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ABSTRACT

This paper considers the role for infant industry protection when credit markets suffer from adverse risk selection. We show that asymmetric information about firm-specific risk leads to under-funding of the infant industry in a competitive credit market. A small amount of infant industry protection is shown to be welfare improving, and the optimal infant industry tariff is derived. Finally, an alternative government policy of production subsidies is considered under the assumption that the government shares private knowledge with infant industry firms. We argue that a tariff may dominate production subsidies as an entry promoting devise in this context.

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I. Introduction

A common justification for "infant industry" intervention in the nontraditional manufacturing or high-tech sectors of LDCs is that the workings of private capital markets can be improved upon, either through the use of temporary protection to induce desirable inflows of foreign capital into the protected sector, or through direct government loans (or loan guarantees). If such an argument is to provide a convincing rationale for intervention, two criteria must be met: first the infant industry must be "under funded" in the absence of intervention, and second intervention must increase the availability of funds in a way that is welfare improving.

In discussing this case for infant industry intervention, Baldwin (1969) argues that while the first criterion is likely to be met in the fledgling industries of LDCs, the second criterion is not. Baldwin has in mind a situation in which potential investors are initially overly pessimistic about the riskiness of new undertakings in the nontraditional sectors of the LDC, and set overly high loan rates as a result. The high loan rates, in turn, may choke off some or all of the potential infant industry activity: protection can enable firms to overcome this handicap and pay the high loan rates initially demanded by investors. As Baldwin notes:

> If this high return over a period of time is all that is needed for investors to acquire sufficient knowledge about the industry for the lending rate to be bid down to a rate reflecting actual risk levels in the industry, then a temporary tariff may be socially desirable. However, while some information about earning prospects is likely to be conveyed to investors by their payments experience, it is doubtful if

> the full information that is socially profitable in terms of investment in knowledge acquisition will ever be conveyed to them simply by this sort of costless experience. The mere fact of tariff protection will make it difficult for investors to infer from their payments experience that they are overestimating investment risks in the industry. If this is so and the spillover problem also exists when outlays to obtain information are made, a temporary tariff cannot be relied upon to move production in the infant industry to a socially optimal level. (p. 303)

We argue in this paper that temporary protection in the presence of asymmetric information about risk <u>can</u> be desirable, not because investors learn about the risk characteristics of projects through experience gained by firms operating behind a tariff wall, but because the tariff will alter the risk characteristics of the average entrant into the infant industry and, in so doing, internalize an important externality that keeps the degree of entry in an infant industry undesirably low. The logic is seen most simply by considering the case where all potential entrants into the infant industry share a common expected return but differ with respect to their probability of default. If banks are unable to distinguish individual firm default probabilities, the loan rate offered to potential entrants will include a premium which reflects the average default risk of the loan pool, and which prevents profitable entry by the safest firms. Protection encourages the entry of these safer firms, lowering the average riskiness of projects in the infant industry. Accordingly, in the presence of protection, competitive investors will reduce their loan rates to infant industry firms. The favorable impact of the marginal firm's entry decision on the loan rate faced by all firms in the industry is an externality which can be internalized by a tariff. As we demonstrate below, a small amount of protection in the infant industry will be Pareto improving, and in general the optimal tariff for the infant industry is strictly positive.

Moreover, we argue that informational asymmetries may reverse the standard welfare ranking of tariffs and production subsidies as policy instruments for addressing production distortions. Specifically, if it is common knowledge that the government has information about the risk characteristics of individual firms that is not shared by potential lenders, then it may be in the social interest for the government to commit <u>not</u> to use this private information when designing its infant industry policy. Because the benefits of a tariff are inherently non-selective with regard to the firms of an industry, while production subsidies can and often are administered on a firm-specific basis, committing not to exploit its private information will be easier for the government under the former than under the latter program. Hence, tariffs may dominate production subsidies as policy instruments for aiding the infant industry in this context.

We characterize the infant industry of an LDC as an industry in which norms have not yet been established, either in production or in financial relationships. Thus, we have in mind the situation of a technological breakthrough which might allow domestic production of an import competing good for the first time. Firms are new to the technology, and relationships between firms and banks are in their infancy, making the cost of bankruptcy to the firm less than if a long-term relationship between bank and firm already existed. Finally, firms are limited in their ability to collateralize loans. This is the setting within which adverse risk selection of the type studied in Stiglitz and Weiss (1981) is most likely to arise, and it is essentially the Stiglitz and Weiss framework within which our analysis is carried out. However, while Stiglitz and Weiss focus on credit rationing equilibria, we focus on equilibria in which credit rationing does not arise. Hence our results depend only on the general properties of adverse selection in credit markets, and not on special conditions which lead to credit rationing.

The remainder of the paper proceeds as follows. Section II lays out the basic model. Section III explores the properties of the equilibrium absent government intervention, and establishes that infant-industry firms will be "under funded" in the presence of adverse risk selection. Section IV then examines the effect of tariff intervention, and derives the optimal tariff for the infant industry. Section V considers several extensions, including the role of production subsidies and loan guarantees in the infant industry. Section VI concludes.

II. The Model

The model we use to explore these issues is partial equilibrium and similar in spirit to the adverse selection model of Stiglitz and Weiss (1981). There are three players in the development of the infant industry under consideration: domestic firms who choose whether or not to take out a loan and enter the infant industry, foreign banks who choose the interest rate at which to make loans available to infant industry firms, and the domestic government who may choose to intervene. We consider each in turn.

