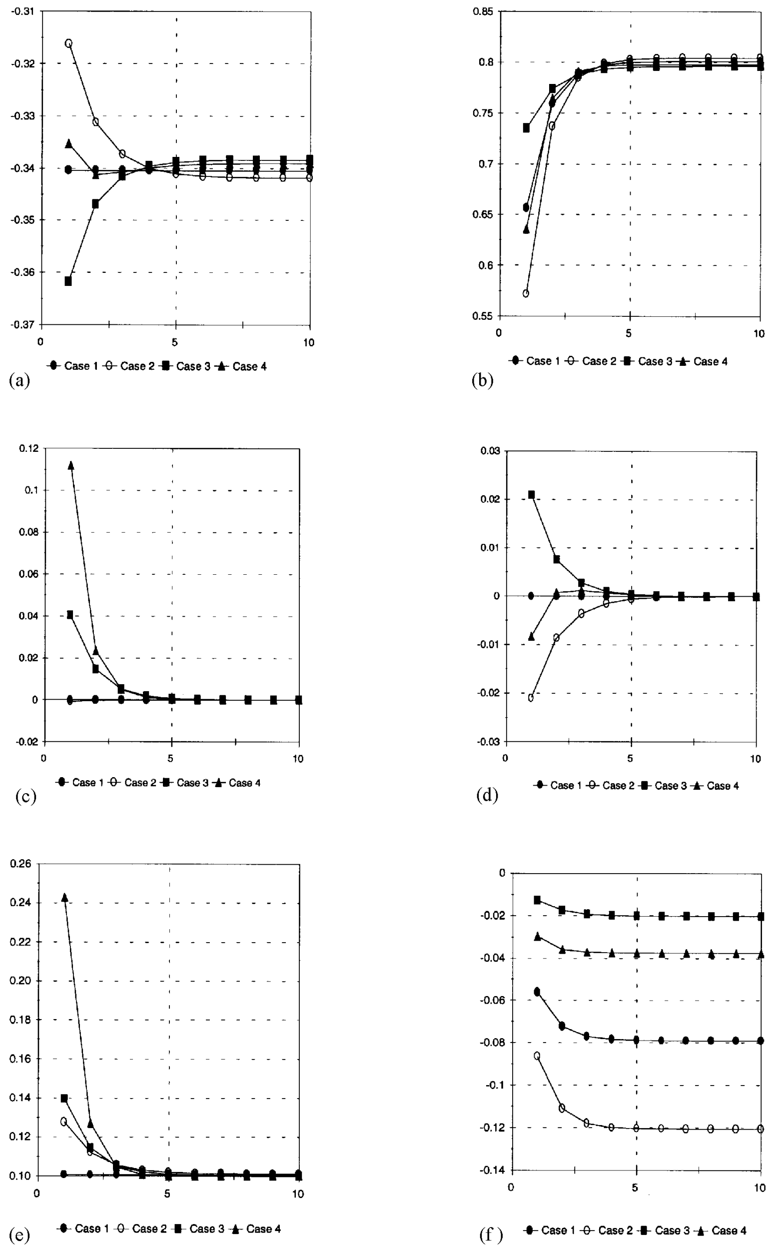

FIG. 2 Government Expenditure Shock: (a) Consumption; (b) Output; (c) Yield Differential; (d) Real Interest Rate; (e) Nominal Exchange Rate; (f) Foreign Bond Holdings

Note: Units of measurement: C_t, Y_t and E_t, percentage deviation from initial equilibrium; r_t, percentage point deviation from initial equilibrium; D_t, deviation as a percentage of the initial consumption level.

breakdown of the UIP condition. Thus the yields on domestic and foreign bonds diverge. Debt accumulation resulting from the government expenditure shock is manifested in high domestic nominal yields and real interest rates as seen in Figs 2(c) and 2(d). This induces agents to defer consumption to the future which accounts for a rising consumption profile, in contrast with case 2's declining one. In this case the exchange rate depreciation, with no PTM, means that the expenditure switching effects of exchange rate pass-through are present and lead to a greater output expansion in the short run.

