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Social Insurance and Transition

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ABSTRACT

We study the general equilibrium effects of social insurance on the transition in a model in which the process of moving workers from matches in the state sector to new matches in the private sector takes time and involves uncertainty. As to be expected, adding social insurance to an economy without any improves welfare. Contrary to standard intuition, however, adding social insurance may slow transition. We show that this result depends crucially on general equilibrium interactions of interest rates and savings under alternative market structures.

1 Introduction

There is a rapidly emerging literature on the process of transition in the former communist countries of Eastern Europe and the Soviet Union. A major issue in this literature is the interaction of social insurance schemes with the process of transition. The conventional wisdom is that adding social insurance will both improve welfare and help speed transition. (See McAuley 1991, Naujoks and Bledowski 1991, Ahmad 1992, Atkinson and Micklewright 1992, Graham 1993, and Maret and Schwartz 1993.)[1]

In this paper we present a simple model in which we analyze the potential for social insurance to improve welfare and speed the transition. In line with the conventional wisdom we find that social insurance schemes do indeed improve welfare. In contrast with this wisdom we find that adding social insurance may actually *slow* transition. Indeed, we are able to demonstrate this result in a very simple model of transition.

The model builds on the idea that during transition large numbers of agents will move from old production activities in the state sector into new production activities in the emerging private sector. We imagine that this is a turbulent process: workers who leave the old state sector abandon specific skills and must spend time trying to find a good match in the private sector with new skills and a new activity.

We model this idea formally as a simple two-period search model. At the beginning of the first period all agents in the state sector have two options: they can stay in the state sector and produce some moderate level of output in both periods or they can leave this sector for the private sector. If they leave for the private sector they produce zero in the first period during which time they are imagined to be acquiring new skills and searching for a good match. In the second period with a certain probability they find a good match and produce a high level of output, alternatively, they find a poor match and produce some moderate level of output.

We begin with an economy with no social insurance in which the only asset avail-

[1]For example, Ahmad (1992, p. 329) sums up his survey on the role of social safety nets with the following: "To speed the efficient transition to market-based economies, temporary social safety nets are needed to protect large groups." Similar views can be found through much of the literature.

able to private agents is a simple bond and searchers must bear the idiosyncratic risk they face. We then add a social insurance scheme in which the government taxes successful searchers and subsidizes unsuccessful ones in a way that eliminates idiosyncratic risk (and replicates what would be the complete markets Arrow-Debreu allocations). Obviously, adding social insurance raises welfare. More interesting is the effect on the speed of transition. The conventional wisdom for why adding social insurance speeds transition is that adding social insurance diminishes the income risk from searching and hence makes it more attractive relative to staying in the state sector. Thus with fixed bond prices, adding social insurance *must* speed transition. We show that this conventional intuition is indeed correct in a small open economy version of the model. We then present a simple example showing how this intuition does not carry over to the general equilibrium of a closed economy. Briefly, if agents have strong precautionary demand for saving, then for each bond price they consume relatively more in the first period economy *with* social insurance. Thus if an economy adds social insurance at each bond price, it can accommodate consumption needs only by having more output and hence fewer searchers. If this general equilibrium effect is strong enough, adding social insurance actually slows transition. We describe how these results generalize to an infinite horizon model.

We interpret the transition in this model as arising from a major tax reform. Under the original policy, the government taxed the returns in the private-sector activities at such a high rate that it was optimal for agents to work in the state sector. The government then undertakes a major tax reform which reduces the taxes on the private-sector activities.

The basic structure of the model draws on elements of the search literature (for a comprehensive discussion see Mortensen 1986 and Pissarides 1990). More specifically, our model is related to models of sectoral reallocation in the labor market (see, for example, Rogerson 1987). Recently, several authors have used sectoral reallocation models to study the dynamics of transition, including Dixit and Rob (1991), Fernandez and Rodrik (1991), and Aghion and Blanchard (1994). Aghion and Blanchard present a model of the dynamics of the transition of the labor force from the state sector to the private sector which builds in several market imperfections. They then analyze the effect of unemployment benefits and incomes policy on the transition. Fernandez and Rodrik consider a model of sectoral adjustment following trade reform that focuses on agents' incentives to block the reform when they face idiosyncratic uncertainty about the cost of the reform. The most closely related paper is that of Dixit and Rob. They consider a model of sectoral adjustment and study the impact of social insurance on agents' incentives to move between sectors. Their model, however, focuses on the properties of the stochastic steady state and the impact of social insurance on the hysteresis bands.

In terms of the general equilibrium effects of alternative social insurance schemes, our work is related to that of Greenwood and Jovanovic 1990 and Bencivenga and Smith 1991. Both of these papers present models of financial intermediation and growth in which financial intermediaries provide a risk-pooling role for investors which is somewhat analogous to social insurance in our model. In contrast to our work, however, these papers focus on the implications of financial intermediation for steady state growth rather than transition.

One interpretation of our results is that alternative financial and institutional arrangements interact with the speed and nature of the transition. Recently Calvo and Coricelli (1992) have analyzed how various imperfections in credit markets interact with the nature of transition. They emphasize the contractionary effects that arise from freeing nominal prices in an environment with restrictions on credit to enterprises. In contrast, we focus on a nonmonetary model with incomplete insurance markets.

2 The Environment

We consider an economy that lasts two time periods, has a continuum of agents, and has two sectors in which production takes place. Each agent is endowed with one unit of time at each date $t = 0, 1$ and has preferences over consumption characterized by the utility function $U(c_0) + \beta EU(c_1)$, where U is strictly increasing, strictly concave, and satisfies $U'(c) \to \infty$ as $c \to 0$.

The two production sectors are labeled sector s (for "state") and sector A. An agent who works in sector s produces 1 unit of output each period he works in that sector. An agent who works in sector A produces either A_1 or A_2 units of output. We assume $A_1 > 1$ and $A_1 > A_2$. All agents are assumed to be in sector s at date 0. At this time, agents can either work in sector s or move to sector A. To move to sector A, an agent must spend one period searching for a good match with an activity in that sector. Agents who move to sector A either find a good match with an activity in that sector with probability π and produce A_1 at date 1, or they fail to find a good match with probability $(1-\pi)$ and produce A_2 at date 1.

Let $z \in [0,1]$ denote the fraction of agents who search for an activity in sector A at date 0. Let c_0^z denote the consumption at date 0 of an agent who searches for an activity in sector A, and let c_0^s denote the consumption at date 0 of an agent who works in sector s. Let $c_1^{A_1}$ denote the consumption at date 1 of an agent who searches at date 0 and finds a high productivity activity in sector A, $c_1^{A_2}$ denote the consumption at date 2 of an agent who searches at date 1 and fails to find a high productivity activity in sector A, and c_1^s denote the consumption at date 1 of an agent who works both periods in sector s. The resource constraints for this economy are given by

$$(1-z)c_0^s + zc_0^z \leq (1-z) \tag{1}$$

$$(1-z)c_1^s + z\pi c_1^{A_1} + z(1-\pi)c_1^{A_2} \leq (1-z) + z\pi A_1 + z(1-\pi)A_2 \tag{2}$$

where $z \in [0,1]$ and $c_0^s, c_1^s, c_0^z, c_1^{A_1}, c_1^{A_2} \geq 0$.

We interpret this model of transition as a closed economy that undergoes a major tax reform. In it the production activities in sector s and the production activities in sector A require different types of labor. Each of the production activities in sector s requires one unit of raw, homogeneous labor, while each of the production activities in sector A requires one unit of task-specific skilled labor. There are many different tasks in sector A. Agents are endowed with raw, homogeneous labor and an inherent ability in a subset of the many different task-specific skills. Ex-ante, agents do not know the skills in which they have inherent ability. For an agent to work in sector A, he must first spend a period acquiring one task-specific skill. If an agent has acquired the skill which matches his inherent ability, his output in that activity is A_1. If he acquires a skill which does not match his ability, his output is A_2. We suppose that, under the original tax system, the effective rate on skilled activities is so high that all agents choose to work in unskilled activities. This effective tax rate is meant to capture the full range of distortionary policies which discourage enterprising agents from investing the time necessary to find good matches for their skills. The tax reform corresponds to changes in policies which lower this effective tax rate enough to encourage agents to attempt to find good matches in skilled activities.

Alternatively, if we assume that $A_2 = 1$, we can interpret workers in sector 1 as working in activities in which they are badly matched. In this case, the movement of workers into sector A in the model can be interpreted as workers attempting to find good matches. In either case, we think of this model as capturing in a simple way the idea that the old system did not lead workers to find good matches in their production activities, whereas the new system does.