Firms

We assume that a continuum of potential infant industry entrants (firms) are indexed by $\theta \epsilon [0,1]$, with $G(\theta)$ $(g(\theta))$ providing the distribution (density) of firms by θ. Each firm is risk neutral, and has at its disposal a stochastic technique for producing the infant industry good. One can think of the population of potential infant industry entrants as the set of entrepreneurs who have "hit" upon an "idea" for how to produce the infant industry good. All techniques require a fixed capital input K, an assumption we discuss in more detail below. This initial investment must be made prior to production, and yields a "plant" with a capacity of one unit. While the prices of variable factors of production, e.g., labor, are fixed by conditions in the rest of the economy, variable factor inputs for unit production in firm θ are random, reflecting the riskiness of the particular production technique. Thus, unit variable costs for firm θ are a random variable $c \in [0,1]$ with mean $\bar{c}$, distribution function $F(c,\theta)$, and density function $f(c,\theta)$, where greater θ corresponds to greater risk in the sense of mean preserving spreads. Formally, $\theta' > \theta''$ implies that

(1) $$\int_0^1 c\, f(c,\theta')\, dc = \int_0^1 c\, f(c,\theta'') dc = \bar{c}$$

and for $x \in [0,1]$, that

(2) $$\int_0^x F(c,\theta')\, dc \geq \int_0^x F(c,\theta'')\, dc$$

Finally, all production will sell domestically at the price $P = (1+\tau)$ where τ is the ad valorem tariff to be chosen by the domestic government and the fixed world price has been normalized to one. Note that, since variable unit costs c will never exceed the domestic product price for $\tau \geq 0$, production for each firm that enters will always be set to capacity (one unit).[1] Thus, each firm has only a single decision; whether or not to enter.

To enter the infant industry (build a "plant") a firm must borrow the amount K facing collateral requirements m and loan rate r. We take K as technologically fixed for each firm (entrepreneur) in the industry and, without loss of generality, assume that it is the same for all firms. The assumption of Leontief technologies is unnecessarily extreme, but is sufficient to rule out the possibility noted in Milde and Riley (1988) of banks sorting firms by riskiness on the basis of loan size. We assume further that, because of costly monitoring, banks do not offer loan rates that are contingent on the final outcome of the project.[2] The collateral requirement m can be thought of as the maximum collateralization that firms in the infant industry can achieve. For simplicity, we assume that it is the same for all firms. Bester (1985) has shown that banks may be able to screen projects by risk by offering contracts which specify the loan rate and level of collateralization, provided that firms face no collateral constraint. Here we assume that firms are collateral constrained in the weak sense that $m < (1+\delta)K$, with δ the bank cost of funds, and that it is costless for a firm to provide the collateral amount m. This ensures

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[1] Allowing realizations of variable costs to exceed price, in which case firms would choose not to produce, will not alter the analysis in any important way. Also, defining τ as a tariff implies that the infant industry is import competing. Alternatively, τ could represent an ad-valorem export subsidy to an export oriented infant industry without any change in the analysis and the results.

[2] Townsend (1979) demonstrates that costly state verification can make complete risk sharing suboptimal.

that no screening on the basis of collateral is feasible.[3]

A firm will default on its loan if the project return (net of variable factor payments) plus collateral is insufficient to pay off the loan, or if

$$(3) \quad (1+\tau) - c + m \leq (1+r)K$$

Thus, if a firm has variable cost realization c, the firm's net profits will be

$$(4) \quad \pi(r,\tau,c) = \max\,[(1+\tau) - c - (1+r)K;\ - m]$$

while the bank's (gross) return on the loan will be

$$(5) \quad \rho(r,\tau,c) = \min\,[(1+\tau) - c + m;\ (1+r)K].$$

The expected profit for firm θ is then given by

$$(6) \quad E\pi(r,\tau,\theta) = \int_0^1 \max\,[(1+\tau) - c - (1+r)K;\ - m]\ dF(c,\theta).$$

The expected (gross) return to the bank from this loan is

[3] It is straightforward to show that with $m < (1+\delta)K$ and costless to provide, the incentive compatibility and competitive bank return conditions required for each loan under screening are made inconsistent by the convexity of firm profits in the returns of the project.

$$(7) \quad E\rho(r,\tau,\theta) = \int_0^1 \min\,[(1+\tau) - c + m;\ (1+r)K]\ dF(c,\theta).$$

Banks

Banks are located in the rest of the world, and are assumed to be risk neutral.[4] Each firm's production technique is known by the banks to share the common expected variable unit cost $\bar{c}$, but banks do not observe individual firm θs. Thus, the riskiness of a firm's production plan is unobserved by banks, who only observe the distribution $G(\theta)$ of firms by riskiness. For now we assume that all projects in the infant industry are indistinguishable to the banks. In a later section we extend our results to the case where banks can distinguish between several groups of projects with different risk characteristics.

Banks compete for loan customers in the domestic infant industry facing a fixed cost of funds. The bank cost of funds is given by δ, and is determined by credit conditions in the (large) world credit market. As discussed above, collateral levels are set at their maximum level of m. This implies that banks compete for infant industry borrowers by offering the lowest interest rate compatible with an expected return on loans to infant industry firms that is equal to the bank cost of funds.

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[4] The location of banks becomes important only when we consider the government's incentives in offering production subsidies in section V.

