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PROTECTING LOSERS: OPTIMAL DIVERSIFICATION, INSURANCE, AND TRADE POLICY

S. Lael Brainard

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ABSTRACT

This paper derives a portfolio diversification rationale for a trade policy regime that insures returns to nondiversifiable human capital investment. In the absence of complete insurance markets for human capital, the decentralized equilibrium is characterized by excessive specialization. The socially optimal investment portfolio entails diversification for the reasons familiar from the CAPM. By credibly promising to protect losers ex post, the government can achieve the optimally diversified investment pattern. In contrast to previous results, two instruments are sufficient to achieve both efficient reallocation and full insurance when human capital is mobile at some cost, due to the endogeneity of the initial investment decision.

S. Lael Brainard
Sloan School of
Management
M.I.T.
Cambridge, MA 02139
and NBER

I. Introduction

To economists steeped in the doctrine of comparative advantage, the prevalence of high trade barriers in disadvantaged industries is a puzzling paradox, or a testament to the perversity of the policymaking process. Investigations of the incidence of these barriers suggest they are most closely associated with labor attachments rather than factors such as profits or market concentration.[1]

In this paper I show how protectionism may arise as a form of insurance for industry-specific human capital investment in industries experiencing relative decline when private insurance markets are imperfect.[2] With nondiversifiable human capital investment and imperfect insurance markets, the free market equilibrium entails an individually rational but socially suboptimal diversification of human capital. In such circumstances, the anticipation that losers will be compensated encourages workers to diversify according to the socially optimal allocation, and raises welfare overall.

The seemingly anomalous prevalence of protective barriers in industries with flagging comparative advantage can thus be seen as the natural outgrowth of policy that is optimal ex ante. In the absence of such policy, resources would be concentrated in a smaller subset of industries. While ex post welfare might be higher or lower in the free market equilibrium than in the protectionist equilibrium depending on the resolution of uncertainty, expected

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[1] See Cheh (1974), Fieleke (1976), Katz and Summers (1988), and Pincus (1975).

[2] In this paper I attribute the source of human capital specificity to industry attachments. Firm or regional attachments may be more important; the evidence is not conclusive. I confine attention to industry specificity for the purposes of clarity, with the understanding that the general results are not sensitive to the source of specificity, although the choice of instruments most likely is.

welfare is always higher when optimal ex post protection is anticipated.

To make this point, I construct a simple, small open economy model with two risky export sectors, a risk-free import sector, and a single factor - labor. Each individual has an indivisible endowment of human capital that he or she may invest in either of the export sectors; each chooses the sector with the risk/return profile that maximizes expected utility. Given that workers are homogeneous in their endowments and in their utility functions, the economy specializes completely at an endpoint of the efficient frontier in the absence of insurance. The government can raise welfare by inducing some workers to move to the less preferred sector through the promise of protection, which in effect insures their capital investments. The government assumes the role of a global investor whose optimal portfolio choice entails diversification for the reasons familiar from the CAPM.

The basic model and the diversification result build on recent work in the area of government intervention and insurance.[3] Using a two-period, general equilibrium, closed economy model, Eaton and Rosen (1980) demonstrate that earnings taxation can raise human capital investment and welfare when there is uncertainty in the returns to investment by reducing the riskiness of the investment. Eaton and Grossman (1985) use a two-period specific factors model, in which fixed capital investment is made ex ante and labor is allocated ex post, to show the potential for trade policy to raise welfare by equalizing the marginal utility of income ex post. And Grossman and Shapiro (1982) show that government provision of insurance raises welfare when workers make an ex ante choice between specializing in either a risky or a safe sector

[3] See Brainard and Cooper (1968), Turnovsky (1974), Fleming et. al. (1977), and Newbery and Stiglitz (1984) for other work in this area.

or diversifying their skill mix at the expense of lower productivity. The provision of insurance raises overall productivity and welfare by encouraging risk averse workers to invest in specialized skills.

In each of these models, the absence of complete insurance markets creates a wedge for government intervention to raise welfare. Intervention raises welfare through one of two channels: through an increase in the efficiency of ex ante investment, or through equalization of the marginal utility of income among workers. Intervention operates through both channels in the model I develop in this paper, but the primary channel is the gain from diversification in the presence of nondiversifiable human capital investment. The provision of insurance through trade taxes enables the government to convexify the human capital investment decision such that the economy achieves an optimal portfolio mix. The increase in welfare from ex post redistribution (the second channel) lends credibility to the government's ex ante promise to protect losers.

The optimality of government insurance provision is not in general robust to circumstances in which workers are partially mobile ex post, or policymakers are subject to informational asymmetries. I consider the implications of each of these caveats for the diversification result in turn.

As Diamond (1982) points out, when workers are even partially mobile ex post, there is a tradeoff between providing insurance and achieving efficient reallocation. Diamond makes this point with a one-period, small open economy model in which each worker starts out arbitrarily attached to one of two industries with unequal relative returns, and decides whether to move at some cost and loss of skill. In these circumstances, the provision of insurance discourages workers in the lower return industry from moving.

In Section III, I explore the implications of ex post mobility for optimal policy, and find that the results hinge on whether the ex ante pattern of human capital investment is influenced by expected policy. The tradeoff between insurance and efficiency can be overcome given an additional instrument to offset the moving cost, as long as the initial investment decision is endogenous to the expected policy. When the set of instruments is limited to industry taxes alone, however, the tradeoff between mobility and insurance given a limited set of instruments is quite stark: ex ante diversification with insurance can be realized only at the expense of ex post mobility, or the reverse.

I next consider the implications of informational asymmetries. The trade-policy-as-insurance result is generally derived, as in the basic model of Section II, assuming private insurance markets are incomplete. Stiglitz (1981) and Dixit (1987) have pointed out that models with incomplete private insurance markets implicitly assume there is an informational restriction in the private sector that does not apply to the public sector. They argue that this restriction should be stated explicitly, and assumed to apply symmetrically to the public and private sectors. Dixit investigates the robustness of the trade-policy-as-insurance result to the assumption that adverse selection affects the public and private sectors symmetrically. He finds that a competitive insurance industry generates the same constrained optimal insurance contracts as those chosen by the government under certain conditions.

In Section IV, I extend the basic model to consider the provision of insurance under adverse selection. There are assumed to be two types of workers with different productivity levels. Knowledge of workers' types is private. In the absence of intervention, all the workers of one type choose the same industry, and there may be diversification or specialization on aggregate, depending on the risk/return profiles of the two sectors for the two types.

An informationally constrained social planner can still raise welfare in the absence of private insurance by imposing trade taxes, but it achieves a second-best allocation due to incentive compatibility constraints. A competitive insurance market is unlikely to attain even the second-best allocation chosen by the informationally constrained social planner, however. If insurance firms are able to ration the number of contracts they offer in each industry, an entrant can select its customer mix in such a way that its customers are made better off at the expense of the viability of preexisting insurance contracts.[4] The introduction of the entrant's contract upsets competitive equilibrium under static Cournot/Nash assumptions. Under reactive Wilson assumptions, a competitive equilibrium achieves lower aggregate welfare than the constrained optimal intervention equilibrium. Government intervention raises welfare either by prohibiting rationing, or by using taxes to provide insurance directly.

The plan of the paper is as follows. I develop the basic model with incomplete insurance markets and ex post immobility in Section II. Section III elaborates the model to incorporate costly intersectoral mobility. Section IV formulates the insurance failure as an adverse selection problem, and compares the insurance market equilibrium with government intervention, assuming the government faces the same information problem as firms.

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[4] See Rothschild and Stiglitz (1976), Miyazaki (1977), Wilson (1977), Jaynes (1978), and Judd (1985) for general theoretical treatments of the tendency for competitive equilibrium to fail under adverse selection.

II. The Basic Model

i. Free Market Equilibrium

In this section I develop a simple, small open economy model to show that anticipated trade policy can raise welfare by inducing workers to diversify their human capital investments. I make several strong assumptions initially to amplify the main result; assumptions 6, 7, and 8 will be relaxed in Sections III and IV.

A1 The economy is sufficiently small in world markets that traded goods prices are taken as exogenous.

A2 There are three goods. Goods one and two are manufactured for export, while good three is imported for consumption. Good three is the numeraire good.[5]

A3 Goods one and two are manufactured with Ricardian, fixed coefficient technology.

[5] This assumption limits the effects of uncertainty on consumption to indirect effects through income. It has the advantage of simplifying the analysis, at the expense of blurring the distinction between taxes on production and trade. Were goods one and two assumed also to be consumption goods, the basic diversification result would go through, but the choice of policy instrument would be sensitive to the effect on consumption. See Eaton and Grossman (1985) for a good example of a model with uncertainty in the terms of trade.

A4 Revenue from the sale of the export goods is subject to uncertainty, which may arise through prices or through the technological coefficients. The uncertainty can be simplified to two states of the world: state a occurs with probability ρ and state b occurs with probability $(1-\rho)$. The value of output in sector j in state i is:

$$\Phi_{ij}L_i = X_{ij} \qquad for\ i=1,2;\ j=a,b \tag{1}$$

where L_i is labor in sector i, and ϕ_{ij} is the value of the marginal product of labor in sector i in state j; $\phi_{ij} = P_{ij}f_{ij}$, for unit labor coefficient f_{ij}, and world price P_{ij}.

In order to make the point as simply as possible, I focus on a case in which neither sector yields higher returns in both states. I assume:

$$\frac{\Phi_{2a}}{\Phi_{2b}} > \frac{\Phi_{1a}}{\Phi_{1b}} \tag{2}$$

A5 There are two periods. In the first period investment decisions are made before the state of the world is known. In the second period, uncertainty is resolved and returns are realized.