In terms of the empirical implications of the model, it is important to note that the shifts across activities may well not show up as shifts across sectors as conventionally measured. For example, consider workers in a state restaurant in Russia just after privatization. They may well attempt to open a new restaurant themselves, searching across restaurant types to find a good match, where types are characterized by, for example, ethnicity, price range, and location. Moreover, even within a given restaurant, a worker who had a certain position under the old regime may search for a new position, one that involves new responsibilities in the new economic environment and for which previous experience provides little guidance. Here the search process will not involve movements across sectors as defined in gross national product (GNP) accounts, but rather across activities within the same sector, perhaps even within the same firm. Much of the search may be done while workers still officially retain their old jobs. If so, then this search will show up not as a rise in unemployment, but as a drop in the productivity of existing firms.

3 The Impact of Social Insurance

In this section we show that adding social insurance to protect agents against the risk that they may fail to find a good match in sector A will actually slow transition if agents have sufficiently strong precautionary demand for saving and are not very risk-averse.

We begin by considering an environment in which there are no private markets for insuring away the idiosyncratic risk experienced by agents who search, where agents who work are paid their marginal product each period, and in which the only asset that agents trade at date 0 is a bond, which for certain pays off 1 unit of consumption at date 1. At date 0, agents choose whether to work in sector s or to search. Clearly, if an agent works in sector s at date 0, he will find it optimal to work in sector s again at date 1.

An agent who works both periods in sector s earns one unit of wages at each date. We refer to such an agent as a "stayer." If we let p denote the price at date 0 of a sure bond paying one unit of consumption at date 1, and b the quantity of such bonds purchased, a stayer faces budget constraints $c_0^s + pb \leq 1$ and $c_1^s \leq 1 + b$. Consolidating these constraints, we can write the agent's problem as

$$V^s(p) = \max_{(c_0^s, c_1^s)} U(c_0^s) + \beta U(c_1^s) \tag{3}$$

subject to

$$c_0^s + pc_1^s \leq 1 + p. \tag{4}$$

Here $V^s(p)$ is the value of utility of an agent who works in sector s for both periods. Let $c^s(p)$ denote the date zero consumption decision rule.

An agent who searches earns no wages at date 0, and at date 1 earns A_1 with probability π and A_2 with probability $(1 - \pi)$. This agent faces budget constraints $c_0^z + pb \leq 0$, $c_1^{A_1} \leq A_1 + b$, and $c_1^{A_2} \leq A_2 + b$. Consolidating these constraints, we can write the problem of an agent who searches as

$$V_I^z(p) = \max_{\{c_0^z, c_1^{A_1}, c_1^{A_2}\}} U(c_0^z) + \beta\left[\pi U(c_1^{A_1}) + (1-\pi)U(c_1^{A_2})\right] \tag{5}$$

subject to

$$c_0^z + p(\pi c_1^{A_1} + (1-\pi)c_1^{A_2}) \le p(\pi A_1 + (1-\pi)A_2) \tag{6}$$

$$c_1^{A_1} \ge c_1^{A_2} + (A_1 - A_2). \tag{7}$$

Let $c_I^z(p)$ denote the decision rule of a searcher for first-period consumption.

An *equilibrium without social insurance* is an allocation $(z, c_0^s, c_1^s, c_0^z, c_1^{A_1}, c_1^{A_2})$ and a bond price p such that (c_0^s, c_1^s) solves (1), $(c_0^z, c_1^{A_1}, c_1^{A_2})$ solves (5), the resource constraints (1) and (2) are satisfied, and either $z = 0$ and $V^s(p) \ge V_I^z(p)$ or $z \ge 0$ and $V^s(p) = V_I^z(p)$.

We have

Proposition 1 *There is a unique equilibrium without social insurance.*

Proof. First note that there can be no equilibrium with $p > \beta$. For such a bond price the stayer's first-order condition $U'(c_0)/U'(c_1) = \beta/p$ and concavity of the utility function imply $c_0 > c_1$. Substituting this in the stayer's budget constraint gives $c_0(1+p) > (1+p)$ so $c_0 > 1$. But this implies that stayers are borrowers, which is infeasible since searchers earn zero.

Consider the functions $V_I^z(p)$ and $V^s(p)$. Since searchers are borrowers, $V_I^z(p)$ is increasing. For $p < \beta$, stayers are lenders so $V^s(p)$ is decreasing. For $p < \beta$, these functions intersect either once or not at all. If they intersect once, the unique equilibrium has search. (All agents are indifferent between searching and not, and the equilibrium number of searchers is determined by the resource constraint.) If these functions do not intersect for $p < \beta$, the unique equilibrium has no search, and $p = \beta$ as agents simply consume their own output. ■

Consider next the equilibrium when we add social insurance that completely eliminates idiosyncratic risk. This equilibrium allocation is the ex-ante optimal allocation and can be decentralized in many ways. For comparison to the equilibrium without social insurance, we focus on a decentralization in which the only private financial markets are for risk-free bonds and the government provides social insurance through taxes and transfers. The income of an agent who works both periods in sector 1 is one unit each period. The income of an agent who searches is zero at date 0, A_1 with probability π, and A_2 with probability $(1-\pi)$ at date 1. This agent receives social insurance transfers $[\pi A_1 + (1-\pi)A_2] - A_1$ if he produces A_1, and receives transfers $[\pi A_1 + (1-\pi)A_2] - A_2$ if he produces A_2. With such transfers, an agent who searches receives after-transfer income equal to $[\pi A_1 + (1-\pi)A_2]$, whether or not he succeeds in search. Since this social insurance scheme simply pools the risk among those who search, it is self-financing and thus involves no taxes on or transfers to the agents who work both periods in sector s.

The problem of a stayer is again given by (3). The problem of a searcher can be written as (5) with constraint (7) dropped. Let $V_c^z(p)$ denote the resulting value of utility of a searcher (with complete markets) and let $c_c^z(p)$ denote a searcher's date zero consumption decision rule. Of course, in this problem $c_1^{A_1} = c_1^{A_2} (= c_1^A)$, and it can be written

$$V_c^z(p) = \max_{c_0^z, c_1^A} U(c_1^z) + \beta U(c_1^A) \tag{8}$$

subject to

$$c_0^z + pc_1^A = p[\pi_1 A_1 + \pi_2 A_2]. \tag{9}$$

The definition of an *equilibrium with social insurance* is identical to that of an equilibrium without social insurance except that $V_c^z(p)$ replaces $V_I^z(p)$.

We have

Proposition 2 *There is a unique equilibrium with social insurance.*

Proof. Following the logic in the proof of Proposition 1, there can be no equilibrium with $p > \beta$, and for $p \leq \beta$, $V^s(p)$ is decreasing and $V_c^z(p)$ is increasing. Thus these functions can intersect at most once with $p \leq \beta$. If they do intersect for $p \leq \beta$, there is a unique equilibrium with search, and all agents are indifferent between searching and staying. Hence if they intersect they must do so at the price p that equates the (after-transfer) incomes of searchers and stayers, namely

$$\hat{p} = [\pi A_1 + (1-\pi)A_2 - 1]^{-1} \tag{10}$$

and this is the unique equilibrium. If they do not intersect for $p \leq \beta$, the unique equilibrium has no search and $p = \beta$. ■

It is important to stress that adding social insurance must clearly improve welfare. We are more interested in the effects that social insurance has on the speed of transition. In both the equilibrium with social insurance and the one without social insurance, general equilibrium effects limit the speed of transition. As more agents search, aggregate income and consumption in the first period fall. This drives down bond prices (drives up interest rates), making it relatively less attractive to search. Indeed, there cannot be a transition in which *all* consumers search, since their date zero consumption would be zero and bond prices would be zero. These general equilibrium interactions of the number of searchers and bond prices are critical in our examples.

Standard partial equilibrium logic of the effect of social insurance on transition is as follows. At a given bond price, adding social insurance diminishes the income risk from searching and hence makes it more attractive relative to staying, that is,

$$V_c^z(p) > V_I^z(p).$$

To see this, recall that the problem of a searcher with social insurance (problem 5 with constraint 7 dropped) is a less constrained version of the problem of the searcher with no social insurance (problem 5). It suffices to show that the solution to the less constrained problem violates the extra constraint. But that is obvious since the first-order conditions imply $U'(c_1^{A_1}) = U'(c_1^{A_2})$ and thus $c_1^{A_1} = c_1^{A_2}$, which violates constraint (7).