Government

We will consider explicitly the effects on the infant industry of a tariff on imports and a production subsidy to infant industry firms. We measure the welfare effect of the tariff (production subsidy) by considering its impact on the sum of domestic producer and consumer surplus in the infant industry, plus tariff revenue (minus subsidy payments).

III. Equilibrium in the Absence of Intervention

In this section we characterize equilibrium in the absence of government intervention. With τ set to zero by assumption, the expected profit of an infant industry firm of type θ facing collateral requirements m and loan rate r is given by (6) as

$$(8)\quad E\pi(r,\tau=0,\theta) = \int_0^1 \text{Max}\ [1 - c - (1+r)K;\ - m]\ dF(c,\theta)$$

Since firm profits (given in (4)) are convex in c, expected firm profits increase with risk (θ). Thus, for a given r, there may exist a level of riskiness, $\tilde{\theta}(r,\tau=0)$, below which expected profits become negative and firms choose not to enter.[5] For r in the range that yields an interior solution $(\tilde{\theta}(r)\epsilon(0,1))$, the critical value of θ is determined by the condition

$$(9)\quad E\pi(r,\tau=0,\tilde{\theta}) = 0.$$

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[5] See Stiglitz and Weiss (1981), Theorem 1.

The adverse risk selection effect of higher interest rates can be seen by asking how $\tilde{\theta}$ changes with r. Total differentiation of (9) yields

$$(10)\quad \frac{d\tilde{\theta}}{dr} = -\frac{\partial E\pi/\partial r}{\partial E\pi/\partial \theta} \quad \text{for} \quad \tilde{\theta}(r) \in (0,1)$$

which is positive, since expected firm profits are decreasing in r but, as noted above, increasing in θ.[6] Thus, higher loan rates increase the riskiness of the applicant pool of entering infant industry firms.[7]

Finally, the expected (gross) return of a bank from a loan of size K that lends at the loan rate r is

$$(11)\quad E\rho(r,\tau=0) = \frac{\int_{\tilde{\theta}(r,\tau=0)}^{1} E\rho(r,\tau=0,\theta)dG(\theta)}{1 - G(\tilde{\theta}(r,\tau=0))}$$

Since bank returns on a loan to firm θ (given in (5)) are concave in c, expected bank returns $(E\rho(r,\tau,\theta))$ decrease with risk (θ). With $E\rho(r,\tau,\theta)$ decreasing in θ and $\frac{d\tilde{\theta}}{dr} > 0$ for $\tilde{\theta}(r) \in (0,1)$ by (10), $E\rho(r,\tau)$ as defined in (11) must be increasing in r for r close to zero but may be nonmonotonic in r elsewhere, i.e., when $\tilde{\theta}(r) \in (0,1)$. We assume that conditions are such that there exist choices of r which make $E\rho(r,\tau=0) \geq (1 + \delta)K$. If this were not true, then banks would not

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6 See Stiglitz and Weiss (1981), Theorem 2.

7 We focus here on the risk selection effect of changes in the loan rate rather than selection by expected project return. In reality, both effects are likely to be present and in section V we take up this issue.

lend to the infant industry at any interest rate, a situation referred to as "red-lining" in Stiglitz and Weiss (1981). We focus here on the case in which neither red-lining nor credit rationing are a problem.[8] Hence, some bank lending occurs even in the absence of government intervention.

Given a fixed cost of funds δ, perfect competition in the banking sector ensures that the equilibrium loan rate to infant industry firms will be bid down to the lowest $\hat{r}$ satisfying

$$(12)\quad \frac{E\rho(\hat{r},\tau=0)}{K} = \frac{\int_{\hat{\theta}(\hat{r},\tau=0)}^{1} E\rho(\hat{r},\tau=0,\theta)dG(\theta)}{[1 - G(\hat{\theta}(\hat{r},\tau=0))]K} - 1 + \delta$$

Equilibrium condition (12) determines the equilibrium loan rate faced by infant industry firms, $\hat{r}$, and through $\hat{\theta}(\hat{r},\tau=0)$, the risk characteristics of the entering infant industry firms. Figure 1 depicts the free trade determination of $\hat{r}$ and $\hat{\theta}$.

In the right quadrant, we represent the relationship between $\tilde{\theta}$ and r by the upward sloping schedule. The left quadrant gives the expected bank return, represented for convenience as a concave function of the loan rate r. The bank cost of funds is represented in the left quadrant as the

[8] Credit rationing in the sense of Stiglitz and Weiss (1981) could never occur in this model, given our assumption that credit is available in infinite supply at the rate δ. See Tomlinson (1987) for a treatment of the role of infant industry protection in a model where the presence of moral hazard leads to credit rationing absent intervention.

vertical line at $1 + \delta$. The free trade equilibrium loan rate $\hat{r}(\tau=0)$ is the lowest loan rate consistent with zero bank profits $\left(\frac{E\rho(\hat{r}(\tau=0),\ \tau=0)}{K} = 1 + \delta\right)$, and determines risk characteristics of the population of entering infant industry firms (characterized by $\hat{\theta}(\hat{r}(\tau=0),\tau=0)$).

We conclude this section with a result which implies that the infant industry will be "under funded" in the absence of intervention, and characterize the capital market imperfection which may give rise to the possibility of welfare-improving policies of infant industry intervention.

<u>Proposition I</u>: If $\hat{\theta}(\hat{r}(\tau=0),\tau=0) < 1$, then $\frac{1 - \bar{c}}{K} > 1 + \delta$.