A6 Workers are homogeneous in productivity and utility. The expected utility function, U, is characterized by constant relative risk aversion.

A7 Each worker has one unit of human capital, which is indivisible and must be wholly and permanently invested in one sector.

A8 There is no private provision of insurance for human capital.

Given n workers, normalization of the labor force implies that each worker has 1/n units of capital to invest. Each worker chooses the investment that maximizes expected utility from the returns to his or her investment. The return to investment is simply industry revenues divided among the workers in the industry. Thus, the indirect utility function is:

$$
\begin{aligned}
U(\phi;\rho) &= Max(U_1, U_2) \\
U_i &= \rho V(\phi_{ia}) + (1-\rho) V(\phi_{ib}) \qquad for\ i=1,2
\end{aligned} \tag{3}
$$

where V'>0, and V is quasi-concave. Because workers are homogeneous, the optimal investment must be the same for all workers, and in equilibrium the economy specializes in the production of a single good.

The free market specialized equilibrium is illustrated in figure 1. Income in state a is measured along the y-axis, and income in state b along the x-axis. Returns to the investment of one unit of human capital in sector 1 in each state, (ϕ_{1b}, ϕ_{1a}), is given by point 1, and by point 2 for sector 2. The indifference curves, V_i, are tangent to the fair odds line, FO, with slope $(1-\rho)/\rho$, at the 45° full insurance line, FI. The economy's efficient frontier is the line segment $\overline{12}$. The utility of the representative worker in sector 1 is given by the indifference curve V_1, and in sector 2 by V_2. Since V_1 is higher than V_2, all workers choose to invest in sector 1.

ii. Intervention

Next a government is introduced under the following assumptions:

A9 The government maximizes social welfare, defined as the sum of workers' utilities. It has at its disposal industry-wide taxes, either on production or trade, and must satisfy budget balance.

If the government is free to allocate human capital among sectors to maximize expected welfare, it can attain any point along the efficient frontier as a linear combination of sector 1 and 2 returns. By setting state-contingent industry taxes and subsidies to equalize the expected utility of investing in the two sectors, the government renders workers indifferent between the sectors, and willing to be allocated in any proportion.[6] The taxes and proportions must be chosen in order to achieve ex post budget balance; this will generally be achieved by choosing taxes that redistribute income from the more productive sector to the less productive sector in each state.[7]

Refer again to figure 1. Suppose the government chooses an arbitrary point D along $\overline{12}$ associated with average returns of $Y_{dj} = \lambda_d \phi_{1j}+(1-\lambda_d)\phi_{2j}$ in state j. Average returns of D are attained by allocating workers in the proportions λ_d, $1-\lambda_d$ to sectors 1 and 2 respectively. The government need only redistribute income in each state to equalize the expected returns to investing in both sectors, to persuade $1-\lambda_d$ workers to invest in sector 2. This is achieved by imposing ad valorem taxes of t_{1b} on sector 1 returns in state b, and using the proceeds to subsidize sector 2 returns in the amount t_{2b}; the reverse is done in state a, using taxes and subsidies t_{2a} and t_{1a}.

[6] The assumption that the government allocates workers among the sectors subject to incentive compatibility constraints is adopted for convenience. Similar results are obtained more plausibly by assuming heterogeneous workers, where taxes are set to equate expected returns for the marginal worker consistent with the optimal allocation.

[7] Throughout, I impose an ex post budget constraint, on the implicit assumption that the government cannot borrow and lend across states. If an ex ante budget constraint were imposed, the efficient frontier would be the fair odds line, FO, with slope $(1-\rho)/\rho$, through point 1. Specialization in sector 1 would be optimal, and the government would borrow in state a and lend in state b to achieve average utility at the intersection of the full insurance and fair odds lines.

All that remains is the choice of the welfare-maximizing investment portfolio. The optimal portfolio is defined by the tangency of the highest attainable indifference curve, V_d, to the efficient frontier, where the marginal rate of substitution between income in each state is equal to the marginal rate of transformation along the efficient frontier.

More formally, the government chooses taxes and capital allocations to maximize welfare:

$$Max_{\lambda,t} \quad \rho[\lambda V(Y_{1a}(t))+(1-\lambda)V(Y_{2a}(t))]+(1-\rho)[\lambda V(Y_{1b}(t))+(1-\lambda)V(Y_{2b}(t))]$$

(4)
$$Y_{1a}(t)=(1+t_{1a})\phi_{1a} \text{ and } Y_{1b}(t)=(1-t_{1b})\phi_{1b}$$
$$Y_{2a}(t)=(1-t_{2a})\phi 2a \text{ and } Y_{2b}(t)=(1+t_{1b})\phi_{1b}$$

subject to incentive compatibility:

(i)
$$\rho V(Y_{1a}(t))+(1-\rho)V(Y_{1b}(t)) = \rho V(Y_{2a}(t))+(1-\rho)V(Y_{2b}(t))$$

and budget balance:

(ii)
$$(1-\lambda)t_{2j}\phi_{2j} = \lambda t_{1j}\phi_{1j} \qquad for\ j=a,b$$

The policy that satisfies the first order conditions sets taxes to equalize income in both sectors in state j:

(5)
$$t_{dij} = \{\ t_{ij}\ |\ Y_{1j}(t_{1j}) = Y_{2j}(t_{2j}) = \lambda_d\phi_{1j}+(1-\lambda_d)\phi_{2j} \qquad for\ j=a,b\ \}$$

and allocates workers in proportions that satisfy:

(6)
$$\lambda_d = \{\ \lambda\ |\ \frac{V'(Y_b)}{V'(Y_a)} = \frac{\rho}{(1-\rho)}\frac{(\phi_{2a}-\phi_{1a})}{(\phi_{1b}-\phi_{2b})}\}$$

Optimal policy thus entails redistribution from the low return sector to the high return sector in each state, such that income is equalized across sectors. Faced with the prospect of equal returns, workers are induced to invest their human capital in sectors 1 and 2 in proportions that equalize the marginal rate of substitution between income in the two states to the marginal rate of transformation. Relative to the free market equilibrium, income is redistributed from the state in which the marginal utility of income is low to that in which it is high.

Notice that workers are willing to diversify in a way that raises total expected welfare because they anticipate that the government will protect their investments. The government's promise to redistribute income is fully credible because redistribution raises welfare ex post. Suppose instead that workers allocate their human capital investments among industries in some arbitrary proportion yielding average return γ_a in figure 1. Then no amount of redistribution between the sectors ex post could achieve utility of V_d; the anticipation of optimal protection is central to the increase in welfare.

III. Ex Post Mobility

i. Free Market Equilibrium

If human capital investment is irreversible, the anticipated protection of comparatively disadvantaged industries raises welfare by providing insurance and encouraging diversification. If human capital is partially transferable between industries (or fully transferable at some cost), however, the provision of insurance discourages efficient reallocation of human capital following the resolution of uncertainty. Thus, advocates of Trade Adjustment Assistance and of free trade argue that protection of declining industries reduces aggregate welfare by calcifying inefficient patterns of resource allocation.

Diamond (1982) illustrates the tradeoff between optimal insurance and efficient ex post reallocation in a one-period model. Starting from an arbitrary diversified pattern of investment, he finds that intervention cannot achieve both optimal insurance and efficient reallocation, even when the set of instruments is expanded to include mobility subsidies in addition to industry taxes. The constrained optimal policy combines less-than-optimal insurance with partial reallocation in proportions that depend on the distribution of moving costs and the shape of the representative utility function.

The analysis misses the critical link between the initial pattern of human capital investment and anticipated policy, however. The finding in Section II, where investment is irreversible, that diversification depends on the anticipation of ex post redistribution, is suggestive for the case where investment is reversible at some cost. In this section, I extend the basic model to explore the tradeoff between insurance provision and efficient reallocation when the human capital investment decision is endogenous.

It turns out that the tradeoff between insurance and efficient reallocation is quite severe when only trade taxes are available, corresponding to a first-period choice between diversification and specialization. When the set of instruments is extended to include moving subsidies, however, the government achieves both optimal insurance and efficient mobility. This result, which contrasts sharply with that of Diamond, obtains because workers anticipate the redistributive policy and are induced to allocate their human capital among industries ex ante in proportions that correspond to the optimally diversified portfolio adjusted for ex post efficient mobility.

Begin by relaxing assumption 7:

A7' After a worker has invested in a sector, she or he can move to the second sector by paying a cost, c. The productivity of a worker who moves is some fraction, m<1, of that of incumbent workers.

Suppose state a is realized. Then income in sector 1 is lower than in sector 2, and workers who originally invested in sector 1 will move to sector 2 if their net returns from moving are positive:

$$m\phi_{2a}-c > \phi_{1a} \tag{7}$$

Similarly for sector 2 workers in state b. Figure 2a illustrates the returns to investment in each industry when ex post mobility is incorporated. Workers who invest in sector 1 have the choice of switching sectors if state a is realized and earning returns of $(m\phi_{2a}-c,\phi_{1b})$ at point 1', or of staying in sector 1 in both states and earning returns (ϕ_{1a},ϕ_{1b}) at point 1. Similarly, sector 2 workers can earn returns at 2' by moving, or at 2 by remaining. Point 1' (2') lies above (to the right of) 1 if the net return from moving to sector 2 (1) exceeds that to staying, and below (to the left of) 1 (2) otherwise.

