HOME BIAS IN PORTFOLIOS AND TAXATION OF ASSET INCOME

by

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March 11, 2001

Abstract. Intuitively, the observed "home bias" in individual portfolios plausibly explains the international capital immobility reported by Feldstein and Horioka (1980) as well as the survival of taxes on capital income. These intuitions are examined in a model where consumers prefer to consume domestically produced goods. The results show that international capital immobility is indeed present in the model: extra domestic savings generate extra investment primarily in the home country. When monetary policy focuses on exchange rate stabilisation random domestic prices cause individuals to heavily invest in domestic equity as a hedge against price fluctuations. However our findings show that the specialisation of equity portfolios does not necessarily provide grounds for the taxation of capital income. While random equity returns facilitate taxes on equity income, as shown in Gordon and Varian (1989) and Huizinga and Nielsen (1997), random consumer prices appear to undermine taxes on capital income.

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There is now extensive evidence that individual investors have a strong tendency to invest in domestic rather than foreign equity.[1] This "home bias" in portfolios can potentially have important implications for economic behavior and economic policy. For one, it suggests that extra savings in a country will be invested primarily at home, consistent with the evidence for a lack of international capital mobility reported in Feldstein and Horioka (1980). In addition, the implied lack of capital mobility may explain the observed taxation of the return to domestic capital. In particular, when capital is fully mobile internationally a tax on domestic capital in a small country does not affect the net–of–tax rate of return available to capital owners and instead would be borne by immobile factors, primarily labor. In this setting, Diamond and Mirrlees (1971) show that such a tax would be dominated by labor income taxes (or consumption taxes) even from the perspective of workers. If capital were not so mobile, however, then capital should bear part of the tax, so that the tax might well be chosen for distributional reasons.

These *presumed* implications of "home bias" can only be judged, however, in the context of some particular model that generates "home bias." The objective of this paper is to choose a plausible explanation for the observed "home bias", and then use a formal model based on this explanation to explore whether the above two implications of "home bias" in fact follow.

The first challenge is that the observed "home bias" is sharply contrary to the conventional forecasts from portfolio models that investors will hold a fully diversified portfolio of equity issued worldwide.[2] One approach to explain "home bias" focuses on the possibility that domestic equity may help domestic investors hedge against other income risks that they inevitably face. For example, Hartley (1986) hypothesizes that the return on publicly traded equity will be negatively correlated with the return on nontraded domestic assets, while Eldor, Pines, and Schwartz (1988) hypothesize that this return will be negatively correlated with domestic labor income. We do not find these theories convincing. To begin with, they depend on a substantial negative correlation between these risks and the return on domestic equity, yet there is no good theoretical reason to expect a stable such correlation — some random events would lead to a negative correlation but others would suggest a positive correlation.[3] In addition, under these stories the forecasted deviation of portfolio

The views expressed are the author's own and do not necessarily reflect those of the ECB or the Eurosystem. We would very much like to thank Soren Bo Nielsen, Teresa Ter-Minassian, and participants in seminars at the Bank of Portugal and Hong Kong School of Science and Technology for comments on an earlier draft. The first author would like to acknowledge financial support from National Science Foundation Grant No. SBR-9422589 during the writing of this paper.

[1] See, for example, Adler and Dumas (1983) and French and Poterba (1991).

[2] See Solnik (1974) for an early formal demonstration.

[3] Bottazzi, Pesenti and van Wincoop (1996) do report a nontrivial negative correlation between profits and the labor share of income, but this is not a direct test of the correlation between share values and wage rates. Pesenti and van Wincoop (1996) find little correlation between the returns on equity and nontraded

choice from full international diversification depends almost proportionately on the size of labor income or ownership of nontraded assets relative to total asset holdings.[4] Since the retired do not need to hedge against random future labor income, for example, they should hold portfolios that are fully diversified internationally. Yet, there is no evidence of such systematic variation in diversification across individuals in the data.

These explanations assume that investors can spend their random income facing non-stochastic consumer prices. In this paper, we instead explore the implications of "home bias" based on a model with random consumer prices. Under plausible assumptions, domestic equity provides a good hedge against domestic price risk, so that random prices lead to specialization in domestic equity.[5] The argument relies on three key assumptions. First, we assume that domestic residents prefer to consume goods produced domestically.[6] If indexed bonds existed, then individuals can hedge against random consumer prices simply by buying indexed bonds. Our second key assumption is that indexed bonds are not available.[7] Third, we assume that the price of domestic capital and domestic consumption goods are closely linked.[8] Given these assumptions, domestic equity provides a hedge against consumer price fluctuations.[9] The hedge is not perfect, given the inherent risk in the return to real capital, but substantial specialization in domestic equity is still forecast.

Under this model, the "home bias" in equity holdings would disappear if monetary policy were used to stabilize domestic prices, allowing exchange rates to absorb any random variation in the relative prices of consumption goods produced in different countries. In particular, indexed bonds now exist automatically, since they are now equivalent to ordinary bonds. Section I provides a formal derivation of the effects of monetary policy on equilibrium portfolio choices, focusing on two extreme cases: (1) monetary policy sta-

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assets.

[4] To see this in the case of a CAPM model, assume that investors in country i earn random labor income $L\tilde{w}_i$, that the return on equity from any country j, denoted $\tilde{s}_j$, is normally distributed with mean g_j and variance σ_j^2, and that the yield on risk–free bonds equals r. For simplicity, assume that the returns on equity are independent across countries, but that the return on domestic equity is correlated with labor income, with a covariance between $\tilde{w}_i$ and $\tilde{s}_i$ equal to ρ. The individual's optimal investment, E_j, in equity from country j then satisfies $E_j = (g_j - r)/(\gamma\sigma^2) - \iota L\rho/(\sigma^2)$, where γ measures the coefficient of absolute risk aversion and where ι equals one when j is the home country and zero otherwise. If investors have constant relative risk aversion, so that γ is inversely proportional to wealth, then the claim follows exactly.

[5] For a survey of past papers exploring the implications of stochastic consumer prices for portfolio diversification, see Branson and Henderson (1985).

[6] Tastes in clothing, food, and product design more generally, differ by country, and domestic firms would have a much easier time keeping track of the trends in domestic tastes. The preference for home goods consumption is commonly referred to as the Armington assumption (following Armington (1969)).

[7] Only a few countries have some form of indexed bonds, among them Australia, Canada, Denmark, France, Ireland, New Zealand, Sweden, the U.S., and the U.K. See, e.g., Bank of England (1996).

[8] Domestic firms can quickly shift between the production of consumption vs. investment goods in response to any change in their relative prices. In equilibrium, the price of existing capital, as reflected in share values, should equal the cost of new investment, e.g. Tobin's q should equal one.

[9] If labor contracts fully insure labor income against variation in consumer prices, as we will assume, then the need to hedge against consumer prices is proportional to financial wealth, implying comparable degrees of portfolio specialization across investors.

bilizes domestic prices, and (2) monetary policy stabilizes the exchange rate. To explain the observed specialization in equity, we must assume that past monetary policies have focused heavily on stabilizing exchange rates.[10]

The bulk of the paper then uses this model to examine whether the initial intuition regarding the implications of "home bias" for capital mobility and tax policy in fact holds, given this particular explanation for "home bias." If "home bias" causes capital immobility and facilitates the taxation of asset income, then we should find that these outcomes arise when monetary policy stabilizes exchange rates but not when it stabilizes domestic prices.

As seen in section II, the model implies that any increase in domestic savings will be invested primarily in domestic capital, consistent with the empirical evidence in Feldstein and Horioka (1980).[11] But this conclusion turns out to hold regardless of the choice for monetary policy, so regardless of whether equity portfolios demonstrate "home bias."

