Preliminary and Incomplete

Long-Run Lunacy, Short-Run Sanity: A Simple Model of Trade with Labor Market Turnover

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International trade is a long run issue – Paul Krugman (1996)

But this long run is a misleading guide to current affairs. In the long run we are all dead. Economists set themselves too easy, too useless a task if in tempestuous seasons they can only tell us that when the storm is long past the ocean is flat again – Lord John Maynard Keynes (1923)

Why aren't we all Keynesians yet? – Paul Krugman (1998)

The first quote from Paul Krugman represents the widespread view that most important international trade issues can best be understood by focusing on long-run relationships. Many of the assumptions that underlie the most influential model of trade – the Heckshcer-Ohlin-Samuelson (HOS) model – are clearly long-run in nature and it is understood that model's predictions are intended to describe long-run relationships. Over the years, there have been many attempts to broaden our scope and begin to take the short-run more seriously. The Specific Factors (SF) model is one such example. It replaces the HOS assumption of complete factor mobility with another extreme assumption – that some factors can only be employed in certain sectors. By now, the relationship between these two models is well known. Reallocating the mobile factors in the SF model allows one to trace out a short-run production possibilities frontier for each set of assumptions about factor mobility. The long-run production possibilities frontier of the HOS model is the outer-envelope of all of the short-run frontiers. Thus, the long-run behavior of the economy is just the natural extension of its short-run behavior.

In this paper, we provide a simple model of international trade with labor market turnover and examine its short run and long run behavior. The empirical relevance of labor market turnover has been widely documented over the past decade (see, for example, Davis, Haltiwanger and Schuh 1996). Models that account for this phenomenon have become the norm in some sub-fields in economics, but not in

international trade. We have argued elsewhere that the existence of labor market turnover forces us to modify many of the standard theorems in international economics (see, for example, Davidson, Martin and Matusz 1999). In this paper, we argue that its presence makes the relationship between an economy's short-run and long-run behavior far more complex than it is in traditional trade models. For example, the economy's short-run production possibilities frontier may lie outside of its long run frontier. In addition, we show that emphasis on long-run relationships is misplaced and can lead one to draw faulty policy conclusions. Focusing on the short-run behavior of the economy restores sanity. The implication is that in the presence of labor market turnover international trade issues can only be understood by focusing on the entire dynamic path of the economy. Long-run relationships should be ignored.

2. The Model

Consider a continuous time model of a small open economy that produces two goods (x and y) with a single factor of production, labor. Workers are infinitely lived, derive utility from consumption and differ according to ability, with the ability level of worker i denoted by a_i.[1] For simplicity, we assume that a_i is uniformly distributed on [0,1] and that the total measure of consumers is one.

The two sectors differ from each other in two dimensions. First, ability has a stronger influence on worker productivity in sector x than it does in sector y.[2] To be specific, we assume that a worker employed in sector y produces q_y units of flow output

[1] If workers are finitely lived, additional complications arise because changes in employment result in intergenerational transfers. For details, see Davidson, Martin, and Matusz (1994).

[2] Since labor is the only input, this assumption is necessary to generate diversified production over a wide range of relative prices.

regardless of ability, while a worker employed in sector x with ability a_i produces $q_x a_i$ units of flow output. We assume that workers are paid the value of their marginal product. Thus, if we choose *y* as the numeraire and use *p* to denote the world price of *x*, then a worker with ability a_i earns a wage of $w_y = q_y$ if employed in sector *y* while her sector *x* wage would be $w_x(a_i) = pq_x a_i$

The other dimension that differentiates sectors is the degree of job turnover. We again opt for simplicity and assume that there is no turnover in sector *y*. Workers who choose to seek employment in that sector find jobs immediately and can remain employed there indefinitely. In contrast, workers who wish to obtain jobs in sector *x* must search for employment and search takes time. In particular, we assume that jobs in this sector are filled stochastically with the rate of job acquisition denoted by λ. It follows that $1/\lambda$ is the expected duration of unemployment in sector *x*. Once a worker secures a job in this sector, she remains employed until an exogenous shock causes the job to dissolve, forcing her to reenter the search process. The rate at which these jobs break up is denoted by *b*, so that the expected duration of a job in sector *x* is $1/b$.[3]

Workers choose their occupation based on expected lifetime income.[4] If we use *r* to denote the discount rate, then a worker with ability level a_i expects to earn $V_{ey}(a_i) = \frac{q_y}{r}$ over her lifetime if she is employed in sector *y*. For sector *x*, we use $V_{ex}(a_i)$

[3] The assumption that search is required to find employment is not essential to our analysis. It could easily be replaced by an assumption that workers must train for employment and that the flow of output produced while training is below the flow produced after training has been completed. All that is required is that there is a labor market state during which output is below its potential level and that there is some randomness in the rates at which workers enter and exit that state.

to denote the expected lifetime income for an employed worker with ability a_i. Analogously, $V_{sx}(a_i)$ denotes the expected lifetime income for a worker with ability a_i who is currently searching for a job in sector *x*. Then, for sector *x* workers we have the following asset value equations

$$(1) \qquad rV_{sx}(a_i) = 0 + \lambda\{V_{ex}(a_i) - V_{sx}(a_i)\} + \dot{V}_{sx}(a_i)$$

$$(2) \qquad rV_{ex}(a_i) = pq_x a_i + b\{V_{ex}(a_i) - V_{sx}(a_i)\} + \dot{V}_{ex}(a_i)$$

