NBER WORKING PAPER SERIES

FACTOR PRICES AND WELFARE UNDER INTEGRATED CAPITAL MARKETS

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Working Paper No. 2447

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 1987

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ABSTRACT

This paper considers the effect on factor prices and welfare of trade between economies whose production is characterized by nation-specific technological uncertainty. The analysis is carried out using a two-country Diamond overlapping-generations model in which technological uncertainty is reflected in factor prices, and "equities" refer to claims on the returns to capital. We find that trade in capital is complementary to trade in commodities, in the sense that adding free trade in capital to the spectrum of permitted economic activities will cause significant changes in wages, output, and capital returns. Furthermore, for countries which are identical, or not very different, factor prices move in parallel when free trade in capital is introduced. Specifically, as we show in the text, capital returns fall, while wages rise, in both countries. These results are based on the portfolio diversification permitted by international capital market integration: the reduction of portfolio risk associated with portfolio diversification induces adjustments in savings behavior which, in turn, change factor prices.

In the realm of normative economics we find that, upon the introduction of free trade in capital, the associated changes in portfolio risk and factor returns have welfare effects entirely distinct from those conventionally associated with open markets for goods. Furthermore, the net effect on consumer welfare of a shift to free trade in equities is more likely to be positive than previously thought.

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FACTOR PRICES AND WELFARE UNDER INTEGRATED CAPITAL MARKETS

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This paper considers the effect on factor prices and welfare of trade between economies whose production is characterized by nation-specific technological uncertainty. We find that trade in capital is complementary to trade in commodities, in contrast to the common view, motivated by the Hecksher-Ohlin model, of factor and goods trade as substitutes. That is, we find that adding free trade in capital to the spectrum of permitted economic activities, including trade in goods, will cause significant changes in wages, output, and capital returns. This complementarity is based on the portfolio diversification permitted by international capital market integration: the reduction of portfolio risk associated with portfolio diversification induces adjustments in savings behavior which, in turn, change factor prices. The complementarity is entirely distinct from the form of complementarity discussed in recent papers by Markusen and Svensson (Markusen 1983; Svensson 1984; Markusen and Svensson 1985). They find that adding trade in factors to trade in goods enhances the correlation between superior technology and exports in countries which produce multiple goods, while in our analysis both countries produce the same good.

When countries shift from autarchy to free trade in goods and capital, factor-prices can move in parallel: specifically, as we show in the text, capital returns could fall, while

*This represents a portion of my thesis research. I am indebted to my advisors, William Branson, Gene Grossman, and Peter Kenen, for their suggestions and support.

wages rise, in both countries. This contradicts all previous results in this area, including a very closely related conclusion of Kareken and Wallace (1975), who find that factor returns under open capital markets will lie between their values under portfolio autarchy. Our result relies on another salient feature of our model: the endogeneity of capital and its relationship to savings. In consequence, the result can be viewed as a long-run aspect of an economic shift which has only previously been analyzed over time horizons in which the world capital supply is fixed.

In the realm of normative economics we find that upon the introduction of free trade in capital the associated changes in portfolio risk and factor returns have welfare effects entirely distinct from those conventionally associated with open markets for goods, and that the resulting equilibrium could be either Pareto superior or inferior to the autarchic equilibrium. This contradicts the finding of Kareken and Wallace (1975) that a shift from portfolio autarchy to integrated capital markets will not under any circumstances lead to a Pareto superior equilibrium, and is consistent with the finding of Grossman (1984) that "some movement of factors is not necessarily better than none". Whether integrated capital markets enhance or compromise steady-state welfare depends upon (i) the direction and magnitude of the response of savings to changes in portfolio risk, and (ii) the position of the economies on the factor-price frontier relative to some welfare-maximizing optimum.

In Part II.A we introduce technological uncertainty into the Diamond (1965) overlapping-generations model. Following the example of Buiter (1981) we consider a two-country treatment of this model, where both countries produce the same good, in Part II.B. In Part III we discuss the effects on factor prices of a shift to free trade in goods and capital. Part IV goes on to consider the welfare effects of such a shift, and in Part V we conclude.

