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Financial globalization and monetary policy

Michael B. Devereux
(CEPR, University of British Columbia and International Monetary Fund)

Alan Sutherland
(CEPR and University of St Andrews)

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Editorial Board: Heinz Herrmann
Thilo Liebig
Karl-Heinz Tödter

Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-0
Telex within Germany 41227, telex from abroad 414431

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077

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Central Banks and Globalisation

10th Bundesbank Spring Conference
(in cooperation with the IMFS)

22-23 May 2008

Thursday, 22 May 2008

9.00 – 9.30	**Introduction**	
	Axel Weber *(Deutsche Bundesbank)*	
	Chair:	Axel Weber *(Deutsche Bundesbank)*
9.30 - 10.30	**Global business cycles: convergence or decoupling?**	
	Speaker:	Ayhan Kose *(IMF)* Christopher Otrok *(IMF)* Esward Prasad *(IMF)*
	Discussant:	Massimiliano Marcellino *(Bocconi University)*
10.30 – 10.45	**Coffee break**	
10.45 – 11.45	**Absorbing German immigration: wages and employment**	
	Speaker:	Gabriel Felbermayer *(University of Tübingen)* Wido Geis *(ifo)* Wilhelm Kohler *(University of Tübingen)*
	Discussant:	Michael Burda *(Humboldt University)*

11.45 – 13.15	**Lunch**	
	Chair:	Stefan Gerlach *(IMFS)*
13.15 – 14.15	**Financial exchange rates and international currency**	
	Speaker:	Philip Lane *(Trinity College Dublin)* Jay Shambrough *(Dartmouth College)*
	Discussant:	Frank Warnock *(University of Virginia)*
14.15 – 14.30	**Coffee break**	
14.30 – 15.30	**International Portfolios and Current Account Dynamics: The Role of Capital Accumulation**	
	Speaker:	Robert Kollmann *(ECARES, Universite Libre de Bruxelles, University Paris XII and CEPR)* Nicolas Coeurdacier (*London Business School*)
	Discussant:	Mathias Hoffmann (*University Zurich*)
15.30 – 15.45	**Coffee break**	
15.45 – 16.45	**Financial globalisation and monetary policy**	
	Speaker:	Michael Devereux *(University of British Columbia)* Alan Sutherland *(University of St Andrews)*
	Discussant:	John Rogers *(Federal Reserve Board)*
16.45 – 17.00	**Coffee break**	
17.00 – 18.00	**Globalization and inflation – evidence from factor augmented Phillips curve regressions**	
	Speaker:	Sandra Eickmeier *(Deutsche Bundesbank)* Katharina Moll *(Frankfurt University)*
	Discussant:	Matteo Ciccarelli (ECB)

19.30 **Dinner**

Speaker: Harold James *(Princeton University)*

Friday, 23 May 2008

Chair: Lars Jonung *(European Commission)*

10.00 – 11.00 **Globalisation of banking and the effectiveness of monetary policy**

Speaker: Linda Goldberg *(Federal Reserve Bank of New York)*
Nicolla Cetorelli *(Federal Reserve Bank of New York)*

Discussant: Claudia Buch *(University of Tübingen)*

11.00 – 11.15 **Coffee break**

11.15 – 12.15 **Foreign capital and economic growth in the first era of globalisation**

Speaker: Michael Bordo *(Rutgers University)*
Chris Meissner *(University of Cambridge)*

Discussant: Albrecht Ritschl *(London School of Economics)*

12.15 – 14.00 **Lunch**

Chair: Beatrice Weder di Mauro *(University Mainz)*

14.00 – 15.00 **Money, liquidity and financial stability**

Speaker: Franklin Allen *(University of Pennsylvania)*
Elena Carletti *(Frankfurt University)*

Discussant: Wolf Wagner *(Tilburg University)*

15.00 – 15.15 **Coffee break**

15.15 – 16.15 **International linkages and financial fragility**

	Speaker:	Falko Fecht *(Deutsche Bundesbank)* Hans Peter Grüner *(University of Mannheim)* Phillip Hartmann *(ECB)*
	Discussant:	Roman Inderst *(Frankfurt University & IMFS)*
16.15 – 16.30	**Coffee break**	
	Chair	Heinz Herrmann *(Deutsche Bundesbank)*
16.30 – 17.30	**Financial globalisation and regulation**	
	Speaker:	Xavier Freixas *(Pompeu Fabra)*
	Discussant:	Arnoud Boot *(University of Amsterdam)*

Financial Globalization and Monetary Policy*

Michael B Devereux† and Alan Sutherland‡

First Draft: September 17, 2006

Revised: July, 2008

Abstract

Recent data show substantial increases in the size of gross external asset and liability positions. The implications of these developments for optimal conduct of monetary policy are analyzed in a standard open economy model which is augmented to allow for endogenous portfolio choice. The model shows that monetary policy takes on new importance due to its impact on nominal asset returns. Nevertheless, the case for price stability as an optimal monetary rule remains. In fact, it is reinforced. Even without nominal price rigidities, price stability is optimal because it enhances the risk sharing properties of nominal bonds.

Keywords: Portfolio Choice, International Risk Sharing, Exchange Rate

JEL: E52, E58, F41

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†[Corresponding author] CEPR, University of British Columbia, and International Monetary Fund. Department of Economics, University of British Columbia, 997-1873 East Mall, Vancouver, B.C. Canada V6T 1Z1. Tel: +1 604 822 2542 Fax: +1 604 822 5915 Email: devm@interchange.ubc.ca

‡CEPR and University of St Andrews

Non technical summary

The growth in the size and complexity of international financial markets has been one of the most striking aspects of the world economy over the last decade. Economists and policy makers have speculated on the implications of financial globalization for the design of monetary policy. Most central banks now follow a policy of inflation targeting. Under this policy, price stability, appropriately defined, is the principal goal of monetary policy. Is this conclusion altered by the presence of large cross border gross holdings of financial assets, where movements in asset prices and exchange rates may have significant wealth redistribution effects?

In a closed economy a monetary rule devoted to stabilizing prices eliminates the inefficiency of costly price adjustment. In an open economy, however, the optimality of price stability as the sole goal of monetary policy depends on the structure of international financial markets. In former papers it has been shown that the absence of full international risk-sharing may interact with the inefficiency arising from sticky prices, so that price stability may not constitute the unique optimal goal of monetary policy. A drawback of many of these papers is that international financial markets are modelled either by the absence of any type of international risk- sharing or by full risk-sharing. In reality, international financial markets seem to be somewhere in the middle. Once allowance is made for endogenous portfolio choice, it is possible that monetary policy actually affects the structure or efficiency of international financial markets.

In our paper we analyze monetary policy under various financial market configurations. In a first case trade in bonds and equities is possible and full international risk-sharing is achieved, for any monetary policy. In this case the portfolio composition of bonds and equities is independent of monetary policy. Then price stability is an optimal policy for conventional reasons, since it eliminates the welfare losses coming from slow price adjustments. On the other hand, when asset trade is restricted to a real non-contingent bond, deviating from price stability is in general desirable in order to alleviate risk- sharing inefficiencies. But in the intermediate and more realistic case, with trade in nominal bonds, monetary policy affects the composition of portfolios. Monetary policy plays a dual role. First it can be used so as to support the flexible price equilibrium of the economy. But monetary policy can also enhance the degree of international risk- sharing itself, by improving the hedging properties of nominal bonds. This second property of policy is conceptually independent of the first; it remains useful even in a flexible price economy. We find that in an environment where nominal bonds are traded, a policy of strict price stability will endogenously generate full international risk-sharing. Strict price stability is desirable on two counts. It supports the flexible price outcome, and it also allows nominal bond returns to offer full risk-sharing against country specific productivity shocks.

Nicht-technische Zusammenfassung

Die wachsende Bedeutung und Komplexität der internationalen Finanzmärkte ist eines der hervorstechendsten Merkmale in der Weltwirtschaft der letzten Jahre. Wirtschaftspolitiker und Wirtschaftswissenschaftler haben darüber spekuliert, welche Folgen diese Entwicklung für die Ausgestaltung einer optimalen Geldpolitik hat. Die meisten Zentralbanken folgen heute einer Politik, bei der ein Ziel für die Inflation verfolgt wird. Dabei ist Preisstabilität, angemessen definiert, das zentrale Ziel der Geldpolitik. Muss diese Schlussfolgerung geändert werden, wenn wir bedenken dass Inländer in großem Umfang ausländische Finanzaktiva halten, wobei Veränderungen in deren Preise und in den Wechselkursen wesentliche Vermögensverteilungseffekte haben?

In einer geschlossenen Volkswirtschaft beseitigt eine geldpolitische Regel, die die Preise stabilisiert, die Ineffizienzen, die mit Preisanpassungen verbunden sind. In einer offenen Volkswirtschaft hängt dagegen die Optimalität einer Politik, die nur auf Preisstabilität ausgerichtet ist, von der Struktur der internationalen Finanzmärkte ab. In früheren Papieren ist gezeigt worden, dass fehlende vollständige internationale Risikoteilung mit den Ineffizienzen aus trägen Preisen zusammen spielen kann und dass im Ergebnis stabile Preise möglicherweise nicht das einzige optimale Ziel der Geldpolitik sein sollten. Ein Nachteil vieler dieser Papiere ist jedoch, dass die internationalen Finanzmärkte entweder so modelliert werden, dass es gar keine internationale Risikoteilung gibt oder dass im anderen Extrem die Risikoteilung vollständig ist. Die Realität scheint aber irgendwo in der Mitte zu liegen. Wenn wir zulassen, dass die Portfoliowahl endogen ist, ist es möglich, dass die Geldpolitik die Struktur und Effizienz der internationalen Finanzmärkte beeinflusst.