Section III then examines in detail the equilibrium tax rates on capital income under the two alternative monetary policies. Given the presence of uncertainty, the Diamond–Mirrlees (1971) results no longer hold, regardless of the choice of monetary policy. When domestic prices are stabilized, the model forecasts that governments would tax domestic capital, and treat domestic investors more favorably than foreign investors.[12] Most countries do in fact have supplementary taxes on foreign investors in domestic shares.

When domestic prices are stochastic, in contrast, the case for capital income taxes and for subsidies to domestic residents are both much weaker. Whether positive tax and subsidy rates are implied depends on parameter values. Now, foreign investors hold fewer domestic shares, and their demand for shares is more elastic than in the case when domestic prices are stabilized, implying less gain from taxing foreign investors. In addition, capital income taxes result in an inefficient reallocation of risk from foreign to domestic shareholders.[13] Therefore, taxation of asset income is more difficult under monetary policies that lead to more specialized equity portfolios, contrary to the initial intuition.

Section IV provides a brief summary of the key results.

I. Portfolio Specialization in an Open Economy

We examine an infinitely–lived world economy containing N countries. The key assumption of the model is that consumers prefer to consume domestically produced goods. For simplicity of notation, we explore the extreme assumption that they consume *only* domestic goods. Denote the rate of consumption at time t by consumers in country i by

[10] For a survey of the role of the European Monetary System in stabilizing exchange rates see, for example, Giavazzi and Giovannini (1989) and Gros and Thygesen (1992).

[11] In fact, when exchange rates are stabilized the model forecasts that the fraction of portfolios invested in domestic equity will equal the fraction of extra domestic savings invested in domestic capital.

[12] These results correspond to those in Gordon–Varian (1989) and Nielsen (1995), and reflect primarily an optimal tariff role for tax policy. The previous papers ignored exchange rate and domestic price uncertainty, however.

[13] Risk premia are not equated initially across investors, since there are not separate financial securities allowing trade in both the random real return to equity and random relative consumer prices.

C_{it}, and the resulting flow of utility they get at time t by $U(C_{it})$. Specifically, assume that

$$U(C_{it}) = \frac{C_{it}^{1-\gamma}}{1-\gamma}, \tag{1}$$

where $\gamma > 0$ to capture risk aversion. The present value of their expected utility equals

$$W_i = \mathrm{E}_0 \int_0^\infty e^{-\delta t} U(C_{it}) dt. \tag{2}$$

Individuals' in country i start with assets A_{it} at date t, and can invest these assets in bonds and stocks from each of the other countries, where B_{ijt} and S_{ijt} denote holdings by individuals from country i in bonds and stocks respectively from country j at date t. The rate of return on each bond, B_{ijt}, is assumed to be nonstochastic in units of the local currency, so that[14]

$$\frac{dB_{ijt}}{B_{ijt}} = r_j dt. \tag{3}$$

The return on stocks in contrast is stochastic in units of the local output, and follows the stochastic process:

$$\frac{dS_{ijt}}{S_{ijt}} = g_j dt + \sigma_j dz_j. \tag{4}$$

For simplicity, we assume that the returns from equity invested in different countries are uncorrelated.[15] For now, we will assume that the parameters in equation (4) do not depend on the aggregate demand for equity from any country j, implying a horizontal supply curve for real capital in any country j.

To express the value of an investor's portfolio in units of domestic output so as to measure its rate of return in real terms, we need to correct for exchange rate movements and changes in the price of domestic output. Let e_{jt} equal the number of units of some hypothetical base currency that can be purchased by a unit of country j's currency at date t, and let p_{jt} equal the domestic price of a unit of country j's output. In general, both the exchange rate and the price, p_{jt}, can evolve stochastically over time. We assume that the price for any country j's output in units of the base currency evolves according to an exogenous stochastic process,[16] so that

$$\frac{d(e_{jt} p_{jt})}{e_{jt} p_{jt}} = \eta_j dt + \theta_j dz_j^e. \tag{5}$$

[14] For simplicity, we assume that interest rates do not change over time.

[15] Adler and Dumas (1983) find that the correlations in the returns to equity portfolios from different countries are in fact very low, though Iwaisako (1996) reports evidence that large negative shocks tend to be more correlated across countries. Our results on the extent of portfolio diversification are unaffected by common risks and depend simply on the size of the idiosyncrasy shocks to equity returns.

[16] By making this process exogenous, we intentionally eliminate the possibility that monetary or fiscal policies can be used to affect the terms of trade and therefore substitute for explicit tariffs.

For simplicity, we assume that the output prices in the various countries, measured in terms of the base currency, are statistically independent both from each other[17] and from the return to equity.[18]

In studying the potential impact of monetary policy on the equilibrium, we will focus on two special cases. In the first, each country stabilizes the domestic price of its own output, so that p_{jt} is nonstochastic and all relative price movements are captured by exchange rate movements. For simplicity of notation in this case, we set $p_{jt} = 1$ for all j. Under these assumptions,

$$\frac{d(e_{jt}p_{jt})}{e_{jt}p_{jt}} = \frac{de_{jt}}{e_{jt}} = \eta_j dt + \theta_j dz^e_j. \tag{5a}$$

In the second, all exchange rates are nonstochastic so that domestic output prices instead become stochastic and evolve according to[19]

$$\frac{d(e_{jt}p_{jt})}{e_{jt}p_{jt}} = \frac{dp_{jt}}{p_{jt}} = \eta_j dt + \theta_j dz^e_j. \tag{5b}$$

In allocating their real wealth, individuals in country i face the budget constraint[20]

$$A_i = \frac{\sum_j e_j(B_{ij} + p_j S_{ij})}{e_i p_i}. \tag{6}$$

Let $b_{ij} \equiv e_j B_{ij}/(e_i p_i A_i)$ equal the fraction of these assets that individuals from country i invest in bonds from country j, let $s_{ij} \equiv e_j p_j S_{ij}/(e_i p_i A_i)$ be the fraction invested in that country's equity, and let $f_{ij} \equiv b_{ij} + s_{ij}$ denote the fraction invested in any securities issued in country j. Individuals choose these portfolio fractions at each point in time as well as their consumption rate to maximize their expected utility as defined in equation (2). By Ito's lemma, the optimization problem can be expressed by[21]

$$0 = \max_{\{C,b,s\}} E_0 \Big\{ U(C_i) - \delta W(A_i) + W'(A_i)dA_i + .5W''(A_i)dA_i^2 \Big\}. \tag{7}$$

[17] Under this assumption, if exchange rates but not prices are stochastic, then the implied variance–covariance matrix of conventional measures of the exchange rate for any country j relative say to the U.S. dollar (denoted by e_{ju}) will satisfy: $\mathrm{var}(e_{ju}) = \theta_j^2 + \theta_u^2$ and $\mathrm{cov}(e_{iu}, e_{ju}) = \theta_u^2$. Therefore, our assumptions simply imply equal off–diagonal elements in this matrix.

[18] An earlier draft allowed for a nonzero correlation with the return to equity, and few insights of interest resulted.

[19] Note that we implicitly assume that domestic prices are fully flexible, eliminating any of the macro disturbances caused by sticky prices. To the extent that such disturbances exist, there should be a stronger correlation between the underlying market clearing prices and equity returns.

[20] Since the return on equity was measured in units of domestic *output*, to determine its value in units of the local currency we need to multiply by p_{jt}. For simplicity of notation, we will drop the subscript t unless it seems important for the interpretation.

[21] We make use of various results in the stochastic calculus summarized in Merton (1990) in the following derivations.