In case 4, the joint presence of full PTM and imperfect capital mobility implies that both the UIP and the PPP conditions fail to hold in the short run. This implies (as in cases 2 and 3) that real interest rates between the two countries may diverge. Debt accumulation puts upward pressure on domestic interest rates but the fall in money demand coming from the fall in consumption puts downward pressure on rates. Figure 2(d) shows that the net result is a small fall in domestic real interest rates. To the extent that real interest rates do fall, consumers shift consumption to the present and adopt a slightly more stable consumption profile starting at a lower level compared with case 2. The upward pressure put on domestic bond yields implies a large overshoot of the nominal exchange rate to create an expected appreciation (see Fig. 2(d)). Although domestic output expands with the government spending shock, full PTM dampens the effects of exchange rate depreciation on output.

The joint presence of incomplete GMI and incomplete FMI (case 4) reduces volatility in certain macro variables like consumption, output and real interest rate which follow dynamic adjustment paths quite similar to those with complete GMI and FMI (case 1). The shock leads to an impact effect in variables which thereafter quickly converge to their long-run equilibrium levels. In case 4 only nominal exchange rates show a very sharp contrast compared with case 1.

Comparing case 4 with case 2, financial integration with full PTM leads to increased volatility in real interest rates and foreign bond holdings and to less volatility in domestic consumption, output and the nominal exchange rate by a significant amount. Moving from case 3 to case 1 where complete GMI exists, financial integration reduces volatility in consumption, output, the nominal exchange rate and real interest rates but increases volatility of foreign bond holdings.

GMI when imperfect capital mobility exists (i.e. moving from case 4 to case 3) leads to less volatility in the nominal exchange rate and foreign bond holdings and to greater volatility in consumption, output and real interest rates. Moving from case 2 to case 1, i.e. GMI when financial markets are completely integrated, leads to more volatility in consumption and output with less volatility in nominal exchange rate, real interest rate and foreign bond holdings.

3.3 Labour Supply Shocks

This section looks at the effects of an asymmetric, permanent shock to labour supply by considering an increase in the parameter κ by 1 per cent for domestic consumers, which implies that they will supply less labour, and a decrease of 1 per cent for foreign consumers. The effects of the negative supply shock on domestic variables are presented in Fig. 3.

Since less labour will be supplied, output will decline in the long run and consumption will also be reduced. In case 1 the PPP and UIP conditions will hold and real interest rates will not diverge. The fall in consumption results in a decline in money demand and therefore a depreciation of the exchange rate. With sticky prices in the short run, the depreciation will mitigate the reduction in domestic output in the short run. As prices are adjusted output will fall to its long-run level. Output being higher than consumption in the short run implies domestic asset accumulation.

In case 2, with full PTM and perfect capital mobility, the PPP condition breaks down while UIP continues to hold, implying that real interest rates can diverge. The fall in money demand caused by the fall in consumption implies a fall in domestic nominal and real interest rates. Lower domestic real interest rates induce consumption to decline by less in the short run. With UIP still holding, lower domestic and higher foreign nominal interest rates imply exchange rate overshooting. With full PTM, this depreciation is not passed on to relative prices so the mitigating effect seen in case 1 is less pronounced and the initial decline in output is larger.

Case 3 with imperfect capital mobility and complete GMI leads to the breakdown of UIP so the desire to accumulate assets drives down domestic yields and real interest rates. As above, consumption is brought forward. With low domestic yields a smaller depreciation is observed in the short run. With no PTM this results in an output contraction in the short run which is greater than in case 2.

In case 4, with full PTM and imperfect capital mobility, the desire to accumulate bonds causes nominal and real interest rates to fall. Real interest rates fall more than they do under case 2 with perfect capital mobility. Decreasing real interest rates bring consumption forward so the contraction in consumption is much less pronounced in case 4 than in case 2. The presence of imperfect capital mobility leads to the breakdown of the UIP condition such that domestic yields fall and foreign yields rise. This is partly brought about by a positive expected depreciation as seen in Fig. 3(e). Full PTM prevents the exchange rate from affecting output so output contracts more in the short run compared with cases 1 and 3.