In unserem Papier analysieren wir Geldpolitik unter unterschiedlichen Annahmen bezüglich der Finanzmärkte. In einem ersten Fall ist Handel mit festverzinslichen Wertpapieren und Aktien möglich. Unabhängig von der Geldpolitik kann hier vollständige internationale Risikoteilung erreicht werden. In diesem Fall ist die Zusammensetzung der Portfolios von der Geldpolitik unabhängig. Aus den bekannten Gründen ist dann eine Geldpolitik, die Preisstabilität sichert, optimal, da sie die Wohlfahrtsverluste beseitigt, die aus langsamen Preisänderungen resultieren. Wenn auf der anderen Seite nur inflationsindexierte Bonds international gehandelt werden können, dann ist im Allgemeinen eine Abweichung von Preisstabilität vorteilhaft, um Ineffizienzen bei der Risikoteilung zu mildern. In dem realistischeren Fall mit Handel mit nicht indexierten Bonds beeinflusst die Geldpolitik die Zusammensetzung des Portfolios der Haushalte. Die Geldpolitik spielt hier eine zweifache Rolle. Sie kann genutzt werden, um ein Gleichgewicht zu realisieren, das dem bei flexiblen Preisen entspricht. Aber Geldpolitik kann auch dazu dienen, die internationale Risikoteilung zu unterstützen, in dem sie die Hedging - Funktion der Bonds verbessert. Diese zweite Funktion ist konzeptionell von der ersten unabhängig; sie bleibt auch in einer Welt mit flexiblen Preisen sinnvoll. Wir finden also, dass in einer Welt in der nominelle Bonds gehandelt werden, eine Geldpolitik, die auf Preisstabilität ausgerichtet ist, endogen vollständige Risikoteilung sichert. Strikte Preisstabilität ist also aus zwei Gründen erwünscht. Sie hilft ein Gleichgewicht bei flexiblen Preisen zu sichern und zum anderen Risikoteilung bei länderspezifischen Schocks zu ermöglichen.

1 Introduction

The growth in the size and complexity of international financial markets has been one of the most striking aspects of the world economy over the last decade. Lane and Milesi-Ferretti (2001,2006) document the increase in gross cross-border holdings of bond and equities, describing this as a process of *financial globalization*. Economists and policy makers have speculated on the implications of financial globalization for the design of monetary policy. [1] Most central banks now follow a policy of inflation targeting. Under this policy, price stability, appropriately defined, is the principal goal of monetary policy. Is this conclusion altered by the presence of large cross border gross holdings of financial assets, where movements in asset prices and exchange rates may have significant wealth redistribution effects?

This paper explores the implications of financial globalization for the design of monetary policy. We can address the question raised above, because our model determines the structure of gross holdings of cross-country financial assets. The principal finding is that endogenous portfolio structure does not alter the case for price stability as an optimal monetary policy. In fact, it may even reinforce this case. In an environment where financial markets are incomplete, price stability is desirable because it enhances the international risk-sharing properties of nominal assets, even without nominal goods price rigidities.

A theoretical foundation for price stability has been given by King and Wolman (1999), Woodford (2003), and others, using sticky-price dynamic general equilibrium models. A monetary rule devoted to stabilizing prices eliminates the inefficiency of costly price adjustment. In an open economy, however, the optimality of price stability as the sole goal of monetary policy depends on the structure of international financial markets. Benigno and Benigno (2003) show that stability of producer prices is optimal when financial markets are complete. But Benigno (2001) and Obstfeld and Rogoff (2002) show that the absence of full international risk-sharing may interact with the inefficiency arising from sticky prices, so that price stability may not constitute the unique optimal goal of monetary policy.

A drawback of many of these papers is that international financial markets are modeled

[1] See, for instance, Fergusen, (2005), Fisher (2006), and Rogoff (2006).

either by the absence of any type of international risk-sharing (e.g. trade in non-contingent bonds) or by full risk-sharing (complete markets). In reality, international financial markets seem to be somewhere in the middle. Once allowance is made for endogenous portfolio choice, it is possible that monetary policy rules actually affect the structure or efficiency of international financial markets. Thus, the analysis of monetary policy with endogenous portfolio structure is an important direction for this literature.

Research along these lines has been hindered by the difficulty of integrating portfolio choice into dynamic stochastic general equilibrium (DSGE) models. This paper resolves this difficulty by using a methodology developed in Devereux and Sutherland (2006), which can incorporate optimal portfolio choice in a standard DSGE setting in a tractable way. This is combined with an otherwise standard two-country model of an open economy with staggered price-setting. The paper allows for a range of financial structures, differing in the number of assets traded across countries. In one case, the only asset is a non-contingent real bond, and there is no portfolio choice at all. In another case, there is trade in nominal bonds and equities and given our stochastic environment, markets are complete. In an intermediate case, nominal bonds denominated in each country's currency can be traded. Portfolio choice is then endogenous, but asset markets are incomplete.

The model delivers analytical solutions for gross asset holdings under each financial market configuration. We ask how monetary policy interacts with portfolio choice in affecting macro-economic outcomes, investigate how monetary policy influences the degree of international risk-sharing, and characterize an optimal monetary policy.

With trade in both bonds and equities full international risk-sharing is achieved, for any monetary policy. In this case the portfolio composition of bonds and equities is independent of monetary policy. Then price stability is an optimal policy for conventional reasons, since it eliminates the welfare losses coming from slow price adjustment.[2] On the other hand,

[2]Throughout this paper the focus is on optimal monetary policy from a global perspective, i.e. where monetary policy in all countries is chosen *cooperatively* to maximize world aggregate welfare. In our model price stability is the optimal cooperative policy for all parameter combinations as long as financial markets are complete. Benigno and Benigno (2003), who analyze a framework which is similar to the complete-markets version of our model, show that price stability is only a *non-cooperative* equilibrium for certain parameter combinations.

when asset trade is restricted to a real non-contingent bond, deviating from price stability is in general desirable in order to alleviate risk-sharing inefficiencies.

But in the intermediate case, with trade in nominal bonds, monetary policy affects the composition of portfolios. Monetary policy plays a dual role. First, it can be used so as to support the flexible price equilibrium of the economy. But monetary policy can also enhance the degree of international risk-sharing itself, by improving the hedging properties of nominal bonds. This second property of policy is conceptually independent of the first; it remains useful even in a flexible price economy. We find that in an environment where nominal bonds are traded, a policy of strict price stability will *endogenously* generate full international risk-sharing. Strict price stability is desirable on two counts. It supports the flexible price outcome, and it also allows nominal bond returns to offer full risk-sharing against country specific productivity shocks. Even if prices are fully flexible, there is still a non-trivial welfare case for price stability, if asset markets are incomplete.

The model implies that countries are holding large offsetting gross nominal asset positions, so that exchange rate movements can generate substantial 'valuation effects'. But the presence of these effects does not directly change the optimal monetary rule. Because portfolios are chosen optimally, the wealth redistribution arising from exchange-rate-induced valuation effects represent the workings of an efficient international financial structure. Moreover, monetary authorities do not have to be concerned with these redistributions. It is desirable to use the exchange rate in the traditional Friedman (1953) manner - to generate efficient terms-of-trade adjustment. The new insight from this paper is that Friedman's prescription may hold *even without* his underlying assumption of sluggish nominal goods price adjustment. When risk sharing is obtained via trade in nominal bonds, the Friedman argument - that it is better to use the exchange rate to facilitate terms of trade adjustment rather than price levels - is supported, *even in a fully flexible price economy.*

This paper is related to a growing literature on the analysis of portfolio composition and financial markets in dynamic general equilibrium models. The method used here is developed in Devereux and Sutherland (2006). Related papers are Engel and Matsumoto (2006), Evans and Hnatkovska (2005), and Kollmann (2006). Engel and Matsumoto (2006) incorporate endogenous portfolio choice into a complete markets version of a sticky-price open economy macro model, focusing on the 'home equity bias' puzzle. They do not directly analyze the role of monetary policy. Kollmann (2006) and Evans and Hnatkovska (2005) construct non-monetary dynamic general equilibrium environments with endogenous portfolio choice. Kollmann's (2006) analysis is based on complete markets, also examining the determinants of home equity bias. Evans and Hnatkovska (2005) employ a numerical approximation method to solve for portfolio choice.[3]

A slightly older literature has examined the determinants of trade in nominal bonds. Svensson (1989) develops a two period cash in advance model to analyze the determinants of nominal bond trading and the welfare gains to asset trade, but does not characterize the specific gross portfolio positions or the determination of optimal monetary policy. Bacchetta and Van Wincoop (2000) also develop a two period endowment economy model, and focus on the impact of nominal bonds on capital flows. An early fundamental contribution is Helpman and Razin (1978).

The next section develops the open economy model. Section 3 discusses the approach to solving for optimal portfolios. Section 4 solves for the optimal portfolios and discusses the effects of monetary policy on portfolios. Some conclusions follow.

