benefits, before retirement age they provide some support for the view that labor force attachment and retirement behavior is affected by anticipated Social Security benefits. Yet, the behavior of older men and women at retirement age is clearly affected by considerations other than income. And it is significantly different for men and women. Indeed, for women just past retirement age, income appears to have a surprisingly small influence on their work behavior.

Third, this sample is based on the "young" elderly; the respondents are described and analyzed as they pass through the conventional retirement age of 65. As this cohort ages, female heads of household will increase, both proportionally and absolutely, and real incomes, especially those of women, can be expected to decrease.

In sum, this study finds significant differences between retirement age women and men not only in income and income sources, but also in their work behavior. Men's work behavior after retirement age (and hence their earnings) is likely to be moderately affected by their financial resources. Women's, on the other hand, is not. The low incomes and limited income sources of retirement age women do not have much impact on older women's work behavior. Rather, retirement age women are unlikely to improve their financial positions through work and earnings.

From a policy perspective, this difference has important implications. Incomes policy for the elderly retired does not now reflect the different behavior and financial circumstances of elderly men and women. Indeed, it has the effect of exacerbating the differences between men's and women's incomes and, hence, their welfare. If income policy toward the elderly sought to improve the financial condition of poorer among today's elderly, it would have to take gender-based behavioral differences into account.

Finally, the results of this study suggest several areas for further study topics which were precluded by limitations of this data set. First, this study has noted the differences between older men and women in terms of both income and behavior. Little research has focused on gender differences in the economic behavior of older Americans. More study of those differences and of older women in particular is needed. Specific areas for future study should include the following topics: 1. Differences in income status and work behavior between those who receive primary survivors' Social Security benefits; 2. Differences among cohorts of the elderly (newly-retired, elderly, and very elderly) with emphasis on gender differences.

References

EXHAUSTIBLE RESOURCES
AND INTERNATIONAL TRADE

PAUL M. COMOLLI*

I. Introduction

Over the past several years there have appeared numerous studies extending the optimal growth/exhaustible resource model of Dasgupta and Heal [9] to include international trade in the exhaustible resource and a produced composite good. Though these studies differ according to whether capital is internationally mobile [24,21,11] or is internationally immobile [18], they all have in common the small open-economy assumptions (i.e., exogenous rate of interest and/or terms of trade). As a consequence, these analyses tend to focus more on the impact of international trade on resource depletion and capital accumulation and less on the purely trade-theoretic aspects of the model (e.g., patterns of trade and specialization). This paper will focus on the latter.

A rigorous analysis of the trade-theoretic aspects of the Dasgupta-Heal model requires that the terms of trade and rate of interest be endogenously determined within a two (or many) country setting. This determination requires that the intertemporal competitive equilibrium for the satchki economy be solved in closed form. This is unattainable when the economy has a positive rate of utility discount. However, as Dasgupta [9] has recently demonstrated, a closed-form solution of the satchki model can be obtained when the utility discount rate is zero. This version of the model and its solution will be set out in Section II.

We should hasten to add that a zero rate of utility discount does not mean that countries have zero rates of interest. Rather, these will be found to be positive though asymptotically vanishing in the model. Moreover, in order that there exist intertemporal gains from trade, countries' satchki interest rates must always differ (except, possibly, at a finite number of points in time). This difference would suggest from the standard neoclassical result that both countries will typically not be simultaneously incompletely specialised [12]. In particular, it will be shown that the country with the lower satchki interest rate imports the exhaustible resource and ordinarily completely specializes in the production of the composite good. A complete account of the patterns of trade and specialization which may arise in the model is given in Section III.

One of the more interesting results in international trade theory is that interest rates are equalized between countries in the long run despite the absence of international capital

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1. Ojzic [18] has recently examined the Dasgupta-Heal model within a two-country framework in which the terms of trade is endogenous. However, his analysis excludes capital accumulation.
mobility [7;10]. The standard assumptions include that countries are incompletely specialized in production and have identical constant-returns-to-scale technologies for each good. In the present analysis only the resource-exporting country is always incompletely specialized and, moreover, the Dasgupta model utilizes a decreasing-returns-to-scale Cobb-Douglas production function for the composite good. Nevertheless, it will be shown in Section III that International trade equalizes domestic rates of interest between countries and, rather surprisingly, this is true intertemporally and not merely asymmetrically.