<u>Proof</u>: With $E\rho(r,\tau,\theta)$ decreasing in θ (risk), it follows that

$$(13)\quad \frac{E\rho(\hat{r}(\tau),\tau,\hat{\theta})}{K} > \frac{E\rho(\hat{r}(\tau),\tau)}{K} = 1 + \delta$$

where the last equality follows from equilibrium condition (12) which must hold if $\hat{\theta} < 1$ so that banks make loans. From the definition of $\hat{\theta}$, it also follows that

$$(14)\quad \frac{E\pi(\hat{r}(\tau),\tau,\hat{\theta})}{K} = 0.$$

Adding (13) and (14) together gives

$$(15)\quad \frac{E\rho(\hat{r}(\tau),\tau,\hat{\theta})}{K} + \frac{E\pi(\hat{r}(\tau),\tau,\hat{\theta})}{K} > 1 + \delta,$$

which, using (6) and (7) reduces under free trade to

$$(16)\quad \frac{1 - \bar{c}}{K} > 1 + \delta .$$

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Proposition I states that a necessary condition for any lending to occur in the infant industry $(\hat{\theta} < 1)$ is that the expected social return of infant industry projects be strictly positive $(1 - \bar{c} - (1+\delta)K > 0)$. Thus we can state the following

Corollary: If $\hat{\theta}(\hat{r}(\tau=0),\tau=0) \epsilon (0,1)$, then there exist infant industry firms with socially desirable projects that, in the absence of intervention, fail to get funded.

Typically, $\hat{\theta}(\hat{r}(\tau=0),\tau=0)$ will be strictly greater than zero. This is because the possibility of default leads banks to raise the loan rate r above the cost of funds δ in order to secure an expected return which covers the cost of funds. Since banks don't observe individual firm default probabilities, the increase in the loan rate must reflect the average default probability of the loan pool. Consequently, firms with low default probabilities (low θs) may find their projects unprofitable at the prevailing loan rate, even though their expected project returns exceed the social cost of funds δ. This is the sense in which adverse risk selection may lead to under funding of the infant industry. It also seems to mirror what Baldwin (1969) had in mind when he wrote:

> As Kafka (1962) pointed out, however, there is one type of market imperfection that tends to be particularly applicable to infant industries. In this situation a lack of knowledge about an industry causes investors to overestimate the risks of investing in the industry and causes workers to overrate the unpleasantness of moving into this line of production... Suppose, for example, that a potential entrant into a new industry, if he could provide potential investors with a detailed market analysis of the industry, could borrow funds from investors at a rate that would make the project socially profitable... Suppose also that, in the absence of this market information, investors will insist upon such high interest charges that the investment will not be privately profitable. (p. 302)

Proposition I has an externality interpretation in the spirit of Greenwald and Stiglitz (1986). In particular, the low θ (safer) firms that choose not to borrow at the loan rate $\hat{r}(\tau)$ do not internalize the favorable effect that their entry would have on the average default risk for the loan pool, and hence on the competitive loan rate offered by banks to all infant industry firms. In this sense, there is too little entry into the infant industry. Hence, policies which encourage entry into the infant industry may, by reducing the bank loan rate, increase the level of domestic welfare from the no-intervention equilibrium. We turn now to an analysis of the effects of intervention.

IV. The Effects of Protection

In this section we examine the effects of government intervention in the infant industry in the form of a tariff on imports into the infant industry. We begin by showing that a small tariff will be welfare-improving, and then derive an expression for the optimal tariff. Welfare in the domestic infant industry is measured as the sum of domestic producer surplus, domestic consumer surplus, and tariff revenues, and can be written as a function of the tariff τ as

$$(17)\quad W(\hat{r}(\tau),\tau) = E\pi(\hat{r}(\tau),\tau) + \left[\int_{1+\tau}^{\infty} D(p)dp\right] + [\tau(D(1+\tau) - Q(1+\tau))]$$

where $E\pi(\hat{r}(\tau),\tau) = \int_{\hat{\theta}(\hat{r}(\tau),\tau)}^{1} E\pi(\hat{r}(\tau),\tau,\theta)\, dG(\theta)$ is domestic producer surplus, $D(\cdot)$ is domestic demand for the infant industry good and $Q(\cdot)$ is domestic supply, and where the large number of infant industry firms eliminates aggregate (industry-wide) uncertainty. Using (17), the welfare effect of a small tariff is given by

$$(18)\quad \left.\frac{dW}{d\tau}\right|_{\tau=0} = \left.\frac{dE\pi(\hat{r}(\tau),\tau)}{d\tau}\right|_{\tau=0} - Q(1).$$

<u>Proposition II</u>: If $\hat{\theta}(\hat{r}(\tau=0),\tau=0)\epsilon(0,1)$ so that some but not all infant industry firms would receive bank funding under free trade, then $\left.\frac{dW}{d\tau}\right|_{\tau=0} > 0$.