2 An Open Economy Macro Model

There is a 'home' and 'foreign' country. Each country is specialized in a particular range of products. Only the equations relating to the home economy are described, since those of the foreign economy are similar. Consumers can trade in a range of financial assets. The menu of assets is varied, but at its most extensive there are four assets, consisting of home and foreign equity shares, and home and foreign nominal bonds. There are two types of shocks in each country; interest rate (or financial market) shocks, and productivity shocks.

[3] See also related papers by Devereux and Saito (2006), Ghironi et al. (2007), and Tille (2005). In addition, Tille and Van Wincoop (2007) present a method similar to that used in this paper.

2.1 Consumers and Firms

All agents in the home country have utility functions of the form:

$$U = E_0 \sum_{t=0}^{\infty} \left[\frac{1}{1-\rho} C_t^{1-\rho} - K L_t \right] \tag{1}$$

where C is a consumption index defined across all home and foreign goods, L is labor supply and E is the expectations operator. The consumption index C for home agents is given by:

$$C = \left[\left(\frac{1}{2}\right)^{\frac{1}{\theta}} C_H^{\frac{\theta-1}{\theta}} + \left(\frac{1}{2}\right)^{\frac{1}{\theta}} C_F^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{2}$$

where C_H and C_F are indices of individual home and foreign produced goods with an elasticity of substitution between individual goods ϕ, where $\phi > 1$. The parameter θ is the elasticity of substitution between home and foreign goods. Home and foreign goods are assumed to have equal weight in the consumption basket. Combined with an assumption of producer currency pricing, this ensures that purchasing power parity holds in all states of the world.

The aggregate consumer price index for home agents is:

$$P = \left[\frac{1}{2} P_H^{1-\theta} + \frac{1}{2} P_F^{1-\theta} \right]^{\frac{1}{1-\theta}} \tag{3}$$

where P_H and P_F are the aggregate price indices for home and foreign goods.

The budget constraint of the home country agent is:

$$P_t C_t + W_{t+1} = w_t L_t + P_t \Pi_t + P_t \sum_{k=1}^{N} \alpha_{k,t-1} r_{kt} \tag{4}$$

where W_t denotes the net value of nominal wealth for the home agent, w_t is the nominal wage, and Π_t is the real profit stream of the home firm that accrues to the home country agent. The final term represents the total return on the home country portfolio, which is comprised of N assets, where $N \leq 4$. The term $\alpha_{k,t-1}$ represents the real holdings of asset k, brought into period t from the end of period $t-1$, and $r_{k,t}$ is the period t real return on this asset. The home consumer is the default owner of home firms and receives all profits from home firms. In cases where an international equity market exists however, claims to home profits may be transferred to foreign consumers via trade in equity shares. From the definition of wealth, it must be the case that $W_t = P_t \sum_k^N \alpha_{k,t-1}$, since, total $t-1$ asset holdings must add up to beginning of period t wealth.[4]

Optimal consumption and leisure choices imply:

$$C_t^{-\rho} = \beta E_t C_{t+1}^{-\rho} r_{N,t+1}, \tag{5}$$

$$w_t C_t^{-\rho} = K P_t. \tag{6}$$

And optimal portfolio choices imply:

$$E_t C_{t+1}^{-\rho}(r_{k,t+1} - r_{N,t+1}) = 0, \qquad k = 1..N-1. \tag{7}$$

Each firm produces a single differentiated product. The production function for firm i is $Y_t(i) = A_t L_t(i)$, where A is a common stochastic productivity shock, which is a random walk process given by $\log A_t = \log A_{t-1} + u_t$,where u_t is an i.i.d. shock with $E_{t-1}[u_t] = 0$ and $Var[u_t] = \sigma_u^2$.

Firms maximize profits. Sticky prices are modeled as Calvo-style contracts with a probability of re-setting price given by $1-\kappa$. To keep the model as close as possible to the benchmark open economy formulation, it is assumed that all prices are pre-set in terms of producer's currency. If firms use the discount factor Ω_{t+i} to evaluate future profits, then the

[4] Firms earn monopoly profits because each firm is the supplier of a differentiated good. Note also that, because the home agent receives all home profits, in a symmetric equilibrium with zero net foreign assets ($W_t = 0$), gross portfolio holdings exactly offset each other in value terms. This is simply an accounting convention which simplifies the development of the model, but it is not at all critical. It is easy to treat all profit income as traded on a stock market. In this case, even in a symmetric equilibrium with zero net foreign assets, agents in each economy would have non-zero *net* portfolio positions. The solution method for portfolios applies equally to this environment.

dynamics of the newly-set price $\widetilde{P}_H$ and the home price index P_H are:

$$\widetilde{P}_{H,t} = \frac{\phi}{\phi - 1} \frac{E_t \sum_{i=0}^{\infty} \Omega_{t+i} \kappa^i \frac{w_{t+i}}{A_{t+i}} X_{H,t+i}}{E_t \sum_{i=0}^{\infty} \Omega_{t+i} \kappa^i X_{H,t+i}}, \qquad P_{H,t} = \left[(1-\kappa) \widetilde{P}_{H,t}^{1-\phi} + \kappa P_{H,t-1}^{1-\phi} \right]^{\frac{1}{1-\phi}}, \quad (8)$$

where $X_{H,t+i}$ represents demand for the home firm's output.[5]

2.2 Monetary Authorities

Monetary policy is represented as an interest rate schedule which is subject to stochastic financial shocks. Monetary authorities follow a policy that adjusts the path of the rate of return on the nominal bonds of their respective currencies. But in addition, assume that there are financial market shocks which affect equilibrium nominal interest rates, outside the direct control of the monetary authorities. This leads to an interest rate rule described by:

$$R_{t+1} = \beta^{-1} \left(\frac{P_{H,t}}{P_{H,t-1}} \right)^{\gamma} \exp(m_t) \quad (9)$$

where m_t is an *i.i.d.* stochastic shock such that, $E_{t-1}[m_t] = 0$, $Var[m_t] = \sigma_m^2 > 0$. The role of m_t shocks in the model is to allow a shorthand way of introducing non-productivity related disturbances to domestic inflation rates.[6]

Note that the rule (9) determines the nominal interest rate as a function of historic domestic PPI inflation rates. We choose PPI rather than CPI inflation rates because it is well known that in a benchmark complete markets open economy (without 'cost-push' or government spending shocks), it is optimal (from a global welfare point of view) to stabilize PPI inflation rates. The main analysis of the paper will focus on the relationship between the stance of monetary policy, captured by the parameter γ, and the equilibrium portfolio

[5] When markets are incomplete, there is an open question relating to the discount factor Ω_{t+i}. If firms discount future profits at the same discount rate as their shareholders, then both home and foreign intertemporal rates of substitution need to enter into the firm's evaluation of future profits. However, at the level of approximation at which the portfolio solution is obtained, time variation in the firm's discount factors drops out. The discount factor at this level of approximation is simply β.

[6] Devereux and Sutherland (2007a) provide a more complete justification for m_t shocks.

holdings among countries.

2.3 The Menu of Assets

Asset trade may take place in nominal bonds of each currency, and in the equities of each country. Home nominal bonds represent a claim on a unit of home currency. The real payoff to a home nominal bond purchased at time t is therefore $1/P_{t+1}$. The real price of the bond is denoted $Z_{B,t}$. The gross real rate of return on a home nominal bond is thus $r_{B,t+1} = 1/(P_{t+1}Z_{B,t})$. From the definition of the monetary policy rule, note that it must be the case that $R_{t+1} = r_{B,t+1}P_{t+1}/P_t = 1/(P_t Z_{B,t})$.

Home equities represent a claim on home aggregate profits. The real payoff to a unit of the home equity purchased in period t is defined to be $\Pi_{t+1} + Z_{E,t+1}$, where Π_{t+1} is the real value of home country profits, and $Z_{E,t}$ is the real price of home equity. Thus the gross real rate of return on the home equity is $r_{E,t+1} = (\Pi_{t+1} + Z_{E,t+1})/Z_{E,t}$.[7]

3 Solving the model

The model is closed with the assumption that GDP is demand determined, hence

$$Y_t = \frac{1}{2}\left(\frac{P_{H,t}}{P_t}\right)^{-\theta} C_t + \frac{1}{2}\left(\frac{P_{H,t}}{S_t P_t^*}\right)^{-\theta} C_t^* \tag{10}$$

The full solution to the model is described by the sequence $\{C_t, C_t^*, \widetilde{P}_{H,t}, \widetilde{P}_{F,t}, P_{H,t}, P_{Ft}, S_t,$ $Y_t, Y_t^*, R_t, R_t^*\}$, $\{r_{1,t}..r_{N,t}\}$, and the vector $\alpha_t = \{\alpha_{1,t}..\alpha_{N,t}\}$ which solves equations (6)-(7), (8)-(10) and the equivalent equations for the foreign economy.

The open economy macro literature typically proceeds by solving a first-order approximation of a model around a non-stochastic steady state. This method, however, can not be used in cases where there are multiple assets but incomplete markets. This is because, up to a first-order all assets are perfect substitutes, so the portfolio allocation is indeterminate.

[7] Aggregate home country profits are defined as $\Pi_t = (P_{H,t}Y_t - w_t L_t)/P_t$.