Note that income at 1' must always be smaller than that at 2 in state a, because sector 1 workers who move to sector 2 make only a fraction of the return of incumbent sector 2 workers, and incur a moving cost. Similarly, state b income at 2' is bounded by that at 1. The economy's efficient frontier is the line which joins the greater of points 2' and 2 with the greater of 1' and 1, while the returns available to an individual worker in the absence of intervention are {1,2,1',2'}. In figure 2a, the highest level of utility attainable by any worker is 1'. In the free market equilibrium, all workers initially choose sector 1, remain there if state b is realized, and move to sector 2 otherwise.

ii. <u>Intervention with One Instrument</u>

Assume as before that the government has a single instrument - state-contingent sector taxes - that it sets to maximize welfare. Then intervention can achieve either optimal diversification ex ante with no reallocation ex post at point D, or ex ante specialization with efficient reallocation ex post at point 1', but not both. With only one instrument, the government cannot discriminate within a sector between new arrivals and those who invested there initially with only one instrument, so that any scheme which is effective at redistributing income discourages efficient reallocation, and vice versa.

Suppose the government attempts to raise welfare by redistributing income using sector-wide taxes . The effect of redistribution from workers in the high return sector to workers in the low return sector is to compensate those who stay in the low return sector, and penalize those who move to the high return sector. Either the level of redistribution is sufficient that no worker has any incentive to move ex post, or the returns to moving net of the tax penalty exceed the subsidized returns to staying, all workers move in the bad state, and there is no redistribution.

To see this, consider a realization of state a in figure 2a. In the absence of intervention, sector 1 workers would move to sector 2, since $m\phi_{2a}-c > \phi_{1a}$. But if taxes in excess of $\bar{t} = (m\phi_{2a}-c-\phi_{1a})/\phi_{2a}$ are imposed in sector 2, sector 1 workers are better off staying than moving to sector 2, even in the absence of corresponding subsidies to sector 1. On the other hand, if sector 2 taxes are below this level, all of the sector 1 workers will move to industry 2, and there is no potential for redistribution to equalize the incomes of incumbents and movers.

If, as in figure 2b, the indifference curve, V_d, that is tangent to $\overline{12}$ at point D lies above points 1′ and 2′, the best the government can do is to impose the taxes, t_d, consistent with optimal insurance defined in equation (5), and to allocate workers to sectors 1 and 2 in proportions λ_d and $(1-\lambda_d)$, defined in equation (6). If, on the other hand, either 1′ or 2′ lies above V_d, the government cannot improve upon the free market equilibrium with efficient ex post mobility.

More formally, call $Y_{sij}(t)$ the income of a worker who stays in sector i in state j, given taxes t. From equations (5) and (6), the government's optimal policy when workers are immobile ex post entails taxes t_d that equalize incomes across sectors, and allocation λ_d that equates the ratio of marginal utilities in the two states to that of the marginal rates of transformation. This policy yields returns to staying of:

(8) $$Y_{sij}(t_d) = \lambda_d\phi_{1j} + (1-\lambda_d)\phi_{2j} \qquad \text{for } i=1,2;\ j=a,b$$

Define Y_{mij} as the return to moving from sector i to sector k in state j:

(9) $$Y_{mij} = m\phi_{kj} - c \qquad \text{for } k=2 \text{ when } i=1, \text{ and the reverse; and } j=a,b$$

There are 2 cases to consider. Whenever staying dominates moving in both sectors in the free market equilibrium ($Y_{sij}(0) > Y_{mij}$ for i=1,2, j=a,b), the optimally diversified equilibrium with no mobility yields higher welfare than either moving equilibrium, and the optimal policy is (t_d, λ_d). If moving dominates staying in at least one sector in the free market equilibrium ($Y_{m1a} > Y_{s1a}(0)$ and/or $Y_{m2b} > Y_{s2b}(0)$), then there are two possibilities. Either the optimally diversified equilibrium yields higher expected utility than investment in the sector with the high return to moving, and the government optimizes by imposing taxes of t_d, as in figure 2b, or the reverse is true, and nonintervention is optimal, as in figure 2a.

Given only sector-wide taxes, the conflict between insurance and efficient reallocation implies that the government cannot improve upon the better of the optimally diversified equilibrium and the free market mobility equilibrium. Straightforward differentiation establishes that the free market equilibrium with mobility is more likely to dominate the less risk averse are workers, and the lower are the cost of moving and the productivity differential between incumbents and movers.

Thus, here there is either efficient mobility or full insurance. The efficient mobility equilibrium is associated with specialization, while the full insurance equilibrium is associated with diversification. In contrast, Diamond finds that the optimal intervention equilibrium with industry taxes entails a combination of reallocation below the efficient level and insurance below the optimal level. The results differ for two reasons. First, the Diamond model does not allow the anticipation of policy to affect the initial allocation of workers, so that the link between insurance and diversification, and mobility and specialization is missing.

Secondly, in the Diamond model, moving costs are assumed to differ for each worker according to some distribution. In any equilibrium with less-than-full equalization of incomes, there are some workers with low costs who move. Incorporating heterogeneous moving costs here would modify the findings somewhat, but preserve the central insight. With a single instrument and heterogeneous moving costs, the government would choose among the two equilibria derived above, along with a third possible equilibrium, in which the government insures investment only in part, so as not to discourage low cost workers from moving. Expected utility is equalized across the two sectors in order to induce high cost workers to diversify, while a sufficient income differential is maintained between the sectors in each state to encourage low cost workers to reallocate. While heterogeneity of moving costs introduces the possibility of partial mobility, the association between insurance and diversification and between specialization and mobility remains, due to the endogeneity of investment. The analysis is elaborated in Appendix A.

iii. Intervention with Two Instruments

The tradeoff between insurance and efficiency arises with only one instrument because the government cannot differentiate within a sector between incumbents and new arrivals.[8] If the government has a second instrument that enables it to differentiate, then the optimal policy can achieve both optimal diversification ex ante and optimal reallocation ex post.

Figure 3a illustrates the case where workers are better off moving than staying in the bad state in both sectors. The economy's efficient frontier with mobility is the line segment $\overline{1'2'}$. An investor with diversifiable capital would choose point M, where the indifference curve, V_m, is tangent to the efficient frontier, and the marginal rates of substitution and transformation are equal. Optimal portfolio diversification at point M requires an initial allocation of workers between sectors one and two in the proportions λ_m and $(1-\lambda_m)$ respectively.

Suppose the government attempts to achieve M using two instruments. By taxing all workers in the favored industry, and compensating movers with subsidies, the government makes workers willing to invest in the optimal proportions in each sector ex ante, and willing to move ex post. In state a,

[8] Except to the extent that with ad valorem taxes, the absolute level of taxes paid by the less productive new arrivals is lower.

the government imposes a tax of t_{m2a} on all workers in sector 2, and uses the revenues to subsidize sector 1 workers who have moved in the amount s_a, which compensates for both the moving cost and the productivity disadvantage. In state b the reverse is done. By making the initial investment consistent with budget balance for the ex post redistribution policy, the government moves the economy to point M.

These results contrast with the Diamond model, in which the tradeoff between insurance and efficiency remains even in the presence of two instruments. Here, the social optimum is attained because the expectation of moving assistance makes workers willing to invest ex ante in proportions consistent with its attainment. The Diamond model, in contrast, permits no interaction between anticipated policy and workers' investments. As a result, the initial allocation of human capital is inconsistent with ex post optimal reallocation. In terms of figure 3a, this corresponds to some arbitrary pattern of ex ante investment, in which a proportion γ_a of workers start in sector 1 and $(1-\gamma_a)$ in sector 2, yielding average returns at point γ_a. In this case, the point M would be unattainable by any redistributive policy.

To define the first-best equilibrium under endogenous investment more completely, four cases must be considered: the returns to staying outweigh those to moving in both sectors, the returns to staying outweigh those to moving in a single sector, and the returns to moving dominate in both sectors (absent of intervention). The case where staying is preferred in both sectors in the free market equilibrium is straightforward: optimal policy is defined in equations (5) and (6), yielding diversification and full equalization of incomes at point D.

In the three remaining cases, mobility is more efficient in one or both of the sectors. The government sets ad valorem taxes t_{ij} and moving subsidies s_j for i=1,2 and j=a,b, and selects allocation λ to maximize welfare, subject to the constraint that workers are indifferent between investing in either sector ex ante, and the budget balances in each state. Figure 3a illustrates the case where moving is better than staying in both sectors. In this case the first order conditions are satisfied for taxes and subsidies:

$$
(10) \qquad
\begin{aligned}
t_{m2a} &= \frac{\lambda_m[c+\phi_{2a}(1-m)]}{\phi_{2a}} \\
t_{m1b} &= \frac{(1-\lambda_m)\,[c+\phi_{1b}(1-m)]}{\phi_{1b}} \\
t_{m1a} &= t_{m2b} = \infty \\
s_a &= \frac{[c+\phi_{2a}(1-m)]\,[(1-\lambda_m)+m\lambda_m]}{c} \\
s_b &= \frac{[c+\phi_{1b}(1-m)]\,[(1-\lambda_m)+m\lambda_m]}{c}
\end{aligned}
$$

yielding full equalization of incomes between incumbents and new arrivals in the high return sector in each state. Human capital is allocated to sector 1 in proportion, λ_m, which equalizes the marginal rate of substitution with the marginal rate of transformation adjusted for mobility:

$$
(11) \qquad \lambda_m = \{\lambda \mid \frac{V'(Y_b)}{V'(Y_a)} = \frac{\rho}{(1-\rho)}\frac{[(\phi_{2a}(1-m)+c)]}{[(\phi_{1b}(1-m)+c]}\}
$$

Thus, in the optimal intervention equilibrium with taxes and moving subsidies there is both full insurance and full mobility.