In each equation, the first term on the right-hand-side is current income while the second term is the product of the capital gain (or loss) from changing labor market states and the rate at which such changes take place. For completeness, we include the final term, which is the derivative with respect to time of expected lifetime income. However, in our framework, expected lifetime income depends only on parameters of the model that are time invariant, and therefore these terms equal zero for all time. These equations can be solved to obtain

$$(3) \qquad V_{sx}(a_i) = \frac{\lambda}{r+b+\lambda}\frac{pq_x a_i}{r}; \qquad V_{ex}(a_i) = \frac{r+\lambda}{r+b+\lambda}\frac{pq_x a_i}{r}$$

The equations in (3) have natural interpretations. With our assumptions about the turnover process, each worker can expect to spend a fraction of her time employed and a fraction of her time searching. The fraction of time spent employed is $\lambda/(b+\lambda)$. Therefore,

[4] As we have already noted, all workers live forever in our model, so we are being loose with our use of the

the worker's expected lifetime income is equal to a weighted average of what she earns while employed $(pq_x a_i)$ and what she earns while searching (zero). Because of discounting, the weight applied to the current activity is slightly higher than the weight applied to the future activity. As such, searchers place slightly greater weight on their current income of zero than on the positive income that they will earn once employed. Similarly, employed workers place slightly greater weight on their positive income and discount the zero income that they will earn when they become unemployed.

In the market-induced steady state equilibrium, unemployed workers opt for sector *y* if $V_{ey}(a_i) > V_{sx}(a_i)$; otherwise, they search for jobs in sector *x*. We define the *marginal* worker as the one who is just indifferent between taking a job in sector *y* and searching for a job in sector *x*. We use a_m to represent the ability level of this worker, where a_m solves $V_{ey}(a_m) = V_{sx}(a_m)$. Using (3) and our value for $V_{ey}(a_i)$ we obtain

$$(4) \qquad a_m = \frac{1}{p}\frac{q_y}{q_x}\frac{r+b+\lambda}{\lambda}.$$

For the marginal worker, $w_x(a_m) > w_y$. This follows because workers in sector *x* spend only a fraction of their time employed and earning income, whereas workers in sector *y* are always employed. Indifference of the marginal worker implies that there has to be a payoff to waiting for a job in sector *x*. Because of this feature, we shall sometimes refer to sectors *x* and *y* as the high-wage and low-wage sectors, respectively.

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term "lifetime". However, it is simpler to use the phrase "lifetime income" rather than the more cumbersome phrase "income discounted over the infinite future."

A diversified production equilibrium exists for a range of prices. That is, $0 < a_m < 1$ as long as the relative price of *x* is neither too high nor too low. Moreover, all workers with $a_i < a_m$ take jobs in the low-wage sector, while all with $a_i > a_m$ are either searching or employed in the high-wage sector. For future reference, we define a_{ft} as the equilibrium value of the marginal worker under free trade. The value of a_{ft} is determined by (4) when the domestic price of *x* is equal to the world price of *x*.

Given our assumption that workers are paid the value of their marginal products, the fact that $w_x(a_m) > w_y$ implies that the value of the *static* marginal product of labor in sector *x* is higher than that in sector *y,* suggesting a possible distortion that policy makers might target by means of an industrial policy. However, we demonstrate below that simply comparing the static marginal products of employed workers leads to faulty conclusions.

Define $E_j(t)$ as the mass of workers employed in sector *j*, and define $S_x(t)$ as the mass of workers searching for employment in sector *x* at time *t*. For notational convenience, we define $E_j(\infty)$ and $S_x(\infty)$ as the corresponding steady-state values of these variables. Recalling our assumptions that the mass of workers is equal to one and ability is uniformly distributed, we conclude that

$$(5) \qquad E_y(\infty) = a_m$$

$$(6) \qquad E_x(\infty) + S_x(\infty) = 1 - a_m .$$

In addition, in a steady-state equilibrium, the flow into sector x employment must equal the flow out of employment. Since $\lambda S_x(t)$ searchers find jobs and $bE_x(t)$ workers lose their jobs at each point in time, we must have $\lambda S_x(\infty) = bE_x(\infty)$, so that

$$(7) \qquad E_x(\infty) = \frac{\lambda}{b+\lambda}(1-a_m)$$

$$(8) \qquad S_x(\infty) = \frac{b}{b+\lambda}(1-a_m)$$

Given the equilibrium value of the ability of the marginal worker, we find the steady-state value of flow output (defined as $I(\infty; a_m)$) by integrating across ability:

$$(9) \qquad I(\infty; a_m) = \int_0^{a_m} q_y da + \int_{a_m}^1 pq_x a\left(\frac{\lambda}{b+\lambda}\right)da = q_y a_m + pq_x\left(\frac{\lambda}{b+\lambda}\right)\left(\frac{1-a_m^2}{2}\right).$$

We use as our measure of social welfare the present discounted value of flow income, $W(a_m)$, where

$$(10) \qquad W(a_m) = \int_0^{\infty} e^{-rt} I(\infty; a_m)dt = \frac{1}{r} I(\infty; a_m).$$

3. Long-Run Lunacy

Suppose that a social planner could allocate labor across sectors in a way to maximize the discounted steady state value of output. That is, suppose that a planner

could choose the ability level of the marginal worker to maximize $W(a_m)$ as defined by (10). Substituting (9) into (10), it is a simple matter to deduce that the allocation of labor that maximizes the discounted steady-state value of output is attained when

$$(11) \qquad a_p = \frac{1}{p}\frac{q_y}{q_x}\frac{b+\lambda}{\lambda}$$

where we have used the subscript "*p*" to indicate that this is the value that the planner would choose to maximize the value of steady state output. Evaluating both (4) and (11) at free-trade prices, it is evident that $a_p < a_{ft}$. That is, the discounted value of steady-state income is not maximized under free-trade. At the margin, moving some workers from the low-wage sector (where ability is not important) to the high-wage sector (where ability is important) increases the discounted value of steady-state output.