PART II: THE MODEL

II.A. Autarchy

We will begin this section by explaining the production side of one overlapping-generations economy, follow that with a discussion of consumer behavior, and finish with a description of the steady-state equilibrium under autarchy.

Production

Output of each firm, where firms are indexed by i, is generated from inputs of labor and capital according to the stochastic production function

$$Q_t^i = F(K_t^i, L_t^i) + \alpha_t K_t^i \quad ,$$

where α_t is an i.i.d. random variable distributed over the interval $[-d,d]$, $0 < d < 1$, with mean zero and variance σ^2.[1] Assuming that $F(K,L)$ is linear-homogeneous, we can re-express production in terms of per-worker output, $q = Q/L$, and the capital-labor ratio, $k = K/L$:

$$q_t^i = f(k_t^i) + \alpha_t k_t^i \quad .[2]$$

The exogenously determined labor force is fully employed in each period, as is the endogenously determined stock of capital. Factor markets are assumed to be perfectly competitive, in consequence of which we can aggregate firms' output and express total output in terms of total capital and labor:

$$Q = F(K,L) + \alpha K = Lq = L[f(k) + \alpha k].$$

Another implication of perfect competition in the factor markets is that labor and capital will always be paid their marginal product: wages will be $w = f(k) - kf'(k)$, and the actual return to capital will be $\underline{r} = f'(k) + \alpha$, with expectation $r = f'(k)$.

Consumption

During any period t a new generation of individuals is born which is n percent larger than the previous generation. Each member of this new generation, who will live for two periods, works during period t earning the prevailing wage, w_t, consumes some (proper) fraction of his income, and invests the rest. The members of the older generation living in period t do not work, and consume their interest-augmented savings. Denoting per-worker savings of the young as s_t, we can see that per-worker output available for consumption in period t, $f(k_t) + \alpha_t k_t + k_t$, will be exhausted by consumption of the young, $w_t - s_t$, investment by the young, s_t, and per-worker consumption of the old, $(1 + r_t + \alpha_t)k_t$, where $k_t = s_{t-1}/(1+n)$. It is convenient to imagine that savings is used to purchase equities from firm managers, who in turn employ the income derived from equity sales as capital. The equities are denominated in terms of the single good and their stochastic return is identical to the return per unit of capital employed.

All individuals have the same utility function: $U(c_1) + \beta V(c_2)$, where $\beta = 1/(1+\rho)$, and ρ is the rate of time preference, so $0 < \beta \leq 1$. We assume that $U(\,)$ is twice continuously differentiable, with $U' > 0$, $U'' < 0$. To simplify the mathematics of uncertainty, we specify the following functional form for V( ):

$$V(c) = \frac{c^{1-\gamma}}{1-\gamma},$$

and assume further that $\gamma = 1/2$.

The value of s_t, which determines generation t's entire (expected) lifetime consumption profile, is chosen by them to solve

$$\underset{s}{Max}\ E_t\{U(w_t - s_t) + \beta V[s_t(1 + r_{t+1} + \alpha_{t+1})]\}\ ,$$

taking w_t, r_{t+1} and the distribution of α_{t+1} as given. The first-order condition for this problem implies:

$$U'(w_t - s_t) = E\{V'(1 + r_{t+1} + \alpha_{t+1})\}$$

The consumers' desired level of savings will be determined implicitly as a function of w_t, r_{t+1}, and the system parameters σ^2, β, and γ: $s = s(w,r,\sigma^2,\beta,\gamma)$. There is one property of consumer behavior which should be noted in this context: a rise in the riskiness of equity returns will cause consumers to desire to reduce their savings. This unambiguously negative response of savings to σ^2 is driven by the assumption that $0 < \gamma < 1$. That is, $0 < \gamma < 1$ ensures that the "income" effect of the change in the variance of returns -- the increase in savings required to achieve the same level of expected future utility -- is dominated by a "substitution" effect -- we can think of $d\sigma^2 > 0$ as an increase in the relative price of future expected utility, which could induce "substitution" away from it. With the utility function of this paper, substitution effects will dominate for interest rate and the variance of future consumption, or not at all (Sandmo 1970). (This and other properties of this model are analyzed in greater detail in Osler (1987b).)