Thus at fixed bond prices, adding social insurance *must* speed transition. This logic can be formalized by dropping the resource constraints and considering a small open economy that can borrow and lend at some fixed bond price $\bar{p}$. In both equilibria, except for knife-edge cases, all agents either stay or search. Since adding social insurance increases the value of searching, in a small open economy social insurance can only speed transition—it can never slow it. In sum we have

Proposition 3 *In a small open economy, adding social insurance either increases the number of searchers or leaves it unchanged.*

We illustrate this result in Figure 1. In Figure 1a we plot the functions $V_I^z(p)$, $V_c^z(p)$, and $V^s(p)$. Let $\hat{p}_x$, $x = c, I$ denote the bond prices at which $V_x^z(p)$ and $V^s(p)$ intersect. Clearly, at $\hat{p}_x$, $x = c, I$, agents are indifferent between staying and searching in the economies with and without social insurance. Since $V_x^z(p)$, $x = c, I$ are both increasing and $V^s(p)$ is decreasing, all agents stay when $p < \hat{p}_x$, search when $p > \hat{p}_x$, and are indifferent between staying and searching when $p = \hat{p}_x$. These decision rules imply that, in the aggregate, the number of agents who search as a function of the bond price is given by

$$z_x(p) = \left\{ \begin{array}{ll} 0 & if\ p < \hat{p}_x \\ \pi & if\ p = \hat{p}_x \\ 1 & if\ p > \hat{p}_x \end{array} \right\}$$

where $x = c, I$ and π is any number in $[0,1]$. Since $V_c^z(p) > V_I^z(p)$, we know that

$$\hat{p}_c < \hat{p}_I.$$

We plot the functions $z_x(p)$, $x = c, I$ in Figure 1b. We see there are three possibilities. Let $\bar{p}$ denote the world bond price. If $\bar{p} < \hat{p}_c$, no one searches in either economy; if $\bar{p} > \hat{p}_I$, all agents search in both economies; and if $\hat{p}_c < \bar{p} < \hat{p}_I$, then all agents search in the economy with social insurance but none do in the economy without social insurance. Thus in a small open economy, adding social insurance either increases the number of searchers or leaves it unchanged.

This proposition makes it clear that social insurance can slow transition in the closed economy only through its *general equilibrium effects.* In the closed economy, the intuition underlying Proposition 3 does not carry over because the economy as a whole cannot borrow to finance consumption for searchers. Instead, enough agents must remain in the state sector in the first period to produce the output consumed by both stayers and searchers in the first period. Formally, equilibrium consumption and number of searchers must satisfy the first-period resource constraint.

To analyze the equilibrium in the closed economy, it is useful to implicitly define functions $n_x(p)$ for $x = c, I$ from the first-period resource constraint. For each p, let $n_x(p)$ solve

$$(1 - n_x(p))c^s(p) + n_x(p)c_x^z(p) = (1 - n_x(p)). \tag{11}$$

Note that $(1 - n_x(p))$ is the number of agents who must stay in the state sector in the first period to fulfill the demands of both searchers and stayers for first-period consumption at bond price p. Thus $n_x(p)$ captures the restrictions on the number of searchers imposed by the resource constraint. Since both searchers' and stayers' first-period consumption demands increase as bond prices rise (as interest rates fall), these functions are decreasing in p.[2] That is, as agents' demand for first-period consumption rises, more agents must stay in the state sector to produce the output that satisfies these demands. Note that if $c_I^z(p) < c_c^z(p)$ for all p, then $n_I(p) > n_c(p)$ for all p. Leland (1968) refers to this situation as one in which agents have a *precautionary motive for saving*. He shows that sufficient conditions for agents to have a precautionary motive for saving are that they are risk averse and U' is convex. These conditions are satisfied when the utility function has either constant relative risk aversion or constant absolute risk aversion. We will think of this situation as one in which *adding* social insurance *raises* the first-period consumption demands of searchers.

Consider the equilibrium in the closed economy. It is not possible for all agents to search since some must stay in the state sector to produce output. Thus, in equilibria with search, agents must be indifferent between staying and searching and the bond price is $\hat{p}_x$, $x = c, I$. The equilibrium number of searchers is $n_x(\hat{p}_x)$, $x = c, I$. Now compare $n_I(\hat{p}_I)$ and $n_c(\hat{p}_c)$. Consider first an extreme case in which agents have no

[2]Differentiating (11) gives

$$\frac{dn_x(p)}{dp} = -\frac{1}{1 - c^s(p) + c_x^z(p)} \left[(1 - n_x(p))\frac{dc^s(p)}{dp} + n_x(p)\frac{dc_x^z(p)}{dp}\right].$$

Clearly $n_x(p)$ is decreasing p if $c^s(p)$ and $c_x^z(p)$ are decreasing in p. With additively separable and concave preferences, it is easy to check that both $c^s(p)$ and $c_x^z(p)$ are decreasing.

precautionary motive for saving (as is the case when utility is quadratic). In this case, $n_I(p) = n_c(p)$. Then clearly $\hat{p}_c < \hat{p}_I$ implies that $n_c(\hat{p}_c) > n_I(\hat{p}_I)$. Adding social insurance lowers bond prices (raises interest rates), in this case reducing agents' first-period consumption and thus raising the number of searchers.

Now suppose that agents have a precautionary motive for saving so that $n_I(p) > n_c(p)$. In Figures 2 and 3 we illustrate two possible outcomes. If, as illustrated in Figure 2, the precautionary motive for saving is relatively small, so $n_I(p)$ is close to $n_c(p)$, then adding social insurance still speeds transition. But if, as illustrated in Figure 3, the precautionary motive for saving is large enough, then adding social insurance slows transition.

To summarize, consider adding social insurance to an economy which previously had none. For each bond price, searching becomes relatively more attractive. If agents are to be indifferent between searching and staying, bond prices must fall (interest rates must rise). By itself, this fall in the bond price lowers total date zero consumption demands and allows the economy to accommodate more searchers. However, with a precautionary motive for saving, for each bond price, adding social insurance increases the total date zero consumption demands, and from the resource constraint (1) it is clear that the economy can accommodate fewer searchers. If the precautionary saving effect dominates the bond price effect (interest rate effect), there will be fewer searchers with social insurance, and also the converse.

We now present examples in which adding social insurance speeds and slows transition when agents have either CRRA or CARA utility.

Example 1 (CRRA preferences). Let $U(c) = c^\gamma/\gamma$, let $A_1 = 6$, $A_2 = 1$, $\beta = 1$, $\pi = 0.9$. If $\gamma = 0.2$, both equilibria have search. The equilibrium bond prices are $\hat{p}_I = 0.31$ and $\hat{p}_c = 0.22$, and the number of searchers in each case is $n_I(\hat{p}_I) = 0.66$ and $n_c(\hat{p}_c) = 0.50$. If $\gamma = -0.5$, then the equilibrium bond prices are $\hat{p}_I = 0.66$ and $\hat{p}_c = 0.61$, and the number of searchers in each case is $n_I(\hat{p}_I) = 0.17$ and $n_c(\hat{p}_c) = 0.24$.

In Figure 4 we keep the parameters listed above, except that we vary γ between -1 and 1 and plot the equilibrium values of searchers $n_I(\hat{p}_I)$ and $n_c(\hat{p}_c)$ in the two economies.

Example 2 (CARA preferences). Let $U(c) = -\exp(-\gamma c)$. Let the parameters be the same as in Example 1, except that we vary γ between 0.3 and 1. In Figure 5 we plot the equilibrium number of searchers in the two economies.

So far, we have presumed that agents have a precautionary motive for saving. Of course, if agents have a precautionary motive for dissaving, so $c_I^z(p) > c_c^z(p)$ for all p, then $n_I(p)$ lies everywhere below $n_c(p)$, and adding social insurance must speed transition.

In sum we have found the following: Adding social insurance into an economy with uncontingent loans raises welfare and decreases the equilibrium bond price (increases the equilibrium interest rate). Social insurance speeds transition if agents have little or no demand for precautionary saving. Social insurance can slow transition if agents have a large precautionary demand for saving.

4 Extension to the Infinite Horizon

So far we have demonstrated our main result in a two-period economy. While this analysis is useful in building intuition, it is deficient in two respects. First, while it shows that adding social insurance may slow down transition, it leaves open the issue of whether it can lead to lower output in the steady state. Second, in the two-period model all of the searchers' consumption is provided by output from the old state sector; thus not all agents can transit. In the infinite horizon model it is no longer necessary that some agents always stay in the state sector because the movement out of the old sector may be financed by previous movers. This version is more appealing aesthetically, since, in actual economies, transition costs are probably financed more by the ongoing productivity gains from economic reform rather than by the older stagnant sectors.

In the two-period economy we established our main results for both CRRA and CARA preferences. In the infinite-horizon economy we focus on CARA preferences. These preferences have the property that the decision to search is independent of the level of bondholdings. In our computations at each point in time we need only record two numbers: the total number of searchers and the total number of well-matched agents. This leads to a difficult but feasible problem. In contrast, if agents have CRRA preferences, an individual's decision to search depends on his level of bondholdings. With idiosyncratic risk, agents who start with identical bondholdings end with different bondholdings after experiencing different realizations of success during their searching. This heterogeneity then implies that to compute the equilibrium at each point in time we would need to record two functions: the distribution of bondholdings of both well-matched and non-well-matched agents. Currently such a computation involves too large a state space to be tractable. Here we demonstrate our main points with CARA preferences.

We make two points. First, adding social insurance may well affect the steady state level of output. Second, even if adding social insurance does not affect the steady state, it may well lower the whole time path of output during the transition to the steady state.