The existing literature therefore tends to confine attention to asset market structures where the portfolio allocation problem is not relevant. This section summarizes a procedure for obtaining optimal portfolio shares for any asset market structure by means of a second-order approximation approach.

A full description of the method of solution for portfolio variables is contained in Devereux and Sutherland (2006). Here, only a brief account of the approach is presented. A separate Appendix with a more complete description of portfolio solutions is available upon request. The method is based on an approximation where all variables except portfolio holdings are set at their values in a symmetric non-stochastic steady state. Portfolio holdings at the approximation point, denoted $\bar{\alpha}$, are treated as unknowns, and the method yields a solution for $\bar{\alpha}$.[8]

First, re-write the portfolio selection equations for the home country as follows:

$$E_t C_{t+1}^{-\rho} r_{x,t+1} = 0, \tag{11}$$

where $r'_{x,t+1} = [r_{1,t+1} - r_{N,t+1}, r_{2,t+1} - r_{N,t+1} ... r_{N-1,t+1} - r_{N,t+1}]$ is the vector of excess returns, using the Nth asset as a reference. Second-order approximation of (11) and its foreign counterpart can be used to obtain the following:[9]

$$E_t \left[\left(\widehat{C}_{t+1} - \widehat{C}^*_{t+1} \right) \widehat{r}_{xt+1} \right] = 0 + O\left(\epsilon^3\right) \tag{12}$$

where a hat is used to indicate a log-deviation from a non-stochastic steady state.[10]

Devereux and Sutherland (2006) that this equation can be used to derive a solution for $\bar{\alpha}$ by making use of the following three properties of the approximated model. First, (12) is a second-order accurate approximation so the individual components $\widehat{C}_{t+1} - \widehat{C}^*_{t+1}$ and $\widehat{r}_{x,t+1}$,

[8] In effect, $\bar{\alpha}$ represents asset holdings in a near-non-stochastic steady state.

[9] Assume that the innovations are symmetrically distributed in the interval $[-\epsilon, \epsilon]$. This ensures that any residual in an equation approximated up to order n can be captured by a term denoted $O\left(\epsilon^{n+1}\right)$

[10] The notation for returns is slightly different. Define $\hat{r}'_{x,t+1} = [\hat{r}_{1,t+1} - \hat{r}_{N,t+1}, \hat{r}_{2,t+1} - \hat{r}_{N,t+1}, ...\hat{r}_{N-1,t+1} - \hat{r}_{N,t+1}]$ where $\hat{r}_{k,t+1}$ $(k = 1...N)$ is the log-deviation of $r_{k,t+1}$ from its value in the non-stochastic steady state..

need only be approximated up to first order. Second, all assets are perfect substitutes in expectation up to first order, so $\widehat{r}_{x,t+1}$ is a mean-zero i.i.d. process up to first order. And third, in a first-order approximation of the model, the only aspect of portfolio behavior that matters is $\bar{\alpha}$.

Devereux and Sutherland (2006) describe in detail the steps involved in employing these three properties to derive a solution for portfolio holdings. In essence, the method combines (12) with a first-order approximation of the non-portfolio equations of the model to yield a solution for $\bar{\alpha}$.

For convenience, Table 1 summarizes the first-order approximation of the non-portfolio parts of the model, where $\lambda = \kappa / [(1-\kappa)(1-\beta\kappa)]$. When $\lambda = 0$, the model all prices are adjusted in each period, so the equilibrium is that of a flexible price economy. Note that, in practice, it turns out to be easier to work with a transformation of $\bar{\alpha}$, given by $\widetilde{\alpha} \equiv \bar{\alpha} / \left(\beta\overline{Y}\right)$, which is approximately the steady state portfolio to GDP ratio.

4 Equilibrium Portfolios and Monetary Policy

Three different asset market configurations are considered. First, assume trade only in a non-contingent risk-free real bond (the 'NC economy'). In this case, there is no portfolio selection problem at all, and the solution is equivalent to the standard incomplete markets open economy model with only intertemporal trade. To obtain this outcome in the model, the condition $E_{t-1}\widehat{r}_{xt} = 0$ is imposed to replace condition (12). The second case allows for trade in nominal bonds in either currency (the 'NB economy'). This allows for more international risk-sharing, so long as the ex-post returns on the two bonds differ. But markets are still incomplete, since there are four independent shocks but only two assets. Finally, allow for trade in both nominal bonds and equity ('the NBE economy'). This sustains complete markets, since there are four assets with independent returns.[11] The key contribution of the

[11] Strictly speaking, this menu of assets is only sufficient to sustain the complete markets equilibrium in a first-order approximation of the model. In general, it would be necessary to add a fifth independent asset (such as an indexed bond) to the NBE economy in order to sustain the full complete markets equilibrium. This additional asset is not held in the symmetric steady state analyzed in this paper. It only comes into

paper is the detailed analysis of the NB economy, since many previous papers have analyzed economies with either no risk-sharing at all (NC), or complete markets (NBE).

4.1 Optimal Portfolios

The model is entirely symmetric, and is approximated around an initial steady state where $W = 0$. This implies that in the NB economy, agents in both countries will have bond holdings that sum to zero, and in the NBE economy, their equity holdings and bond holdings will separately sum to zero. Thus, for the home country, $\widetilde{\alpha}_{B,NB} + \widetilde{\alpha}^*_{B,NB} = 0$ in the NB economy, and separately, $\widetilde{\alpha}_{B,NBE} + \widetilde{\alpha}^*_{B,NBE} = 0$, $\widetilde{\alpha}_{E,NBE} + \widetilde{\alpha}^*_{E,NBE} = 0$ in the NBE economy, where an asterisk denotes the investment in the foreign asset, and the other notation is self-explanatory.

Table 2 describes the optimal portfolio holdings in the NB and NBE economies. Note that when $\theta = 1$ (unit elasticity of substitution across home and foreign goods), the optimal asset holdings in all cases are zero. This is the Cole and Obstfeld (1991) result that trade in goods alone ensures full risk-sharing across countries under a unit elasticity of substitution between home and foreign goods. In the NB economy, optimal holdings of home currency bonds are positive (negative) when $\theta > 1$ ($\theta < 1$).[12] But the size of $\widetilde{\alpha}_{B,NB}$ depends on the importance of technology shocks relative to monetary policy shocks. When technology shocks are predominant, so that $\sigma_A^2/\sigma_m^2 \longrightarrow \infty$, bond holdings tend to $\frac{1}{2}\frac{(\theta-1)}{(1-\beta)}$, while as $\sigma_A^2/\sigma_m^2 \longrightarrow 0$, bond holdings tend to $\frac{1}{2}\frac{\lambda(\theta-1)}{(1+\lambda)}$.

To explain these portfolio shares, first imagine that each country has a zero portfolio share of all assets. The model from Table 1 can then be solved by setting $\widetilde{\alpha} = 0$ and the resulting solution for $\widehat{C}_t - \widehat{C}^*_t$ is[13]:

$$\widehat{C}_t - \widehat{C}^*_t = \frac{(\theta-1)}{1+\rho(\theta-1)}\left[(u_t - u^*_t) - \frac{\lambda(1-\beta)}{(\gamma+\lambda)}(m_t - m^*_t)\right]. \tag{13}$$

play at higher orders of approximation, where time variation of portfolio holdings is relevant.

[12] The regularity condition $1+\rho(\theta-1) > 0$ is assumed. This ensures that a home technology shock leads to a terms of trade deterioration for the home economy.

[13] To simplify the notation, in deriving these expressions it is assumed that $\widehat{W}_t = 0$. Since total wealth is predicable one-period ahead, it has no implications for portfolio solutions.

At the same time, if each country held a zero portfolio, the excess return on foreign bonds (which equals the unanticipated depreciation in the exchange rate) would equal:

$$\widehat{r}_{x,t} = \frac{1}{1+\rho(\theta-1)}\left[(u_t - u_t^*) - \frac{(1+\lambda+(\theta-1)\rho(1+\beta\lambda))}{(\gamma+\lambda)}(m_t - m_t^*)\right]. \tag{14}$$

Without any portfolio diversification, (13) shows that in response to a positive home country productivity shock, home relative consumption rises, when $\theta > 1$. To hedge this consumption risk, home consumers should hold an asset that has a negative correlation with home productivity. Since from (14) the exchange rate depreciates when home productivity is positive, then it is best to have a long position in home bonds, matched by a short position in foreign bonds. The scale of bond holdings must be proportional to $1/(1-\beta)$ since the payoff on a one period bond represents a one-time, transitory return, while the productivity shock is a permanent income increment. Thus, in order to hedge the consumption risk from productivity shocks, bond holdings must be large relative to GDP.

In response to a home country interest rate shock, from (13) relative home consumption falls by $\frac{\lambda(\theta-1)(1-\beta)}{(1+\lambda)(1+\rho(\theta-1))}$, when $\theta > 1$. At the same time, (14) indicates that domestic inflation falls relative to foreign inflation, and the exchange rate appreciates. A portfolio with a long position in home bonds will then have a positive payout, offering a hedge against the interest rate shock. Thus, in the NB economy, for both types of shocks, consumers would like to hold a positive position in domestic currency bonds, and a negative position in the other country's bonds, when $\theta > 1$.[14]

When $\theta < 1$, the opposite reasoning applies. Now $\widehat{C}_t - \widehat{C}_t^*$ falls in response to a home productivity shock,[15] and rises in response to a home country interest rate shock. So foreign currency bonds represent a good hedge against consumption risk on both counts.