Armed with this information, it is easy to imagine a political pundit calling for an industrial policy aimed at expanding the high-wage sector. Many in the policy community have called for such a policy arguing that it is our interest to protect high-wage jobs and expand sectors where ability is rewarded.[5] If we focus on the long run, it appears that this model provides support for such an argument. Of course, this argument ignores the role played by the short-run transitions between steady states. But, if trade is truly a long-run concern, perhaps these short-run costs *should* be ignored. Below, we argue that this is not the case.

[5] See, for example, the writings of Robert Reich or Lester Thurow.

To fix ideas, imagine that this economy is a net importer of good *x*, so that an industrial policy aimed at expanding this sector is equivalent to an import tariff.[6] What would happen if this economy, initially in the free trade steady-state equilibrium, were to institute a small tariff of size τ on the imports of *x*? The tariff would make the protected sector more attractive (V_{sx} and V_{ex} would both increase) and some workers would start to switch out of the low-wage sector and search for jobs in the high-wage sector. From (4), the tariff-induced increase in the domestic price of good *x* generates a new value of a_m. By appropriate choice of τ, it is possible for an industrial policy to target $a_m = a_p$, so that, evaluated at world prices, the tariff maximizes the discounted value of steady-state income. Upon implementation of the tariff, all workers with ability $a_i \in \lfloor a_p, a_{ft} \rfloor$ immediately quit their low-wage jobs and start to search for jobs in sector *x*. Since search takes time, aggregate flow income measured at world prices, $I(t; a_p)$, immediately drops and then, as these workers find new jobs, it begins to gradually rise towards its new (higher) steady-state value. A typical time path for $I(t; a_p)$ is depicted in Figure 1. The discounted value of income in this situation is $W(a_p) = \int e^{-rt} I(t; a_p) dt$. If $W(a_p) > W(a_{ft})$, then the tariff is justified. Otherwise, the short run adjustment costs required to reach the new steady state exceed any long-run benefits that can be gained by expanding the import-competing sector.

In the next section, we explicitly solve for $I(t; a_p)$ and $W(a_p)$ and show that the adjustment costs are indeed too high to justify the tariff. Yet, it is easy to imagine that even with such information available we might still hear calls for import protection.

[6] Alternatively, the policy instrument would be an export subsidy if good *x* is the export good. The

After all, it might be argued, the only thing that makes this policy unattractive is the *short-run* costs. Why not bite the bullet, accept the short-run costs and expand the high-wage sector for the sake of the next generation? We may be worse off for a while, but once we approach the new steady state we will be better-off forever after. It is easy to imagine such an argument, peppered with quotes from Krugman and other international trade luminaries about the importance of the long run, carrying the day.

Suppose now that the economy adopts such a policy and institutes the tariff that maximizes the discounted value of steady-state output. Suppose further that enough time has passed that the economy is now arbitrarily close to the new steady state. Is it now in the economy's interest to stay there or should trade be liberalized? If the tariff is removed, the import-competing high-wage sector becomes less attractive and some workers start switching back to the export sector. If the tariff is removed completely, all workers with ability $a_i \in \lfloor a_p, a_{ft} \rfloor$ want to move to the low-wage sector, where jobs are easy to find and last forever. Workers who are searching for jobs in the high-wage sector at the time of liberalization make the move immediately while those who are employed in that sector move only after they have lost their job (assuming that after the tariff has been removed $V_{ex}(a_i) > V_{ey}$ for all $a_i \in \lfloor a_p, a_{ft} \rfloor$). Thus, the adjustment is gradual, and, if jobs in the import-competing sector are durable, it may take considerable time to approach the free trade steady-state equilibrium.

Aggregate flow-income (measured at world prices) during the adjustment to free trade is depicted in Figure 2. Since searchers produce no output, the aggregate value of output jumps up immediately when they switch sectors, instantly becoming employed in

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qualitative results remain unchanged.

sector *y*. However, as time passes, the fact that the value of the output produced by these workers is less in the low-wage sector than they would have produced had they remained in the high-wage sector starts to weigh on the economy, and flow income starts to decrease. It continues to fall until it approaches its new (free trade) steady-state value. Liberalization is optimal if the discounted value of aggregate flow-income along the adjustment path is greater than what could be earned by remaining in the tariff-distorted steady state. In the next section, we show that this is indeed the case, so that both arguments in favor of an industrial policy (both of which are based on *long-run* concerns) are flawed.