4.1 An Infinite Horizon Economy

Time is denoted $t = 0, 1, 2, \ldots$. All agents in the model have identical preferences, of the form $E\sum_{t=0}^{\infty}\beta^t U(c_t)$, with $U(c) = -\exp(-\gamma c)$. We assume that $A_1 = A > 1$ and $A_2 = 1$. Let λ_t be the number of agents who have good matches in sector A at date t. These agents produce output $A\lambda_t$ at date t. Let z_t be the number of searchers and let $(1 - \lambda_t - z_t)$ be the number of agents who work but are not well-matched in sector A at date t. These agents who work when not well-matched in sector A produce $(1 - \lambda_t - z_t)$. At date 0 there is some initial stock of agents λ_0 who are well-matched in sector A. At every date t, any agent who is not well-matched in sector A can search for a match in sector A. An agent who searches must forgo employment for that period and has a probability π of finding a good match in sector A. Current production and the next period's number of workers well-matched in sector A are given by the equations

$$Y_t = A\lambda_t + 1 - \lambda_t - z_t \tag{12}$$

$$\lambda_{t+1} = \lambda_t + \pi z_t. \tag{13}$$

Consider first the allocations from an equilibrium with social insurance. It is immediate that they maximize the utility of the representative agent, subject to the resource constraints. Since our utility function $U(c) = -\exp(-\gamma c)$ is homothetic, the aggregate consumption allocations c_t, number of searchers z_t, and fraction of agents in sector A, λ_t solve

$$\max \sum_{t=0}^{\infty} \beta^t U(c_t) \tag{14}$$

subject to (13) and

$$c_t = A\lambda_t + 1 - \lambda_t - z_t$$

with $\lambda_t \in [0,1]$, $c_t, z_t \geq 0$. At an interior point the first-order conditions imply

$$U'(c_t) = \beta U'(c_{t+1})[\pi A + (1-\pi)]. \tag{15}$$

Consider next the economy without social insurance. We assume that agents get paid their marginal product and that the only asset that agents trade is a one-period risk-free bond. An allocation in this economy is a set of sequences

$$\{\lambda_{t+1}, c_t^A(b), z_t^s(b), c_t^s(b)\}_{t=0}^{\infty} \tag{16}$$

and value functions $\{V_t^s(b), V_t^A(b)\}_{t=0}^{\infty}$, where: λ_t is the number of agents well-matched in sector A; $c_t^A(b)$ is the consumption of agents who are well-matched in sector A and have bondholdings b at date t; $c_t^s(b)$ is the consumption of agents who are not well-matched in sector A and have bondholdings b at date t; $z_t^s(b) \in \{0,1\}$ is the decision of agents who are not well-matched and have bondholdings b to search ($z=1$), or work in the state sector ($z=0$) at date t; and $V_t^s(b)$ and $V_t^A(b)$ are the discounted expected utilities, from date t on, of agents in sectors s and A respectively. Let ψ_0^A be the distribution of initial bondholdings for those who are well-matched in sector A, ψ_0^s be the distribution of initial bondholdings for those who are not well-matched in sector A, and λ_0 be the number of agents initially well-matched in sector A. Let $\{p_t\}_{t=0}^{\infty}$ be a sequence of bond prices, where p_t is the price paid at date t for a bond that for certain pays off one unit at date $t+1$. The resource constraints in this economy are

$$\int_b c_t^s(b)d\psi_t^s + \int_b c_t^A(b)d\psi_t^A = A\lambda_t + \int_b z_t^s(b)d\psi_t^s \quad . \tag{17}$$

where ψ_t^A and ψ_t^s are the distribution of bondholdings for both types of agents as determined by those agents' decision rules, and the evolution of the number of agents well-matched in sector A is given by

$$\lambda_{t+1} = \lambda_t + \pi \int_b z_t^s(b)d\psi_t^s. \tag{18}$$

The resource constraint (17) simply requires that the total consumption of agents who are not well-matched plus the total consumption of agents who are well-matched add up to total output. Each well-matched agent produces A and each non-well-matched agent produces 1 if not searching and 0 if searching. The transition law (18) gives the total number of well-matched agents at $t+1$ as the sum of the well-matched agents at t plus π times the total number of searchers (where we have invoked a law of large numbers).

In the equilibrium without social insurance, we require that agents' decision rules solve the following utility maximization problems stated as Bellman equations when bond prices $\{p_t\}_{t=0}^{\infty}$ are taken as given: $c_t^A(b)$ solves

$$V_t^A(b_t) = \max_{c_t, b_{t+1}} u(c_t) + \beta V_{t+1}^A(b_{t+1}) \tag{19}$$

subject to the budget constraint

$$c_t + p_t b_{t+1} = b_t + A \tag{20}$$

and $c_t^s(b)$, $z_t^s(b)$ solves

$$\begin{aligned} V_t^s(b_t) &= \max_{c_t, b_{t+1}, z_t} u(c_t) + (1-z_t)\beta V_{t+1}^s(b_{t+1}) \\ &\quad + z_t\beta[\pi V_{t+1}^A(b_{t+1}) + (1-\pi)V_{t+1}^s(b_{t+1})] \end{aligned} \tag{21}$$

subject to the budget constraint

$$c_t + p_t b_{t+1} = b_t + (1 - z_t) \tag{22}$$

and the constraint that $z_t \in \{0, 1\}$.

An *equilibrium without social insurance* is an allocation and a sequence of prices $\{p_t\}$ such that: (i) $c_t^A(b)$ solves (19) subject to (20); (ii) $c_t^s(b), z_t^s(b)$ solve (21) subject to (22); (iii) the resource constraints are satisfied; and (iv) the law of motion for λ_t, (18), is satisfied.

4.2 Steady State Analysis

We begin with the analysis of the steady states with and without social insurance. We characterize the possible steady states as functions of the underlying parameters. We show that if the returns to search are sufficiently high, then in both economies the unique steady state is for all agents to be in sector A. If the returns to search are somewhat lower, then the unique steady state in the economy with social insurance has all agents in sector A. For the same parameter values, however, no agents will search in the economy without social insurance; thus no agent who starts in the state sector will leave. Therefore adding social insurance can affect the steady state level of output.

Consider first the economy with social insurance. Consider the parameter restriction

$$\beta[\pi A + (1 - \pi)] > 1. \tag{23}$$

The following proposition then follows immediately from (15):

Proposition 4 *If (23) holds, then the unique steady state of the economy with social insurance has all agents in sector A, so $\lambda = 1$. If (23) does not hold, then any $\lambda \in [0, 1]$ is a steady state fraction of agents in A.*

Since the equilibrium allocations solve a strictly concave programming problem, it is possible to say something stronger. If (23) holds, then the unique dynamic transition path $\{\lambda_t\}$ has λ_t converging to 1 as t goes to infinity. If the reverse (strict) inequality holds, then the solution to the first-order conditions is at the corner, with $z_t = 0$, and no one searches. The unique dynamic transition path then has $\lambda_t = \lambda_0$, where λ_0 is the initial number of agents in sector A. Of course, in this case, as the initial condition λ_0 varies in $[0, 1]$, so does the limiting steady state. Finally, in the knife-edge case where (23) holds with equality, then, starting from any initial condition λ_0, there is (trivially) a continuum of limiting steady states $\lambda \in [0, 1]$.

Consider next the economy without social insurance. In any steady state, $p = \beta$, and we can simplify the value functions as follows. Consider an agent who is well-matched in sector A. Clearly, at the steady state prices this agent consumes a constant amount. From the budget constraint, $c + \beta b = A + b$, so $c = A + (1 - \beta)b$ and

$$V^A(b) = U(A + (1 - \beta)b)/(1 - \beta). \tag{24}$$

Consider next an agent who has bonds b, is not well-matched, and has value function $V^s(b)$. This agent can either search or not search. Conditional on searching the agent's problem is

$$V^z(b) = \max_{b'} U(b - \beta b') + \beta[\pi V^A(b') + (1 - p)V^s(b')]. \tag{25}$$

That is: an agent earns zero today; with probability π the agent finds a good match, and from tomorrow onward has discounted utility $V^A(b')$; while with probability $(1 - \pi)$ the agent is not well-matched, and from tomorrow onward has discounted utility $V^s(b')$. Conditional on not searching, the value function is

$$V^n(b) = \max_{b'} U(1 + b - \beta b') + \beta V^s(b'). \tag{26}$$

That is, the agent earns 1 today and tomorrow is not well-matched. The value function $V^s(b)$ satisfies

$$V^s(b) = \max[V^z(b), V^n(b)]. \tag{27}$$

If $V^s(b) = V^z(b)$, the agent searches; otherwise he does not.