The extent of nominal bond holdings will depend on the degree of price stickiness. As

[14] This result does depend on the configuration of shocks, the structure of the model, and the monetary policy specification. Under a monetary targeting rule for monetary policy, an optimal bond portfolio may involve a long (short) position in foreign currency (home currency) bonds, even when $\theta > 1$.

[15] In this case the negative welfare impact of a terms-of-trade decline following an increase in u is greater that the positive welfare effect of higher home GDP.

λ falls, there is less price stickiness, so that consumers can ignore the direct consumption fluctuations due to interest rate shocks, and bond holdings will be lower. Note also that $\left|\frac{\lambda(\theta-1)}{(1+\lambda)}\right| < \left|\frac{(\theta-1)}{(1-\beta)}\right|$. Since interest rate shocks are transitory, households need to hold a smaller bond position to hedge these shocks than productivity shocks. Thus, as σ_A^2/σ_m^2 rises, gross bond portfolios will rise in both countries.

When $\lambda = 0$ (i.e. fully flexible prices) the solution for $\widetilde{\alpha}_{B,NB}$ is $\frac{1}{2}\frac{(\theta-1)}{(1-\beta)}\frac{\gamma^2\sigma_A^2}{\gamma^2\sigma_A^2+(1+\rho(\theta-1))\sigma_m^2}$. The greater are interest rate shocks, the smaller is the country's bond portfolio. This points to a key qualitative feature of the model with endogenous portfolio choice. In the benchmark open economy macro model of Table 1, money is completely neutral if prices are flexible, since the model is based on a 'cashless' economy as described by Woodford (2003). The NC economy reflects this property (see below). But in the NB economy, where agents must use nominal bonds to engage in international risk-sharing, the excess return on nominal bonds (i.e. the exchange rate) is affected by interest rate shocks, *even in a flexible price economy*, as shown in (14). Hence, interest rate shocks reduce the effectiveness of nominal bonds as a hedging device against consumption risk due to productivity shocks.

In the NBE economy, households will also hold a positive nominal bond position in home currency bonds (negative in foreign currency bonds) when $\theta > 1$, but will also now hold a positive share of foreign equity. Unlike the NB economy, portfolio shares are now independent of the relative size of shocks. Since markets are complete in this case, the NBE portfolio ensures that $\widehat{C}_t - \widehat{C}_t^* = 0$ for every possible realization of shocks. This implies that the relative volatilities of the shocks are irrelevant for the portfolio solutions which achieve this.

Holdings of foreign equity are given by $\frac{1}{2}\frac{1}{1-\beta}\frac{(\theta-1)(1+\lambda\beta)}{(\theta-1)(1+\lambda\beta)+\lambda(\phi-1)(1-\beta)}$. If prices were fully flexible, i.e. $\lambda = 0$, then no nominal bonds would be held at all, and the optimal equity portfolio would hold a share $\frac{1}{2}\frac{1}{1-\beta}$ in foreign equity, matched by the negative of this in home equity. This is a 'full diversification' outcome. Agents in each country hold equity shares such that, in equilibrium, they have a claim to half of the GDP of their own country, and half that of the other country. When $\lambda = 0$, the real return on equity is independent of monetary shocks. In this case, agents hold no nominal bonds. In contrast to the NB case, money is fully neutral in the NBE economy, under flexible prices.

More generally, with sticky prices, the real return on equity and bonds depends on both productivity shocks and money shocks, so the optimal portfolio weights must reflect this. As λ rises, portfolio shares held in equity fall, while the portfolio share in bonds rises. In fact there is an interesting discontinuity in the determination of equity holdings at $\lambda = 0$. With fully flexible prices, the elasticity θ has no implications for equity holdings at all,[16] and there is complete portfolio diversification. But for *any* positive λ there is a value of θ close enough to unity such that $\widetilde{\alpha}_{E,NE} \approx 0$. Thus, there can be almost complete equity *home bias* even for very small degrees of price rigidity, if θ is relatively close to unity.[17]

4.1.1 Portfolio holdings and Monetary Policy

How does the stance of monetary policy affect portfolio holdings? Using the parameter γ as a measure of the tightness of monetary policy, a higher γ can be interpreted as a policy placing more emphasis on price stability. From Table 2 the following result can be established:

> **Result 1:** In the NB economy, a rise in γ increases the gross holdings of nominal bonds. In the NBE economy, the holdings of bonds and equities are independent of γ.

In the NB economy, markets are incomplete, and bond holdings have to act as a hedge against a combination of productivity shocks and interest rate shocks. The higher is γ, the less impact will interest rate shocks have on the variance of consumption. As γ rises, bonds holdings are dedicated more and more to the hedging of productivity shocks, which require higher gross holdings. On the other hand, in the NBE economy, the portfolio which achieves full risk-sharing is independent of the relative importance of each shock, as shown above. But the effect of changes in the monetary policy parameter γ in the model is only to scale up

[16] This is because both relative consumption (as in (13)) and relative equity returns respond to productivity shocks in proportion to $(1 - \theta)$.

[17] Home bias is equivalent to a value of $\widetilde{\alpha}_{E,NE}$ close to zero, since the zero-portfolio status quo implies that the home agent owns 100 percent of the home equity. The potential for sticky prices to generate home equity bias in portfolio is highlighted in Engel and Matsumoto (2006). These results are different principally due to the different monetary rule employed in this paper.

or down the relative importance of the interest rate shocks in overall volatility. As a result, changes in the monetary policy stance which alter the share of total volatility due to the different shocks have no impact on the portfolio shares in the NBE economy.

4.2 Risk-Sharing and Portfolio Holdings

Now we focus on the risk-sharing implications of the portfolio positions under each asset market structure, and describe the optimal monetary policy rules in each case. To avoid issues of non-cooperative behavior, define an optimal monetary rule as one which maximizes the sum of expected utility across home and foreign households. Since the model is fully symmetric, in equilibrium expected utility is equalized across countries. Moreover, because the welfare distortions due to both price stickiness and incomplete assets markets may be separated, an optimal monetary policy rule may be described without explicitly solving a welfare-maximizing policy problem.

As a measure of risk-sharing, Table 3 reports the conditional variance of relative consumption movements; $var_{t-1}(\widehat{C}_t - \widehat{C}_t^*)$. In addition, for each case, the Table reports consumption variance $var_{t-1}(\widehat{C}_t)$.[18]

It is easiest to begin the description of Table 3 from the NBE case, in which markets are complete. In this case, there is full risk-sharing. Since there is no home bias in preferences or real exchange rate variability, consumption is equalized across countries. Due to price stickiness however, monetary policy does affect the variability of consumption. A policy of strict price stability will eliminate the effect of interest rate shocks on consumption. This captures the traditional role for monetary policy. By eliminating the effect of sticky prices, monetary policy replicates the flexible price equilibrium with complete markets. In other words, as seen from Table 3, setting $\gamma \longrightarrow \infty$ in the NBE economy is equivalent in its effect

[18]While the efficiency of assets markets in risk-sharing can be assessed by the degree to which $var_{t-1}(\widehat{C}_t - \widehat{C}_t^*)$ differs from zero, there is no special welfare significance to the use of $var_{t-1}(\widehat{C}_t)$ as opposed to the conditional variance of output or employment in either country. The comparison of $var_{t-1}(\widehat{C}_t)$ across the three asset market configurations serves to illustrate the different characteristics of monetary policy in the NC and NBE economies as opposed to the NB economy. In particular, monetary policy is important in the first two cases only to the extent that $\lambda \neq 0$. Finally, as noted above, all conditional variances are well defined, despite the unit root in the wealth distribution.

to setting $\lambda = 0$. Since markets are complete, then it must also be the case that full price stability is an optimal *cooperative* monetary policy in the NBE environment.[19]

In the NC economy there is a failure of international risk-sharing, except in the special case where $\theta = 1$. Monetary policy can enhance risk-sharing by eliminating the impact of interest rate shocks on consumption. Conceptually however, this works in the same way as in the NBE economy. That is, monetary policy enhances international risk-sharing only by supporting the full flexible price equilibrium of the NC economy. Moreover, monetary policy cannot attain full international risk-sharing. Even in the flexible price equilibrium households cannot use non-contingent bond trade to offset the consumption risks of productivity disturbances.[20] Within this restricted class of monetary rules, a policy of price stability is still optimal in the NC economy. But it may be inferred from the results of Benigno (2001), Obstfeld and Rogoff (2002) and Devereux (2004), that an alternative monetary rule (e.g. a rule which responds to both the interest rate and the exchange rate), which leads allocations to deviate from the flexible price equilibrium would do better. An alternative rule would act so as to eliminate interest rate shocks, but also lead consumption and employment in each economy to respond more closely to that of the equilibrium with complete markets.[21] Hence, price stability is not efficient within a wider class of monetary rules.

In the NB economy, the stance of monetary policy has a more complex effect. This is because monetary policy affects the holdings of nominal bonds in each currency. Monetary policy has a two-fold effect on risk-sharing. First, as in the NC and NBE economies, by setting $\gamma \to \infty$, monetary policy can in the traditional manner, support the flexible price equilibrium and eliminate the influence of interest rate shocks on consumption volatility. But the monetary stance also *endogenously* enhances international risk-sharing. A policy of strict price stability leads agents to concentrate their gross nominal portfolio holdings towards eliminating country specific productivity shocks, and allowing them to ignore the

[19] It is assumed that any distortions associated with monopoly pricing are eliminated by optimal subsidies.