The empirical evidence regarding the size of γ is mixed, so we assume $0 < \gamma < 1$ because it brings the model of this paper into consistency with those of its forebearers, such as Buiter (1981), Blanchard (1985), and Kole (1985), where $s_r > 0$ is assumed. It is usually not difficult to ascertain how the results presented here would differ if income effects dominated substitution effects.

Temporary Equilibrium

Three equilibrium conditions characterize the economy in each period:

$$U'(w_t - s_t) = E\{V'[1 + r_{t+1} + \alpha_{t+1}]\}$$
$$r_{t+1} = E\{f'(k_t) + \alpha_{t+1}\} = f'[s_t/(1+n)]$$
$$w_t = f(k_t) - k_t f'(k_t).$$

The first two of these conditions comprise a system in the two endogenous variables s_t and r_{t+1}, which could be re-expressed as $s_t = s(w_t, r_{t+1}; \sigma^2, \beta, \gamma)$ and $r_{t+1} = r(s_t)$. We know that $s_r(\,) > 0$ and $r'_{t+1}(\,) < 0$, so the assumption that these two functions intersect is sufficient to ensure an unique equilibrium, the location of which depends on w_t, σ^2, β, and γ. Henceforth we will discuss optimum savings only at its economy-wide equilibrium value, $\tilde{s}(w_t; \sigma^2, \beta, \gamma)$.

Steady-State Equilibrium

This model will have no "steady state" in the normal sense, because it is stochastic: in particular, the path of the actual return to equities, $r_t = r_t + \alpha_t$, is necessarily uncertain. The paths of w_t, k_t, and r_t can be determined with certainty, however, if we know the initial value of one of them. The fact that $f(k)$ is strictly increasing and twice continuously differentiable ensures that we can find functions $k(w)$ and $r(w)$, the latter of which is commonly known as the "factor-price frontier". A first-order difference equation in capital can be generated by using the familiar relations

$$k_t = \tilde{s}_t(w_{t-1})/(1+n)\,, \tag{1a}$$
$$w_t = f(k_t) - k_t f'(k_t)\,, \tag{1b}$$

since together these imply:

$$k_{t+1} = \frac{\tilde{s}[f(k_t) - k_t f'(k_t)]}{(1+n)}\,. \tag{2}$$

where the dependence of $\tilde{s}_t$ on σ^2, β, and γ has been suppressed. Equation (2) allows us to trace the behavior of k_t from some initial period through time indefinitely. The steady state of this system is a value k^* such that $k_{t+1} = k_t$. We can be sure that such a fixed point exists, since $k(w)$ is bounded and continuous (LaSalle, 1976). It is also unique.[3]

II.B Two-Country Equilibrium

Suppose now that there is a "home" country and a "foreign" country, both of which produce the same good, and which freely trade both output and equities. (Unless otherwise specified, the word "domestic" will refer to the home country, while foreign values of endogenous and exogenous variables will be denoted by a superscript ^.)

Production

Each country has an underlying production function of the same type that we have assumed in earlier chapters. Denote foreign production technology as:

$$\hat{Q} = F(\hat{K},\hat{L}) + \hat{\alpha}\hat{K}.$$

The random productivity shocks, α at home and $\hat{\alpha}$ abroad, have mean zero, variances σ^2 and $\hat{\sigma}^2$, respectively, and correlation coefficient η, which we assume is unequal to unity.

Consumption

Consumers must still choose a savings level, but now they must also choose the allocation of their savings between the assets of both countries. Savers will invest in "equities" which are denominated in terms of the output of the country from which they are purchased, and have stochastic returns corresponding identically to that country's return to capital. "π" will represent the share of domestic savings invested in home equities, and the

share of foreign savings invested in domestic equities will be "$\tilde{\pi}$". Choice of π will contribute to determining the realized value, expected value, and variance of individuals' returns to savings as follows:

$$R_{t+1} = 1 + \pi_t(r_{t+1} + \alpha_{t+1}) + (1-\pi_t)(\tilde{r}_{t+1} + \tilde{\alpha}_{t+1}), \quad (3a)$$

$$E\{R_{t+1}\} = 1 + \pi_t r_{t+1} + (1-\pi_t)\hat{r}_{t+1}, \quad (3b)$$

$$Var(R_{t+1}) = \pi_t^2\sigma^2 + (1-\pi_t)^2\tilde{\sigma}^2 + 2\pi_t(1-\pi_t)\sigma\tilde{\sigma}\eta . \quad (3c)$$