In the remaining two cases, moving yields higher returns in the bad state in one sector and not in the other. The optimal policy combining taxes and moving subsidies is a hybrid. Assume that moving is preferred by sector 1 workers in the free market equilibrium, while staying is preferred in both states by sector 2 workers. In state b, the optimal taxes are those derived for the no mobility equilibrium in equation (5) and the optimal subsidy is 0, while in state a, the optimal taxes and moving subsidy are those derived for the mobility equilibrium in equation (11). The optimal policy again yields full insurance, while replicating the free market pattern of ex post resource allocation.This policy yields full equalization of incomes between sectors in each state. Here workers are allocated ex ante in proportions, λ_{md}, so as to equate the marginal rate of substitution with the marginal rate of transformation between states.

$$\lambda_{md} = \{ \lambda \mid \frac{V'(Y_b)}{V'(Y_a)} = \frac{\rho}{(1-\rho)} \frac{[(\Phi_{2a}(1-m)+c)]}{[(\Phi_{1b}-\Phi_{2b}]} \} \tag{12}$$

There is also a special case shown in figure 3b. Whenever the returns available to workers in one of the sectors under mobility span the full insurance line, no policy can improve upon full mobility with ex ante specialization in that sector.

As above, the assumption of heterogenous moving costs would modify the findings slightly, without changing the essential result. With heterogeneous moving costs and endogenous investment, it is sufficient to introduce a second instrument that enables the government to distinguish between new arrivals and incumbents to fully insure high cost workers and induce the efficient number of low cost workers to move. If moving subsidies are uniform across workers within a sector, the incomes of individual low cost workers who move will differ by an amount that depends on their moving cost. The details are in Appendix A.

Thus, when resources are partially mobile, the optimal policy requires an additional instrument that distinguishes within a sector between new arrivals and incumbents to achieve both optimal insurance and efficient reallocation ex post. A combination of industry taxes and moving subsidies is sufficient both to redistribute income fully, and to provide incentives for optimal reallocation ex post, because it induces optimally diversified investment ex ante. When only industry taxation is available, however, there is a sharp tradeoff between insurance and efficient reallocation. The government chooses between diversified equilibrium with full insurance and no movement optimal diversification, and specialized equilibrium with full mobility and no insurance. The first is preferred the more risk averse are workers and the higher are the costs and productivity loss associated with moving.

IV. Adverse Selection

So far, I have implicitly assumed that there are informational imperfections that distort private insurance markets but do not apply to policymakers. In this section I return to the basic (no mobility) model of Section II and modify assumption 8 to examine whether the symmetric application of informational restrictions to the public and private sectors significantly undermines the case for government intervention.[9] The informational restriction is formulated as an adverse selection problem.

First, I show that the government can offer tax/insurance contracts that pareto dominate the no insurance equilibrium under adverse selection, but it cannot in general attain the first best equilibrium. I then introduce an

[9] It is arguable whether the conditions that distort the private provision of human capital insurance apply equally to the public sector. While in theory one could imagine a private insurer offering contracts such as the one discussed below, in practice they are rarely if ever observed. Fundamentally, human capital insurance markets are incomplete because of limits imposed on contracts by the legal protection of rights in the presence of informational asymmetries (eg, restrictions on indentured service), rather than the asymmetries themselves. Because these restrictions apply differently to the private and public sectors, the latter may be uniquely qualified to provide such insurance.

informationally-constrained private insurance market, and examine whether it replicates the constrained optimal equilibrium with government intervention. In general it does not. If firms are allowed to restrict the number of contracts they offer, a competitive pooling equilibrium under the static Nash solution concept does not in general exist. A competitive equilibrium may exist under the Wilson (1977) reactive solution concept (which includes any Nash separating equilibria), but it generally attains lower aggregate welfare than the constrained optimal intervention equilibrium.

i. First Best Intervention

I start by modifying assumption 6 to incorporate adverse selection.

A6′ There are two types of workers, who are differentiated by their relative productivities, and whose types are private knowledge. A fraction γ ($0<\gamma<1$) of workers are "talented", and have unit labor coefficients $\bar{\phi}_{ij}$, while the remaining "average" ($1-\gamma$) workers have unit labor coefficients $\underline{\phi}_{ij}$. For simplicity, I assume that talented workers are at least as productive as average workers in both states in sector 1, relatively more productive in state b in sector 1, and identical in sector 2:[10]

$$(13) \qquad \frac{\bar{\phi}_{1b}}{\bar{\phi}_{1a}} > \frac{\underline{\phi}_{1b}}{\underline{\phi}_{1a}}; \quad \bar{\phi}_{1a} \geq \underline{\phi}_{1a}; \quad \bar{\phi}_{2i} = \underline{\phi}_{2i} = \phi_{2i} \quad i=a,b$$

I first develop the intuition for the intervention equilibrium diagrammatically, and then go on to provide a more formal explanation. The returns of the two types of workers are illustrated in figure 4. Assumption

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[10] There are 8 cases to consider in all. In this section I confine my attention to one specific case in order to illustrate several points clearly, with the understanding that they apply more generally.

6′ implies that all of the workers of one type choose to invest in the same sector in the free market equilibrium. Talented workers choose between returns at points 2 and $\bar{1}$, and average workers choose between 2 and $\underline{1}$. In figure 4, workers of both types prefer sector 1, and there is economy-wide specialization in equilibrium. In general, there need not be specialization across types.

The economy-wide efficient frontier is the locus $\overline{2P1}$. To see this, start at point 2, the per capita return when all workers of both types invest in sector 2. Shifting one talented worker at a time from sector 2 to sector 1 moves the per capita return down along the line segment $\overline{2P}$. Point P is reached when all γ talented workers are allocated to sector 1, and all $1-\gamma$ average workers remain in sector 2. The per capita return moves down the line segment $\overline{P1}$ as average workers are shifted one at a time from sector 2 to sector 1, holding all of the talented workers fixed in sector 1. At point 1, all workers of both types are allocated to sector 1. Any point on the efficient frontier is attainable through a linear combination of the two types in the two sectors.

Suppose an investor with full information about workers' types were to allocate the workers between the sectors to maximize social welfare. The investor would choose the allocation yielding per capita returns S^*, at the tangency of the efficient frontier and the indifference curve, V_s^*. S^* is achieved by allocating all of the talented workers to sector 1, where they are relatively more productive, and splitting the average workers between sectors 1 and 2 in proportions λ_s^* and $1-\lambda_s^*$ respectively.

Given full information about types and a budget balance, per capita returns of $S*$ are attainable through a set of three tax/insurance contracts that leave all workers indifferent between investing in either sector. Contracts ${t^*}_s = [(\underline{t}^*_{s1a}, \underline{t}^*_{s1b}), (\overline{t}^*_{s1a}, \overline{t}^*_{s1b}), (t^*_{s2a}, t^*_{s2b})]$ are offered to average workers in sector 1, talented workers in sector 1, and average workers in sector 2 respectively. The net effect is to redistribute income in state b from both types of sector 1 workers to sector 2 workers in different amounts, and in the reverse direction in state a, such that each worker receives equal income within each state. The allocation of average workers between the two sectors, ${\lambda_s}^*$, is chosen to equate the marginal rate of substitution to the marginal rate of transformation of the average workers.

It should be clear that S^* is the best allocation when returns are equalised among all workers in each state. To check that S^* is the best attainable allocation overall, consider the set of alternatives when returns are unequal. Refer again to figure 4. Suppose an investor (with full information) were to optimize over each type of worker separately. Given a pool of homogeneous talented workers, the best attainable allocation yields per capita returns of E, at the tangency of the indifference curve to the "talented" frontier (given by the line segment $\overline{2\overline{1}}$). Returns at E are obtained by a linear combination of sector 1 returns and sector 2 returns in proportions λ_e and $(1-\lambda_e)$ respectively. The investor optimizes over the average workers by allocating them between sectors 1 and 2 in proportions λ_u and $(1-\lambda_u)$ respectively, to attain per capita returns of U, at the point of tangency between the indifference curve and the efficient frontier associated with the average workers (line segment $\overline{2\underline{1}}$). U lies along a ray from the origin through S^*, due to the homotheticity of the utility function. Per capita returns across the two groups are given by the point R′, at the intersection of $\overline{21}$ and $\overline{UE}$.

Since the talented frontier lies above the average frontier, and both types of workers are equally productive in sector 2, it should be immediately obvious that the investor can raise welfare further by allocating more talented workers to sector 1, moving the economy-wide average return up along $\overline{R'R}$. Since the optimal sector 1 allocation along the talented frontier, λ_*, exceeds the proportion of talented workers in the economy overall, γ (P lies above E), the investor allocates all of the talented workers to sector 1 in combination with a fraction, $\gamma(1-\lambda_*)/\lambda_* < (1-\gamma)$, of average workers to sector 2, and then optimizes over the remaining average workers. This allocation yields average returns of E among a fraction γ/λ_* of all workers, consisting of all the talented workers and a subset of the average workers, and per capita returns of U among the remaining average workers. The average economy-wide return for this allocation is given by the intersection of the line segment $\overline{UE}$ with the economy-wide efficient frontier, $\overline{2P1}$, at point R.

Notice that although some workers are better off at R, per capita utility is higher at S*. Due to the concavity and the homotheticity of the workers' utility functions, the allocation that yields the highest per capita utility is also the allocation that attains the highest aggregate welfare. Since the allocation with equal returns S^*, at the point of tangency with the indifference curve, V_s^*, yields the highest attainable per capita utility along the economy-wide efficient frontier, any other point along the efficient frontier, such as R, must yield lower aggregate welfare. Thus, S^* is the first-best separating equilibrium.[11]

[11] A separating equilibrium in this context refers to an equilibrium in which there are separate contracts for the two types within a sector.

ii. Intervention under Adverse Selection

Now consider the case where workers' types are not observed by policymakers. Suppose government policy attempts to achieve S^* by offering the tax contracts t^*_s. Refer again to figure 4. By taking the tax contract intended for the average workers in sector 1, talented workers earn returns of $\bar{I}_s$, which lies a distance of $\underline{t}^*_{s1a}\bar{\phi}_{1a}$ above and $\underline{t}^*_{s1b}\bar{\phi}_{1b}$ to the left of $\bar{I}$. Since utility at $\bar{I}_s$ exceeds that at S^*, talented workers are tempted to cheat, thereby upsetting budget balance. To maintain the viability of the tax scheme in the presence of private information, the contracts must be modified in such a way that both types have incentives to reveal their types truthfully in equilibrium. The contract intended for the talented workers must leave them at least as well off as either contract for the average workers. Likewise, the contract for the average workers must leave them indifferent to switching between sectors, and at least as well off as the talented workers' contract.