Here, dA_i represents the change in the individual's real wealth over time. Decisions are made subject to the individual's budget constraint that $\sum_j(b_{ij}+s_{ij})=1$. In addition, we assume that the aggregate supply of bonds from each country is zero, so that $\sum_i B_{ij}=0$.

Equilibrium When Domestic Prices are Stabilized

By Ito's lemma, the stochastic differential of equation (6) under the above assumptions equals

$$\frac{dA_i}{A_i}=\sum_j f_{ij}\frac{de_j}{e_j}+\sum_j s_{ij}\frac{dS_j}{S_j}+\sum_j b_{ij}\frac{dB_j}{B_j}-\frac{de_i}{e_i}+$$

$$.5\left(2(1-f_{ii})\left(\frac{de_i}{e_i}\right)^2\right)-\frac{C_i}{A_i}. \tag{8}$$

Using equations (3), (4), and (5a), the expected value of this differential equals

$$E_t\frac{dA_i}{A_i}=\sum_j(r_j+\eta_j)b_{ij}+\sum_j(g_j+\eta_j)s_{ij}-\eta_i+(1-f_{ii})\theta_i^2-\frac{C_i}{A_i}. \tag{8a}$$

The expected variance of the net change in real assets, by Ito's lemma, satisfies

$$E_t\frac{dA^2}{A^2}=\sum_j\sigma_j^2s_{ij}^2+\sum_j f_{ij}^2\theta_j^2+(1-2f_{ii})\theta_i^2. \tag{9a}$$

At the optimal portfolio, increasing s_{ij} and decreasing b_{ij} to compensate has no effect on utility at the margin, implying that[22]

$$g_j-r_j=\gamma s_{ij}\sigma_j^2 \tag{10a}$$

for all j, implying a conventional expression for the risk premium on equity. Similarly, at the optimal allocation, increasing b_{ij} and decreasing b_{ii} to compensate also has no effect on utility at the margin, implying that

$$(r_i+\eta_i)-\gamma f_{ii}\theta_i^2=(r_j+\eta_j)-\gamma f_{ij}\theta_j^2+(1-\gamma)\theta_i^2. \tag{11}$$

The last term in this equation captures two separate effects of variability in the value of the domestic currency. For one, this variability raises the expected rate of return on foreign security holdings,[23] in itself reducing the attractiveness of investing in domestic securities. However, this variability also makes holdings of foreign securities more risky, a risk that is avoided by investing at home.

What are the implications of these first–order conditions for the equilibrium portfolio choice? Consider the simple case where countries are symmetric, so that $r_j=r$, $g_j=g$,

[22] We make use of a standard result here that $AW''(A)/W'(A)=-\gamma$ in the equilibrium to such a model.

[23] $E(1/e_i)$ is increasing in the variability of e_i by Jensen's inequality.

$\sigma_j = \sigma$, $\theta_j = \theta$, and $\eta_j = \eta$. Here, after some algebra the resulting first–order conditions can be shown to imply that $s_{ii} = s_{ij}$ for all j, implying full diversification in equity holdings. In addition, they imply that $b_{ii} = b_{ij} + (\gamma - 1)/\gamma$. If $\gamma = 1$, so that $U(C) = \log(C)$, then investors own equal amounts of bonds from each country as well. Empirical estimates[24] of γ suggest, however, that $\gamma >> 1$, implying that $b_{ii} > b_{ij}$. In the limit as γ grows without bound, $b_{ii} \approx b_{ij} + 1$ implying that $s_{ij} + b_{ij} = 0$ for $j \neq i$ — investors would be fully hedged against exchange rate fluctuations.

Equilibrium When Exchange Rates are Stabilized

How does the equilibrium portfolio change when monetary policy instead stabilizes exchange rates? Consider first what happens if indexed bonds are made available, so that the return to bonds described by equation (3) is measured in units of domestic *output* rather than the domestic currency. Now equation (6) becomes

$$A_i = \frac{\sum_j e_j p_j (B_{ij} + S_{ij})}{e_i p_i}. \qquad (6a)$$

Given equation (6a), the choice of a monetary rule has no effect on the equilibrium. The prior results therefore continue to hold.

Few countries have indexed bonds, however.[25] Unindexed bonds fail to provide any hedge against consumer price fluctuations — their return in fact is nonstochastic, as measured in units of the base currency. Equity, though, provides some hedge against price fluctuations, given the assumption that the value of equity changes proportionately with the value of domestic output, everything else equal. But the return to equity is still risky, so unlike indexed bonds it does not provide a perfect hedge.

Consider how the equilibrium changes if in fact no countries have indexed bonds. When all bonds earn a nonstochastic rate of return in their local currency, and all exchange rates are fixed, bonds from each country become perfect substitutes, so that $r_j = r$ for all j. The stochastic differential of equation (6) now becomes

$$E_t \frac{dA_i}{A_i} = \sum_j r b_{ij} + \sum_j (g_j + \eta_j) s_{ij} - \eta_i + (1 - s_{ii})\theta_i^2 - \frac{C_i}{A_i}. \qquad (8b)$$

The expected variance in the net change in real assets becomes

$$E_t \frac{dA_i^2}{A_i^2} = \sum_j s_{ij}^2 (\sigma_j^2 + \theta_j^2) + (1 - 2s_{ii})\theta_i^2. \qquad (9b)$$

24 See, e.g. Engel (1994).

25 An interesting question is why, since the model implies that indexing the return on bonds raises expected utility in a country. Certainly, existing price indices are imperfect, e.g. due to their lack of correction for quality change, but that does not seem a sufficient explanation. Perhaps, a market cannot easily function due to substantial inside information about innovations to these existing price indices, for example in a large firm that has a nontrivial impact on the index.

Borrowing to finance an extra unit of equity of country j should leave utility unchanged in equilibrium, implying that

$$g_j + \eta_j - r = \gamma s_{ij}(\theta_j^2 + \sigma_j^2), \tag{10b}$$

for $j \neq i$. By comparing equations (10a) and (10b) we see that stabilising the exchange rate rather than domestic prices has important effects on the relative attractiveness of foreign equity and foreign bonds. Previously, borrowing locally to buy foreign equity provided a full hedge against exchange rate risks. But when domestic prices instead are stochastic, only domestic equity is affected by fluctuations in local prices, so that debt financed purchases of equity on net raise the investor's exposure to relative price risk. Offsetting this new cost to equity investments, however, any expected appreciation in the value of foreign goods raises the rate of return on equity but not bonds issued in the country.

The analogous first–order condition for securities of country i is

$$g_i + \eta_i - r = \gamma s_{ii}(\theta_i^2 + \sigma_i^2) + \theta_i^2(1 - \gamma). \tag{10c}$$

Comparing equations 10a and 10c, we find that fixed exchange rates also have strong effects on equilibrium holdings of domestic securities. Domestic bonds no longer protect the investor from fluctuations in the value of domestic goods — only domestic equity provides a hedge against fluctuations in the cost of consumer goods. The explanation for the term $\theta_i^2(1-\gamma)$ is therefore the same as in equation (11).

Under the same symmetry conditions as before, we find that

$$s_i = s_j + \frac{\theta^2(\gamma - 1)}{\gamma(\theta^2 + \sigma^2)}. \tag{12}$$

When $\gamma = 1$, equity holdings are fully diversified. If $\gamma > 1$, however, investors tend to invest relatively more in domestic equity. For plausible parameter values, the second term on the right–hand side of equation (12) can imply substantial specialization of portfolios in domestic equity. Therefore, the model provides an explanation for substantial "home bias" as long as actual monetary policies focus heavily on stabilizing exchange rates.