Comparing case 4 and case 2, financial integration with full PTM leads to increased volatility in consumption, the nominal exchange rate

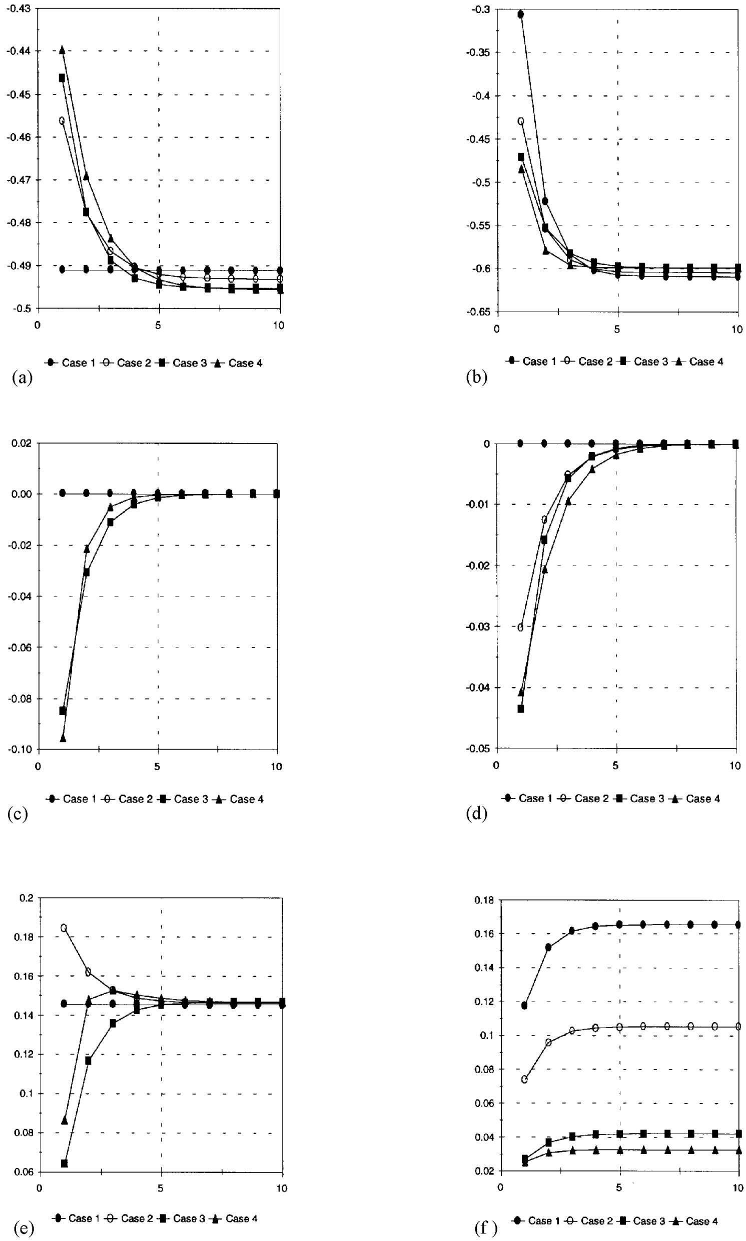

FIG. 3 Labour Supply Shock: (a) Consumption; (b) Output; (c) Yield Differential; (d) Real Interest Rate; (e) Nominal Exchange Rate; (f) Foreign Bond Holdings

Note: Units of measurement: C_t, Y_t and E_t, percentage deviation from initial equilibrium; r_t, percentage point deviation from initial equilibrium; D_t, deviation as a percentage of the initial consumption level.

and foreign bond holdings, and to less volatility in domestic output and real interest rate. Moving from case 3 to case 1 where complete GMI exists with PPP, financial integration reduces volatility in output and real interest rate but increases the volatility of consumption, nominal exchange rate and foreign bond holdings.

As for GMI, when imperfect capital mobility exists moving from case 4 to case 3, GMI leads to less volatility in output and nominal exchange rate, whereas it leads to greater volatility in consumption, real interest rate and foreign bond holdings. Moving from case 2 to case 1, GMI leads to more volatility in consumption and foreign bond holdings, with less volatility in output, nominal exchange rate and real interest rate.