Some observations on the applicability of the analytical results to more general settings (e.g., positive rate of utility discount and CRS production functions) are offered in Section IV.

II. The Dasgupta Model

The problem confronting the perfectly competitive economy may be posed as follows:

\[
\max_{{C_t, A_t}} \int_0^\infty u(C_t) \, dt
\]

s.t. \( R_t = F(K_t, R_t) - C_t \)

\( K_0 > 0 \) given

\( S_0 \geq \int_0^\infty R_t \, dt \)

\( S_0 > 0 \) given

where \( K_0 \) and \( S_0 \) are the society's initial endowments of capital and the exhaustible resource, \( u(\cdot) \) is a measure of its current utility, and \( F(\cdot) \) is a measure of its current productivity. The economy may be taken to solve this problem by choosing nonnegative values of consumption of the composite good \( C_t \) and utilization of the exhaustible resource \( R_t \) for all \( t \geq 0 \).

Following [3] we shall assume that

\[ u(C_t) = -C_t^{1-h} \quad h > 1, \]

where the constant \( h \) represents the society's elasticity of marginal utility, and that

\[ F(K_t, R_t) = F(K_t^a R_t^b) \quad a > h > 0; a + b < 1 \]

where the constants \( a \) and \( b \) are output elasticities satisfying

\[ h > (1 - b)/(a - b). \]

The parameter restriction (6) will ensure that a unique interior solution exists to the problem.\(^2\)

Necessary and sufficient conditions for optimality include

\[ u'(C_t) = y_t \]

\[ F_t(K_t, R_t) = X/y_t \]

\[ F_t(K_t, R_t) = -y_t/y_t \]

along with (1) and (2) holding as an equality. The auxiliary variable \( y_t \), associated with (1), and the Lagrange multiplier \( X_t \), associated with (2), reflect positive utility prices of \( K_t \) and \( S_0 \), respectively.

Substituting from (3) and (4), the optimal solution can be obtained as follows:

\[ R_t = (\alpha K_t^{a-1} - 1/(a - 1) + 1 + a)/(\alpha K_t^{a-1} - 1/(a - 1))^{1/\alpha} \]

\[ K_t = \begin{cases} \alpha - A/(a - b) & \text{if } a - b > 0 \;
\end{cases} \]

\[ S_t = \begin{cases} \alpha - A/(a - b) & \text{if } a - b > 0 \;
\end{cases} \]

where \( k \) and \( e \) are positive constants given by

\[ k = b - 1 + (a - b)/h, \quad e = 1 + b/(h - 1) \]

and the constant \( g \) is given by\(^3\)

\[ g = (1 - a)/(a - b)/(a - b) < 0. \]

Equations (9)-(11) represent competitive equilibrium paths for the closed economy. It is straightforward to show that \( R_t \) asymptotically tends to zero and \( K_t \) asymptotically tends to infinity, and both are convex functions of \( t \). Whereas \( C_t \) asymptotically tends to infinity, its convexity is indeterminate.\(^4\)

Observe that the RHS of (7) has the natural interpretation in a perfectly competitive economy of the relative price of the resource in terms of the composite good, viz.,

\[ p_t = X/y_t \]

and the RHS of (8) has the natural interpretation of the perfectly competitive interest rate, viz.,

\[ r_t = -y_t/y_t \]

where, upon differentiating (14),

\[ r_t = y_t/y_t \]

Equation (16) is the familiar market equilibrium condition discovered by Hotelling [9] which asserts that resource extractive firms, given costless extraction and perfect foresight, are indifferent between supplying a unit of the resource at two different points in time so long as the relative price of the resource rises at the competitive rate of discount. Equivalently, it is immediate from (7) and (8) that one can advance (16) in the form of

\[ F_t = R_t / F_t \]

suppressing functional arguments, which is a stock market equilibrium condition asserting that resource extractive firms, given costless extraction and perfect foresight, are indifferent between holding a unit of the resource and holding a unit of capital so long as these two assets earn identical rates of return (viz., \( r_t \)). Both of these interpretations of the intertemporal nature of a competitive equilibrium will be useful in the sequel.