II. be "Price Stability, Exchange Rate Stability and International Capital Mobility

What do these models imply about the degree of international capital mobility? In particular, if savings were to rise in country k, implying an increase in A_k, what will happen to real investment in each country? Feldstein and Horioka (1980) find empirically that a dollar of extra savings undertaken in a particular country raises the capital stock in that country by around 0.6 to 0.8 dollars. What does the model forecast, and how does this forecast vary with the assumed monetary policy?

Consider the implications of an increase in A_k in country k, for simplicity starting from a symmetric equilibrium in which $A_j = A^*$, $r_j = r$, $\eta_j = \eta$, $g_j = g$, $\sigma_j = \sigma$, $\theta_j = \theta$ and $e_j p_j = 1$ for all j. In each model, investors in country k would want to expand their existing portfolios proportionately as long as market prices do not change. If prices do not change, then the fraction of the additional assets invested in real capital in country j simply equals s_{kj}. But in general, prices will be forced to change.

Consider first the case when monetary policy stabilizes exchange rates. Assuming symmetry, investors hold no debt. When their assets increase, investors in country k would like to expand their equity holdings proportionately. Given the assumed horizontal supply curve for equity, no price adjustments are needed in equilibrium. Therefore, $\partial S_k/\partial A_k = s_{kk}$. The forecasted fraction of additional domestic savings invested in domestic capital equals the fraction of the equity portfolios of domestic residents invested in domestic equity. For example, if 80% of equity portfolios are invested in domestic equity, then 80% of additional domestic savings is invested in new domestic capital, easily rationalizing the Feldstein and Horioka (1980) estimates.

What happens if monetary policy instead stabilizes the domestic price level? Now, when A_k increases, investors will try to borrow more abroad and to invest more in bonds at home. In equilibrium, this will drive up r_j for $j \neq k$, and drive down r_k. As a result, investment will go up by less than s_{kj} in any foreign country, and by more than s_{kk} at home. Since, given symmetry, $s_{kj} = s_{kk}$, this implies some capital immobility.

To solve for the specific changes that result, we first differentiate equations (10a) and (11) with respect to A_k:

$$\frac{\partial s_{ij}}{\partial A_k} = -\frac{1}{\gamma\sigma^2}\frac{\partial r_j}{\partial A_k}, \quad \text{and} \tag{13}$$

$$\frac{\partial f_{ij}}{\partial A_k} = \frac{\partial f_{ii}}{\partial A_k} + \frac{1}{\gamma\theta^2}\left[\frac{\partial r_j}{\partial A_k} - \frac{\partial r_i}{\partial A_k}\right]. \tag{14}$$

Summing equation (14) over j, substituting equation (13), and making use of the facts that $f_{ij} = b_{ij} + s_{ij}$ and $\sum_j f_{ij} = 1$, we find:

$$\frac{\partial b_{ii}}{\partial A_k} + \left(1 + \frac{\sigma^2}{\theta^2}\right)\frac{\partial s_{ii}}{\partial A_k} = \frac{\sigma^2}{N\theta^2}\sum_j \frac{\partial s_{ij}}{\partial A_k}. \tag{15}$$

Equation (14) in fact implies that the left–side of equation (15) remains unchanged if b_{ii} and s_{ii} are replaced by b_{im} and s_{im}, for any m.

Note that

$$\sum_i \frac{\partial B_{im}}{\partial A_k} = b_{km} + \sum_i A_i \frac{\partial b_{im}}{\partial A_k} = 0, \tag{16a}$$

$$\sum_i \frac{\partial S_{im}}{\partial A_k} = s_{km} + \sum_i A_i \frac{\partial s_{im}}{\partial A_k}, \qquad \text{and} \tag{16b}$$

$$\sum_i \sum_j \frac{\partial S_{ij}}{\partial A_k} = \sum_j s_{kj} + \sum_i \sum_j A_i \frac{\partial s_{ij}}{\partial A_k} = 1. \tag{16c}$$

Weighting equation (15) by A_i, summing over i, and making use of equations (16a,b,c), we find that

$$\frac{\partial S_i}{\partial A_k} = s_{ki} + \frac{\theta^2 b_{ki} + \sigma^2 \sum_j b_{kj}/N}{\theta^2 + \sigma^2}. \tag{17}$$

The left–hand side of this equation represents the change in the real capital stock in any country i that results from additional savings in country k. The right–hand side equals the extra investment that would occur ignoring price changes (s_{ki}) plus a correction term measuring the effects of price changes. This correction term will be positive when $i = k$, and negative otherwise. In the symmetric case, $\partial S_k/\partial A_k = \theta^2(\gamma - 1)/[\gamma(\theta^2 + \sigma^2)]$. As seen from equation (12), this yields the same forecast as found when monetary policy instead stabilizes the exchange rate. Surprisingly, the degree of capital mobility is not affected by the choice of monetary policy and the associated degree of portfolio specialization.

III. Implications of Stochastic Prices for Taxes on Asset Income

Past research papers ignoring the implications of risk argue that taxes on portfolio income in an open economy are either infeasible or dominated by other available tax instruments. A residence–based tax, for example, is viewed to be infeasible because governments have no effective mechanism available to monitor the foreign–source earnings of domestic investors.[26] A source–based tax on interest payments made by domestic firms and financial intermediaries has also proven to be infeasible, given that accounts denominated in the same currency with a foreign financial intermediary would be effectively a perfect substitute yet avoid the source–based tax.[27]

While a source–based tax on the earnings accruing to capital physically located in the country should be feasible, this line of research suggests that it would be dominated by other available taxes. In response to a source–based tax on capital, investors will shift capital abroad until after–tax returns are again equated across countries. If a country is small relative to world capital markets and all investments are perfect substitutes, then the after–tax rate of return available to investors on the world market would not be affected when one country imposes such a source–based tax. Firms would continue to locate in that country only if domestic wage rates drop by enough to compensate for the increase in the before–tax cost of capital. The incidence of the tax is therefore entirely on workers. As a result, the tax is dominated by direct taxes on workers — in both cases the tax is borne entirely by workers, discouraging their labor supply, but the capital income tax creates an extra excess burden by discouraging capital investment in the country.

A. Tax Policy in a Nonstochastic Setting

A simple two–period, one–good, small open economy model capturing these arguments can be described as follows, to set the context for our analysis of tax policy given un-

[26] Governments can require domestic firms and financial intermediaries to report the identity of all recipients of interest and dividend income, but cannot impose equivalent requirements on foreign firms and financial intermediaries. Bilateral information–sharing agreements are not a substitute, since individuals can simply route their funds through a third country that assures anonymity. That is, residents can avoid a residence–based tax even on their investments in domestic assets simply by routing their funds through a third country, so that the owner of the domestic equity appears to be foreign according to the available information.

[27] Germany and the Netherlands for example both attempted to impose a source–based tax on interest income accruing in domestic bank accounts, and found that a large fraction of these domestic accounts were quickly shifted abroad.

certainty. There are two types of individuals in this economy: investors and workers.[28] Investors start out with assets A which they can either consume in the first period or invest at a rate of return r. Assume that income accruing to capital physically invested in the country is subject to a tax at rate τ_r in the second period. Since domestic assets are a perfect substitute for foreign assets which earn a rate of return r^*, and since domestic taxes on *foreign* assets by assumption are infeasible, the after–tax rate of return to domestic assets must equal r^* (i.e. $r = r^*/(1-\tau_r)$).