<u>Proof</u>: From their definitions, the sum of producer surplus and bank returns

in the infant industry is given by

$$(19)\quad E\pi(\hat{r}(\tau),\tau) + [1-G(\hat{\theta}(\hat{r}(\tau),\tau))] \cdot E\rho(\hat{r}(\tau),\tau) = (1+\tau-\bar{c})[1 - G(\hat{\theta}(\hat{r}(\tau),\tau))].$$

Differentiating (19) with respect to τ at $\tau=0$ yields

$$(20)\quad \frac{dE\pi(\hat{r}(\tau),\tau)}{d\tau}\Big|_{\tau=0} + [1-G(\hat{\theta})]\frac{dE\rho(\hat{r}(\tau),\tau)}{d\tau}\Big|_{\tau=0} - g(\hat{\theta})E\rho(\hat{r}(\tau),\tau)\frac{d\hat{\theta}}{d\tau} = Q(1) - g(\hat{\theta})(1-\bar{c})\frac{d\hat{\theta}}{d\tau},$$

where we exploit the fact that $Q(1+\tau) = 1-G(\hat{\theta}(\hat{r}(\tau),\tau))$. But equilibrium condition (12) implies that $E\rho(\hat{r}(\tau),\tau) = (1+\delta)K$ and that $\frac{dE\rho(\hat{r}(\tau),\tau)}{d\tau} = 0$. Thus, substituting (20) into (18) yields

$$(21)\quad \frac{dW}{d\tau}\Big|_{\tau=0} = -[(1-\bar{c}) - (1+\delta)K]\, g(\hat{\theta})\frac{d\hat{\theta}}{d\tau}\Big|_{\tau=0}.$$

From Proposition I we know that $(1-\bar{c})$ must be strictly greater than $(1+\delta)K$ if $\hat{\theta} < 1$, that is, if any lending takes place absent intervention. Thus, the sign of $\frac{dW}{d\tau}\Big|_{\tau=0}$ is opposite that of $\frac{d\hat{\theta}}{d\tau}\Big|_{\tau=0} = \frac{\partial\hat{\theta}}{\partial\tau}\Big|_{\tau=0} + \frac{\partial\hat{\theta}}{\partial\hat{r}}\frac{d\hat{r}}{d\tau}\Big|_{\tau=0}$. Expression (9) defines $\hat{\theta}$ implicitly as $E\pi(\hat{r},\tau,\hat{\theta}) = 0$: total differentiation yields an expression for $\frac{\partial\hat{\theta}}{\partial\tau}$ and for $\frac{\partial\hat{\theta}}{\partial\hat{r}}$ of

$$(22)\quad \frac{\partial\hat{\theta}}{\partial\tau} = \frac{-\partial E\pi(\hat{r},\tau,\theta)/\partial\tau}{\partial E\pi(\hat{r},\tau,\theta)/\partial\theta} < 0$$

$$(23)\quad \frac{\partial\hat{\theta}}{\partial r} = \frac{-\partial E\pi(\hat{r},\tau,\theta)/\partial\hat{r}}{\partial E\pi(\hat{r},\tau,\theta)/\partial\theta} > 0.$$

Finally, totally differentiating equilibrium condition (12) yields an expression for $\frac{d\hat{r}}{d\tau}$ of

$$(24)\quad \frac{d\hat{r}}{d\tau} = \frac{-\partial E\rho(\hat{r}(\tau),\tau)/\partial\tau}{\partial E\rho(\hat{r}(\tau),\tau)/\partial r}.$$

Provided that $E\rho(\hat{r}(\tau),\tau)$ does not reach a local maximum at $\hat{r}(\tau)$, $E\rho(r,\tau)$ must be strictly increasing in r at $\hat{r}(\tau)$, since bank competition for borrowers constrains the equilibrium loan rate $\hat{r}(\tau)$ from above.[9] With $\frac{\partial E\rho(\hat{r}(\tau),\tau)}{\partial r}$ strictly positive as well, (24) implies that $\frac{d\hat{r}}{d\tau} < 0$. Together with (22) and (23), we then have from (16) that

$$(25)\quad \left.\frac{dW}{d\tau}\right|_{\tau=0} > 0.$$

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[9] In the case where $E\rho(\hat{r}(\tau),\tau)$ does reach a local maximum at $\hat{r}(\tau)$, an infinitesimal increase in τ would lead to a finite drop in $\hat{r}(\tau)$.

Figure 2 depicts the result of the proposition. Starting at the initial equilibrium values of $\hat{r}(\tau=0)$ and $\hat{\theta}(\hat{r},\tau=0)$, a small increase in the tariff τ shifts leftward the $\hat{\theta}$ curve in the right quadrant: for any loan rate, there will be greater entry ($\hat{\theta}$ falls) as a result of the tariff. At the original loan rate $\hat{r}(\tau=0)$, the induced reduction in $\hat{\theta}$ is given in the figure by the distance $\overline{ba}$ ($\frac{\partial\hat{\theta}}{\partial\tau} < 0$). However, this is only half the story. The tariff will lower the average riskiness of loans made at any loan rate. It will do so in two ways: directly (holding $\hat{\theta}$ constant) by reducing the default probability of each firm in the loan pool, and indirectly (allowing $\hat{\theta}$ to change) by inducing entry of firms whose default probability is lower than the industry average. With the average riskiness of loans made at any loan rate lower as a result of the tariff, the $\frac{E\rho}{K}$ curve in the lefthand quadrant of Figure 2 shifts leftward, leading to a drop in the loan rate from $\hat{r}(\tau=0)$ to $\hat{r}(\tau>0)$ to restore zero bank profits, and a further reduction in $\hat{\theta}$ given by the distance $\overline{cb}$ ($\frac{\partial\hat{\theta}}{\partial\hat{r}}\frac{d\hat{r}}{d\tau} <$ 0). From (21), the domestic welfare improvement is then given by the expected net value (at free trade prices) of the firms whose entry into the infant industry was induced by the tariff.