III. International Trade

Employing (4), (9), (10), and (14), one can use (12) and (13) to rewrite (7) as

\[ \log p_t = \log p_t + A t \log (1 + B) p_0 = \alpha - A(0)/K_0 /K_0 \]

where \( A = a/k/(a - b) \) and \( B = (a - b)K_0^a/(a - b/2) \). Equation (18) characterizes the autarky equilibrium relative price path, and it is graphed in Figure 1. It is obvious that an increase in \( K_0 \) (or a decrease in \( S_0 \) or \( h \)) raises the relative equilibrium price, say from \( p_0 \) to \( p_0 \). Further, it is immediate from (16) that the slope of the relative price path at any time \( t \) represents the equilibrium interest rate

\[ r_t = AB/(1 + B) \]

Partially differentiating (19) it can be verified that an increase in \( K_0 \) (or a decrease in \( S_0 \) or \( h \)) lowers \( r_t \) for all \( t \geq 0 \). This confirms the depiction given in Figure 1 that an

\[ 3 \text{The mathematical proof is available from the author upon request.}
\]

\[ 4 \text{It can be shown that } C_t \text{ is convex or concave in } t = -e(h - 1)/d, \text{ i.e., as } 2e - 1 \text{ is greater or less than } h(0 - 1). \]
would opt to postpone extraction in order to reap the capital gains that accrue to holding the resource and extracting it later.

Therefore, with the advent of free trade, the foreign country would completely specialize in the production of the composite good and export the exhaustible resource, although it would remain incompletely specialized. This is because, in the Cobb-Douglas case, the relative price of the resource could never rise sufficiently under trade so as to exceed the marginal product of the resource in producing the composite good.³ Obviously, at some finite time \( T \), the home country will exhaust \( S_h \), whereupon the pattern of trade and specialization will be reversed. At time \( T \) the home country will completely specialize and export the exhaustible resource. Under perfect foresight the reversal time \( T \) must be consistent with \( S_h \) being exhausted asymptotically.

The heavily lined curve in Figure 1 portrays the equilibrium terms of trade path. Since the slope of this curve at any time \( t \) represents the world interest rate, it is obvious that trade in the exhaustible resource has served to equilibrate domestic rates of interest. Apparently, the reason that this result holds intertemporally, and not merely asymptotically as in the Heckscher-Ohlin analysis, is because of the ascendancy of exhaustible resources. The stock market equilibrium condition (17) requires that both capital and the exhaustible resource always earn identical rates of return. There is no analogous condition in the Heckscher-Ohlin analysis. In the latter the interest rate (15) equals the difference between \( F_K \) and the economy’s rate of utility discount. Because \( F_K = F_K^* \) in general, domestic rates of interest are never equal except asymptotically as \( F_K \) and \( F_K^* \) vanish.⁵

Notice that the unique intersection established in Figure 1 was predicated on the assumption that countries are identical except in one parameter (e.g., \( K_0 + K_2 \) but \( S_0 = S_2 \) and \( a = \lambda^2 \)). Since changes in the parameters of the model affect both the initial relative price as well as the rate of growth in the relative price, it would seem that two other possible cases could arise in the model when countries differ in more than one parameter. The first case is where countries' autarky equilibrium relative price paths asymptotically converge but do not interest.⁶ For example, if \( w_1 > w_2 \) for all \( t \), then the home country would always export the exhaustible resource and the foreign country would always export the composite good. Since it would be inefficient for the foreign country to exhaust \( S_h \) in finite time, both countries would remain incompletely specialized. The second case is where countries' autarky equilibrium relative price paths intersect more than once. While it would still be true that domestic interest rates are always equalized, this case allows for multiple reversals in the pattern of trade. For example, in Figure 1 the autarky equilibrium relative price paths intersect at a second time \( T^* \), then the home country would be the sole supplier of the exhaustible resource over the intervals \( 0 \leq t < T \) and \( T^* < t < \infty \), while the foreign country would be the sole supplier over the interval \( T < t \leq T^* \).

³ In the Cobb-Douglas case, \( F_K(0) = 0 \) and \( F_K(1) = 0 \), so that the factor \( a \) is constant.

⁵ In the Heckscher-Ohlin case with constant elasticity \( a \), the former condition does not hold when \( 1 < t < \infty \) and the latter condition does not hold when \( 0 < t < 1 \). Consequently, in the general CES case the opening of free trade may cause \( a \) to be violated for the resource-exporting country moving to complete specialization.