Workers start out in the first period with assets A_w. In the second period, these individuals can work as much as they wish at a gross–of–tax wage rate w. Labor income is subject to a tax at rate τ_w. Assume for simplicity that A_w is small enough that the workers would want to borrow if they could against their future earnings, but that such uncollateralized loans are unavailable. The indirect utility of investors and workers can be expressed by $V^1(r^*)$ and $V^2(w(1-\tau_w))$ respectively.

The country is small relative to the world market, so takes both output prices and r^* as given. Let the output price be the numeraire. Firms produce with a constant–returns-to-scale technology, and must break even to be willing to locate in the country. The firm's unit cost must equal the output price, so that $c(w, r^*/(1-\tau_r)) = 1$. For firms to continue to break even when τ_r increases, we infer that $\partial w/\partial \tau_r = -(K/L)r^*/(1-\tau_r)^2$.

We assume a conventional measure of social welfare:

$$W = V^1(r^*) + V^2(w(1-\tau_w)) + \lambda(\tau_w wL + \tau_r r^* K/(1-\tau_r)),$$

where λ measures the social value of the expenditures financed by tax revenue. Given the pretax incomes of investors vs. workers, assume that the government would like to redistribute towards workers.

Consider the impact on social welfare of a marginal increase in τ_r and a compensating drop in τ_w chosen to leave the net–of–tax wage unchanged, starting from an initial equilibrium with $\tau_r = 0$. If welfare rises, then the optimal value of τ_r is positive.

The required compensating drop in τ_w must satisfy $\partial\tau_w/\partial\tau_r = [(1-\tau_w)/w]\partial w/\partial\tau_r$. Since the net–of–tax wage does not change, the labor supply and utility of workers are left unaffected by these combined tax changes. Investors also face an unchanged factor price. The impact on social welfare therefore depends only on what happens to government revenue. In fact,

$$\frac{\partial W}{\partial \tau_r} = \lambda\left[-\frac{r^*K}{(1-\tau_r)^2} + \frac{r^*K}{(1-\tau_r)^2} + \frac{\tau_r r^*}{1-\tau_r}\frac{\partial K}{\partial \tau_r}\right].$$

Evaluated at $\tau_r = 0$, we find that government revenue and therefore welfare is unaffected at the margin by this tax change. Note that the extra revenue collected from capital income (before any behavioral changes) must be paid out in full to workers if their after–tax wage is to be left unaffected by the combined policies.

[28] This artificial distinction is introduced to simplify the discussion, by eliminating any feedback from rates of return on different assets unto labor supply decisions.

We conclude that the optimal value of τ_r is zero (assuming the second–order conditions are satisfied). Only labor income taxes will be used to finance government expenditures. This is true regardless of the strength of the distributional preference in favor of workers.

B. Tax Policy When Exchange Rates are Stochastic

To what degree do these results change when uncertainty in relative prices is present, assuming each country remains small relative to the world capital market? Will the answer be affected by the choice of monetary policy? To begin with, investments in different countries are no longer perfect substitutes when country–specific uncertainty is introduced, so the above argument no longer applies.

To examine what in fact happens to optimal tax policies, we need to add some more structure to the initial model. As in the two–period model, we assume for simplicity that there are two types of individuals. The situation of investors was described previously. Workers are assumed to supply labor each period at a nonstochastic before–tax real wage rate w, so that (following the labor contracting literature) capital owners bear all the risk within the firm. Workers choose how much to work, L, given that the resulting labor income is subject to tax at rate τ_w. Their resulting utility equals $\int_0^\infty U^w(C^w_{it}, L_{it})e^{-\delta t}dt$, where $C^w_{it} = w(1-\tau_w)L_{it}$.[29]

If firms in country i hire L_i units of labor and have K_i units of capital, then their rate of profit equals

$$\pi = p_i[f(K_i, L_i) - wL_i](1-\tau_r)dt + \phi_i p_i f(K_i, L_i)(1-\tau_r)dz_i$$

for some measure of the amount of uncertainty, ϕ_i, facing the firms.[30] If the market value of the shares issued by firms in country i is S_i, then equation (4) implies that

$$g_i \equiv p_i[f(K_i, L_i) - wL_i](1-\tau_r)/S_i \tag{18}$$

and

$$\sigma_i \equiv \phi_i p_i f(K_i, L_i)(1-\tau_r)/S_i. \tag{19}$$

Firms can buy capital domestically each period and will choose to do so until the market values the return from an extra dollar of capital at just a dollar.

Government revenue, R_i, is now stochastic. Its real value, measured relative to the domestic price level, equals

$$R_i = \left[\tau_w wL_i + \frac{\tau_r}{1-\tau_r}g_i S_i\right]dt + \frac{\tau_r}{1-\tau_r}\sigma_i S_i dz_i. \tag{20}$$

[29] To simplify the analysis further, we continue to assume that these workers do not own any financial assets, e.g. fixed costs to setting up a financial account are large per capita per worker but trivial per capita for investors.

[30] Since wage payments have been assumed to be nonstochastic, they do not appear in the measure of the uncertainty facing the firm.

The government receives the same risk as it would from owning $\tau_r S_i/(1-\tau_r)$ privately purchased shares. If government expenditures are also stochastic, then we face the complication of how much risk should be reallocated from private to government expenditures, and the implications of this for optimal tax rates. To avoid having this issue affect the analysis of the optimal tax structure, we assume that the government keeps a nonstochastic revenue stream by transferring the risk in its tax revenue to domestic investors while compensating them by enough to make these investors indifferent to the transfer.[31] This compensated transfer is equivalent to giving domestic investors $\tau_r S_i/(1-\tau_r)$ shares in exchange for the same value of domestic bonds. The remaining government revenue, R_i^n, is nonstochastic and equals

$$R_i^n = \left[\tau_w w L_i + \frac{\tau_r}{1-\tau_r} r_i S_i\right] dt.$$

The government chooses its policies to maximize the following objective function:

$$W = \mathrm{E}_0 \int_0^\infty \left[U^w(C_{it}^w, L_{it})dt + U(C_{it}) + \lambda R_{it}^n\right] e^{-\delta t} dt. \tag{21}$$

Consider the same type of policy experiment described in the context of the two–period model. In particular, consider as before the impact of a marginal increase in τ_r offset by a drop in τ_w chosen so as to leave the net–of–tax wage rate and therefore labor supply and the utility of workers unchanged. The question is whether such a tax change raises welfare, starting from $\tau_r = 0$.

In the two–period model, this policy change had no impact on the welfare of investors. The two–period model also implied that the extra tax revenue from capital income ignoring behavioral changes would be fully offset by the compensating drop in tax payments by workers. To see how results are affected by the introduction of uncertainty, consider first the determinants of a firm's market value. To solve for this market value, we need to aggregate the first–order conditions for s_{ji} across all purchasers of the shares issued in country i in order to derive the rate of return required by the market. Multiplying equation (10a) by A_j and summing over j gives

$$A(g_i - r_i) = \gamma\sigma_i^2 \left(\sum_j S_{ji} + \frac{\tau_r S_i}{1-\tau_r}\right) = \gamma\sigma_i^2 \frac{S_i}{1-\tau_r}, \tag{22}$$

where $A \equiv \sum_j A_j$ and $S_{ji} \equiv s_{ji}A_j$, and where $\tau_r S_i/(1-\tau_r)$ represents the risk transferred to domestic investors by the government. The second equality follows from the fact that $S_i = \sum_j S_{ji}$. Equation (22) can then be reexpressed in a somewhat more conventional form:

$$g_i = r_i + \frac{\gamma}{A}\mathrm{cov}\Big(\sigma_i dz_i, dZ_i\Big), \tag{23}$$

[31] The transfer could take the form of random government expenditures on goods that are a perfect substitute for the private consumption of investors. Alternatively, we can simply assume directly that the government uses the risk premium of domestic investors when calculating the certainty–equivalent value of government revenue.

where $dZ_i = \phi p_i f(K_i, L_i) dz_i$.