The informationally-constrained optimal intervention equilibrium may be one of two types: a pooling equilibrium, in which a single tax contract is offered in each sector, or a separating equilibrium, in which a separate tax contract is designed for each type of worker in sector 1.[12]

In any pooling equilibrium, all of the workers of at least one type are allocated to one of the sectors, because at most one type of worker can be made indifferent between the sectors given a single tax contract. In figure 5a, there are two sets of pooling equilibria. One lies along the economy-wide efficient frontier, on the segment $\overline{2P}$, and the second lies on the segment $\overline{2P'}$

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[12] Attainment of the constrained optimal separating equilibrium requires a choice of tax contracts in at least one of the sectors. If the government is restricted to a single industry-wide tax contract, the best it can attain is a pooling equilibrium.

the average production possibility frontier. I restrict attention to the set of equilibria along $\overline{2P}$, since it dominates.

The first-best pooling equilibrium entails specialization of each type in the sector in which it is comparatively advantaged, whenever the slope of the indifference curve at its intersection with the full insurance line exceeds that of the talented workers' frontier, $\overline{\overline{P1}}$. Thus, the pooling equilibrium that yields the highest utility in figure 5a is given by P, the per capita return when all talented workers invest in sector 1 and all average workers invest in sector 2. The same conditions on the slopes of the indifference curve and the talented workers' frontier ensure that the first best pooling equilibrium, P, is dominated by the first best separating equilibrium, S^* (except trivially when the exogenously given proportions (γ, $1-\gamma$) exactly match the optimal allocation (λ^*_s, $1-\lambda^*_s$)).

The first-best pooling equilibrium is feasible under private information as long as average workers prefer the sector 2 tax package, and talented workers prefer the sector 1 tax package. In figure 5a, the talented workers are indifferent between the two sectors. The returns to cheating for the average workers are given by point $\underline{1}_p$; since $\underline{1}_p$ is dominated by P, the first-best pooling equilibrium is attainable.[13] When the talented workers are only relatively advantaged, the first-best pooling equilibrium is feasible as long as the slope of their frontier is less than that of the indifference curve at its intersection with the full insurance line.

Now consider the constrained optimal separating equilibrium. If a separating equilibrium exists, it must leave the average workers indifferent

[13] The optimal pooling equilibrium is always attainable when one type of worker is absolutely advantaged in sector 1, eg when $\overline{\phi}_{1j}>\underline{\phi}_{1j}$ for j=a,b.

between the sectors, and give higher utility to the talented workers as an inducement not to cheat. Define the constrained optimal equilibrium as the tax contracts t_s, yielding returns of $(\overline{S}_1, \underline{S}_1, S_2)$ to talented workers in sector 1, average workers in sector 1, and to both types in sector 2 respectively.

Referring to figure 5b, the constrained optimal separating equilibrium is derived as follows. Starting from the first best contract, S^*, income in both states is redistributed away from the average workers to the talented workers until they are just indifferent between cheating and telling the truth. Define the return to the talented workers from cheating as the point $\overline{I}_s$; it lies a distance $\underline{t}_{1a}\overline{\phi}_{1a}$ above and $\underline{t}_{1b}\overline{\phi}_{1b}$ to the left of $\overline{I}$. The binding incentive constraint implies that $\overline{S}_1$ lies on the same indifference curve as $\overline{I}_s$. The temptation for the talented workers to cheat is further reduced by redistributing income between the average workers in the two sectors within each state, while maintaining intersectoral equality of their expected utility. The tax contracts for the average workers are modified so that sector 2 workers receive relatively more income in state b, and sector 1 workers receive relatively more in state a. Thus, S_2 and S_1 lie along the same indifference curve below S^*, S_1 lies on a ray from the origin above that through the point S_2, and $\overline{S}_1$ lies on a ray at or below it.

In figure 5b, the constrained optimal separating equilibrium yields higher welfare for both types of workers than the first-best pooling equilibrium. The welfare ordering can go either way depending on the marginal rate of substitution and the productivity parameters of the two types.

I will now show more formally that the first-best separating equilibrium, S^*, is not attainable under private information, due to the incentive constraints, and then give the conditions for the optimal pooling equilibrium. The government chooses state-contingent taxes and allocations for each type of worker to solve the maximization problem:

$$
\begin{array}{llll}
 & \multicolumn{3}{l}{Max_{\overline{t},\underline{t},t,\overline{\lambda},\underline{\lambda}}} \\
 & \multicolumn{3}{l}{\underline{\lambda}(1-\gamma)[\rho V(\underline{Y}_{1a}(\underline{t}))+(1-\rho)V(\underline{Y}_{1b}(\underline{t}))] + \overline{\lambda}\gamma[\rho V(\overline{Y}_{1a}(\overline{t}))+(1-\rho)V(\overline{Y}_{1b}(\overline{t}))]} \\
 & \multicolumn{3}{l}{\quad +[(1-\underline{\lambda})(1-\gamma)+(1-\overline{\lambda})\gamma][\rho V(Y_{2a}(t)) + (1-\rho)V(Y_{2b}(t))]} \\
 & \multicolumn{3}{l}{\textit{subject to:}} \\
 & (i) & \rho V(\overline{Y}_{1a}(\overline{t}))+(1-\rho)V(\overline{Y}_{1b}(\overline{t})) \geq \rho V(\overline{Y}_{1a}(\underline{t}))+(1-\rho)V(\overline{Y}_{1b}(\underline{t})) & \mu_1 \\
(14) & (ii) & \rho V(\overline{Y}_{1a}(\overline{t}))+(1-\rho)V(\overline{Y}_{1b}(\overline{t})) \geq \rho V(Y_{2a}(t))+(1-\rho)V((Y_{2b}(t)) & \mu_2 \\
 & (iii) & \rho V(\underline{Y}_{1a}(\underline{t}))+(1-\rho)V(\underline{Y}_{1b}(\underline{t})) \geq \rho V(\underline{Y}_{1a}(\overline{t}))+(1-\rho)V(\underline{Y}_{1b}(\overline{t})) & \mu_3 \\
 & (iv) & \rho V(Y_{2a}(t))+(1-\rho)V(Y_{2b}(t)) \geq \rho V(\underline{Y}_{1a}(\underline{t}))+(1-\rho)V(\underline{Y}_{1b}(\underline{t}) & \mu_4 \\
 & (v) & [\gamma(1-\underline{\lambda})+(1-\gamma)(1-\overline{\lambda})]t_{2a}\phi_{2a} \geq \gamma\overline{\lambda}\overline{t}_{1a}\overline{\Phi}_{1a}+(1-\gamma)\underline{\lambda}\underline{t}_{1a}\underline{\phi}_{1a} & A \\
 & (vi) & [\gamma\overline{\lambda}\overline{t}_{1b}\overline{\Phi}_{1b}+(1-\gamma)\underline{\lambda}\underline{t}_{1b}\underline{\phi}_{1b}] \geq [\gamma(1-\overline{\lambda})+(1-\gamma)(1-\underline{\lambda})]t_{2b}\phi_{2b} & B
\end{array}
$$

where:

$$Y^m_{1a}(t^n) \equiv (1+t^n_{1a})\phi^m_{1a};\ Y^m_{1b}(t^n) \equiv (1-t^n_{1b})\phi^m_{1b} \qquad \textit{for}\ Y^m=\overline{Y},\ \underline{Y};\ t^n=\overline{t},\ \underline{t}$$

$$Y_{2a}(t) \equiv (1-t_{2a})\phi_{2a};\ Y_{2b}(t) \equiv (1+t_{2b})\phi_{2b}$$

Constraints (i) through (iv) are incentive compatibility constraints.[14] Constraints (v) and (vi) are budget balance constraints; they bind at the optimum.[15]

Under full information, constraints (i) and (iii) do not apply, and the first order conditions are satisfied for t^*_s and λ^*_s such that:

$$(15) \qquad Y^*_{sj} \equiv \overline{Y}_{1j}(\overline{t}^*_{sj},\lambda^*_s) = \underline{Y}_{1j}(\underline{t}^*_{sj},\lambda^*_s)) = Y_{2j}(t^*_{sj},\lambda^*_s) = (1-\gamma)[\lambda^*_s\underline{\phi}_{1j}+(1-\lambda^*_s)\phi_{2j}]+\gamma\overline{\Phi}_{1j} \qquad j=a,b$$

$$(16) \qquad \lambda^*_s = \{\overline{\lambda}=1;\ \underline{\lambda}=\lambda \mid \frac{V'(Y^*_{sa})}{V'(Y^*_{sb})} = \frac{(1-\rho)}{\rho}\frac{(\underline{\phi}_{1b}-\phi_{2b})}{(\phi_{2a}-\underline{\phi}_{1a})}\}$$

In equilibrium, all workers receive the same income in each state, and average

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[14] In the case considered here, the participation constraints are slack, so I leave them out.

[15] The full set of first order conditions is given in Appendix B.

workers are allocated between sectors in proportions that equate the marginal rate of substitution to the marginal rate of transformation along their efficient frontier, as shown diagrammatically above.