We will construct equilibrium value functions using undetermined coefficients (the guess and verify method) as follows. Suppose the value functions have the form

$$\begin{aligned} V^z(b) &= -\exp[-\gamma(Z + (1-\beta)b)]/(1-\beta) && (28) \\ V^n(b) &= -\exp[-\gamma(N + (1-\beta)b)]/(1-\beta) && (29) \end{aligned}$$

where N and Z are constants to be determined. Notice that (28) and (29) imply

$$V^s(b) = -\exp[-\gamma(1-\beta)b]\min[\exp(-\gamma N), \exp(-\gamma Z)] \qquad (30)$$

and, as we have already derived in (24)

$$V^A(b) = -\exp[-\gamma(A + (1-\beta)b)]/(1-\beta). \qquad (31)$$

With these conjectured value functions, if $Z > N$, all agents search; if $Z = N$, agents are indifferent; if $Z < N$, no agents search. Suppose first that $Z \leq N$. Then $V^s(b) = V^n(b)$, and the value function for not searching satisfies

$$\begin{aligned} (1-\beta)V^n(b) &= \max_{b'} -(1-\beta)\exp[-\gamma(1 + b - \beta b')] && (32) \\ &\quad -\beta\exp[-\gamma(N + (1-\beta)b')]. \end{aligned}$$

The first-order conditions imply $b' = 1 + b - N$. Substituting this back into the value function gives

$$(1-\beta)V^n(b) = -\exp[-\gamma((1-\beta) + \beta N + (1-\beta)b)]. \qquad (33)$$

Equating coefficients in (29) and (33) gives that N satisfies $N = (1-\beta) + \beta N$ or $N = 1$. (This, of course, is what we would obtain from directly computing the value as in 24.)

The value function for searching can be written

$$(1-\beta)V^z(b) = \max_{b'} -(1-\beta)\exp[-\gamma(b - \beta b')] - \beta\exp[-\gamma((1-\beta)b' + F(N))] \quad (34)$$

where $F(N)$ is defined by $\exp(-\gamma F(N)) = \pi\exp(-\gamma A) + (1-\pi)\exp(-\gamma N)$. The first-order condition implies $b' = b - F(N)$. Substituting this back into the value function gives

$$(1-\beta)V^z(b) = -\exp(-\gamma[(1-\beta)b + \beta F(N)]). \qquad (35)$$

Equating coefficients in (28) and (35) gives $Z = \beta F(N)$. Using the definition of F and evaluating F at $N = 1$ gives that Z is determined by $\exp(-\gamma Z/\beta) = \pi \exp(-\gamma A) + (1-\pi)\exp(-\gamma)$ or $Z = -\beta \log[\pi e^{-\gamma A} + (1-\pi)e^{-\gamma}]/\gamma$. Using the definition of U, we have that Z satisfies $U(Z/\beta) = \pi U(A) + (1-\pi)U(1)$. Since U is increasing, we have $Z \leq N = 1$ if the parameters satisfy

$$U(1/\beta) \geq \pi U(A) + (1-\pi)U(1). \tag{36}$$

Next, if we suppose $Z > N$, so that all agents always search, similar calculations imply Z is (implicitly) defined by

$$Z = -\beta \log[\pi e^{-\gamma A} + (1-\pi)e^{-\gamma Z}]/\gamma \tag{37}$$

and $N = (1-\beta) + \beta Z$. Using the definition of U we see that this will be true if and only if the fixed point of

$$U(Z/\beta) = \pi U(A) + (1-\pi)U(Z) \tag{38}$$

has $Z > 1$. This will be true if and only if the parameters satisfy

$$U(1/\beta) < \pi U(A) + (1-\pi)U(1). \tag{39}$$

Notice that if (39) holds, then at $Z = 1$ the left-hand side of (38) is strictly less than the right-hand side. Increasing Z increases the left-hand side more than it does the right-hand side, so the fixed point must have $Z > 1$.

Since the functional equations (25) and (26) are contractions, standard arguments imply that the constructed value functions and associated policy rules are unique (see Stokey, Lucas, and Prescott 1989).

Proposition 5 *If (39) holds, then the unique steady state of the economy without social insurance has all agents in sector A, that is, $\lambda = 1$. If (39) does not hold, then any $\lambda \in [0,1]$ is a steady state fraction of agents in A. Moreover, if (39) holds, then so does (23), but not the converse.*

Proof. If (39) holds, then $Z > N$ and all agents prefer to search regardless of the bondholdings. The unique steady state is thus $\lambda = 1$. If (36) holds as a strict inequality, agents prefer not to search, while if it holds as an equality, agents are indifferent between searching and not searching. In either case, given any distribution λ, no agents have an incentive to search, and so λ is a steady state distribution.

To see the second part of the proposition, notice that we can rewrite (23) as $-\gamma[\pi A + (1-\pi)] < -\gamma/\beta$. We can rewrite this as

$$U(1/\beta) < U(\pi A + (1-\pi)). \tag{40}$$

Since U is strictly concave for $\gamma > 0$, $U(\pi A + (1-\pi)) > \pi U(A) + (1-\pi)U(1)$. Thus if (39) holds, then so does (40) and thus so does (23). ■

Notice that if (36) holds as a strict inequality, then if λ_0 is an initial distribution the unique equilibrium is for no agents to search, and the unique limiting steady state is simply this initial distribution λ_0.

4.3 Transitional Dynamics

Here we compare the transitional dynamics in the economies with and without social insurance. The equilibrium with social insurance is simply computed by using the planning problem (14). The equilibrium without social insurance is computed by using backward recursions starting near the steady state.

We compute (an approximation to) the equilibrium without social insurance as follows. We choose parameter values so that the unique steady state is for all agents to be in sector A. We consider some time $T+1$ at which the economy is near the steady state and almost all agents are in sector A. We suppose that from time $T+1$ onward, agents cannot search. In particular, any agents in sector s must remain there after $T+1$. We solve for the value functions recursively from $T+1$.

For any t, agents in sector A stay there. We can define $q_t = \prod_{s=0}^{t-1} p_s$ and rewrite (19) as

$$V_t^A(b_t) \quad = \quad \max \sum_{s=t}^{\infty} \beta^s U(c_s) \tag{41}$$

$$\sum_{s=t}^{\infty} q_s c_s \leq \sum_{s=t}^{\infty} q_s A + q_t b_t.$$

The first-order conditions imply $c_s = c_t - [\log(q_s/\beta^{s-t} q_t)]/\gamma$. Substituting for c_s in the budget constraint and solving gives

$$c_s = Q_t b_t + H_t + A - \log(q_s/\beta^{s-t} q_t)/\gamma \tag{42}$$

where $Q_t = q_t/(\sum_{s=t}^{\infty} q_s)$ and $H_t = (Q_t/\gamma)\sum_{s=t}^{\infty}(q_s/q_t)\log((q_s/q_t)/\beta^{(s-t)})$. Observe, for later use, that

$$Q_t = Q_{t+1}/(p_t + Q_{t+1}) \tag{43}$$

and

$$H_t = \left[H_{t+1} + \frac{1}{\gamma}(\log(p_t) - \log(\beta))\right] p_t/(p_t + Q_{t+1}). \tag{44}$$

Substituting (42) for c_s into (41) and simplifying gives

$$V_t^A(b_t) = -\exp[-\gamma(A + Q_t b_t + H_t)]/Q_t. \tag{45}$$

For the rest of the value functions we have the following proposition.

Proposition 6 *The value functions for the economy with no opportunity to search after T are given as:*

$$V_t^z(b_t) = -\exp[-\gamma(Z_t + Q_t b_t + H_t)]/Q_t \tag{46}$$

$$V_t^n(b_t) = -\exp[-\gamma(N_t + Q_t b_t + H_t)]/Q_t \tag{47}$$

$$V_t^s(b_t) = -\exp[-\gamma(Q_t b_t + H_t)]\min[\exp(-\gamma Z_t), \exp(-\gamma N_t)]/Q_t$$

where

$$Z_t = \frac{-1}{\gamma}\frac{p_t}{Q_{t+1} + p_t}\log[\pi\exp(-\gamma A) + (1-\pi)\exp(-\gamma Z_{t+1})]$$

and $N_t = p_t Z_{t+1}/(Q_{t+1} + p_t) + Q_t$ *for* $t = 0, ..., T$ *and* $Z_{T+1} = 1$.

Proof. We establish the proposition by induction from $T+1$. That is, we suppose the value functions are of the conjectured form for $t+1$, and we show that the value functions for t have the conjectured form. We suppose throughout that $Z_t \geq N_t$. The value function for searching at t is thus

$$V_t^z(b_t) = \max_{b_{t+1}} \{-\exp[-\gamma(b_t - p_t b_{t+1})] - \beta \exp[-\gamma(Q_{t+1}b_{t+1} + H_{t+1} + F_{t+1})]/Q_{t+1}\}$$

where F_{t+1} is defined by $\exp(-\gamma F_{t+1}) = \pi \exp(-\gamma A) + (1-\pi)\exp(-\gamma Z_{t+1})$. The first-order conditions imply that

$$b_{t+1} = \left[b_t - \frac{1}{\gamma}\log(p_t/\beta) - H_{t+1} - F_{t+1}\right] / [Q_{t+1} + p_t].$$

Substituting this back into the value function gives

$$V_t^z(b_t) = -\left[\frac{Q_{t+1} + p_t}{Q_{t+1}}\right] \exp\left[-\gamma\left(\frac{Q_{t+1}(b_t - \log(p_t/\beta)/\gamma) + p_t(H_{t+1} + Z_{t+1})}{Q_{t+1} + p_t}\right)\right]. \tag{48}$$

Using (43) and (44) gives that (4.3) simplifies to (46).