Firms in country i will invest until $\partial S_i/\partial K_i = 1$, since a unit of capital costs $p_i = 1$. In doing so, each firm would use equation (23) to evaluate the impact of investment on firm value, taking as given the aggregate risks, dZ_i, faced by the economy as a whole. Given equations (18) and (19), we then find after simplifying that investment continues until

$$f_K = \frac{r_i}{(1-\tau_r)D}, \tag{24}$$

where

$$D \equiv 1 - \frac{\gamma}{A}\text{cov}(\phi dz_i, dZ_i).$$

Equation (23) can also be used to solve for the impact of a marginal change in τ_r on the equilibrium wage rate, w. Firms will continue to break even only if the wage rate drops by enough so that firm value, S_i, still equals the set–up costs of the firm, K_i. Given equations (18), (19), and (24), the assumption of constant returns to scale, the assumption that the wage rate is nonstochastic, and the envelope condition for K_i and L_i, we find that

$$(1-\tau_r)L\frac{\partial w}{\partial \tau_r} = -\frac{r_i S_i}{(1-\tau_r)} - S_i\frac{\partial r_i}{\partial \tau_r} - \frac{\gamma}{A}\text{cov}\Big(\sigma_i dz_i, dZ_i\Big)\left(\frac{f_K K}{f}\right)\frac{\partial K_i}{\partial \tau_r}. \tag{25}$$

If the net–of–tax wage is to remain unchanged, the required change in τ_w satisfies $\partial\tau_w/\partial\tau_r = [(1-\tau_w)/w](\partial w/\partial \tau_r)$. The impact on government tax revenue of a marginal change in τ_r combined with this compensating adjustment in τ_w, evaluated at $\tau_r = 0$, then can be shown to equal

$$\frac{\partial R_i^n}{\partial \tau_r} = -\left[S_i\frac{\partial r_i}{\partial \tau_r} + \frac{\gamma}{A}\text{cov}\Big(\sigma_i dz_i, dZ_i\Big)\left(\frac{f_K K}{f}\right)\frac{\partial K_i}{\partial \tau_r}\right]dt. \tag{26}$$

Previously, the interest rate was fixed and there was no risk premium. Now both terms are nonzero.[32]

To evaluate the first term in equation (26), we need an expression for $\partial r_i/\partial \tau_r$. To obtain this, we aggregate equation (12) over investors from each country j, comparing their return on bonds from countries i vs. j. Weighting each first–order condition by A_j, summing over j, and taking account of the fact that $\sum_j A_j f_{ji} = S_i$,[33] we find that

$$r_i + \eta_i = r_j + \eta_j + \frac{\gamma}{A}\Big[S_i\theta_i^2 - S_j\theta_j^2\Big] + (1-\gamma)\frac{A_i\theta_i^2 - A_j\theta_j^2}{A}. \tag{27}$$

Note that domestic interest rates can be affected by domestic policies even in a small open economy.[34] In particular, τ_r causes S_i to change. Since $S_i = K_i$ and investment falls in

[32] In the related analyses by Gordon and Varian (1989) and Nielsen (1995) in which prices were assumed to be nonstochastic, taxes did not affect interest rates but did affect the risk premium as occurs here.

[33] Given that the net supply of bonds from country i to the world economy is zero, but $\tau_r S_i/(1-\tau_r)$ of these bonds are held by the government in country i, we infer that $\sum_j A_j f_{ji} = S_i$.

[34] See Solnik(1974) for a similar result.

response to the tax change, r_i falls. Therefore, the first term in equation (26) represents an increase in tax revenue.

Raising τ_r naturally also causes K_i to fall. Therefore, we conclude that tax revenue increases in response to the combined tax changes. To judge whether the desired value of τ_r is positive, however, we need to examine not only the effect on government tax revenue but also the implications for the utility of domestic investors. To judge the extent of fiscal spillovers, we also need to look at the impact of the tax changes on the utility of foreign investors. In the two–period model, neither group of investors was affected by the proposed tax change, but this is no longer true. Now, the impact on the utility of domestic investors is proportional to

$$A_i \left[b_{ii}^* \frac{\partial r_i}{\partial \tau_r} + s_{ii}^* \frac{\partial g_i}{\partial \tau_r} - \gamma s_{ii}^{*2} \sigma_i \frac{\partial \sigma_i}{\partial \tau_r} \right], \tag{28}$$

where $s_{ii}^* \equiv s_{ii} + \tau_r S_i/(A_i(1-\tau_r))$, $b_{ii}^* \equiv b_{ii} - \tau_r S_i/(A_i(1-\tau_r))$, and where the derivative $\partial g_i/\partial \tau_r$ implicitly includes the effects of the compensating change in τ_w. Given equations (10a) and (23), this expression can be rewritten as

$$A_i \left[f_{ii} \frac{\partial r_i}{\partial \tau_r} + s_{ii}^* \frac{\gamma}{S_i A} \mathrm{cov}\Big(\sigma_i dz_i, dZ_i\Big) \left(\frac{f_K K}{f} \right) \frac{\partial K_i}{\partial \tau_r} \right], \tag{29}$$

The equivalent expression for the impact of these tax changes on the utility of investors from country j equals

$$A_j \left[f_{ji} \frac{\partial r_i}{\partial \tau_r} + s_{ji} \frac{\gamma}{S_i A} \mathrm{cov}\Big(\sigma_i dz_i, dZ_i\Big) \left(\frac{f_K K}{f} \right) \frac{\partial K_i}{\partial \tau_r} \right]. \tag{30}$$

It is straight–forward to show that the sum of these effects on the utility of investors equals minus $\partial R_i^n/\partial \tau_r$ — investors as a group lose given that tax revenue increases. Since $b_{ii} > b_{ji}$ and $s_{ii} = s_{ji}$, we find that each domestic investor loses more than each foreign investor per dollar of assets.

While foreign investors fare better than domestic investors, under any reasonable parameter values they still lose from the tax change. In particular, our earlier results on optimal portfolio holdings under symmetry imply that $s_{ji} = 1/N$, while $b_{ji} = -1/N + 1/(N\gamma)$, so that $f_{ji} > 0$ — as a result both terms in equation (30) are negative. That foreign investors lose implies that the gain in tax revenue to the government exceeds the losses incurred by domestic investors. Since tax revenue by assumption receives more weight in the objective function than income to domestic investors, we conclude that the optimal value of τ_r is positive.

So far we have ignored possible differences in the effective tax treatment of foreign vs. domestic investors in domestic equity. While the government cannot feasibly tax domestic investors at a higher rate than foreign investors since domestic investors can hide their nationality using foreign financial intermediaries, it can feasibly treat them more leniently.[35] Would it want to do so? To judge this, start with the optimal source–based

[35] Foreign investors cannot easily take on the guise of a domestic investor to take advantage of a more favorable treatment available to domestic investors.

capital income tax, τ_r. Then consider introducing a marginal subsidy to domestic investors at rate α in proportion to their ownership of domestic capital, adjusting the rate τ_r so as to leave the equilibrium amount of domestic investment unchanged.