3. Short-Run Sanity

One of the advantages of a model as simple as ours is that it is possible to solve for the adjustment path across steady states and take this path into account when making welfare comparisons. Some additional notation will help in this regard. Define a_{m1} as the ability level of the marginal worker in some initial steady state. In this context, $a_{m1} = a_{ft}$ if we are examining movements away from the free-trade steady state, and $a_{m1} = a_p$ if we are examining movements away from the tariff-induced steady state. Similarly, define a_{m2} as the ability level of the marginal worker after the implementation of the tariff (or after trade liberalization). From our discussion in the previous section, it is clear that the only workers who are induced to switch sectors because of the policy change are those with ability levels between a_{m1} and a_{m2}. We therefore define $ME_j(t; a_{m1}, a_{m2})$ as the mass of workers who move between sectors in response to the

policy change and are employed in sector *j* at time *t*. For example, a policy change that causes workers to move from sector *x* to sector *y* causes sector *y* employment to jump up immediately (as all sector-*x* searchers with ability levels in the critical interval switch sectors), and then it continues to increase gradually as those workers who are employed in sector *x* move to sector *y* upon separation. We similarly define $MS_x(t; a_{m1}, a_{m2})$ as the mass of movers who are searching for employment at time *t*. This measure is zero for all values of *t* if the policy change causes the high-wage sector to shrink, since all searchers (within the relevant range of abilities) immediately move to the low-wage sector upon implementation of the policy. However, this measure jumps up and then gradually recedes to its steady-state value for a policy change that makes the high-wage sector more attractive.

We have two cases to consider. First, we consider the case where $a_{m2} = a_{m1} - \Delta$, with $\Delta > 0$. This would be the situation where trade policy protects the high-wage sector, causing it to expand. As we have already noted, $ME_y(t; a_{m1}, a_{m1} - \Delta) = 0$ for all *t*. We find $ME_x(t; a_{m1}, a_{m1} - \Delta)$ and $MS_x(t; a_{m1}, a_{m1} - \Delta)$ by solving the following system of differential equations:

$$(12) \qquad \frac{dME_x(t; a_{m1}, a_{m1} - \Delta)}{dt} = \lambda MS_X(t; a_{m1}, a_{m1} - \Delta) - bME_x(t; a_{m1}, a_{m1} - \Delta)$$

$$(13) \qquad ME_x(t; a_{m1}, a_{m1} - \Delta) + MS_x(t; a_{m1}, a_{m1} - \Delta) = \Delta .$$

Equation (12) simply notes that the change in sector *x* employment equals the difference between the mass of workers who find jobs after searching and the mass of

workers who lose their jobs. Equation (13) is an adding up constraint that follows from the fact that all movers are either employed or searching in sector *x*. Solving this system yields

$$(14) \qquad ME_x(t; a_{m1}, a_{m1} - \Delta) = \left(\frac{\lambda}{b+\lambda} - \frac{\lambda}{b+\lambda} e^{-(b+\lambda)t} \right) \Delta$$

$$(15) \qquad MS_x(t; a_{m1}, a_{m1} - \Delta) = \left(\frac{b}{b+\lambda} + \frac{\lambda}{b+\lambda} e^{-(b+\lambda)t} \right) \Delta$$

The flow of workers is reversed when a policy change makes the high-wage sector *less* attractive. We can represent this situation by letting $a_{m2} = a_{m1} + \Delta$. Here, $MS_x(t; a_{m1}, a_{m1} + \Delta) = 0$ for all *t* since all searchers immediately switch to sector *y* upon implementation of the policy, and all those employed in sector *x* switch to sector *y* upon separation. The differential equations describing $ME_j(t; a_{m1}, a_{m1} + \Delta)$ are:

$$(16) \qquad \frac{dME_x(t; a_{m1}, a_{m1} + \Delta)}{dt} = -bME_x(t; a_{m1}, a_{m1} + \Delta)$$

$$(17) \qquad ME_y(t; a_{m1}; a_{m1} + \Delta) + ME_x(t; a_{m1}; a_{m1} + \Delta) = \Delta .$$

Using the initial condition that $ME_x(0; a_{m1}, a_{m1} + \Delta) = \frac{\lambda}{b+\lambda} \Delta$, we solve this system to obtain

$$(18) \qquad ME_x(t; a_{m1}, a_{m1} + \Delta) = \frac{\lambda}{\lambda + b} e^{-bt} \Delta$$

$$(19) \qquad ME_y(t; a_{m1}, a_{m1} + \Delta) = \left(1 - \frac{\lambda}{\lambda + b} e^{-bt}\right) \Delta .$$

Finally, define $G(a_{m1}, a_{m2})$ as the discounted value of the gross increase in output and $L(a_{m1}, a_{m2})$ as the discounted value of the gross reduction in output (both measured at world prices) resulting in the move from the initial steady state to the new one. For example, $G(a_{m1}, a_{m2})$ would correspond to the discounted value of the increase in sector *x* output and $L(a_{m1}, a_{m2})$ would correspond to the discounted value of the reduction of sector *y* output when the high-wage sector *x* expands due to import protection ($a_{m1} < a_{m2}$). Using these definitions, a change in policy is welfare improving if $G(a_{m1}, a_{m2}) > L(a_{m1}, a_{m2})$.