The value function for not searching at t is

$$\begin{aligned} V_t^n(b_t) &= \max_{b_{t+1}} - \exp[-\gamma(1 + b_t - p_t b_{t+1})] \\ &\quad -\beta \exp[-\gamma(Q_{t+1}b_{t+1} + H_{t+1} + Z_{t+1})]/Q_{t+1}. \end{aligned}$$

The first-order conditions imply

$$b_{t+1} = [1 + b_t - \log(p_t/\beta)/\gamma - H_{t+1} - Z_{t+1}]/(Q_{t+1} + p_t).$$

Substituting this back into the value function gives

$$V_t^n(b_t) = -\left[\frac{Q_{t+1} + p_t}{Q_{t+1}}\right] \exp\left[-\gamma\left(\frac{Q_{t+1}(b_t + 1 - \log(p_t/\beta)/\gamma) + p_t(H_{t+1} + Z_{t+1})}{Q_{t+1} + p_t}\right)\right].$$

Using (43) and (44) gives that this value function simplifies to (47).

Now at $t = T+1$ there is no opportunity to search. We capture this by setting both $V_{T+1}^z(b_{T+1})$ and $V_{T+1}^n(b_{T+1})$ (and hence $V_{T+1}(b_{T+1})$) equal to the value of not searching from $T+1$ onward. The value function is the same form as (46) and (47), with $Z_{T+1} = N_{T+1} = 1$. To see this, note that the algebra in establishing it is identical to that in the derivation of $V_t^A(b_t)$, with the income 1 replacing the income A. ■

Notice that if we set $p_t = \beta$ and take the limit of these expressions as T tends to infinity, they reduce to the steady state value functions (28), (29), and (30). Notice also that in this economy, with no opportunity to search after T, production is constant after T and the equilibrium allocations from T onward are simply the steady state allocations.

We solve for the transition by working backward from a terminal date T and a value of λ^A_{T+1} close to one. We set Z_{T+1}, H_{t+1}, and Q_{T+1} equal to their steady state values, namely $Z_{T+1} = Z$ (defined implicitly in 37) $H_{T+1} = 0$, and $Q_{T+1} = (1-\beta)$. Observe that, working backward in time

$$\lambda^A_t = (\lambda^A_{t+1} - \pi z_t)/(1 - z_t \pi)$$

where z_t is the fraction of agents not in sector A who search at date t. Given the solution for prices from date $t+1$ on, we first guess $z_t = 1$ and find the corresponding bond price p_t which clears the goods market at date t. If, at this bond price, the value of searching exceeds the value of working in sector s, then this is the equilibrium bond price at date t and everyone in sector s searches at this time. If the value of searching does not exceed the value of working in sector 1 at this bond price, we then solve for the bond price p_t that makes individuals indifferent between searching and working in sector s. In this case, this is the equilibrium bond price at date t, and then z_t is chosen to clear the goods market at date t. We recursively check the assumption that $Z_t \geq N_t$. We iterate this procedure until λ^A falls below zero.

In Figure 6, we present transition paths for output and λ_t when $A = 10$, $\beta = 0.6$, and $\pi = 2/5$, with the coefficient of absolute risk aversion $\gamma = 2$. We have chosen parameter values so that (39) holds; thus both economies have the same steady state. In the limit, all agents transit from the state sector to the private sector. Here the precautionary saving effects are strong enough that the speed of transition is slower in the economy with social insurance. Of course, if these effects were weaker, then adding social insurance would speed transition to the steady state. If we chose parameters so that (40) holds but (39) does not, then the transition path for the economy with social insurance would be similar in the economy without social insurance; however, there would be no transition as all agents simply stayed where they started.

5 Conclusion

In this paper we have studied the impact of social insurance on the transition process. We have shown that while social insurance improves welfare, it may actually slow transition. Indeed, one way to state our main result is that the optimal speed of transition with social insurance may be lower than the equilibrium speed without social insurance.

We have also shown that in a small open economy, adding social insurance as part of a reform necessarily speeds transition (in addition to improving welfare). In terms of policy, if it is feasible for the government to simply move from a closed economy to an open one of the type considered here, it should do so. In our simple model, the more that capital markets are liberalized, the smaller the general equilibrium effects of social insurance are and the less likely it is that adding social insurance will slow transition. While this is true in theory, we do not find it a particularly compelling way to model actual international borrowing and lending. The simple model we use has abstracted from all the issues that come up in the sovereign debt literature, such as incentives to default, incentives to divert funds (to increase consumption of some particular agents) rather than productively invest them, and so on. Any serious analysis that considers sovereign debt would have to deal with such issues. We leave it to future work to investigate the interaction of capital market reforms with domestic reforms.

In this analysis we have abstracted from several important issues, including incentive problems in search and political considerations surrounding transition. In Atkeson and Kehoe 1995 we analyze the optimal social insurance scheme when there is moral hazard arising from the assumption that agents must exert some unobserved effort in search. For models of the role of politics in transition, see Fernandez and Rodrik 1991 and Dewatripont and Roland 1992. We leave it to future work to build a model which incorporates these political considerations into the design of social insurance.