The optimization problem facing domestic residents,

$$\underset{s,\,\pi}{Max}\ U(w_t - s_t) + \beta E\{V(s_t R_{t+1})\},$$

has first-order conditions

$$U' = \beta E\{V' R_{t+1}\} \quad (4a)$$

and

$$E\{V'\}(r_{t+1} - \hat{r}_{t+1}) = E\{V'(\alpha_t - \tilde{\alpha}_t)\} . \quad (4b)$$

The interpretation of equation (4a), which describes consumers' optimal savings level, was discussed in Section II.A. Equation (4b) describes equilibrium portfolio shares. As equations (3b) and (3c) illustrate, a change in π_t will affect expected retirement utility through R_{t+1} and $Var(R_{t+1})$. Equilibrium condition (4b) states that at the margin, the change in expected utility from these two factors should be equal and opposite.

Temporary Equilibrium

Ten conditions that characterize the temporary equilibrium: the four consumers' first-order conditions, corresponding to s_t, π_t, $\hat{s}_t$, and $\hat{\pi}_t$; the four factor-market clearing conditions, corresponding to w_t, r_{t+1}, $\tilde{w}_t$, and $\hat{r}_{t+1}$; and the definition of domestic and foreign capital stocks:

$$k_{t+1} = \frac{\pi_t s_t + \hat{\pi}_t \hat{s}_t}{1+n}, \qquad \hat{k}_{t+1} = \frac{(1-\pi_t)s_t + (1-\hat{\pi}_t)\hat{s}_t}{1+n} .$$

The capital account, per domestic worker, equals capital inflow minus capital outflow:

$$\kappa_t \equiv [\hat{\pi}_t \hat{s}_t - (1-\pi_t)s_t] - \left(\frac{1}{1+n}\right)[\hat{\pi}_{t-1}\hat{s}_{t-1} - (1-\pi_{t-1})s_{t-1}]$$

The current account is the negative of the capital account, and the trade balance is the difference between the current account and net capital service inflow, or:

$$tb_t = -\kappa_t - \left(\frac{1}{1+n}\right)\{(\hat{r}_t+\hat{\alpha}_t)(1-\pi_{t-1})s_{t-1} - (r_t+\alpha_t)\hat{\pi}_{t-1}\hat{s}_{t-1}\}.$$

The balance of payments will automatically be in equilibrium whenever consumers satisfy their budget constraints.

Steady-State Equilibrium

The long-run steady-state values of k and $\hat{k}$ will be the solutions to the following system of nonlinear equations:

$$k(w,\hat{w}) = \frac{\pi^*(.)s^*(.) + \hat{\pi}^*(.)\hat{s}^*(.)}{1 + n}$$

$$\hat{k}(w,\hat{w}) = \frac{[1-\pi^*(\cdot)]s^*(\cdot) + [1-\hat{\pi}^*(\cdot)]\hat{s}^*(\cdot)}{1 + n}$$

where

$$w^* = f[k(w^*,\hat{w}^*)] - k(w^*,\hat{w}^*)f'[k(w^*,\hat{w}^*)]$$

$$\hat{w}^* = f[\hat{k}(w^*,\hat{w}^*)] - \hat{k}(w^*,\hat{w}^*)f'[\hat{k}(w^*,\hat{w}^*)]$$

and the arguments in $s^*(.)$ and $\pi^*(.)$ are w^*, $\hat{w}^*$, r^*, $\hat{r}^*$, σ^2, $\hat{\sigma}^2$, η, and n. Since w and $\hat{w}$ are bounded, this system has a nonempty set of fixed points (LaSalle 1976). For the case of symmetric countries, we will assume that the solution $w^* = \hat{w}^*$ is one of these fixed

points, and in fact is the unique fixed point. The condition for local stability of the system is:

$$0 < 1 - m\pi s_w - \widehat{m}(1-\widehat{\pi})\widehat{s}_w < 1,$$

where

$$m \equiv {}^{\partial w}/_{\partial k} = {}^{-kf''}/_{(1+n)} > 0,$$

and $\widehat{m}$ is defined accordingly. We will assume that $m, \widehat{m} \leq 1$, which ensures that this stability condition is satisfied.