Suppose now that we start at the free trade steady state and impose a tariff on the imports of *x*, causing this sector to expand. Using our notation, $a_{m1} = a_{ft}$ and $a_{m2} = a_{ft} - \Delta$ with (14) and (15) describing the evolution of employment in each sector. We note also that, evaluated at world prices, the instantaneous value of output lost for each worker who exits the low-wage sector is q_y, while the instantaneous value of output gained by the *average* worker moving into the high-wage sector is $pq_x\left(a_{ft} - \frac{\Delta}{2}\right)$.[7] Therefore,

[7] This latter value follows from our assumption that ability is uniformly distributed.

$$(20) \qquad G\left(a_{ft}, a_{ft}-\Delta\right)=\int_0^{\infty} e^{-rt} ME_x\left(t; a_{ft}, a_{ft}-\Delta\right) pq_x\left(a_{ft}-\frac{\Delta}{2}\right) dt$$

$$(21) \qquad L\left(a_{ft}, a_{ft}-\Delta\right)=\int_0^{\infty} e^{-rt} q_y \Delta dt\,.$$

Proposition 1: Expanding the high-wage sector by any amount above its free trade level reduces the net present discounted value of output evaluated at world prices. That is, $G\left(a_{ft}, a_{ft}-\Delta\right)< L\left(a_{ft}, a_{ft}-\Delta\right)$ for all $\Delta > 0$.

Proof: Substitute (14) into (20) and carry out the integration to obtain:

$$G\left(a_{ft}, a_{ft}-\Delta\right)=\frac{pq_x}{r}\left(a_{ft}-\frac{\Delta}{2}\right)\left(\frac{\lambda}{\lambda+b}\right)\left(1-\frac{r}{r+\lambda+b}\right)\Delta < \quad \frac{pq_x a_{ft}}{r}\left(\frac{\lambda}{\lambda+b}\right)\left(1-\frac{1}{r+\lambda+b}\right)\Delta =$$

$$\frac{pq_x a_{ft}}{r}\left(\frac{\lambda}{r+\lambda+b}\right)\Delta = \quad \frac{q_y}{r}\Delta = \quad L\left(a_{ft}, a_{ft}-\Delta\right).$$

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Proposition 1 shows that expanding the high-wage sector beyond the free-trade equilibrium results in discounted net losses. The short-run costs outweigh the long-run gains.

Suppose, however, that policies have already been implemented to protect the high-wage sector. Or, alternatively, policies to protect that sector are given serious

consideration as a way for the current generation (which bears all of the costs) to provide a benefit to future generations (who would appear to reap all of the benefits).[8] Liberalizing trade would result in a decline in the long-run value of instantaneous output. However, this would only occur after an initial burst of activity resulting in a spike in instantaneous output. This follows from the fact that some workers would cease searching for employment in the high-wage sector (where they are not producing anything) and immediately accept employment in the low-wage sector. In this case,

$$(22) \qquad G(a_p, a_p + \Delta) = \int_0^\infty e^{-rt} ME_y(t; a_p, a_p + \Delta) q_y dt$$

$$(23) \qquad L(a_p, a_p + \Delta) = \int_0^\infty e^{-rt} \frac{\lambda}{\lambda + b} pq_x\left(a_p + \frac{\Delta}{2}\right)\Delta dt - \int_0^\infty e^{-rt} ME_x(t; a_p, a_p + \Delta) pq_y\left(a_p + \frac{\Delta}{2}\right) dt$$

Equation (23) shows that the discounted loss due to liberalization is the difference between what the movers would have produced had there been no liberalization and what they produce along the adjustment path. In deriving (23), we made use of the fact that the average productivity of the mass of workers who exit sector x is $\left(a_p + \frac{\Delta}{2}\right)$.

Liberalization yields discounted net benefits if the short-run gains outweigh the long-run costs. This is indeed the case, as we now demonstrate.

[8] Of course all individuals are infinitely-lived in our model, so our discussion of current and future generations is merely metaphorical in this context.

Proposition 2: Suppose that the high-wage sector is initially protected so that $a_{m1} = a_p < a_{ft}$. Consider a small amount of liberalization such that $a_p < a_{m2} \leq a_{ft}$. Then liberalization increases the net discounted value of output (evaluated at world prices) for all values of $\Delta = a_{m2} - a_p$.

Proof: In this case, workers are moving from the high-wage sector *x* to the low-wage sector *y*. Employment evolves according to (18) and (19). Substituting (18) into (23) and carrying out the integration yields:

$$L(a_p, a_p + \Delta) = \frac{pq_x}{r}\left(a_p + \frac{\Delta}{2}\right)\left(\frac{\lambda}{\lambda + b}\right)\left(1 - \frac{r}{r+b}\right)\Delta < \frac{pq_x a_{ft}}{r}\left(\frac{\lambda}{\lambda + b}\right)\left(1 - \frac{r}{r+b}\right)\Delta =$$

$$\left(\frac{\lambda + r + b}{\lambda}\right)\left(\frac{q_y}{r}\right)\left(\frac{\lambda}{\lambda + b}\right)\left(1 - \frac{r}{r+b}\right)\Delta = \left(\frac{\lambda + r + b}{\lambda + b}\right)\left(\frac{b}{r+b}\right)\frac{q_y}{r}\Delta = G(a_p, a_p + \Delta).$$

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The last step of the proof follows from substituting (19) into (22) and carrying out the integration. As long as there is any tariff in place, further liberalization increases the net discounted value of output.