[20] If productivity disturbances were temporary, then non-contingent bond trade would offer some risk sharing benefits. In this case also, monetary policy can enhance the sharing of consumption risk due to productivity shocks, but it still cannot achieve fully efficient risk sharing.

[21] See Benigno (2001) for an elaboration, within a model almost identical to our NC economy.

presence of interest rate shocks. In doing so, increasing γ generates effectively complete international assets markets. Table 3 indicates that as $\gamma \to \infty$, $var_{t-1}(\widehat{C}_t - \widehat{C}_t^*)$ goes to zero, and $var_{t-1}(\widehat{C}_t)$ approaches $\frac{1}{2}\frac{\sigma_A^2}{\rho^2}$. Thus, price stability leads to the *equivalence* of the NB and the NBE economies.

The enhanced role of monetary policy in the NB economy is distinct from the traditional function of monetary policy in eliminating the effects of sticky prices. To see this, take the case of fully flexible prices; i.e. $\lambda = 0$. Then there is no role for monetary policy at all in the NC or the NBE economies. But in the NB economy, monetary policy still plays a role. When $\lambda = 0$, in the NB economy,:

$$var_{t-1}(\widehat{C}_t) = \frac{1}{2}\left[\frac{\gamma^2(\sigma_A^2)^2 + (1-2\rho(1-\theta)(1+\rho(\theta-1)))\sigma_A^2\sigma_m^2}{\rho^2(\gamma^2\sigma_A^2 + (1+\rho(\theta-1))^2\sigma_m^2)}\right] \tag{15}$$

$$var_{t-1}(\widehat{C}_t - \widehat{C}_t^*) = 2\left[\frac{(1-\theta)^2\sigma_A^2\sigma_m^2}{\gamma^2\sigma_A^2 + (1+\rho(\theta-1))^2\sigma_m^2}\right] \tag{16}$$

The monetary stance parameter γ still appears in (15) and (16), even though $\lambda = 0$. Moreover both consumption variance and the degree of risk-sharing are affected by the variability of interest rate shocks. By setting $\gamma \to \infty$ monetary policy eliminates the influence of interest rate shocks, ensuring that $var_{t-1}(\widehat{C}_t)$ in (15) approaches the consumption variance of the NBE economy, and that $var_{t-1}(\widehat{C}_t - \widehat{C}_t^*)$ in (16) approaches zero. The influence of monetary policy in this case operates purely through its ability to enhance the effectiveness of nominal bonds in hedging country specific productivity disturbances. The relative return on nominal bonds is given by the unanticipated change in the exchange rate. When $\lambda = 0$, the conditional variance of the return may be written as:

$$var_{t-1}(\Delta S_t)^{NB}_{\lambda=0} = \frac{2\left(\gamma^2\sigma_A^2+(1+\rho(\theta-1))\sigma_m^2\right)^2}{\gamma^2(\gamma^2\sigma_A^2+(1+\rho(\theta-1))^2\sigma_m^2)}$$

By pursuing a policy of price stability, the policy-maker ensures that the distribution of returns on nominal bonds depends only on productivity shocks, and is independent of interest rate shocks.

The welfare implications for the NB economy follow immediately from these observations. Price stability is an optimal policy in the NB economy, even though markets are incomplete. Price stability is optimal for two reasons. First, it eliminates the effect of sticky nominal prices. Secondly, even if all prices were flexible, price stability is still optimal because it ensures that the real return on nominal bonds reflect only the efficient fundamental shocks to productivity, and are independent of interest rate shocks. This ensures that households may use nominal bonds to achieve full cross-country risk-sharing. Therefore, price stability supports the first-best allocation.[22]

The discussion of this sub-section may be summarized as follows:

> **Result 2:** a) In the NC economy, international risk sharing is limited, and an optimal monetary rule would in general deviate from price stability; b) In the NBE economy, there is full risk international sharing, and price stability is optimal because it replicates the flexible price equilibrium; c) In the NB economy, price stability is optimal, because it replicates the flexible price equilibrium, and at the same time generates full international risk-sharing.

The generality of these results is discussed below. Note however that if there were no interest rate shocks, then there would be full risk sharing, independent of γ, since in this case the exchange rate would reflect only productivity shocks. But even in this case, monetary policy is important in the sense that nominal exchange rate flexibility is required for nominal bonds to share risk. If one or both countries acted so as to peg the nominal exchange rate, then no risk-sharing at all could be achieved in the NB economy.

4.3 Capital Flows and Exchange Rate Volatility

The previous section showed that a policy of price stability can act so as to enhance international risk-sharing as well as sustain a flexible price equilibrium. What implications does

[22] It is important to note that this result does not depend on our restricted class of monetary rules. Any monetary policy rule that generates full risk sharing can be fully optimal only if it also supports price stability. Even when $\lambda = 0$, an optimal policy using a wider class of monetary rule than (9) will ensure that the nominal exchange rate responds efficiently to productivity shocks, and PPI inflation is zero.

this have for exchange rates and capital flows? Since exchange rates affect the returns on nominal bonds and equity, this question also relates to the issue of how monetary policy should affect the distribution of asset returns.

Table 4 illustrates the implications of each asset market environment for the behavior of the current account (locally equivalent to the trade balance) and the exchange rate. The table shows the variance of the current account and the exchange rate as a function of the underlying interest rate and productivity.

4.3.1 Exchange Rate Volatility

From Table 4 it can be seen that in the NC economy, for both interest rate and productivity shocks, exchange rate variability is lower, the higher is θ, while the same mechanism does not operate in the NBE economy. This is due to the income effects of shocks, causing labor supply to move in the opposite direction to consumption and output, acting so as to stabilize the terms of trade. This channel does not operate in the economy with full risk-sharing across countries. But these effects will partially operate in the NB economy, since risk-sharing is not perfect in that case.

How does exchange rate variability differ across the three different asset market configurations? First, focus on a comparison of exchange rate variability for a given value of γ and σ_m^2. Using the relevant rows of Table 4, the following result can be established:

> **Result 3**: For given values of γ and σ_m^2 exchange rate volatility across regimes satisfies the following inequalities: $var_{t-1}(\Delta S_t)^{NBE} \geq var_{t-1}(\Delta S_t)^{NB} \geq var_{t-1}(S_t)^{NC}$.

The expressions for $var_{t-1}(\Delta S_t)^{NBE} - var_{t-1}(\Delta S_t)^{NB}$ and $var_{t-1}(\Delta S_t)^{NB} - var_{t-1}(\Delta S_t)^{NC}$ are shown in Table 4. Both expressions are positive, for $\theta > 1$. Thus, exchange rate volatility is greatest under the complete markets regime, and lowest in the regime with no risk-sharing at all, with the nominal bond economy lying somewhere in between. Notice from the expression for $var_{t-1}(\Delta S_t)^{NBE} - var_{t-1}(\Delta S_t)^{NB}$, if either type of shock is absent, then exchange rate volatility is equal in the NBE and the NB economy. This follows from the results of the previous section, since with only one type of shock, nominal bonds can achieve full risk-sharing.

Result 3 indicates that increasing the number of assets traded increases exchange rate volatility, for a given monetary rule. But the previous section showed that the monetary rule itself could alter the effective degree of completeness of assets markets. This raises the question of how the stance of monetary policy influences exchange rate volatility.

From inspection of Table 4, it can be seen that under both the NC and NBE economies, a policy of price stability unambiguously reduces exchange rate volatility, since it eliminates the direct component of exchange rate volatility coming from interest rate shocks. Under the NB economy however, the monetary stance affects exchange rate variability both directly through the affect of interest rate shocks and indirectly through altering the composition of the portfolio. The first effect will clearly reduce exchange rate volatility, but from Result 3 the second effect may increase exchange rate volatility, since it moves the NB economy closer to the NBE economy. Again using Table 4, the following may be established:

> **Result 4**: An increase in γ may either increase or reduce exchange rate volatility. In addition, the relationship may not be monotonic.

This result can be verified by looking at a special case of $var_{t-1}(S_t)^{NB}$ where prices are flexible ($\lambda = 0$). In that special case:

$$\left.\frac{\partial var_{t-1}(S_t)^{NB}}{\partial \gamma}\right|_{\lambda=0} \propto -\sigma_m^2(\sigma_A^2\gamma^2(1+\rho-\rho\theta)+\sigma_m^2(1+\rho(\theta-1))^2) \qquad (17)$$

If $\theta > (1+\rho)/\rho$, this expression may be positive. The more important are productivity shocks relative to interest rate shocks, the more likely it is that the expression is positive. Moreover, the relationship may be non-monotonic, since when $\theta > (1+\rho)/\rho$, (17) is more likely to be positive, the higher is γ itself. Since price stability is an optimal monetary policy in, in the NB economy, it follows that an optimal policy may involve either increasing or reducing the volatility of asset returns.

In the more general case however, with some price stickiness, the direct channel of monetary policy on exchange rate volatility becomes more important. In fact, calibration of the general value for $\frac{\partial var_{t-1}(S_t)^{NB}}{\partial \gamma}$ suggests that it is likely to be negative in the range of empirically relevant parameter values.