Finally, it is straightforward to derive the optimal tariff for the infant industry

$$(26)\quad \hat{\tau} = \left[\frac{(1-\bar{c}) - (1+\delta)K}{D'(1+\hat{\tau})}\right] g(\hat{\theta}) \frac{d\hat{\theta}(\hat{r}(\hat{\tau}),\hat{\tau})}{d\tau}$$

which is strictly positive. Expression (26) makes clear the point that the welfare enhancing role of the infant industry tariff stems from its entry-promoting effect $(d\hat{\theta}(\hat{r}(\hat{\tau}),\hat{\tau})/d\tau < 0)$ in an industry where expected social returns to further entry are positive $([(1-\bar{c}) - (1+\delta)K] > 0)$. This benefit must be weighed at the margin against the costs of distortions in consumption $(D'(1+\hat{\tau}) < 0)$.

We close this section with several comments. First, since it is not immediately apparent from the optimal tariff formula in (26), it deserves reemphasis that the <u>entire</u> domestic welfare gain from infant industry intervention comes in the form of a reduction in the loan rate faced by all infant industry firms. It is easily shown using (18) that, if the bank loan rate were fixed (rather than determined by the zero bank profit equilibrium condition as assumed in the derivation of (26)), the optimal tariff would be zero. Second, since the entire domestic benefit of protection comes from the reduction in loan rates to infant industry firms, time-consistency issues are likely to arise in the implementation of this infant industry program. In particular, the government has an incentive to announce high tariffs to secure low-interest loans for its firms but to renege on the promised protection once plants are built and production begins. Such incentives would tend to undermine the credibility of the announced program, and could lead to under-utilization of infant-industry protection in this context.[10] Third, in the context of infant industry protection, the question of how the industry "grows up" naturally arises. While a formal analysis of this question would require a dynamic model, it seems natural to think of the accumulation of profits and the subsequent relaxation of the collateral constraint as the central mechanism by which the capital market

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[10] For a related point in a more general context, see Staiger and Tabellini (forthcoming).

imperfection which provides the rationale for the infant industry policy would over time disappear.[11] Finally, as with optimal taxation generally, to set the tariff optimally the government must have information about the key parameters. Among other things, the implementation of the optimal tariff in (26) requires knowledge of the industry product demand function and the distribution of firms in the industry by risk type. In applying a welfare-improving "small" tariff, on the other hand, the government need only observe that the loan rate fall to know that its infant industry intervention has increased welfare.

V. Extensions

In this section, we consider several extensions to the analysis of the previous section. We begin by relaxing the assumption that all projects in the infant industry share the same expected return. We show that the welfare-improving role for infant industry intervention remains. We then comment on the role of production subsidies and loan guarantees in the development of the infant industry.

Multiple Expected Returns

It is straightforward to show that the role for infant industry protection laid out above is not undone by variation in the expected return of projects in the infant industry. If banks can distinguish between projects of different mean return, then the analysis of the previous sections will apply directly to each observationally distinguishable group. In particular, Proposition I will hold, so that <u>any</u> group receiving loans

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[11] Of course, as the political economy literature on protection has pointed out, this in no way implies that protection <u>will</u> be temporary, but only that it "<u>ought</u>" to be.

under free trade will have a strictly higher expected return than the social cost of funds. Therefore, if there exists a loan group i with $\hat{\theta}_i(\hat{r}_i(\tau=0),\tau=0)\epsilon(0,1)$, then there exist infant industry firms with socially desirable projects that, in the absence of intervention, fail to get funded. Hence, a small tariff will be welfare improving.[12]

If banks can not distinguish between projects with different expected returns, then all loans will be made at a common interest rate. Nonetheless, grouping projects by expected return, it must still be true that, of all the firms in a group that receive funding at the given interest rate, the marginal entrant in that group yields the highest expected return to the bank. This, however, no longer assures that banks can maintain a competitive overall return only if the expected (social) return on loans made to the marginal entrants is strictly greater than the bank cost of funds: it is possible that in equilibrium the distribution of marginal borrowers by expected returns is such that banks (and thus society) make negative returns on loans to this marginal group, and yet earn a competitive return overall due to an inframarginal distribution of loan types skewed heavily toward high expected return firms. When this is the case, there is "too much" entry in the infant industry, and an entry deterring infant industry import subsidy would be called for. Even here, however, there is at least in principal a simple way to engineer a welfare-improving program of infant industry intervention: simply adopt a "small" amount of intervention in whatever direction results in a fall in the bank loan rate

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[12] An implication of Proposition I is that a "small" tariff could never induce bank funding of a new socially inefficient group of firms as long as banks can distinguish between project groups of different mean return.

to infant industry firms. A "small" tariff (subsidy) will lead to a fall in the equilibrium bank loan rate if and only if, on average, the social return of marginal entrants induced into (out of) the infant industry by the intervention is strictly positive (negative).

Production Subsidies

The capital market imperfection that we have analyzed above results in a production distortion in the infant industry, as a socially deficient level of entry occurs under free trade. A tariff can partially address this production distortion because it is a combination production subsidy/consumption tax, but is potentially inferior as a policy tool to a direct production subsidy for two reasons: the tariff finances its production subsidy with a distortionary tax on domestic consumers of the infant industry good whereas a direct production subsidy may be financed by a less distortionary means if such taxes are available, and the tariff taxes domestic consumers at a rate that raises more revenue than is needed to finance its subsidy to infant industry producers (the excess being the tariff revenue), and thus utilizes the distortionary consumption tax excessively as compared to the revenue needs of the production subsidy.