Propositions 1 and 2 underscore the importance of the short-run. If we look only at long-run outcomes it appears that free trade is sub-optimal and that the economy could gain by protecting the high-tech sector. Yet, this is not the case at all – what goes on

between the steady-states is what matters most and when adjustment costs are taken into account free trade emerges as the optimal policy *regardless of the initial steady-state*. This means that in Figure 1, the up-front loss in flow income is greater than any long-run benefit from expanding sector 2. It also means that in Figure 2, the short-run increase in flow income that is triggered by liberalization swamps any long-run losses from expanding sector 1. Of course, this is what the vast majority of economists believe – free trade is always the best option – but when labor market turnover is present we only reach this conclusion when we focus on the short-run behavior of the economy and ignore its long-run properties.

5. Intuition

We now generalize our model in order to gain a deeper understanding of the relationship between the short and long run. Towards that end, we now assume that both sectors are characterized by job turnover, and that wages in both sectors are increasing in ability. Furthermore, we make no particular assumptions about the distribution of ability other than the normalization that $a_i \in [0,1]$ for all *i*.

Given these assumptions, unemployed workers must choose a sector in which to search for a job. In an equilibrium with diversified production, the marginal worker is just indifferent between sectors. This means that the marginal level of ability is defined by $V_{sy}(a_m) = V_{sx}(a_m)$, where

$$(24) \qquad V_{sj}(a_i) = \frac{\lambda_j}{r + b_j + \lambda_j} \frac{w_j(a_i)}{r}$$

and where our notation follows logically from our earlier discussion. Imagine now that, starting from an initial steady state, we move a small measure of workers into sector *j*. As in our earlier analysis, moving workers between sectors means changing the identity of the marginal worker from a_m to $a_m + \Delta$, where $\Delta > 0$ if the move is from *x* to *y*, and $\Delta < 0$ if the move is in the opposite direction. As before, the discounted gross gain in the value of output in the sector that expands is measured by $G(a_m, a_m + \Delta) = \int_0^\infty e^{-rt} ME_x(a_m, a_m + \Delta)\overline{w}_x dt$, where $\overline{w}_x \equiv \int_{a_m - \Delta}^{a_m} w_x(a) f(a) da$ and where $f(a)$ is the density function of ability. Following Diamond (1980), we define the value of the *dynamic* marginal product of labor as the present discounted value of output that can be obtained by adding an infinitesimal measure of workers to a sector, noting that all workers who enter the sector begin as searchers. Using this definition and (14), the value of the dynamic marginal product of labor in sector *x* is

$$(25) \qquad \lim_{\Delta \to 0} \frac{G_j(a_m, a_m + \Delta)}{\Delta} = \frac{\lambda_j}{r + \lambda_j + b_j} \frac{w_j(a_m)}{r} = V_{sj}(a_m).$$

In equilibrium, these values are equated across sectors. This is no surprise. Forward-looking agents choose the sector that generates the highest discounted value of wages (which reflect output), taking into account expected durations of employment and unemployment. Any movement away from the free-trade equilibrium breaks this equality (when evaluated at world prices) and reduces the discounted value of net output.

By contrast, the steady-state value of output is maximized when the steady-state values of the marginal products of labor are equated. The steady-state marginal product

of labor for sector *j*, defined as the increase in the steady state value of good *j* given a small increase in the mass of workers in sector *j* is

$$(26) \qquad \lim_{t\to\infty}\left\{\lim_{\Delta\to 0}\frac{ME_j}{\Delta}\overline{w}_j\right\}=\frac{\lambda_j}{\lambda_j+b_j}w_j(a_m).$$

There are only two ways that the both the steady-state marginal products and the dynamic marginal products of labor can be simultaneously equated across sectors. The first is if $r=0$, so that the future is just as important as the present. The second is if $\lambda_x=\lambda_y$ and $b_x=b_y$.

In general, using trade policy to protect the sector with the higher steady-state value of the marginal product of labor results in a higher steady-state value of output, but reduces the net discounted value of output. This can only happen if instantaneous output initially falls, which must indeed happen in this case. The negative welfare effects of this policy are clearly seen only by considering the short run.

It is also possible, of course, to fall prey to short-run lunacy. This could happen if a policy were implemented to provide protection to the sector with the lower steady-state marginal product of labor in the hopes of gaining a quick burst of output, delaying the ultimate costs (in the form of lower steady-state output) to the future. For example, returning to the parametric assumptions of Section 3, providing protection to sector *y* (in this case an export subsidy) would cause an immediate expansion in this sector and consequent increase in the value of output. Ultimately, however, the instantaneous value of output must fall as some workers who lose their high-wage jobs take low-wage jobs rather than return to searching in sector *x*. However, we know that movement away from

the free-trade equilibrium necessitates a reduction in the net discounted value of output. The short run-gain is not enough to overcome the long-run pain.

6. Production Possibilities Versus Sustainable Production

We are certainly not the first to explore the relationship between the short-run and long-run in the context of a general equilibrium model of trade. Seminal papers by Jones (1971), Mayer (1974), Mussa (1974), and Neary (1978) have all enriched our understanding of this connection. We argue here, however, that there is a distinct difference between our approach and the approach taken by others. In the standard approach, exemplified by Mayer (1974), it is assumed that some factor of production (say capital) is immobile in the short run, but then gradually moves between sectors in response to a differential in the rental rate. Ultimately, the allocation of capital reaches its long-run equilibrium when the rental rate (and therefore the marginal product of capital) is the same in both sectors. As Mayer shows, this sort of analysis leads to a long-run production possibilities frontier that is the outer envelope of a family of short-run frontiers, each of which is parameterized by a particular short-run allocation of capital. The key point is that the value output in the short run can never be higher than in the long run. This result is clearly at odds with our formulation.