For any given τ_r and α, the observed rate of return in the market on domestic shares is still defined by equations (18) and (19). When domestic investors own these shares, however, they receive an income flow equal to $(g_i + \alpha)dt + \sigma_i dz_i$, implying that they invest until

$$g_i + \alpha - r_i = \gamma s_{ii} \sigma_i^2. \tag{10d}$$

Government revenue is now

$$R_i = \left(\frac{\tau_r S_i}{1 - \tau_r} \right) (g_i dt + \sigma_i dz_i) - \alpha S_{ii} dt.$$

As before, the government bears risks equivalent to those received from investments in $\tau_r S_i/(1 - \tau_r)$ domestic shares. To dispose of these risks, it transfers this risk to domestic investors, compensating them by enough to leave them indifferent. As a result, net government revenue becomes nonstochastic and equals

$$R_i^n = \left[\left(\frac{\tau_r S_i}{1 - \tau_r} \right) (r_i - \alpha) - \alpha S_{ii} \right] dt. \tag{20a}$$

In order to judge what combined tax rates will leave investment incentives unchanged, we proceed as before to solve for the aggregate pricing relationship. In particular, we weight equation (10a) for each j by A_j, add over $j \neq i$ then combine this with equation (10d) for country i (modified to reflect the extra risks acquired from the domestic governments) weighted by A_i, to find that

$$g_i = r_i - \frac{A_i \alpha}{A} + \frac{\gamma}{A} \sigma_i^2 \left[\frac{S_i}{1 - \tau_r} \right], \tag{31}$$

where we simplified using the assumption that $A_i = S_i$. Equation (31) can be reexpressed as

$$g_i^* = \frac{r_i}{1 - \tau_r} - \frac{A_i \alpha}{A(1 - \tau_r)} + \gamma \left[(\sigma_i^*)^2 S_i \right], \tag{31a}$$

where a superscript "*" indicates a before–tax value. If the combined tax changes are to leave investment incentives unchanged, then the sum of the first two terms on the right–hand side of equation (31a) should remain unchanged.[36] This is true if

$$\frac{\partial \tau_r}{\partial \alpha} = \frac{A_i (1 - \tau_r)}{A r_i}. \tag{32}$$

What then happens to government revenue and the welfare of investors due to a marginal increase in α and an associated change in τ_r, starting from $\alpha = 0$? The impact on the utility of domestic investors can be calculated from equation (28), modified to

[36] Inspection of the equilibrium condition for r_i shows that r_i remains unchanged as long as K_i remains unchanged.

take into account the change in α. Given equation (32), it quickly follows that the dollar equivalent gain to domestic investors equals

$$S_{ii}\left[1-\frac{A_i}{A}\right]dt>0.$$

Domestic investors clearly gain from these combined tax changes.

The impact of these tax changes on government revenue, evaluated at $\alpha=0$, equals

$$\frac{\partial R_i^n}{\partial\alpha}=\left\{\left(\frac{S_i}{1-\tau_r}\right)\left(\frac{A_i}{A}-\tau_r\right)-S_{ii}\right\}.$$

We find that tax revenue falls if $\tau_r>A_i/A$, as almost surely must be true in a small open economy. However, the dollar equivalent gains to domestic investors are clearly larger than the losses in tax revenue — the difference equals $A_i(S_i-S_{ii})/A>0$.[37] Therefore a positive value of α is attractive as long as the relative weight λ on government revenue is not too large. Many governments in fact do provide a subsidy to domestic investment in domestic equity, e.g. through dividend imputation schemes.[38]

C. Tax Policy when Domestic Prices are Stochastic

How are the results affected if monetary policy instead stabilizes the exchange rate? Consider as before the impact of introducing a source–based capital income tax at rate τ_r, with a compensating reduction in a labor income tax rate chosen to keep the net–of–tax wage unchanged. The resulting government revenue is still described by equation (20). As before, the government transfers the risk in this revenue to domestic residents, compensating them by enough to leave them indifferent.[39] Following equation (10d), the expected amount that domestic residents must receive to be left indifferent to the transfer of this risk is

$$\frac{\tau_r S_i}{1-\tau_r}(g_i+\eta_i-r-[1-\gamma(1-s_{ii})]\theta_i^2). \tag{33}$$

After paying this amount to compensate domestic residents for absorbing the risk in tax revenue, net government revenue becomes

$$R_i^n=\left[\tau_w wL_i+\frac{\tau_r S_i}{1-\tau_r}(r-\eta_i+[1-\gamma(1-s_{ii})]\theta_i^2)\right]. \tag{34}$$

[37] Foreign investors pay for this net gain to domestic residents through the drop in their return on domestic equity due to the increase in τ_r.

[38] Under these schemes, domestic investors owe personal income tax on the pretax corporate earnings used to fund dividend payments, but receive a credit for corporate taxes already paid on this income. As long as the corporate rate exceeds the personal tax rate, domestic investors receive a cash refund on net under the personal income tax. Most countries, the U.K. being a noted exception, do not provide equivalent refunds of corporate tax payments to foreign owners.

[39] Since no security is already traded with this particular risk characteristic, investors from different countries would charge different amounts to accept this risk. In fact, it is straight–forward to show that domestic residents would charge more to accept this risk than would foreign investors. Rather than simply marketing the "security" on the market, however, we assume that the domestic government disposes of the risk through stochastic cash transfers to domestic investors with a compensating adjustment in the mean transfer.

The change in monetary policy also has implications for the determinants of the market value of domestic firms. The first–order condition characterizing foreign demand for equity from country i remains equation (10a). Given the nature of the risks that the government transfers to domestic residents, the first–order condition characterizing domestic demand for this equity becomes

$$g_i + \eta_i - r = \theta_i^2[1 - \gamma(1 - s_{ii})] + \gamma \left(s_{ii} + \frac{\tau_r S_i}{A_i(1-\tau_r)} \right) \sigma_i^2. \tag{10e}$$

Assume that $S_i = A_i$, implying no net capital flows into country i. Aggregating these first–order conditions across investors as before, we find that

$$g_i + \eta_i - \frac{A_i}{A}\theta_i^2 = r + \frac{\gamma}{A}\mathrm{cov}(\sigma_i dz_i, dZ_i), \tag{23a}$$

where dZ_i is defined the same as in equation (23). As long as the capital account is balanced, the extra value of equity to domestic investors as a hedge against price fluctuations is just counterbalanced by the extra costs of equity due to exchange rate risks for foreign investors, leaving no net effect of hedging demand on equity prices.

Firms in country i will invest until $\partial S_i/\partial K_i = p_i$. In doing so, they would use equation (23a) to forecast the market's valuation of their marginal project, taking as given the aggregate risks faced by the market. Investment therefore continues until

$$f_K = \frac{r - \eta_i + (A_i/A)\theta_i^2}{(1-\tau_r)D_u} \equiv r_K, \tag{24a}$$

where

$$D_u = 1 - \frac{\gamma}{A}\mathrm{cov}(\phi dz_i, dZ_i).$$

Equation (23a) can also be used to solve for the impact of a marginal increase in τ_r on the market clearing wage rate. Using equations (18), (19), and (24a), we find that

$$(1-\tau_r)L\frac{\partial w}{\partial \tau_r} = -\frac{r - \eta_i + (A_i/A)\theta_i^2}{(1-\tau_r)}S_i - \frac{\gamma}{A}\mathrm{cov}\Big(\sigma_i dz_i, dZ_i\Big)\left(\frac{f_K K}{f}\right)\frac{\partial K_i}{\partial \tau_r}. \tag{25a}$$

Given the implied compensating change in τ_w, the impact of a marginal increase in τ_r, starting from $\tau_r = 0$, equals

$$\frac{\partial R_i^n}{\partial \tau_r} = S_i[1 - \gamma(1 - s_{ii}) - A_i/A]\theta_i^2 - \frac{\gamma}{A}\mathrm{cov}\Big(\sigma_i dz_i, dZ_i\Big)\left(\frac{f_K K}{f}\right)\frac{\partial K_i}{\partial \tau_r}. \tag{26a}$$

Since $\partial K_i/\partial \tau_r < 0$, the second term on the right–hand side of equation (26a) results in an increase in tax revenue. The sign of the first term is unclear in general. Assuming symmetry among countries, however, we can use equation (12) and the condition that $\sum_j s_{ji} = 1$ to show that

$$[1 - \gamma(1 - s_{ii}) - A_i/A] = -(\gamma - 1)\left(\frac{N-1}{N}\right)\left(\frac{\sigma^2}{\theta^2 + \sigma^2}\right).$$

This term is therefore negative as long as $\gamma > 1$, implying an ambiguous impact in general of the tax change on revenue. Revenue could fall, for example, if investment were sufficiently inelastic.