4.3.2 Capital Flows

It has been shown that monetary policy affects the gross portfolio position in the NB economy. But the monetary rule also impacts on net capital flows. This is described in Table 4. Given that productivity shocks are permanent, in the economy without risk-sharing, a productivity shock has no impact on the current account, since there are no gains from intertemporal consumption smoothing following a productivity shock. Table 4 indeed indicates that under the NC economy, the current account is affected only by interest rate shocks. In comparing the NBE and NC economies for a given monetary policy rule, the volatility of the current account is unambiguously higher in the complete markets case. It is also possible to show that the current account is more volatile in the NB economy than the NC economy, although the comparison between the NB economy and the NBE economy is theoretically ambiguous.[23]

In the NC and NBE economies, Table 4 indicates that a rise in γ always reduces the volatility of the current account, since it tends to eliminate the component of the current account that is due to interest rate shocks. But in the NB economy, a rise in γ also increases the weight put on hedging against productivity shocks in the optimal portfolio. This tends to increase the volatility of the current account, since the more that productivity shocks are hedged, the more the country will engage in trade imbalances as a result of the risk-sharing of these shocks. To illustrate this mechanism, again focus on the special case where $\lambda = 0$. In that case:

Result 5: In the NB economy with $\lambda = 0$, current account volatility is increasing in γ.

[23]For $\lambda = 0$, the volatility of the trade balance is always higher in the NBE economy. But for a high degree of price stickiness, this conclusion may be reversed.

This result may be confirmed by noting from Table 4 that the volatility of the current account is independent of σ_m^2 in both the NC and NBE economies. But in the NB economy, the current account may be then written as:

$$var_{t-1}(CA_t)|_{\lambda=0} = \frac{1}{2}(1-\theta)^2 \left[\frac{\gamma^2 \left(\sigma_A^2\right)^2}{\gamma^2 \sigma_A^2 + \left(1+\rho(\theta-1)\right)^2 \sigma_m^2} \right]. \qquad (18)$$

Expression (18) implies that interest rate shocks reduce the volatility of the current account, since consistent with the previous results, they reduce the usefulness of nominal bonds in supporting risk-sharing. An increase in γ eliminates the effect of these shocks on bond returns and enhances the effectiveness of nominal bonds in risk-sharing. Hence it increases the variability of capital flows.

When $\lambda > 0$, the conventional channel of monetary policy operates. In that case, a policy of price stability may either increase or reduce the volatility of capital flows.

5 Generalizing the results

The analysis above is restricted to a special case, with utility linear in leisure, no home bias in preferences, and permanent productivity shocks. This is necessary only so as to obtain manageable algebraic expressions. The solution procedure also gives solutions for more general cases, but they can be interpreted only through calibration and numerical solutions. But even so, the qualitative results of the paper are unchanged in more general cases. Conceptually, it is straightforward to see why this is so. Even under more general conditions, but remaining within a framework where there exist just productivity and interest rate shocks, a monetary policy which supports the flexible price equilibrium in the NB economy will lead to an endogenous movement towards completeness in financial markets. Therefore, because it eliminates all welfare distortions, this policy must be fully optimal.

With a more general extension of the model, the results would have to be qualified somewhat. For instance, if more shocks are introduced, it is no longer true that price stability facilitates full risk sharing in the NB economy, since eliminating interest rate shocks as a source of variability in bond returns would not allow for complete markets. For example the model can be extended to allow for common shocks to the preference for home vis a vis foreign goods. In that case, price stability does not generate full risk sharing in the NB economy. But price stability is fully optimal in the NBE economy, because with productivity interest rate and preference shocks, setting $\gamma \to \infty$ eliminates the impact of preference shocks on bond returns, and allows a portfolio of equity and nominal bond holdings to support full risk-sharing (an Appendix, available on request describes this model more fully).

Of course more generally, for a wider mix of country-specific shocks, an explicit welfare comparison across alternative monetary rules would be necessary. This would require higher order solutions.[24] Nevertheless, the principle that monetary policy has a role to play in enhancing the efficiency of nominal asset returns would still remain.

6 Conclusion

This paper shows how a simple benchmark two-country sticky-price open-economy macro model can be amended so as to incorporate endogenous portfolio choice. We solve for the optimal portfolio holdings of national equities and nominal bonds, and show how these depend on the magnitude of stochastic shocks, the degree of price stickiness, and the stance of monetary policy. A key result is that a monetary policy of strict price stability is desirable, not just because it sustains the flexible price equilibrium outcome of the real economy, but also because it endogenously generates full international risk-sharing. This argument for price stability holds even in a fully flexible price economy, and arises due to the fact that such a policy maximizes the risk-hedging properties of nominal bond returns.

More generally, our results suggest that while financial globalization alters the environment within which monetary policy operates, it may not alter the fundamental objectives of optimal monetary policy.

[24] In addition, it would be necessary to compute higher order elements of portfolio solutions of the type described by Devereux and Sutherland (2007b)

References

Bacchetta, P., van Wincoop, E., 2000. Trade in nominal assets and net international capital flows. Journal of International Money and Finance 19, 55-72.

Benigno, G., Benigno, P., 2003. Price stability in open economies. Review of Economics Studies 70, 743-764.

Benigno, P., 2001. Price stability with imperfect financial market integration. CEPR Discussion Paper No 2858.

Cole, H.L., and Obsfeld, M., 1991. Commodity trade and international risk sharing: how much do financial markets matter? Journal of Monetary Economics 28, 3-24.

Devereux, M.B., 2004. Should the exchange rate be a shock absorber? Journal of International Economics 62, 359-377.

Devereux, M.B., Saito, M., 2006. A portfolio theory of international capital flows. CEPR Discussion Paper No 5746.

Devereux, M.B., Sutherland, A., 2006. Solving for country portfolios in open economy macro models. CEPR Discussion Paper No 5966.

Devereux, M.B., Sutherland, A., 2007a. Financial globalisation and monetary policy. CEPR Discussion Paper No 6147.

Devereux, M.B., Sutherland, A., 2007b. Country portfolio dynamics. CEPR Discussion Paper No 6208.

Engel, C., Matsumoto, A., 2006. Portfolio choice in a monetary open-economy DSGE model. NBER Working Paper No 12214.

Evans, M., Hnatkovska, V., 2005. International capital flows, returns and world financial integration. NBER Working Paper 11701.

Fergusen, R., 2005. Globalization: evidence and policy implications. Speech at the Association for Financial Professionals Global Corporate Treasurers Forum, San Francisco.

Fisher, R.W., 2006. Coping with globalization's impact on monetary policy. Speech at the Allied Social Science Association Meetings, Boston.

Friedman, M., 1953. The case for flexible exchange rates. In: Friedman, M. Essays in positive economics, University of Chicago Press, Chicago, pp. 157-203.

Ghironi, F., Lee, J., Rebucci, A., 2007. .The valuation channel of external adjustment. NBER Working Paper No 12937

Helpman, E., Razin, A., 1978. A theory of international trade under uncertainty. Academic Press, New York .

King, R. G., Wolman, A.L., 1999. What should the monetary authority do when prices are sticky? In: Taylor, J.B., (Ed.), Monetary policy rules. University of Chicago Press, Chicago, pp. 349-398.

Kollmann, R., 2006. International portfolio equilibrium and the current account. CEPR Discussion Paper No 5512.

Lane, P, Milesi-Ferretti G.M., 2001. The external wealth of nations: measures of foreign assets and liabilities for industrial and developing countries. Journal of International Economics 55, 263-294.

Lane, P, Milesi-Ferretti, G.M., 2006. The external wealth of nations mark II. IMF Working Paper No 06-69.

Obstfeld, M , Rogoff, K., 2002. Global implications of self-oriented macroeconomic policies? Quarterly Journal of Economics 117, 503-535.

Rogoff, K., 2006. Impact of globalization on monetary policy. In: The new economic geography: effects and policy implications. Federal Reserve Bank of Kansas City, Kansas , pp. 265-305.

Svensson, L., 1989. Trade in nominal assets. Journal of International Economics 26, 1-28.

Tille, C., 2005. Financial integration and the wealth effect of exchange rate fluctuations. Federal Reserve Bank of New York Staff Report No 226.

Tille, C., van Wincoop, E., 2007. International capital flows. NBER Working Paper No 12856.

Woodford, M., 2003. Interest and prices. MIT Press, Cambridge.