The notion that a tariff is a second-best policy for addressing a production distortion comes directly from the theory of targeting in the presence of distortions. However, Rodrik (1986) has challenged the view that production subsidies dominate tariffs in the presence of production distortions. His point is that production subsidies, which can be and often are applied to individual firms, will induce greater lobbying effort than will tariffs, which are inherently nondiscriminatory across domestic firms and therefore carry with them substantial free-rider problems from the point of view of domestic industry lobbyists. Hence, once the political process within which policy levels are determined is taken into account, tariffs may welfare-dominate production subsidies in the presence of domestic production distortions.

The ability to help firms selectively which is afforded by a policy of production subsidies may also be costly to the government when, as in the environment explored in this paper, informational asymmetries are present. In particular, if the government is an informed player, possessing information about firm types that banks do not have, then it will find irresistible the temptation to use this private information to its advantage and to the detriment of the banks. This in turn can undermine its infant industry subsidy program. A tariff, because it is inherently non-selective, is then a way by which the government can commit not to use its private knowledge. Here we show that a tariff may be preferable to a production subsidy for this reason.

To formalize this idea, suppose that each domestic firm's private knowledge about its own θ is revealed to the domestic government, but that foreign banks continue to know only the risk characteristics of the applicant pool as a whole. Suppose further that if the government chooses to subsidize production in the infant industry, banks can observe whether a particular loan applicant received a subsidy and, if so, the level of the subsidy. Banks continue, however, to be unable to observe directly the risk characteristics at any particular firm.

We now show that, when the government shares private knowledge with its firms, the cost of employing production subsidies instead of tariffs takes the form of potentially higher revenue requirements under the former than under the latter to achieve the same level of infant industry entry. In order to illustrate this point in its starkest form, we take an extreme case. Suppose that the maximum collateral firms can provide, m, is set to zero. Suppose further that instead of second order stochastic dominance (condition (2)), the stronger condition of first order stochastic dominance holds, so that for any $\theta' > \theta''$,

(27) $F(c,\theta') \geq F(c,\theta'') \;\forall\; c \in [0,1]$.

Finally, suppose that the optimal tariff defined in (26) supports full entry into the infant industry so that $\hat{\theta}(\hat{r}(\hat{\tau}),\hat{\tau}) = 0$.

Now consider a program of infant industry production subsidies offered by the government. We do not solve for the optimal subsidy, but simply show that the subsidy payments required to support the level of entry achieved under the optimal tariff can be very large, raising the possibility that with costly means of finance the tariff may dominate the production subsidy as a policy tool in this context.

Knowing firm types, the government can design a type-specific subsidy program, $s(\theta)$. We assume that the government does not have available to it lump sum tax instruments, so that financing the subsidy payments is achieved through some form of distortionary taxation in the LDC economy. For simplicity, we let the distortionary costs of government finance be constant, so that the cost of generating a dollar of revenue to finance the production subsidy is given by $(1+q)$ with $q > 0$. Of course, one of the government's options is to tax consumption of the infant industry good to raise the required revenue for its infant industry production subsidy, but we allow for the possibility of other less distortionary tax options.

The expected return to the government from subsidizing a firm of type θ at the rate $s(\theta)$, given a loan rate r, is given by the expected firm profits net of the cost of subsidy payments, or

$$(28)\quad E\pi(r,s(\theta),\theta) - (1+q)s(\theta) = \int_0^1 \max[1-(c-s(\theta)) - (1+r)K;\ 0]dF(c,\theta) - (1+q)s(\theta)$$

$$= \int_0^1 \max[(1-c) - (1+r)K-qs(\theta);\ -(1+q)s(\theta)]dF(c,\theta).$$

The important point to note from (28) is that the government's expected return from subsidizing firm θ at the rate $s(\theta)$ given r is exactly the expected profit of firm θ facing a loan rate r and collateral requirements $s(\theta)$ and a cost q per dollar of collateral generated. Thus, the banks' problem is identical to that studied in Bester (1985), in which banks can offer a menu of loan rate and collateral combinations to firms that face a common per unit cost of raising collateral. As such, a bank that offers screening contracts defining different combinations of the loan rate and collateralization can sort firms by risk (through the implicit collateralization $s(\theta)$ determined by the government subsidies). Moreover, banks will only offer such contracts, since any other loan contracts would be unprofitable (see Bester, 1985).