To judge whether a tax increase is attractive, we need to examine as well the impact of the tax change on the welfare of domestic investors, which is again described by equation (28). Evaluating this expression, given equations (26a) and (10e), we find that the dollar–equivalent impact of the combined tax changes on the welfare of domestic residents equals

$$\frac{S_{ii}}{S_i}\left[-\frac{\partial R_i^n}{\partial \tau_r} + [1-\gamma(1-s_{ii}) - A_i/A]\theta_i^2\left(\frac{f_K K}{f} - 1\right)\frac{\partial K_i}{\partial \tau_r}\right]. \tag{35}$$

At least under our symmetry assumption, the second term inside the brackets is negative.

If the increase in τ_r causes a fall in tax revenue, we conclude that welfare falls as well — the gains (if any) to domestic residents cannot be sufficient to offset the revenue loss. If tax revenue does increase due to an increase in τ_r, the desired τ_r is positive unless λ is small and the second term in expression (35) is too negative. While previously, we concluded unambiguously that the optimal τ_r was positive, results are no longer clear.

The key reason for this change in results is that the process of taxation leads to a worsening of the allocation across investors of the risks from domestic production. As seen comparing equations (10b) and (10e), in equilibrium domestic investors charge a higher risk premium than foreign investors for the risk from domestic production — domestic investors accept the extra risk in exchange for the hedging gains from domestic equity. Taxation leads to a further allocation of production risk to domestic investors with no further hedging gains, worsening a preexisting misallocation that results from the lack of indexed bonds.

Consider also the effect of this alternative monetary policy on the choice whether to treat domestic owners of domestic equity more favorably than foreign owners under the tax law. In particular, we start from the optimal τ_r, and examine the effects of a marginal increase in τ_r compensated by introducing a marginal subsidy to domestic owners at rate α sufficient to leave investment incentives unchanged.

The resulting first–order condition for domestic investors, assuming $S_i = A_i$, is now

$$g_i + \alpha + \eta_i - r = \theta_i^2[1-\gamma(1-s_{ii})] + \gamma\left(s_{ii} + \frac{\tau_r}{(1-\tau_r)}\right)\sigma_i^2. \tag{10f}$$

Summing these first–order conditions across investors as before, we find that the market equilibrium condition is

$$g_i + \eta_i + \frac{A_i}{A}(\alpha - \theta_i^2) = r + \frac{\gamma}{A}\mathrm{cov}(\sigma_i dz_i, dZ_i).$$

Starting from $\alpha = 0$, the adjustment in α needed to leave investment incentives unchanged when τ_r rises equals

$$\frac{\partial \alpha}{\partial \tau_r} = \frac{A}{A_i(1-\tau_r)}\left[r - \eta_i + \frac{A_i}{A}\theta_i^2\right]. \tag{32a}$$

As before, the impact on domestic investors of these combined tax changes is positive. In particular, the dollar–equivalent impact on domestic investors, evaluated at $\alpha = 0$, equals

$$\left(S_{ii} + \frac{\tau_r S_i}{1-\tau_r}\right)\left[\frac{\partial \alpha}{\partial \tau_r} - \frac{r - \eta_i + [1-\gamma(1-s_{ii})]\theta_i^2}{1-\tau_r}\right].$$

Given equation (32a), this expression is clearly positive in a small open economy.

What happens to government revenue? Net government revenue is now

$$R_i^n = \frac{\tau_r S_i}{1-\tau_r}(r - \alpha - \eta_i + [1-\gamma(1-s_{ii})]\theta_i^2) - \alpha S_{ii}. \qquad (34a)$$

The impact on government revenue of these combined tax changes equals

$$\frac{\partial R_i^n}{\partial \tau_r} = S_i \frac{r - \eta_i + [1-\gamma(1-s_{ii})]\theta_i^2}{(1-\tau_r)^2} - \left(\frac{\tau_r S_i}{1-\tau_r} + S_{ii}\right)\frac{\partial \alpha}{\partial \tau_r}.$$

Given equation (32a), we find that government revenue clearly drops due to these tax changes in a small open economy.

Unlike in the previous case, the benefits to domestic investors are not necessarily larger than the loss in government revenue. In particular, the difference equals

$$(S_i - S_{ii})\left[\frac{r - \eta_i + [1-\gamma(1-s_{ii})]\theta_i^2}{1-\tau_r}\right],$$

and the expression in brackets is not necessarily positive. If this expression is in fact negative, then so is the optimal value of α. Even if the expression is positive, so that domestic investors gain more than the government loses in tax revenue, the optimal value of α is positive only if the value of λ is not too large.

These results suggest that the change in monetary policy can have important effects on the optimal tax structure. The main role of taxes previously was to act as a tariff on foreign investors. Now foreign investors own a much smaller fraction of the shares in domestic equity, so that overall taxes on capital income fall more heavily on domestic shareholders. In addition, foreign demand is more elastic than before, since the relative price risk is unaffected by tax changes, reducing the optimal tariff rate. Domestic demand, however, has become less elastic due to the hedging gains from equity, making it more attractive to tax domestic owners.

Given the additional hedging demand by domestic investors for domestic equity, they continue investing until their marginal risk premium for the production risk from equity is much higher than that of the foreign investors. As a result, a marginal reallocation of production risk from foreign to domestic investors is an efficiency loss. Yet this is just what happens when taxes are imposed on foreign owners, and the resulting randomness in tax payments is transferred to domestic shareholders. As a result, taxes on foreign owners exacerbate a preexisting misallocation of risk, resulting from an incomplete set of financial securities,[40] reducing the attractiveness of the tax.

[40] If indexed bonds are added to the model, the difference in risk premia disappears.

IV. Conclusions

Based on the above analysis, we conclude that the choice of monetary policy can have potentially dramatic effects on portfolio behavior, with important implications for tax policy. The effects are not necessarily those that would have been expected, however.

In particular, it would have been plausible to forecast that using monetary policy to eliminate exchange rate risk would result in an increase in portfolio diversification, since foreign equity no longer bears this added risk. Instead, we forecast that this monetary policy results in increased portfolio specialization in domestic equity. The reason is that the shift to a rigid exchange rate means that any fluctuations in the real value of domestic goods must show up entirely in fluctuations in domestic nominal prices. Domestic equity would likely provide residents the best available hedge against these price fluctuations.

Another plausible expectation is that capital income tax rates will increase if portfolios become more specialized, due to the apparent fall in capital mobility. However, we find that tax rates on capital income likely fall and may not even remain positive when monetary policy shifts to stabilizing exchange rates, in spite of the resulting specialization in portfolios. In particular, foreign demand for domestic equity falls and becomes more elastic, reducing the optimal tariff.

The model also provides a possible explanation for the Feldstein–Horioka (1980) observation that most extra domestic savings are invested at home. Here, surprisingly, the forecasts are largely invariant to the choice of monetary policy and the implied degree of portfolio specialization.

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