4 Summary of Results

Having discussed in detail the specific movements and causalities underlying the responses of macroeconomic variables to shocks to money supply, government expenditure and labour supply, it is useful to summarize the effects of GMI and FMI on macroeconomic volatility. Table 1 presents the direction of the change in the impact effect of each variable to each shock in the cases of

(1) FMI with
  (i) incompletely integrated goods markets, i.e. moving from case 4 to case 2, and
  (ii) completely integrated goods markets, i.e. moving from case 3 to case 1;

Table 1
Summary of Impact Effects

		C_t	Y_t	r_t	E_t	F_t
Financial market integration						
M shock	Case 4 to 2	−	−	−	+	−
	Case 3 to 1	−	+	−	+	+
G shock	Case 4 to 2	−	−	+	−	+
	Case 3 to 1	−	−	−	−	+
N shock	Case 4 to 2	+	−	−	+	+
	Case 3 to 1	+	−	−	+	+
Goods market integration						
M shock	Case 4 to 3	−	+	−	−	+
	Case 2 to 1	−	+	−	−	+
G shock	Case 4 to 3	+	+	+	−	−
	Case 2 to 1	+	+	−	−	−
N shock	Case 4 to 3	+	−	+	−	+
	Case 2 to 1	+	−	−	−	+

Notes: Case 1, complete GMI, complete FMI; case 2, incomplete GMI, complete FMI; case 3, complete GMI, incomplete FMI; case 4, incomplete GMI, incomplete FMI.

(2) GMI with
   (i) incompletely integrated financial markets, i.e. moving from case 4 to case 3, and
   (ii) completely integrated financial markets, i.e. moving from case 2 to case 1.

The table aims to provide a summary of impact effects of FMI and GMI on the volatility of variables under each case separately. A negative sign shows that integration leads to less volatility in the variable in question and a positive sign shows integration leads to an increase in volatility. The table brings together the results discussed in the previous section.

Two general points emerge.

(i) The way FMI affects the volatility of a variable does not seem to change significantly with the presence of incomplete GMI. In other words, when the effects of a shock on the volatility of a variable are observed, the sign of the volatility effect does not change when moving from case 4 to case 2 (FMI with incomplete GMI), to case 3 to case 1 (FMI with complete GMI). Thus the presence of incomplete GMI does not seem to alter the effects of financial integration on the volatility of a variable. The exceptions are the money supply shock's effect on output and the real demand shock's effect on the real interest rate.
(ii) The same applies to GMI: how GMI affects the volatility of a variable seems to be unaffected by the presence of incomplete FMI, i.e. capital immobility. Exceptions in this case are the effects of real demand and money supply shocks on the real interest rate.

The pattern emerging from the above results is that the effect of increased FMI on the volatility of a variable is not much affected by the degree of GMI. The same also holds true for the financial market: the effect of increased GMI on the volatility of a variable in response to a particular shock does not depend strongly on the degree of FMI between the two countries. In other words, the integration in one market is independent of the extent of integration in the other market.[8]

5 Conclusions

Since the main results have already been discussed above, one can conclude by considering possible extensions to the analysis. The model can

[8]This conclusion is obviously based on the linearized solution of the model. It is possible that this solution may be overlooking some interactions between the goods and financial markets in the two countries. It is assumed that these interactions are of second-order magnitude.

be developed further in several ways. First, incorporating foreign equity markets to take into account domestic ownership of foreign equities and vice versa would lead to a more coherent approach to households' interactions with financial markets. Cole (1993) presents theoretical arguments for the effects of increased international diversification on the volatility of key macroeconomic variables. Extending the analysis of financial integration to take account of international diversification may have important implications for the impact of increased financial integration and its interaction with GMI. Second, the model could be modified to incorporate capital accumulation which is claimed to be an important determinant of current account behaviour by Baxter and Crucini (1993). This would add a further dynamic dimension to the firms' production problem.

Lastly, since the model enables a meaningful and rigorous analysis of welfare implications of alternative policies by providing explicit micro foundations, a welfare analysis would be an interesting extension. This would be applicable especially to analysing policy coordination efforts necessitated by the economic and monetary union to take place amongst EU members in the near future.

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