Now consider the problem under private information. As above, both budget constraints bind. In any separating equilibrium, talented workers are allocated to sector 2 only after the total pool of average workers has been exhausted, since talented workers have a comparative advantage in sector 1. Either average workers are split between sectors and talented workers specialize in sector 1, such that constraint (iv) binds, or average workers specialize in sector 2 and talented workers diversify, such that constraint (ii) binds. The latter case would yield a pooling equilibrium on the line segment $\overline{2P}$ exclusive of the end points; it was shown above that this is dominated by P. Of the remaining two constraints, either or both may bind, depending on whether talented or average workers have greater temptation to cheat.

The first order conditions are satisfied for taxes t_s and allocation λ_s with constraints (iv), (v), and (vi) binding, along with either or both (i) and (iii). Constraint (ii) is satisfied whenever both (iv) and (i) are satisfied. Constraint (iv) implies that the returns to the average workers in sector 1, $\underline{S}_1$, lie along the same indifference curve as sector 2 returns, S_2.

The direction of distortion away from the optimal separating equilibrium depends on which of constraints (i) and (iii) bind. If constraint (i) binds, the tax package designed for average workers in sector 1 distorts the allocation of income among states to reduce its attractiveness to talented workers. If constraint (iii) binds, the package designed for talented workers is distorted just sufficiently to render it unattractive to average workers.

The marginal rate of substitution (MRS) of sector 2 workers between states is unaffected by the incentive constraints:

$$(17) \qquad \frac{V'(Y_{2a}(c_{sa}))}{V'(Y_{2b}(c_{sb}))} = \frac{(1-\rho)}{\rho}\frac{A}{B}$$

where:

$$\frac{A}{B} = \frac{\underline{\Phi}_{1b}\underline{c}_{1b} - \Phi_{2b}c_{2b}}{\Phi_{2a}c_{2a} - \underline{\Phi}_{1a}\underline{c}_{1a}} = \frac{\gamma\overline{\Phi}_{1b}\overline{c}_{1b} + (1-\gamma)\underline{\Phi}_{1b}\underline{c}_{1b}}{\gamma\overline{\Phi}_{1a}\overline{c}_{1a} + (1-\gamma)\underline{\Phi}_{1a}\underline{c}_{1a}}$$

In contrast, the MRS of average sector 1 workers diverges from that in sector 2 if the talented workers' incentive constraint binds:

$$(18) \qquad \frac{V'(\underline{Y}_{1a}(\underline{c}_{sa}))}{V'(\underline{Y}_{1b}(\underline{c}_{sb}))} = \frac{(1-\rho)}{\rho}\frac{A}{B}\underline{K}(\mu_1,\Phi) \qquad \text{for } \Phi \equiv \frac{\overline{\Phi}_{1b}\backslash\underline{\Phi}_{1b}}{\overline{\Phi}_{1a}\backslash\underline{\Phi}_{1a}}$$

$$\mu_1 = 0 \qquad \underline{K} = 1$$

$$\mu_1 > 0 \qquad \underline{K} < 1 \quad \Phi > 1; \qquad \underline{K} > 1 \quad \Phi < 1; \qquad \frac{\delta \underline{K}}{\delta \Phi} < 0$$

Similarly, the MRS of talented sector 1 workers diverges when the incentive constraint of average workers in sector 1 binds:

$$(19) \qquad \frac{V'(\overline{Y}_{1a}(\overline{c}_{sa}))}{V'(\overline{Y}_{1b}(\overline{c}_{sb}))} = \frac{(1-\rho)}{\rho}\frac{A}{B}\overline{K}(\mu_3,\Phi) \qquad \text{for } \Phi \equiv \frac{\overline{\Phi}_{1b}\backslash\underline{\Phi}_{1b}}{\overline{\Phi}_{1a}\backslash\underline{\Phi}_{1a}}$$

$$\mu_3 = 0 \qquad \overline{K} = 1$$

$$\mu_3 > 0 \qquad \overline{K} > 1 \quad \Phi > 1; \qquad \overline{K} < 1 \quad \Phi < 1; \qquad \frac{\delta \overline{K}}{\delta \Phi} > 0$$

In the most likely case, the incentive constraint of the talented workers binds, and that of the average workers is slack. By equation (19), the MRS of talented workers in sector 1 just equals that in sector 2. Equation (18) implies that the MRS of the average workers in sector 1 is lower than that in sector 2 by a factor that depends positively on the shadow value of relaxing the talented workers' constraint and on the sector 1 productivity differential between the talented and average workers. This implies that average workers in sector 1 receive relatively higher income in state a and relatively lower income in state b than sector 2 workers, since by constraint (iv), the expected utility of average workers is equal:

$$(20) \qquad \begin{array}{ll} \mu_1>0 & \dfrac{Y_{2a}(t_{sa})}{\underline{Y}_{1a}(\underline{t}_{sa})} < 1 < \dfrac{Y_{2b}(t_{sb})}{\underline{Y}_{1b}(\underline{t}_{sb})} \\ \mu_1=0 & \qquad = 1 = \end{array} \qquad for \quad \frac{\overline{\Phi}_{1a}}{\underline{\Phi}_{1a}} < \frac{\overline{\Phi}_{1b}}{\underline{\Phi}_{1b}}$$

Thus, when the talented workers' incentive constraint binds, the tax package designed for average workers in sector 1 leaves them with lower income in the state in which they are more productive relative to sector 2 workers.

If instead the average workers' incentive constraint binds, and that of the talented workers is slack, it is the talented workers whose MRS is distorted. From equation (18), with μ_1 equal to zero the MRS of average workers is equal across sectors; along with constraint (iv), this implies equal income in both states. Equation (19) implies that when constraint (iii) binds, the MRS of talented workers between states a and b lies above that of the average workers by a factor that depends positively on the productivity differential between the two types of workers in sector 1, and on the shadow value of relaxing the average workers' constraint. The marginal utility of income of talented sector 1 workers is higher in state a than in state b relative to the average workers, suggesting less redistribution between states in order to dissuade average workers from cheating:

$$(21) \qquad \begin{array}{ll} \mu_3>0 & \dfrac{V'(Y_{2a}(t_{sa}))}{V'(Y_{2b}(t_{sb}))} < \dfrac{V'(\overline{Y}_{1a}(\overline{t}_{sa}))}{V'(\overline{Y}_{1b}(\overline{t}_{sb}))} \\ \mu_3=0 & \qquad\qquad = \end{array} \qquad for \quad \frac{\overline{\Phi}_{1a}}{\underline{\Phi}_{1a}} < \frac{\overline{\Phi}_{1b}}{\underline{\Phi}_{1b}}$$

For most parameter ranges, at least one incentive constraint binds. Due to the information asymmetry, the MRS for each group of workers diverges from the full information optimum, and the redistribution of income is second best.

In the first-best pooling equilibrium, each type specializes so that $\underline{\lambda}=0$ and $\overline{\lambda}=1$, and there is one tax contract for each sector, so that constraints (i) and (iii) do not apply. Here, the government chooses one set of taxes $t=(t_{ij})$ for $i=1,2$ and $j=a,b$ to solve equation (14), given $\underline{\lambda}=0$, $\overline{\lambda}=1$, subject to incentive compatibility constraints (ii) and (iv), and budget constraints (v) and (vi). The optimal policy for the pooling equilibrium is $(t_p, \underline{\lambda}_p=0, \overline{\lambda}_p=1)$:

$$(22) \qquad Y_{pj}=\overline{Y}_{1j}(\overline{t}_{pj})=Y_{2j}(t_{pj})=\gamma\overline{\Phi}_{1j}+(1-\gamma)\Phi_{2j} \qquad \text{for } j=a,b$$

The first-best pooling equilibrium is attainable when neither type of worker gains by cheating; talented workers are indifferent between the two sectors, and average workers earn at least as much in both states by investing in sector 2 as by cheating.

$$(23) \qquad \underline{Y}_{1j}(\overline{t}_{pj})-Y_{2j}(t_{pj})=\frac{(\Phi_{1j}-\overline{\Phi}_{1j})}{\Phi_{1j}}Y_{pj} \qquad \text{for } j=a,b$$

At the optimum, with taxes t_p and allocation $\lambda_p=\gamma$, the income of the two groups is equal in each state.

While the first-best separating equilibrium pareto dominates overall, the welfare ranking of the constrained optimal separating equilibrium relative to the optimal pooling equilibrium depends on the productivity parameters and the proportion of types of workers. The government maximizes welfare by choosing between these two equilibria, and offering state-contingent tax contracts that induce the allocation of human capital consistent with its attainment.

iii. Competitive Equilibrium

Next I consider whether a competitive private insurance market can achieve the welfare-maximizing constrained optimal equilibrium under adverse selection. Depending on the equilibrium concept, there may be no competitive equilibrium in the market for insurance. When competitive equilibrium does exist, it generally yields lower aggregate welfare than the constrained optimal intervention equilibrium, although it may be parieto optimal.

The potential for competitive equilibrium to fail under adverse selection was first demonstrated by Rothschild and Stiglitz (1976), and was explored further by Wilson (1977), Miyazaki (1977), Jaynes (1978), and Judd (1987). In the context of the model developed above, the failure arises when an entrant to the insurance market can ration the number of contracts it offers in sector 1 and sector 2 in such a way that it makes profits at the expense of the viability of the constrained optimal contracts.

Whether a competitive equilibrium exists hinges on the equilibrium concept used. Following Rothschild and Stiglitz, I start by considering static Cournot/Nash equilibrium, and show that there is no competitive pooling equilibrium, and the separating equilibrium may also fail. I then go on to consider the outcome when there is potential entry under the Wilson reactive equilibrium concept.