In order to illustrate the difference between sustainable production and production possibilities, we return to the specialized model of earlier sections. Define $Q_j(t)$ as the aggregate quantity of output produced in sector *j* at time *t*. Using our earlier notation,

$Q_j(\infty) = \lim_{t\to\infty} Q_j(t)$, the steady state level of output in sector *j*. Multiplying total steady-state employment by average worker productivity in each sector, sustainable production levels are defined by (27) and (28):

$$(27) \qquad Q_x(\infty) = \frac{\lambda}{\lambda + b}\frac{1 - a_m^2}{2} q_x$$

$$(28) \qquad Q_y(\infty) = a_m q_y .$$

Simple substitution of (27) into (28) shows that the set of outputs that are sustainable in a steady state form a negatively sloped, concave curve, as illustrated in Figure 3. This is the analogue of the textbook production possibilities curve. However, we have already seen that the quantity of output in one sector or the other could temporarily exceed (or fall short of) its long run value.

In Figure 3, the lines points labeled $E_{ft}(\infty)$ and $E_p(\infty)$ represent the free-trade and tariff-induced steady states. The straight lines that pass through these points represent world prices.[9] As in the discussion above, Figure 3 is drawn to show that the value of steady-state output is not maximized at the free trade equilibrium. Rather, the economy would need to move more resources into the high-wage sector to maximize the value of steady-state output. However, implementation of a tariff causes an immediate reduction in the quantity of good *y* produced, while the quantity of *x* increases only slowly. The adjustment path lies inside the locus of steady state production. Measured at

[9] In order to avoid clutter, we have not drawn in the line representing domestic relative prices in the case of distorted trade.

world prices, the value of output first drops, then expands only gradually, corresponding to Figure 1.

Starting from the tariff-distorted steady state, removal of the tariff causes an immediate increase in the production of y (with no corresponding reduction in x) as searchers exit sector x, followed by a further gradual increase in y and reduction in x. As with Figure 2, the value of output expands in the short run, and this is enough to outweigh the lower value of output produced in the steady state.

While we have drawn Figure 3 based on the version of our model where turnover exists in only one sector, it should be clear that the principles are very general. In the special case where turnover parameters are the same in both sectors, adjustment occurs along the steady-state frontier. In this case, the free-trade allocation of resources maximizes the steady-state value of output. Implementation of a tariff reduces this value, but the reduction comes only gradually as resources are absorbed in the expanding sector at exactly the same rate as they are released from the contracting sector. The standard full-employment model is a special case, with $b = 0$ and $\lambda = \infty$ in both sectors. That is, once a worker becomes employed, she keeps the job forever (unless she chooses to quit), and all jobs are found immediately. A change of policy will, in this case, induce workers to quit one sector and enter the other (this follows since $V_{ej}(a_i) = V_{sj}(a_i) = V(a_i)$ for $j = x, y$) and the transition between one steady state and another is immediate.[10]

6. Conclusion

[10] In terms of Figure 1, output falls immediately to the new steady-state level and remains there forever. In terms of Figure 2, output immediately increases to the new steady-state level and remains there forever.

Early in our careers a senior colleague warned us that many people read just the introduction and conclusion of papers, figuring that all the essential information is contained in those two sections. Much of the analysis in international trade has followed a similar approach by focusing only on the initial and final equilibria without paying sufficient attention to the manner in which the economy goes from one steady state to another. The purpose of this paper has been to point out that if one just compares long run steady state equilibria they may be led to draw invalid conclusions. To see how we make this point, you will have to read the intermediate sections of this paper.