The steady-state capital account and trade balance will appear as follows:

$$\kappa^* = \left(\frac{n}{1+n}\right)\left(\widehat{\pi}^*\widehat{s}^* - (1-\pi^*)s^*\right),$$

$$tb^* = \left(\frac{1}{1+n}\right)\left\{\left(r^* + \alpha_t - n\right)\widehat{\pi}^*\widehat{s}^* - \left(\widehat{r}^* + \widehat{\alpha}_t - n\right)(1-\pi^*)s^*\right\}.$$

PART III: EFFECTS ON FACTOR PRICES OF A SHIFT TO FREE TRADE

IV.A. Identical Countries

We will begin our analysis of this economic system at the steady-state equilibrium corresponding to symmetry countries: $\beta = \widehat{\beta}$, $\sigma^2 = \widehat{\sigma}^2$, etc. Factor prices will be the same everywhere, implying equal domestic and foreign capital stocks. Savings will also be equal in the two countries, and all portfolios will be evenly divided between home and foreign equities. With so much symmetry, the fact that the (expected) value of each constituent element of the balance of payments will be zero can be proven with a simple

glance at the expressions which describe them. Since individuals hold diversified porfolios both countries will be both importers and exporters of equities, though there will be no net capital flows.

In the transition from autarchy to free trade, there will be an immediate and permanent switch to perfect diversification of portfolios, followed by an extended rise in wages and savings To see this more clearly, let us trace the events of a transition which takes place in period t. In order to reduce portfolio risk, members of generation t diversify their portfolios. Having achieved that lower risk, consumers increase their savings, raising period t+1's capital stock and wages, and reducing equity returns, relative to their values in the autarchic steady state. With higher disposable income, generation t+1 will save even more than generation t, which in turn will raise the wages of generation t+2. In this way each country's wages will continue to rise, and equity returns to decline, converging eventually on new steady-state values. Thus we have shown:

Proposition 1: *For identical countries, wages rise, equity returns fall, and the variance of second-period consumption declines in both countries upon a shift from autarchy to free trade in goods and equities*.

If identical countries were only allowed to trade in commodities, there would be no motivation for trade and no change whatsoever from the autarchy equilibrium. This result shows that in the presence of uncertainty, trade in factors is "complementary" to trade in goods, in the sense that it has effects on the equilibrium entirely distinct from the effects of allowing trade in goods. This "complementarity" between trade in goods and trade in factors is quite distinct from that discussed by Markusen and Svensson (1985), who find

that the correlation between technological superiority and exports increases when trade in factors is allowed in addition to trade in goods. Their analysis is concerned with the effects of factor trade when countries produce multiple goods under conditions of certainty, while we inquire about the effects of factor trade when both countries produce a single good under uncertainty.

In Buiter's original two-country treatment of the overlapping-generations model, the equilibrium for identical economies is unchanged by a shift out of portfolio autarchy (1981). Our result contrasts sharply with his, yet it is driven by two of the model's most general properties: the desire to diversify portfolios across countries, and the response of savings to portfolio risk.[4] The endogeneity of capital is also important, since redistributing fixed national capital stocks across countries would cause factor prices to move in opposite directions, or not at all. However, endogeneity of capital is more of a necessary condition than a sufficient one, since wages in both countries will not change at all if random productivity shocks in the two countries are perfectly correlated.

III.B. Asymmetric Countries

In this section we will use some of our earlier analysis to show that factor prices could move in parallel upon the opening of financial markets even if countries differ.