First, consider a competitive insurance market where the first-best pooling equilibrium dominates the constrained optimal separating equilibrium, and workers of both types specialize in sector 1 in the absence of insurance. This is shown in figure 6a. Suppose a potential entrant considers offering a new contract. By selecting its customer mix appropriately, the entrant can maximize returns along the talented workers' efficient frontier, and offer insurance contracts which are preferred over P. The entrant offers insurance contracts, $\{t_e\}$, with returns E, which lie at the point of tangency of the highest attainable indifference curve to the talented workers' efficient frontier. The entry strategy is feasible if contracts are rationed such that a proportion λ_e are offered to sector 1 workers and $(1-\lambda_e)$ to sector 2 workers. Recall from above that only a subset of the average workers can participate in insurance contracts which yield returns E, since the exogenously given proportion of talented workers in the population overall, γ, is below the optimal proportion, λ_e.

The new contract is feasible as long as the talented workers prefer the entrant's sector 1 contracts, and excluded average workers do not. Under Cournot/Nash assumptions, the set of contracts on offer by other firms will not change in response to the introduction of a new contract. Thus, the relevant reservation utility levels for the incentive constraints are given by the pooling equilibrium insurance contracts, P. By buying the sector 1 contract intended for talented workers, average workers earn returns $\underline{1}_e$, at a distance $\bar{t}_{e1a}\phi_{1a}$ above and $\bar{t}_{e1b}\phi_{1b}$ to the left of $\underline{1}$, which is associated with lower expected utility than P. Talented workers are indifferent between the two contracts. Thus, the incentive constraints of both groups are satisfied, so that the entrant's contract is viable, and the competitive pooling equilibrium fails.

The failure of the pooling equilibrium holds generally under adverse selection, as demonstrated by Rothschild/Stiglitz. But in specific cases, the constrained optimal separating equilibrium also fails for the same reasons. Consider a case where the optimal constrained separating equilibrium dominates the first best pooling equilibrium, as shown in figure 6b. Again the entrant considers offering contracts which yield returns of E to all talented workers in sector 1 and a subset, $\gamma(1-\lambda_*)/\lambda_*$, of the average workers in sector 2. For the contracts to be feasible, the entrant's sector 1 contract must exceed the reservation utility of the talented workers, $\underline{S}$ and fall below the reservation utility of the excluded average workers, while the sector 2 contract must exceed the reservation utility of the average workers. Talented workers clearly do better by accepting the contract with returns E than the contract with returns $\overline{S}_1$. Average workers who are excluded from the entrant's contract are not tempted to purchase the entrant's contract for sector 1 because the returns, given by $\underline{1}_*$, are lower than those under the separating contract, $\underline{S}_1$, while the average workers who are able to purchase the entrant's contract for sector 2 prefer it to S_2. Thus, the entrant's contract is feasible and the constrained optimal separating equilibrium fails.

The failure of the constrained optimal separating equilibrium is more likely the greater is the difference between the productivity levels of the two types of workers in each state, and the more the exogenously given distribution of types deviates from the optimal diversification allocation.

If a separating equilibrium does exist under Cournot/Nash conditions, it also satisfies Wilson's conditions for equilibrium, so I proceed to examine both together. Wilson proposes a refinement of the equilibrium concept that is less likely to fail under adverse selection. Wilson's "reactive equilibrium" requires that the entrant evaluate the profitability of entry under the assumption that any existing contracts that are rendered unprofitable by the new contracts will be withdrawn. This amounts to a difference in the reservation utility levels for the incentive constraints on the entrant's contract; workers evaluate the returns to cheating against their expected utility when all insurance contracts that are bankrupted by the introduction of the new contract have been withdrawn.

In figures 6a and 6b, neither the pooling equilibrium nor the constrained optimal separating equilibrium is viable once the entrant has stolen away all of the talented workers. Thus, the appropriate reservation utility level for the incentive constraint of the excluded workers under the Wilson equilibrium concept is the highest return available to the individual worker in the absence of insurance, point $\underline{1}$ in figures 6a and 6b. Since $\underline{1}$ is associated with higher utility than the returns from cheating, $\underline{1}_e$, there is a Wilson competitive equilibrium. It entails utility in state j of $V(Y_j(t_e))$ for all of the talented workers and a subset, $\gamma(1-\lambda_e)/\lambda_e$, of the average workers, and $V(\underline{\phi}_{1j})$ for the remainder of the average workers.

Under certain circumstances, the reservation utility of the excluded workers might be that associated with optimal diversification along the average production possibility frontier, point U. But the contract associated with diversification among the average workers is not in general immune to cheating by the talented workers. In figures 6a and 6b, for instance, talented workers derive higher utility from cheating (point $\overline{1}_u$) than from purchasing the entrant's contract, E, so that U is not feasible. This leaves $\underline{1}$ as the reservation utility of average workers.

Thus, there is a competitive equilibrium under the Wilson equilibrium concept, but it is not the one chosen by a social planner. The average return in the competitive equilibrium is given by E', at the intersection of the line segments $\overline{E\underline{1}}$ and $\overline{P\overline{1}}$. In figure 6a, the average return under government intervention, P, exceeds that at E'. Similarly, in figure 6b, the per capita return under government intervention, which lies between the points $\overline{S}_1$, $\underline{S}_1$, and S_2, exceeds that at E'. In both cases, constrained optimal intervention achieves higher social welfare than the competitive insurance market. It does not, however, parieto dominate the competitive equilibrium. The welfare differential between the constrained optimal and competitive equilibrium is greater the larger is the divergence of the exogenously given proportion of talented workers from the constrained optimal proportion of sector 1 workers.

Under either equilibrium concept, the government can raise aggregate social welfare either by prohibiting private insurers from rationing the contracts they offer, or by providing insurance through industry taxes directly. When competitive equilibrium fails under Cournot/Nash conditions, government intervention is also parieto improving, while under Wilson conditions, government intervention may leave the workers who would have secured the entrant's contracts worse off.

IV. Conclusion

This paper starts from the premise of socially suboptimal investment in the presence of nondiversifiable, industry-specific human capital, uncertainty in production, and incomplete insurance markets. In this context, the expectation that the government will protect losers raises welfare by inducing a socially optimal diversification of human capital investment.

When workers can move between industries at some cost after the uncertainty has been resolved, it is still possible for the anticipation of intervention to improve the efficiency of the ex ante pattern of investment and raise welfare. With ex post mobility, however, the optimal policy requires an additional instrument that targets moving costs, in order to achieve both diversification ex ante and efficient reallocation ex post.

Optimal policy uses tax revenues from the booming sector to subsidize movement out of the declining sector, as long as the social costs of mobility are outweighed by the increase in efficiency. If workers differ in their moving costs, optimal policy combines moving subsidies for low cost workers with protection of high cost workers. In either case, the anticipation of intervention raises ex ante diversification.

To the extent that the inadequacy of private insurance reflects informational restrictions that apply equally to the public sector, enthusiasm for insurance-oriented policies in declining industries should be qualified. When there is an adverse selection problem, the first-best allocation is unattainable, and government intervention is constrained optimal. There is still a role for government intervention, however, as the competitive insurance market does not attain the constrained optimal allocation. Depending on the productivity parameters and the distribution of types, there may be no competitive equilibrium that is immune to insurance contracts that skim off the most profitable mix of customers under static, Cournot/Nash assumptions. Under reactive Wilson assumptions, the competitive equilibrium may be comprised solely of such contracts. Government intervention, either through the direct provision of insurance or through regulation of the insurance market, raises welfare in both cases, and also achieves a parieto improvement in the first.

The paper says little about the optimal form of policy, other than to note that efficiency considerations in the presence of ex post mobility call for additional instruments that target moving costs. By isolating the consumption decision from the effects of uncertainty, and simplifying the production process to a single factor, the model sidesteps consideration of the relative merits of taxes on production, factors, and trade. With a more complicated production and consumption structure, the general point that anticipated policy can raise welfare by influencing the ex ante allocation of investment in the presence of uncertainty would remain, but the equivalence of trade and production taxes would not. The principle of targeting suggests that an instrument that narrowly targets the stickiness in human capital or the imperfection in insurance will be best.

Another issue that merits investigation in a richer framework is the source of workers' attachments. Whether human capital specificity is related to the firm, the industry, or the region has important implications for the choice of instruments, given policy objectives of encouraging optimal diversification ex ante and efficient reallocation ex post.

Lastly, mobility considerations have important implications for instrument choice that cannot be addressed within the simple framework presented here. The degree of public support for retraining and reallocation varies widely among countries, along with the relative emphasis placed on insurance.[16] The model's simple framework does not address issues such as the relative efficiency of public support for general skills training for labor force entrants that lower average switching costs, as against retraining after uncertainty has been resolved. However, the conclusion that a predictable policy regime that insures workers' capital investments and encourages efficient reallocation can raise welfare by improving entrants' initial matches is quite general.

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[16] In Sweden, for example, low interindustry wage differentials are coupled with extensive public assistance for relocation, such as centralized vacancy listings and retraining programs, to provide both mobility incentives and insurance. In contrast, in the US some insurance is provided through ad hoc trade protection, and retraining and relocation programs have not been successful.