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Figure 1a

VALUES FOR SEARCHING AND STAYING AS FUNCTIONS OF THE BOND PRICE

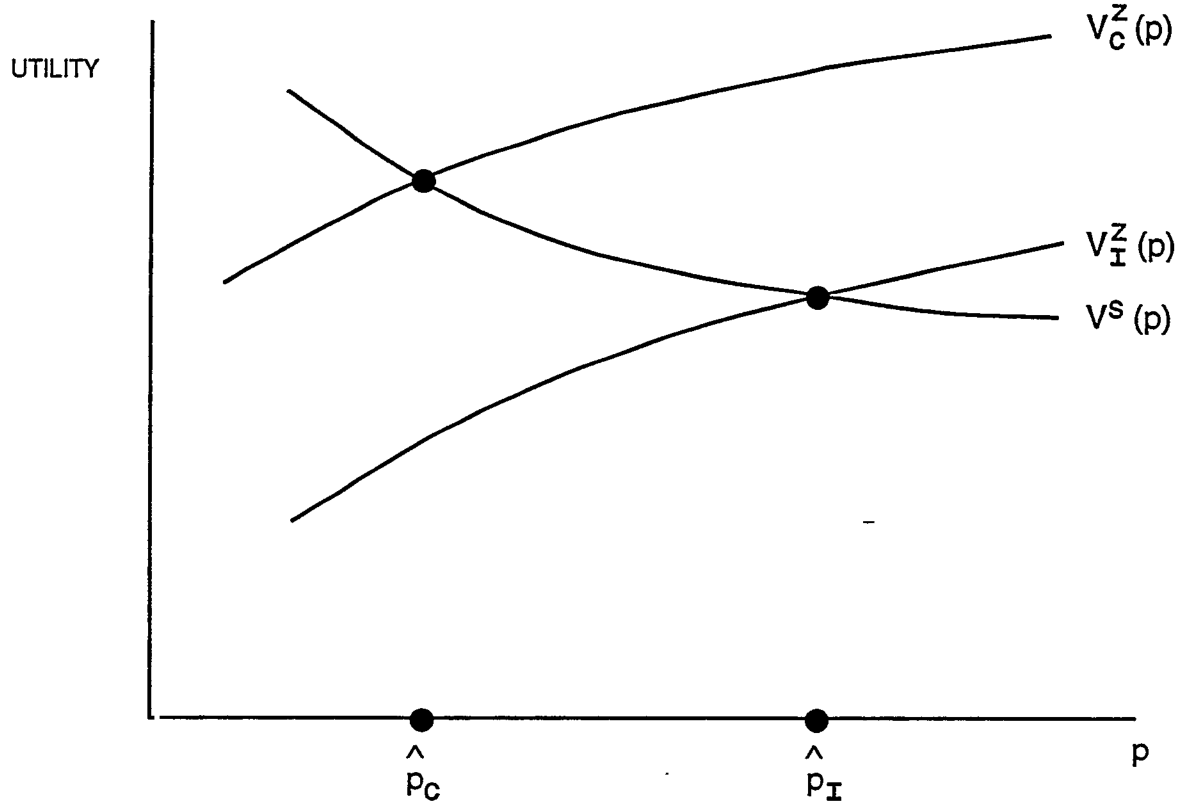

Figure 1b

THE AGGREGATE NUMBER OF SEARCHERS AS FUNCTION OF THE BOND PRICE

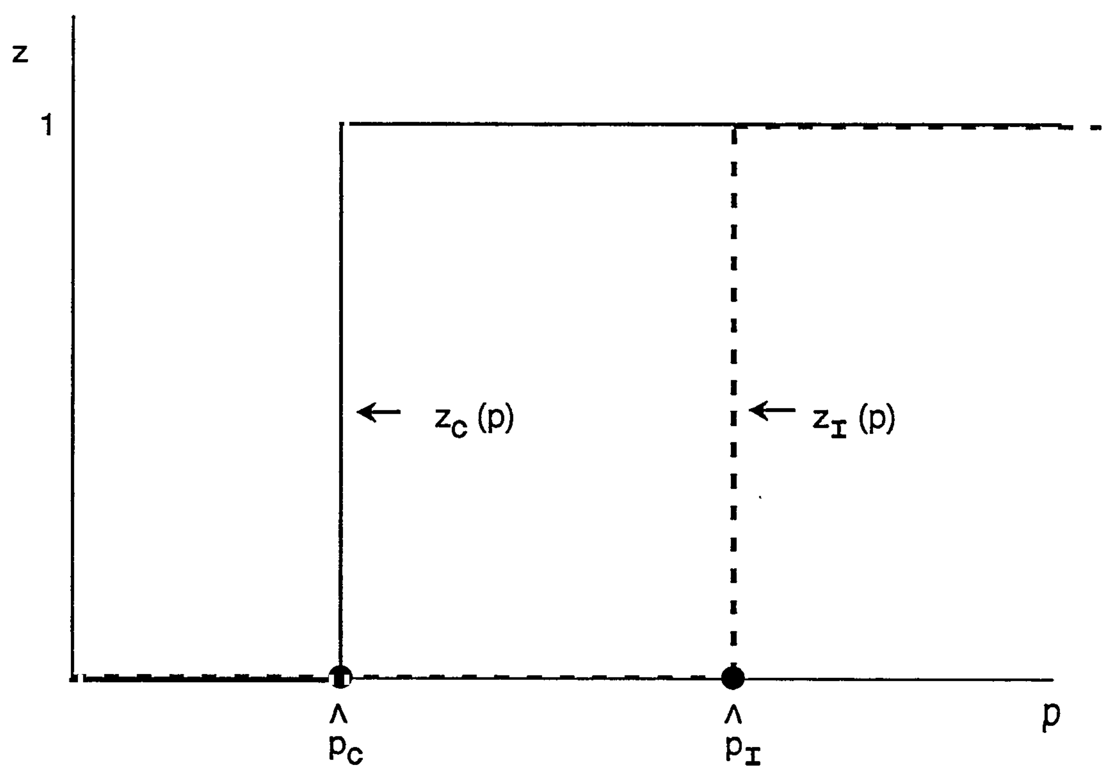

Figure 2

SOCIAL INSURANCE SPEEDS TRANSITION

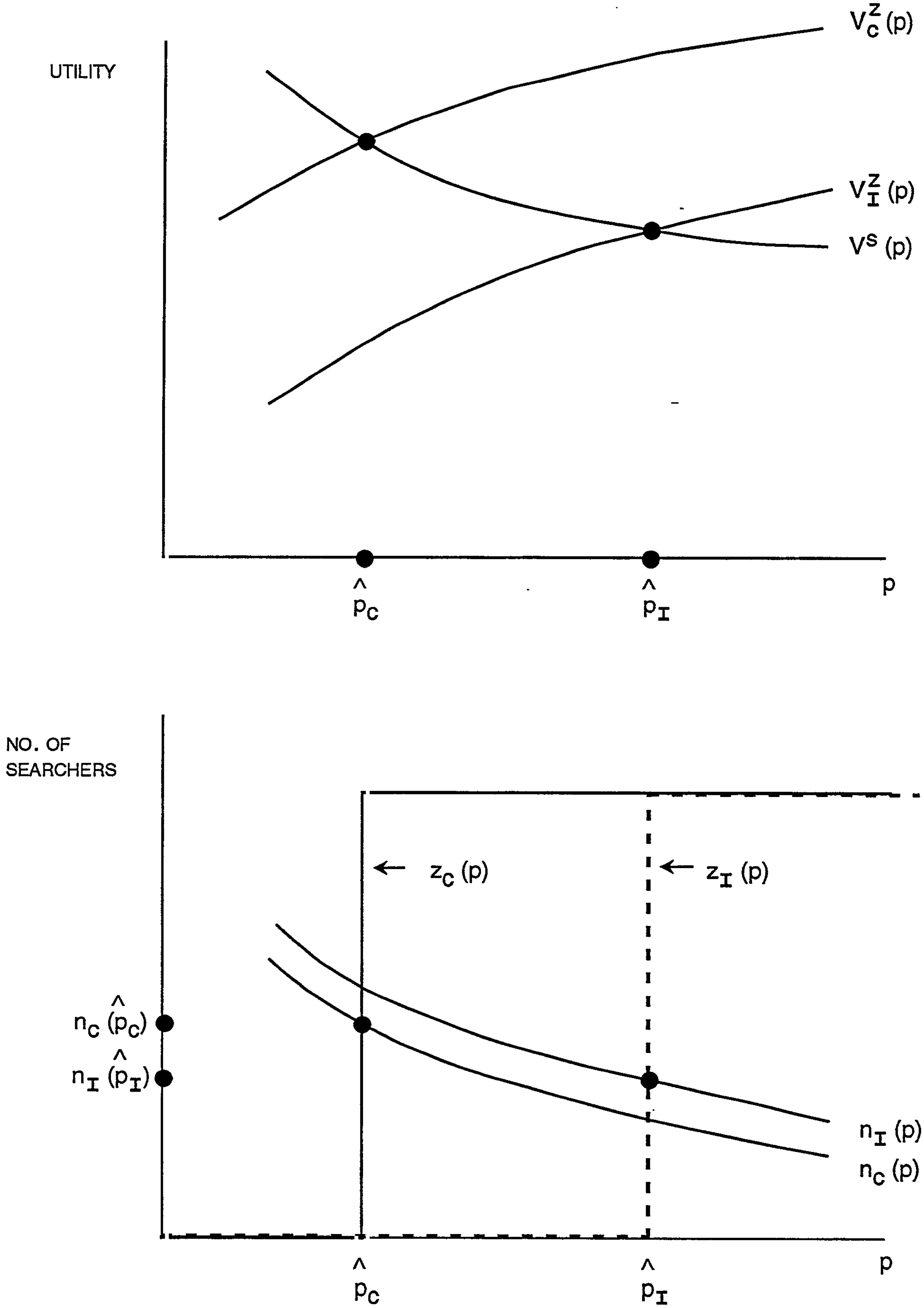