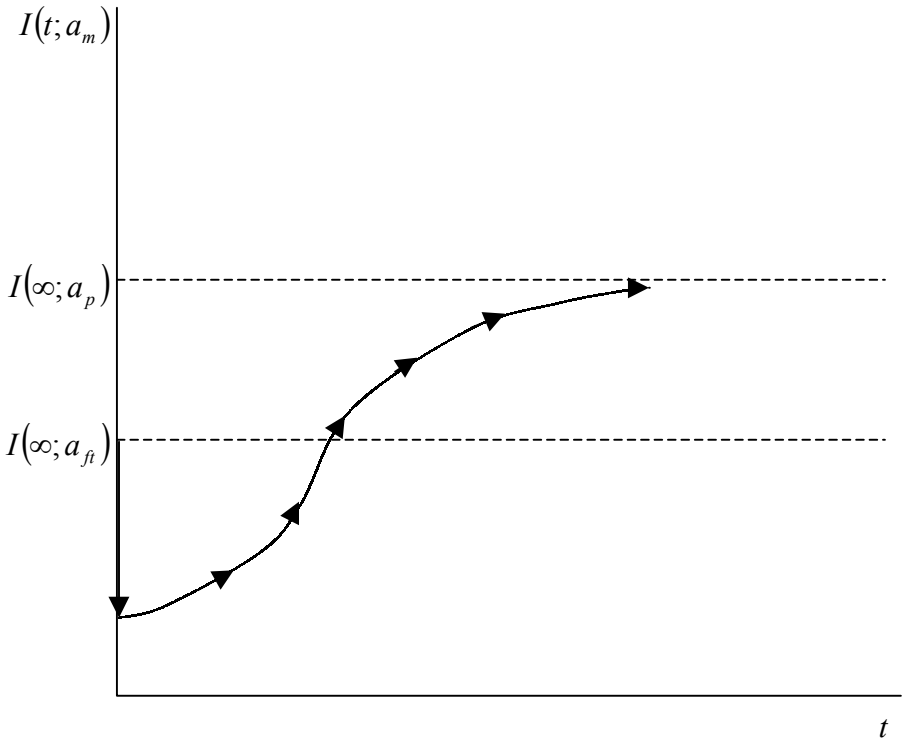

Figure 1:Expanding the High-Wage Sector when initially in Free Trade

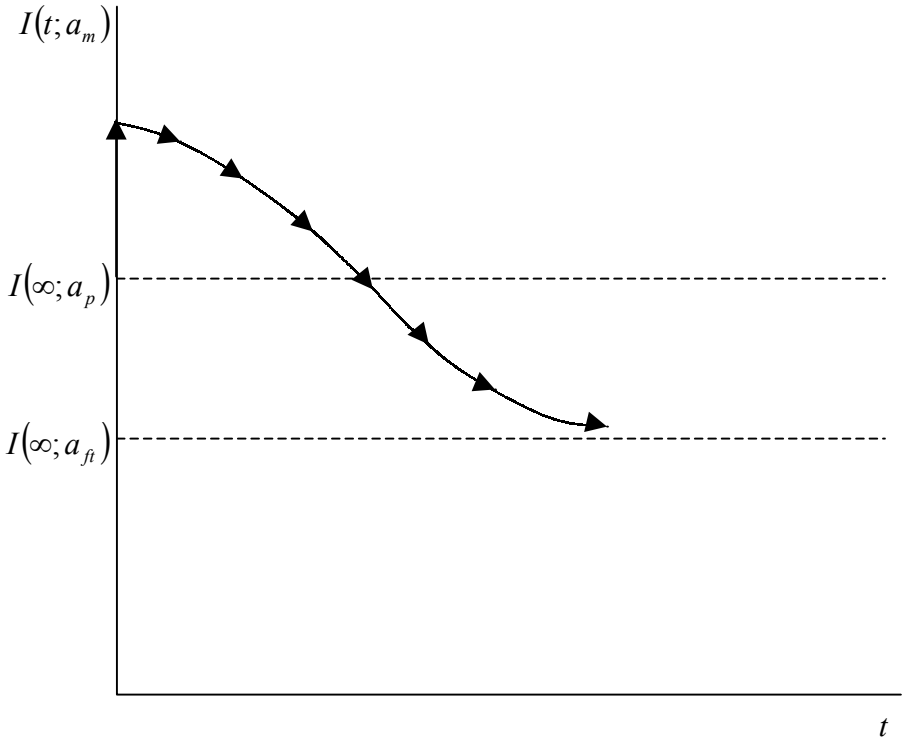

Figure 2: Liberalizing Trade

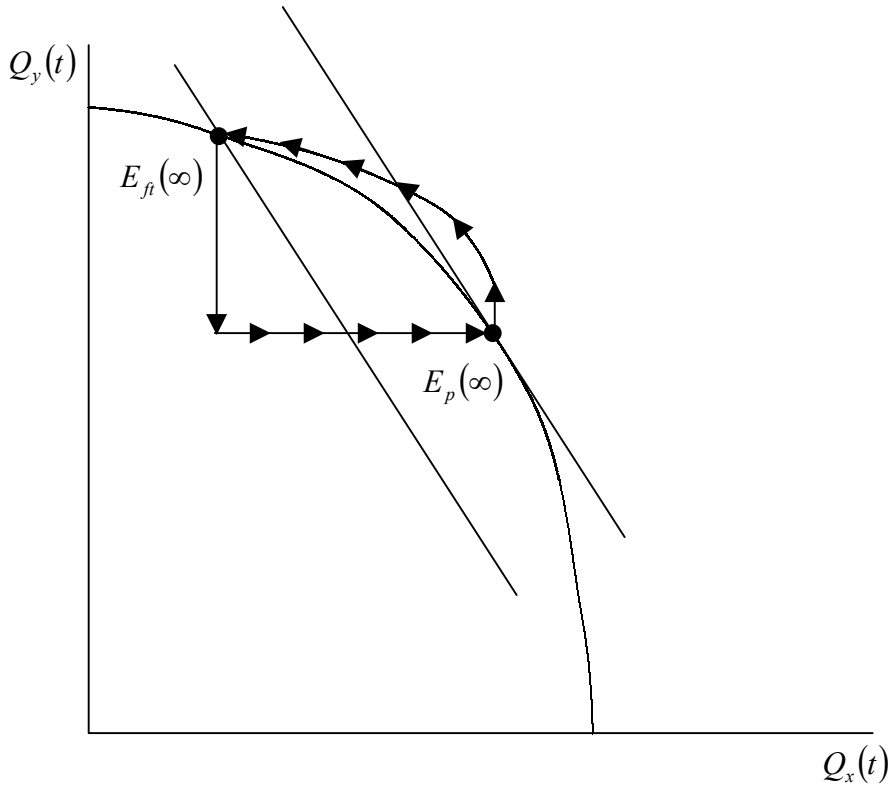

Figure 3: Short Run Production Possibilities and Steady State Possibilities

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