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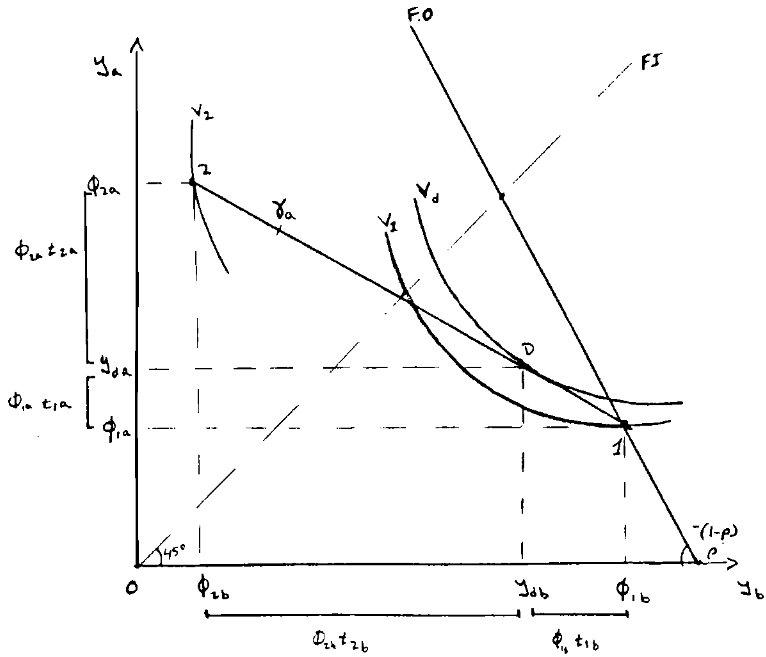


FIGURE 1

Figure 2a

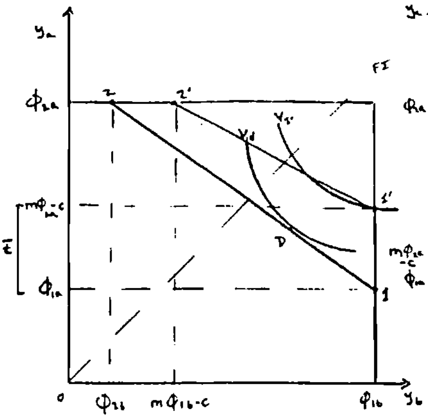
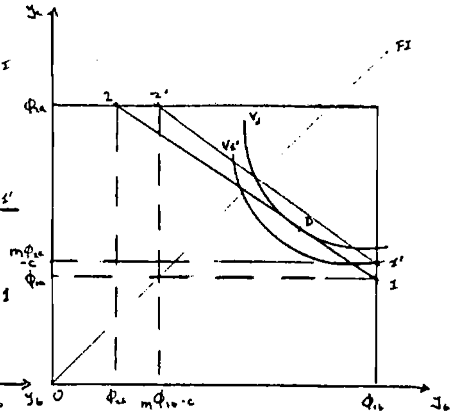


Figure 2b



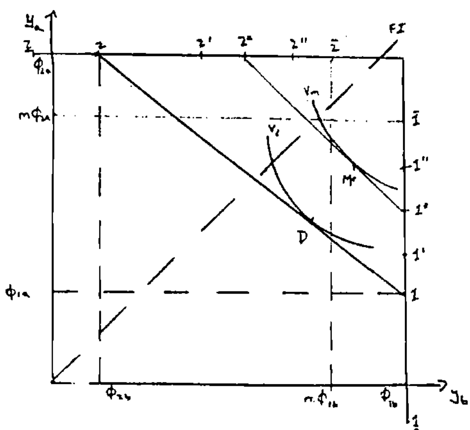
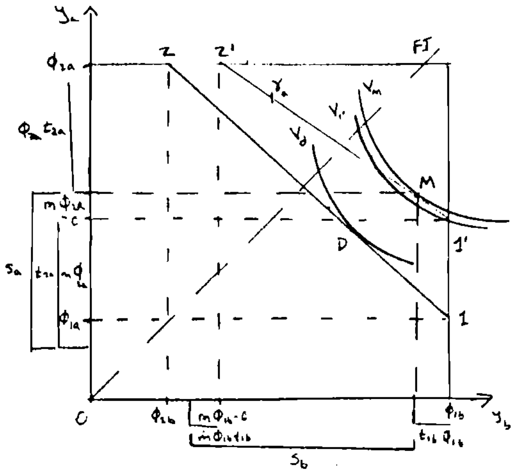


Figure 2c

FIGURE 3a



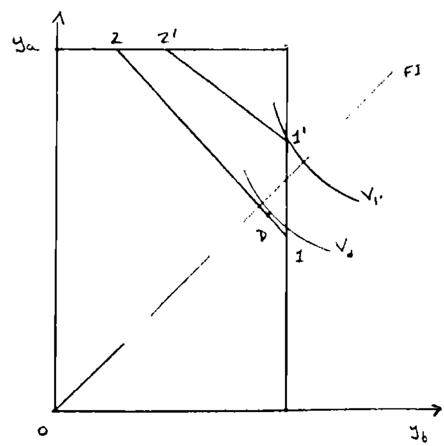


FIGURE 3b

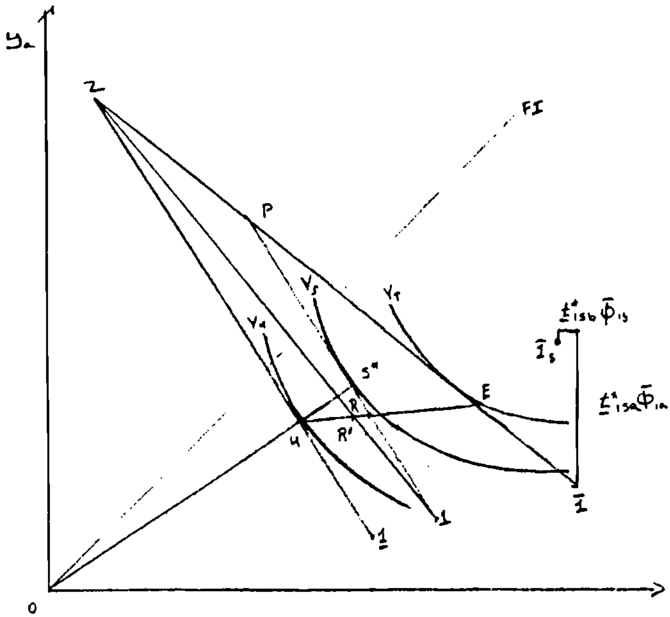
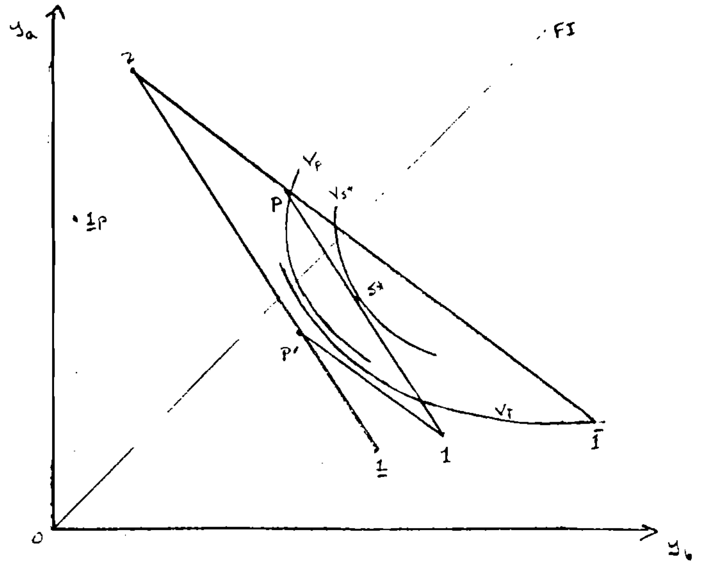


FIGURE 4

FIGURE 5a



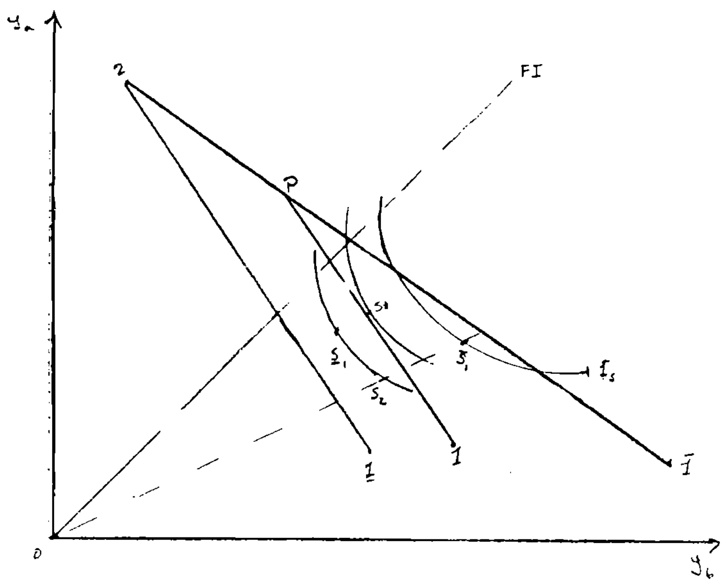


FIGURE 5b

FIGURE 6a

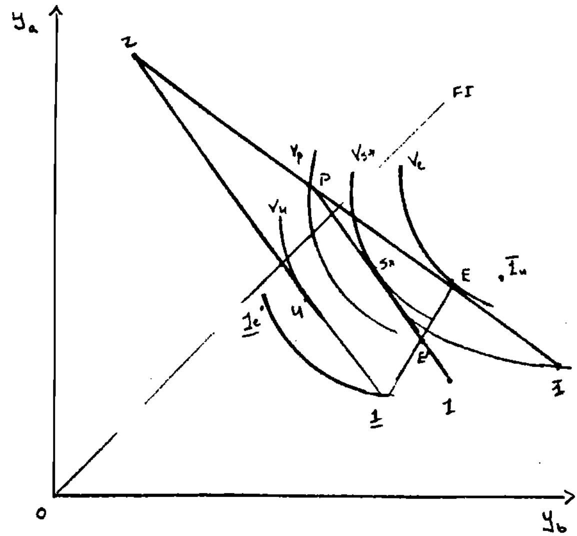


FIGURE 6b