Suppose for specificity that the domestic level of relative risk aversion exceeds the foreign level, of $\hat{\gamma} > \gamma$. As shown in Osler (1987b), under autarchy the returns to equities will be higher for the home country than for the foreign country, since domestic consumers will tend to save less. Once they are allowed to invest internationally, consumers will divide their portfolios equally between domestic and foreign equities, equalizing factor

returns. If savings were not responsive to changes in risk, then domestic returns would fall while foreign returns rose. However, with the reduction in portofolio riskiness will cause savings to rise, tending to reduce returns in both countries. This savings effect, while enlarging the decline of domestic equity returns, causes the direction of change of foreign equity returns to be uncertain. The general priniciple here, which applies to changes in all system parameters, is that the savings effect will dominate, and returns will move in parallel, if countries are sufficiently similar to begin with. This "similarity" can be quantified: for instance in the case of differences in rate of time preference, foreign equity returns will decline, as well as domestic returns, so long as $\hat{s}_T - \hat{s}_A > (\hat{s}_T - s_T)/2$.

That equity returns or wages could actually move in parallel upon a shift from autarchy to trade is a result unfamiliar to the international trade literature, whether we consider trade in goods, in capital, or both. In the standard models of free trade in goods, factor prices will move in opposite directions, if they move at all. Included here would be the Ricardo-Viner model with capital supplies specific to each traded good, and of course the Hecksher-Ohlin model (Dixit and Norman 1980). Models allowing free trade in capital as well as goods have also required factor payments to move in opposite directions, whether or not uncertainty was considered, and whether or not they allowed the aggregate supply of capital to vary. Examples are: Grossman and Razin (1984, 1985), who assume a fixed total capital stock but incorporate uncertainty, and Buiter (1981) whose model has no uncertainty but allows the aggregate capital stock to vary endogenously. An especially interesting example is Kareken and Wallace's (1975) paper in which they analyze an overlapping-generations model with fixed endowments of land. The land is combined with labor in each country to produce two goods, both of which can be traded. Their paper is

interesting because the authors compare explicitly the equilibrium with only goods trade to the equilibrium with international purchases of both goods and land. They conclude that if land returns differ across countries in the more restricted equilibrium, then under "laissez-faire" land returns will be equalized across countries at a rate between the two that prevailed without land trade.

Why is it interesting that factor prices might move in a parallel fashion when capital trade opens up? Because currently such trade is growing in leaps and bounds (Crabbe 1987). International portfolio diversification is surging world-wide as its benefits have become dramatically less costly to achieve and equally dramatically more apparent over recent years. (See for example, Levy and Sarnat 1970; Solnik 1974a; Kohlhagen 1983) The effects of such a change in investment patterns should be of interest to all involved. Workers, for example, will want to know what might happen to their wages. Investors will be especially keen to know if this must imply a rise in expected returns in markets with relatively low ones, such as Germany: if so, they might experience capital gains during the transition, rather than losses.

PART IV: WELFARE EFFECTS OF A SHIFT TO FREE TRADE

In this section we continue our analysis of a shift to free trade for identical economies, focusing on changes in individual welfare. We begin by expressing this change in welfare analytically. The measure of consumer welfare we use is:

$$W(w_t, r_{t+1}, \tilde{r}_{t+1}; \sigma^2, \tilde{\sigma}^2, \eta) = \underset{s,\ \pi}{Max}\ U(w_t - s_t) + \beta E\{V(s_t R_{t+1})\}\ .$$

Taking the parameters of the system as given, we can think of consumer welfare as determined by three elements: portfolio variance, expected portfolio returns, and wages. The effects of each factor on welfare can be expressed as follows:

$$\frac{\partial W}{\partial Var(R)} = \beta s^2 \frac{\partial E\{V\}}{\partial Var(R)} < 0,$$

$$\frac{\partial W}{\partial R} = \beta s E\{V'\} > 0, \qquad \frac{\partial W}{\partial w} = U' > 0.$$

A logical expression for appreciating the welfare effects of a change from autarchy (A) to free trade (T) is the following:

$$dW_t = \beta s^2 \frac{\partial E\{V\}}{\partial Var(R)}[Var(R_T) - Var(R_A)] + \beta s_t E\{V'\}(R_{Tt+1} - R_A) + U'(w_{Tt} - w_A).$$

Our next step is to consider in detail the changes in portfolio variance, portfolio returns, and wages. The change in portfolio variance can be divided into two parts, one due to the imperfect correlation of returns across countries, the other due to the divergence between domestic and foreign equity variances:

$$Var(R_T) - Var(R_A) = 2\pi(1-\pi)\sigma^2(\rho - 1) + (1-\pi)^2(\tilde{\sigma}^2 - \sigma^2).$$

For identical economies, only the first of these terms is unequal to zero, and it is negative. (Time subscripts can be dropped because the independence of optimal portfolio shares from income implies that portfolio variances will be the same during all periods subsequent to the change in policy.)