Figure 3
SOCIAL INSURANCE SLOWS TRANSITION

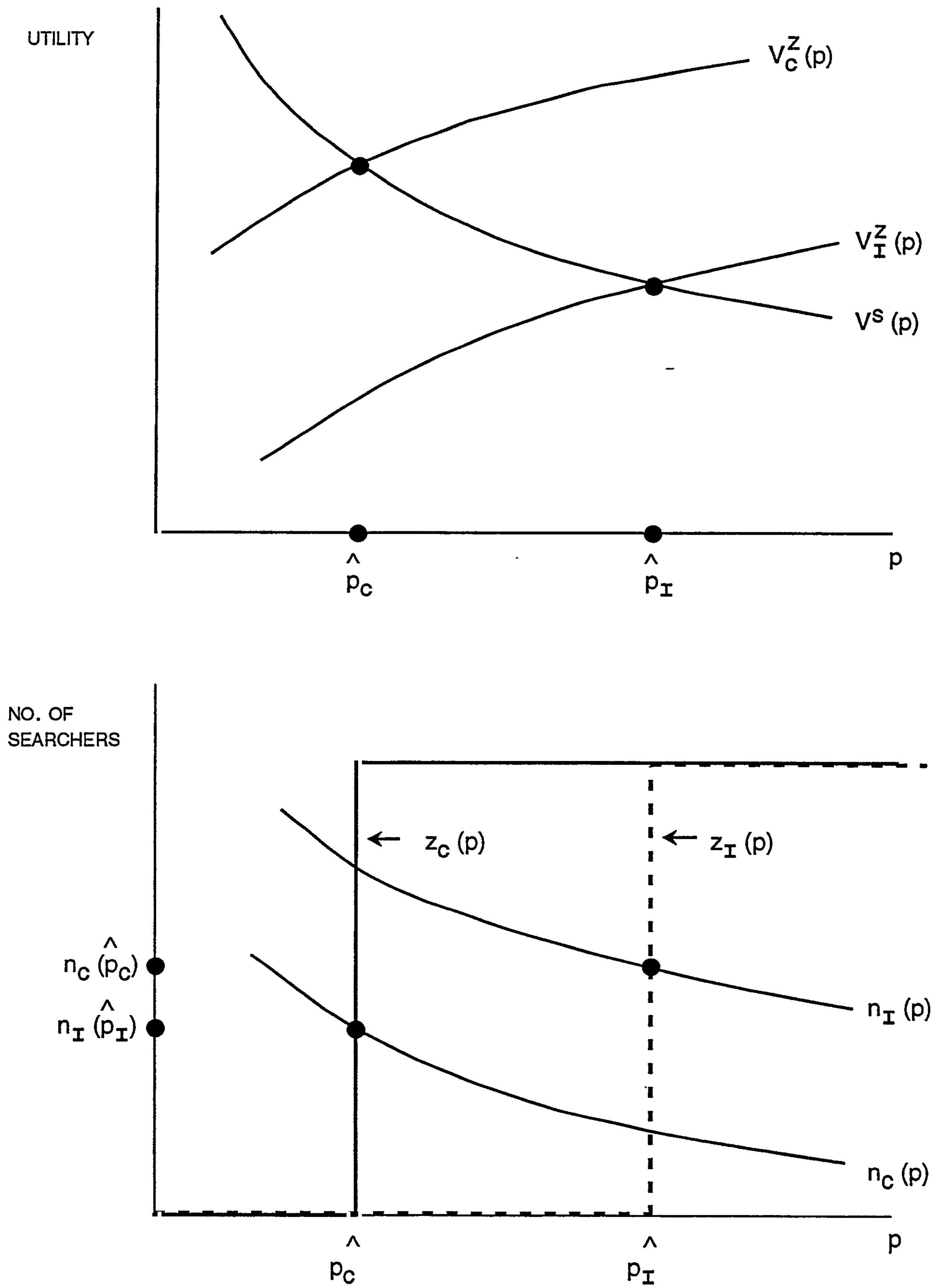

Figure 4

NUMBER OF SEARCHERS VS. COEFFICIENT OF RELATIVE RISK AVERSION

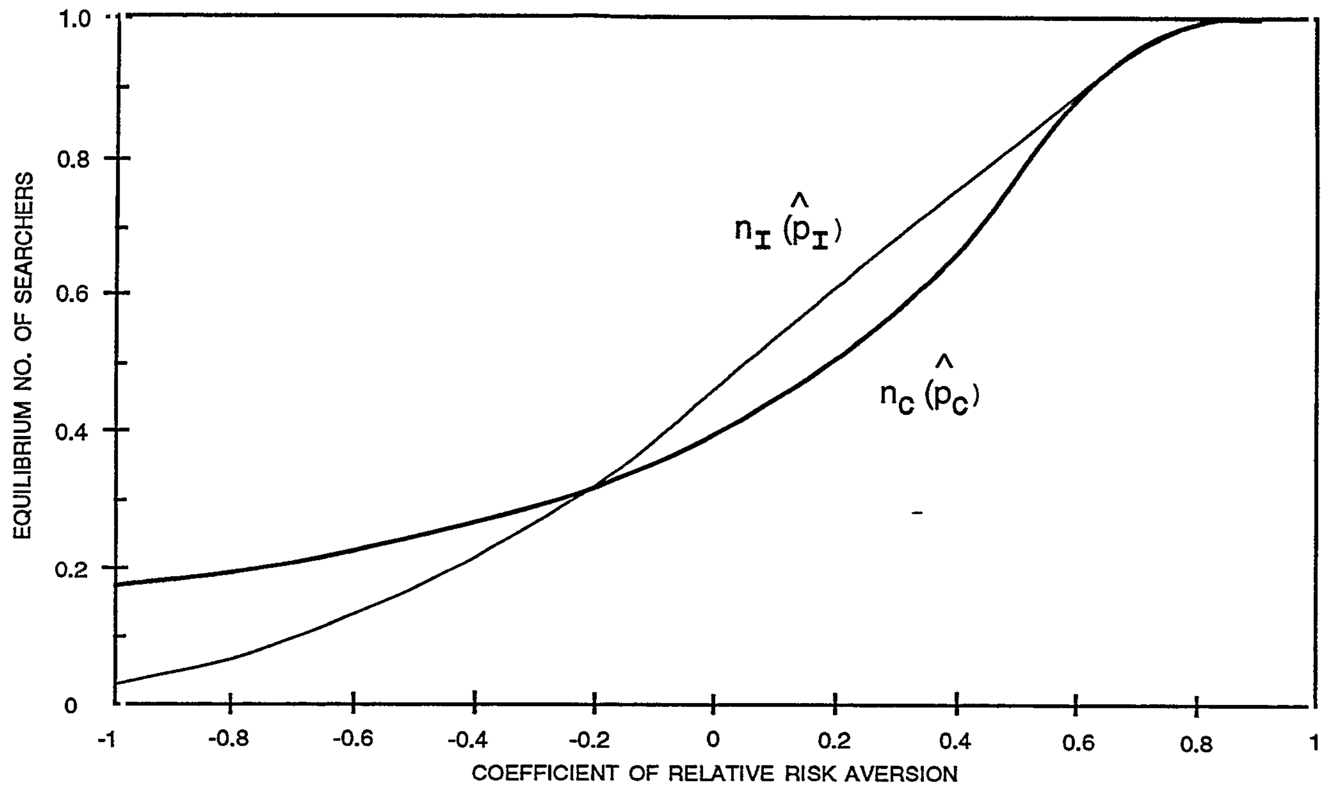

Figure 5

NUMBER OF SEARCHERS VS. COEFFICIENT OF ABSOLUTE RISK AVERSION

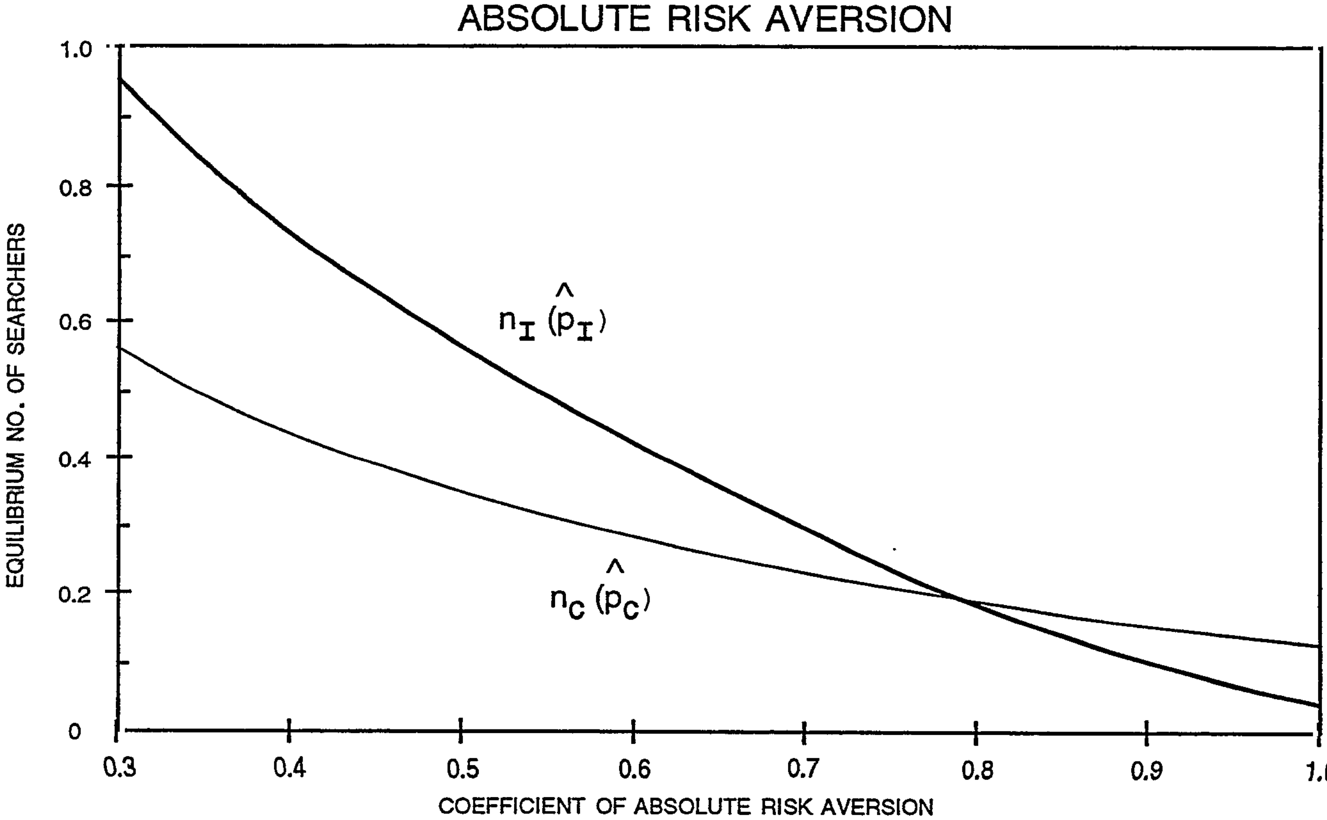

Figure 6
TRANSITION PATHS