⁶ This assumption, of course, that countries possess identical rates of utility discount; for, otherwise, domestic rates of interest would not be equalized over the long run.

⁷ Notice that countries' autarky equilibrium relative price paths must converge asymptotically if they do not intersect. If these paths did not converge, then at least one of the countries' autarky equilibrium paths must be nonoptimal. Either the country with the higher relative price achieves \( p_2 = 0 \) for some finite time, or else the country with the lower relative price has \( p_1 < 0 \), which implies that the natural resource is insufficiently exhausted in finite time, or else the country with the lower relative price has \( p_1 < 0 \), which implies that the natural resource is insufficiently exhausted.
IV. Concluding Observations

A plausible conjecture is that the analytical results of Section III are applicable to more general specifications of the model. This conjecture cannot be rigorously proved, of course, but it can be well argued heuristically. Observe that the fundamental result which is central to the analysis is the intertemporal equilibrium condition (17) or, equivalently, (16). Dasgupta and Heal [5] have demonstrated that this condition holds in the general case of an arbitrary CES production function and positive rate of utility discount. This would suggest that so long as the resource-exporting country remains incompletely specialized so that (7) holds with equality, whence (17) holds with equality, one should expect to obtain intertemporal equalization of domestic interest rates and one or more reversals in the intertemporal pattern of trade and specialization.

This is not to say that there would exist no qualitative differences in the analysis. It is easy to show that both the relative price and the interest rate under autarky are bounded from above (respectively, from below) when the elasticity of factor substitution is less than (respectively, greater than) unity. Similarly, the introduction of a positive rate of utility discount may result in the capital accumulation (and composite-good consumption) path to tend to zero asymptotically, instead of tending to infinity asymptotically as in Section III. The fact that countries may possess different rates of utility discount would seem to be unimportant however, since their domestic rates of interest are different anyway. Thus, provided that countries have identical CES production functions, the principal conclusions of Section III concerning interest rate equalization and intertemporal trade pattern should be preserved.

References


*See Proposition 4 is [5,15-16]. Their proof requires that the utility rate of discount \( d > q(1 - h) \), where the constant \( q = \min \Phi \). Denoting the constant elasticity of factor utilization by \( y \), \( q = 0 \) when \( y < 1 \) and \( q = 0 \) when \( y > 1 \).

Dasgupta and Heal [10] have shown that \( K_t \) and \( G_t \) asymptotically tend to zero (respectively, infinity) if \( d \) is greater than (respectively, less than) 4.


MACROECONOMIC ADJUSTMENT UNDER A SLIDING PEG EXCHANGE RATE AND IMPERFECT CAPITAL MOBILITY

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I. Introduction

In their efforts to find non-traditional ways to curtail inflation various Latin American countries devised an anti-inflationary strategy based on the preannunciation of the exchange rate. Traditionally, these countries sought inflation through tight monetary policy; in particular, their objective was to reduce the rate of growth of the money supply. This type of policy was widely used during the 1960s and early 1970s, and despite the rise in unemployment that usually accompanied the implementation of these plans, in general, they eventually succeeded in reducing the rate of inflation.

An alternative policy was followed in the southern countries of Latin America. The novel element in these policies was the choice of an exchange rate rule consisting in the preannunciation of the future values of the exchange rate. These future values embodied a drastic reduction in the rate of devaluation of the exchange rate from their prevailing levels (ranging from 80 to 80 percent). In the long run, this reduction in the rate of devaluation should translate into a proportional reduction in the rate of inflation.

One possible motivation for the choice of an exchange rate target was the important role played by foreign currency in these economies. The U.S. dollar was extensively used as a unit of account, and in some instances, even as a medium of exchange. An additional advantage of following this rule is that the exchange rate, as opposed to money, is a price in itself, the price of foreign currency, whose value was widely known and followed in these economies.

Argentina, Chile and Uruguay implemented this preannunciation policy in the late 1970s by issuing a schedule including the future values of the exchange rate. These stabilization efforts, which are now widely known as the "Southern Cone stabilization plans," were unique experiences that attracted the attention of researchers and policy makers since their initial implementation.

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1This schedule was known as "la tabla"—which in Spanish means the table. The extent of period for which the value of the forward exchange rate was preannounced varied from country to country and even for the same country from period to period.

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