The change in expected portfolio returns has two parts, the first due to the change in domestic equity returns, the second due to differences between returns across countries under trade:

$$\bar{R}_{Tt+1} - \bar{R}_A = (r_{Tt+1} - r_A) + (1-\pi_T)(\tilde{r}_{Tt+1} - r_{Tt+1}).$$

With identical economies, only the first of these need be considered.

Though a change in wages is straightforward, it is useful to think of it in two parts, one related to a movement along the factor-price frontier, and one associated with the fact that, before the steady state is reached, the wages received by a generation, say generation t, will not correspond along the factor-price frontier to the equity returns they expect to receive: $w_t = f(k_t) - k_t f'(k_t) \neq w(r_{t+1}) = f(k_{t+1}) - k_{t+1} f'(k_{t+1})$. Thus

$$w_{Tt} - w_A = \frac{\partial w}{\partial r}(r_{Tt+1} - r_A) + \frac{\partial w}{\partial r}(r_{Tt} - r_{Tt+1})$$

We can now re-express the welfare change for identical economies as follows:

$$dW_t = \beta s^2 \frac{\partial E\{V\}}{\partial Var(R)} \frac{\sigma^2(\rho\text{-}1)}{2} - k_A[U' - \beta(1+n)E\{V'\}](r_{Tt+1} - r_A) - U' k_A[r_{Tt} - r_{Tt+1}] .$$

where $k = \partial w/\partial r$, and we evaluate U', $E\{V'\}$, etc. at the initial, autarchic, steady state.

The first term on the right, which measures the welfare change due to reduced portfolio variances, applies to all generations born after the policy shift . This effect is unambiguously positive, since diversification reduces the portfolio variance of all generations subsequent to the policy transition.

The second term, which also affects all generations, tells us the welfare effect of movement along the factor-price frontier. This effect could be positive or negative, depending on the initial location of the economy relative to some theoretical welfare-maximizing equilibrium. In the present model, as in most growth models, the effect will be positive so long as autarchy equity returns exceed their optimal value, r^*. This follows

directly from the conditions describing r^*,

$$E\{V'\}(r - n) = -E\{V'\alpha\} \quad > \quad 0 \quad .$$

and from the consumers' first-order condition for s , which together imply that $U' - \beta(1+n)E\{V'\} > 0$ if and only if $r > r^*$.[5] Some authors rule out the possibility of such an equilibrium, arguing that rational agents would not allow such inefficiencies to persist, while others point out that it is not always possible for rational agents to arrange otherwise.[6] The assumption that $r > r^*$ can be interpreted in terms of intertemporal efficiency since, if r were below its theoretical optimum, one generation could consume more in both periods of its life and still leave subsequent generations better off, so long as an appropriate arrangement for intergenerational transfers were in place. We will adopt the assumption of intertemporal efficiency throughout the text in order to avoid listing explicitly the consequences of $r < r^*$ as well as of $r > r^*$.

The third effect, relevant only to generations alive before the steady state is reached, is negative, since expected equity returns will be declining during the transition.

Considered together, the three welfare effects of a shift from autarchy to trade imply the following:

Proposition 2: *For identical countries which are intertemporally efficient and for which* $\gamma = \hat{\gamma} < 1$, *the shift from autarchy to free trade in goods and equities will cause an unambiguous improvement in steady-state welfare. The welfare of intermediate generations may either rise or fall. Thus, free trade in goods and equities may be Pareto superior to autarchy, but it may also reduce welfare.*

Whether trade in factors, in addition to trade in goods, can affect welfare has been a concern of trade theorists for generations. Earlier trade models concluded that trade in factors was often redundant when trade in goods is availlable. For example, in the standard Hecksher-Ohlin model, identical countries are unaffected by the introduction of either capital goods trade or capital trade, and introducing trade in capital affects welfare only if countries are so distinct that they end up specializing in production (Mundell 1957). In a more recent analysis Grossman concludes that "some movement of factors is not necessarily better than none" (1984), which is consistent in spirit with out own result, though motivated entirely differently. In his model, equilibria are static and there is no uncertainty: the welfare loss due to trade in factors is associated with changes in the terms of trade, since each country produces multiple goods. In our model, the welfare change is associated with portfolio diversification and with the savings and income responses it generates.