Table 1 Linear approximation of the model for given $\bar{\alpha}$

Optimal consumption	$E_t(\widehat{C}_{t+1} - \widehat{C}_t) = E_t(\widehat{C}^*_{t+1} - \widehat{C}^*_t)$
Budget constraint	$\widehat{W}_{t+1} = \frac{1}{\beta}\widehat{W}_t + \widehat{Y}_t - \widehat{C}_t - \frac{1}{2}\widehat{\tau}_t + \widetilde{\alpha}'\widehat{r}_{x,t}$
Home output	$\widehat{Y}_t = \frac{1}{2}[\widehat{C}_t + \widehat{C}^*_t - \theta(\widehat{P}_{H,t} - \widehat{P}_t) - \theta(\widehat{P}_{H,t} - \widehat{S}_t - \widehat{P}^*_t)]$
Home inflation	$\pi_{H,t} = \lambda^{-1}[\rho\widehat{C}_t + \frac{1}{2}\widehat{\tau}_t - u_t] + \beta E_t \pi_{H,t+1}$
Foreign inflation	$\pi^*_{F,t} = \lambda^{-1}[\rho\widehat{C}^*_t - \frac{1}{2}\widehat{\tau}_t - u^*_t] + \beta E_t \pi^*_{F,t+1}$
Home monetary rule	$\gamma\pi_{H,t} + m_t = \rho(E_t\widehat{C}_{t+1} - \widehat{C}_t) + E_t[\pi_{H,t+1} + \frac{1}{2}\widehat{\tau}_{t+1} - \widehat{\tau}_t]$
Foreign monetary rule	$\gamma\pi^*_{F,t} + m^*_t = \rho(E_t\widehat{C}^*_{t+1} - \widehat{C}^*_t) + E_t[\pi^*_{F,t+1} - \frac{1}{2}\widehat{\tau}_{t+1} + \widehat{\tau}_t]$

Note: A bar over a variable indicates its value at the approximation point and a hat indicates the log deviation from the approximation point except for $\hat{r}'_{x,t+1} = [\hat{r}_{1,t+1} - \hat{r}_{N,t+1}, \hat{r}_{2,t+1} - \hat{r}_{N,t+1}, ...\hat{r}_{N-1,t+1} - \hat{r}_{N,t+1}]$ and $\widehat{W}_t = W_t/\bar{Y}$. $\pi_{H,t}$ and $\pi_{F,t}$ are the inflation rates of producer price, defined as $\pi_{H,t} = \widehat{P}_{H,t} - \widehat{P}_{H,t-1}$ and $\pi_{F,t} = \widehat{P}_{F,t} - \widehat{P}_{F,t-1}$ and $\lambda = \kappa/\left[(1-\kappa)(1-\beta\kappa)\right]$. $\hat{\tau}_t = \widehat{P}^*_{F,t} + \widehat{S}_t - \widehat{P}_{H,t}$ is the home country terms of trade.

Table 2: Optimal Portfolio Holdings

NB	$\widetilde{\alpha}_{B,NB} = \frac{1}{2}\frac{(\theta-1)}{(1-\beta)}\frac{(\gamma+\lambda)^2\sigma_A^2+[1+\lambda+\rho(\theta-1)(1+\lambda\beta)]\lambda(1-\beta)\sigma_m^2}{(\gamma+\lambda)^2\sigma_A^2+[1+\lambda+\rho(\theta-1)(1+\lambda\beta)](1+\lambda)\sigma_m^2}$
NBE (Bonds)	$\widetilde{\alpha}_{B,NE} = \frac{1}{2}\frac{\lambda(\theta-1)(\phi-1)}{(\theta-1)(1+\lambda\beta)+\lambda(\phi-1)(1-\beta)}$
NBE (Equity)	$\widetilde{\alpha}_{E,NE} = -\frac{1}{2}\frac{1}{1-\beta}\frac{(\theta-1)(1+\lambda\beta)}{(\theta-1)(1+\lambda\beta)+\lambda(\phi-1)(1-\beta)}$

Table 3 risk-sharing across alternative asset market configurations

NC	$var_{t-1}(\widehat{C}_t)$	$= \frac{1}{2}\left[(1+\frac{\rho^2(1-\theta)^2}{(1+\rho(\theta-1))^2})\sigma_A^2 + \frac{\lambda^2}{(\lambda+\gamma)^2}(1+\rho^2(1-\beta)^2\frac{(1-\theta)^2}{(1+\rho(\theta-1))^2})\sigma_m^2\right]$
	$var_{t-1}(\widehat{C}_t - \widehat{C}_t^*)$	$= 2\left[\frac{(1-\theta)^2}{\theta^2}\sigma_A^2 + \frac{\lambda^2}{(\lambda+\gamma)^2}(1-\beta)^2\frac{(1-\theta)^2}{\theta^2}\sigma_m^2\right]$
NB	$var_{t-1}(\widehat{C}_t)$	$= \frac{1}{2}\left[\frac{(\lambda+\gamma)^4\left(\sigma_A^2\right)^2+\Omega\sigma_A^2\sigma_m^2+\lambda^2[1+\lambda+\rho(\theta-1)(1+\beta\lambda)]^2\left(\sigma_m^2\right)^2}{\rho^2\left((\lambda+\gamma)^4\sigma_A^2+(\lambda+\gamma)^2[1+\lambda+\rho(\theta-1)(1+\beta\lambda)]^2\sigma_m^2\right)}\right]$
	$var_{t-1}(\widehat{C}_t - \widehat{C}_t^*)$	$= 2\left[\frac{(1+\lambda\beta)^2(1-\theta)^2\sigma_A^2\sigma_m^2}{(\lambda+\gamma)^2\sigma_A^2+[1+\rho(\theta-1)(1+\beta\lambda)]^2\sigma_m^2}\right]$
NBE	$var_{t-1}(\widehat{C}_t)$	$= \frac{1}{2}\left[\frac{\sigma_A^2}{\rho^2} + \frac{\lambda^2}{(\lambda+\gamma)^2}\frac{\sigma_m^2}{\rho^2}\right]$
	$var_{t-1}(\widehat{C}_t - \widehat{C}_t^*)$	$= 0$

Note: Ω is given by
$\Omega = (\lambda+\gamma)^2\left[(1+\lambda)^2+\lambda^2-2\rho(1-\theta)(1+\lambda\beta)(1+\lambda+\rho(\theta-1)(1+\beta\lambda))\right]$

Table 4 Capital Flows and Exchange Rate variability

NC

$$var_{t-1}(CA_t)^{NC} = \frac{1}{2}(1-\theta)^2 \frac{\lambda^2\beta^2}{(\lambda+\gamma)^2}\sigma_m^2$$

$$var_{t-1}(\Delta S_t)^{NC} = \frac{2}{(1+\rho(\theta-1))^2}\left[\sigma_A^2 + \frac{(1+\rho(\theta-1)+\lambda(1+\beta\rho(\theta-1))^2}{(\lambda+\gamma)^2}\sigma_m^2\right]$$

NB

$$var_{t-1}(CA_t)^{NB} = \frac{1}{2}(1-\theta)^2\left[\frac{(\lambda+\gamma)^4\left(\sigma_A^2\right)^2+\Psi\sigma_A^2\sigma_m^2+\lambda^2[1+\lambda+\rho(\theta-1)(1+\beta\lambda)]^2\left(\sigma_m^2\right)^2}{(\lambda+\gamma)^4\sigma_A^2+(\lambda+\gamma)^2[1+\lambda+\rho(\theta-1)(1+\beta\lambda)]^2\sigma_m^2}\right]$$

$$var_{t-1}(\Delta S_t)^{NB} = 2\left[\frac{(\lambda+\gamma)^4\left(\sigma_A^2\right)^2+\Upsilon\sigma_A^2\sigma_m^2+(1+\lambda)^2[1+\lambda+\rho(\theta-1)(1+\beta\lambda)]^2\left(\sigma_m^2\right)^2}{(\lambda+\gamma)^4\sigma_A^2+(\lambda+\gamma)^2[1+\lambda+\rho(\theta-1)(1+\beta\lambda)]^2\sigma_m^2}\right]$$

NBE

$$var_{t-1}(CA_t)^{NBE} = \frac{1}{2}(1-\theta)^2\left[\sigma_A^2 + \frac{\lambda^2}{(\lambda+\gamma)^2}\sigma_m^2\right]$$

$$var_{t-1}(\Delta S_t)^{NBE} = 2\left[\sigma_A^2 + \frac{(1+\lambda)^2}{(\lambda+\gamma)^2}\sigma_m^2\right]$$

$$var_{t-1}(\Delta S_t)^{NBE} - var_{t-1}(\Delta S_t)^{NB} = \frac{(1+\lambda\beta)^2(1-\theta)^2\sigma_m^2\sigma_A^2}{(1+\rho(\theta-1)+\lambda(1+\beta\rho(\theta-1)))^2\sigma_m^2+(\gamma+\lambda)^2\sigma_A^2}$$

$$var_{t-1}(\Delta S_t)^{NB} - var_{t-1}(\Delta S_t)^{NC} = \frac{(\theta-1)(\lambda+\gamma)^4(2+\rho(\theta-1))\sigma_A^2+\Xi\sigma_m^2\sigma_A^2+\Lambda\sigma_m^2}{(\lambda+\gamma)^2(1+\rho(\theta-1))^2\left[(1+\rho(\theta-1)+\lambda(1+\beta\rho(\theta-1)))^2\sigma_m^2+(\gamma+\lambda)^2\sigma_A^2\right]}$$

Note: Ψ, Υ, Ξ and Λ are given by

$\Psi = \lambda(\lambda+\gamma)^2\left[2(1+\lambda+\rho(\theta-1)(1+\lambda\beta))+\lambda\beta^2\right]$

$\Upsilon = 2(1+\lambda)(\lambda+\gamma)^2(1+\lambda+\rho(\theta-1)(1+\lambda\beta))$

$\Xi = 2(\lambda+\gamma)(1+\lambda+\rho(\theta-1)(1+\lambda\beta))^2+\lambda(1-\beta)$

$\Lambda = \lambda(1-\beta)(1+\lambda+\rho(\theta-1)(1+\lambda\beta))^2[(2+\lambda)(1+\rho(\theta-1))+\lambda(1+\beta\rho(\theta-1)]$

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