A closer analogy to our model is found in Kareken and Wallace's (1975) analysis of an overlapping-generations version of the Hecksher-Ohlin model. They find that "the laissez-faire [free trade in goods and capital, steady-state] equilibrium allocation is not Pareto superior to the portfolio autarchy allocation" (page 71), in direct contradiction to our result. The same conclusion holds concerning this model without uncertainty, if the two countries are symmetrical. As ever, it is the possibilities of portfolio diversification that lead our model to have unfamiliar results.

Finance theorists have been aware for years that integrating capital markets brings benefits in terms of reduced portfolio variances, though their perspective has been entirely

absent from the standard international trade literature (Solnick 1974b). Our contribution is to asses the long-run implications of such risk reduction on savings behavior, factor returns, and welfare.

PART V: CONCLUSIONS

In this paper we have analyzed a two-country Diamond overlapping generations model with uncertainty. The distinguishing feature of this model is the importance of portfolio diversification, which in turn relies on the imperfect correlation between equity returns in the two countries. The reduction in portfolio variance associated with international diversification is the driving force between both of our main results: factor returns under free trade need not lie between their autarchy values; and (ii) the net effect on consumer welfare of a shift to free trade in equities is more likely to be positive than previously thought.

NOTES

1: The requirement that $0 < d < 1$ ensures that members of the older generation will always consume a positive amount. Since we have assumed $r \geq 0$, their retirement resources of $(1 + r + \alpha)s$ will be positive whenever $\alpha \geq 1$.

2: The choice of functional form for the production function deserves some comment. It is more common to analyze a linear homogenous function multiplied by a stochastic term with unit mean: $Q = \alpha F(K,L)$. Examples include Batra 1975; Mayer 1976; Baron and Forsythe 1979; Helpman and Razin 1978a and b; Grossman and Razin 1984, 1985. In this case the variance of the return to capital is $(f')^2\sigma^2$, implying that any change in per-worker capital stock affects not only the return to capital but also its variance. Since this is a complication with which this thesis is not concerned, our alternative formulation was adopted. Another advantage of the additive form is that it mimics reality more closely than the model with multiplicative uncertainty, since in actuality the return to capital does absorb most of the variance in output. The risk-sharing arrangements responsible for this asymmetry between labor and capital, which are the focus of the implicit contracts literature, (Bailey 1974) are not readily incorporated into this particular model.

3: The uniqueness of the equilibrium can be ascertained by noting that $k'(w) > 0$ and $k''(w) > 0$ (where $k(w) = w^{-1}(k)$), while $\tilde{s}_w > 0$, $\tilde{s}_{ww} < 0$ everywhere.

4: Proposition 1 holds as stated for the levels of risk aversion assumed in this thesis -- γ and $\hat{\gamma} < 1$. If we were instead to assume $1 < \gamma$ and $\hat{\gamma}$, then wages would both fall.

5: The "golden rule" of traditional models, $r^* = n$ (Samuelson 1958), is motivated by the fact that $r = n$ maximizes total steady-state consumption, $f(k) - nk$. In the stochastic model, setting $r = n$ likewise maximizes steady-state consumption. However, in the newer model, a rise in k increases the variance of consumption as well its expected value, so that at $f' = n$ the costs from of marginal unit of capital exceed the benefits. In consequence, under uncertainty the optimal level of expected equity returns exceeds the rate of population growth by a margin which is positively related to the variability of those returns.

6: Overlapping-generations models which could be "inefficient" in the steady state have been discussed by Diamond (1965) as well as Blanchard (1985).

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