Given that, when an informed government offers production subsidies to its firms, banks will offer to lend to infant industry firms at combinations of collateral and loan rates which sort firms by risk type, we now wish to derive the revenue requirements of a government subsidy program that completely funds the infant industry.[13] We begin by noting that competitive banks will offer screening contracts which leave them with a zero expected return on each loan. Thus for each θ, the expected social return of the project will be captured in the expected firm profits net of the cost of subsidy payments, so that $r(s(\theta))$ and $s(\theta)$ will satisfy

$$(29)\ E\pi(r(s(\theta)),\ s(\theta),\theta) - (1+q)s(\theta) = (1-\bar{c}) - (1+\delta)K - qs(\theta).$$

Moreover, incentive compatibility requires that

$$(30)\ E\pi(r(s(\theta')),s(\theta'),\theta'') - (1+q)s(\theta') < (1-\bar{c}) - (1+\delta)K - qs(\theta'')\ \forall\ \theta',\ \theta''\epsilon[0,1]$$

Suppose now that the safest firm type, $\theta = 0$, is riskless. Then $r(s(\theta=0))$ and $s(\theta=0)$ must satisfy (29), which since $\theta = 0$ is a riskless project, implies that

$$(31)\ r(s(\theta=0)) = \delta,$$

with restrictions on $s(\theta=0)$ then given by the incentive compatibility condition. Given (31), the incentive compatibility condition (29) implies that

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[13] Note that banks are precluded from sorting firms in this way when the government uses a tariff precisely because the tariff can not be selectively applied to individual firms.

$$(32)\ s(\theta{=}0) > (1+\delta)K - [1-z(\theta')] - q \left\{\frac{[s(\theta{=}0) - s(\theta')]}{[1-F(\underline{c}(\delta),\theta')]}\right\} \ \forall\ \theta' \in (0,1]$$

where $z(\theta')$ is the average value of c for firm θ' when it goes bankrupt facing a loan rate δ, and $\underline{c}(\delta)$ is the critical value of c above which bankruptcy occurs.

From (32) it is clear that, if a) there exist firms in the infant industry pool whose distribution of returns is such that $z(\theta')$ is close to one (so that when the project goes bankrupt, it can be expected to produce almost no revenue net of variable costs) and b) q is sufficiently small (perhaps because product demand is inelastic and the production subsidy is financed by a consumption tax), then the subsidy for safe projects must be so large as to obviate the need for bank loans for these projects $(s(\theta{=}0) > (1+\delta)K)$. Moreover, if in addition the distribution of firm types in the industry is heavily skewed toward these riskless or nearly riskless projects, then the total revenue requirements for a government production subsidy program that would support entry of all infant industry firms could exceed the total amount of bank lending to the infant industry, obviating the need for bank loans to the infant industry at large. On the other hand, the tariff which supports complete infant industry entry under these conditions will be low: to induce riskless firms to enter, the tariff must satisfy

$$(33)\ \tau \geq (1+\hat{r}(\tau))K - (1-\bar{c})$$

However, for fixed τ, $\hat{r}(\tau)$ is decreasing in the fraction of riskless firms in the pool, and falls to δ as this fraction approaches one. Thus, when the fraction of riskless or nearly riskless firms is high, the tariff needed to support complete entry of a socially desireable infant industry, i.e., an industry where $(1+\delta)K - (1-\bar{c}) < 0$, will be low.

Hence, in the absence of lump sum tax instruments that can be used to finance a government program of production subsidies to infant industry firms, and when the government shares private information with its firms, the potentially greater revenue requirements under the production subsidy relative to a tariff in achieving a given level of infant industry entry may make it in the government's interest to commit not to exploit its private information about firm types by opting for a policy of infant industry tariffs rather than production subsidies.[14]

Loan Guarantees

A potential alternative to tariffs or subsidies is a program of government loan guarantees. Such a program would make loans riskless to the banks, who would then be willing to loan funds at the social rate δ. However, the problem with such a program is its effect on banks' incentives to do any screening of projects. Thus, for example, if at some cost banks could sort projects into groups with different expected returns, with the expected returns of some groups below the social cost of funds, then projects in these groups would typically receive no funding under (the appropriate) tariff or subsidy program. However, under a program of loan guarantees, banks would have no incentive to undertake costly screening

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[14] This point is in a similar spirit to the point made by Riordan (1987) that a firm which cannot commit to how it uses information gathered through monitoring may be better off taking actions which preclude it from monitoring.

operations, and would provide loans indiscriminately.

Under a program of loan guarantees, then, the government is at best faced with the problem of how to induce banks to perform the appropriate amount of project screening. At worst, the government loan guarantee program could induce such indiscriminate lending on the part of banks that the LDC would be made worse off by this form of government intervention than it would be with no government infant industry program at all.

VI. Summary and Conclusion

We have shown that in an industry where firms have expected returns higher than the cost of funds on the world capital market, and where investors have no information about the riskiness of individual firms and are unable to employ contracts that would screen firms according to riskiness, the industry will typically be underfunded in the sense that some socially worthwhile firms do not enter. A small tariff on competing imports (or a subsidy to exports) would allow relatively safe firms to enter, lowering the cost of borrowing for all firms, and would consequently increase welfare. The optimal tariff (export subsidy) balances this gain against the cost of the usual distortion in consumption.

We argue that the setting that is required for these results is typical for an infant industry in an LDC. The infancy of the industry means that little information exists about firms, and the low level of income and general scarcity of capital in LDCs implies that relatively little risk capital is available. Our model should therefore not be taken as a general argument for intervention in infant industries anywhere, since the collateral constraints central to our arguments are presumably less important in developed countries.

Our case for infant industry protection is open to a general point of criticism of arguments for intervention, namely that it does not incorporate all the aspects of intervention, and therefore does not make a correct comparison of two alternatives. In particular, it does not incorporate general equilibrium or political economy aspects and associated costs. It is possible that when such costs are taken into account the scope for welfare improving intervention becomes much smaller or even non-existent. Still, even if this is the case, our model points to an important externality that may exist in infant industries in LDCs, and to a welfare gain that should be included in complete account of the gains and losses from intervention.

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Figure 1

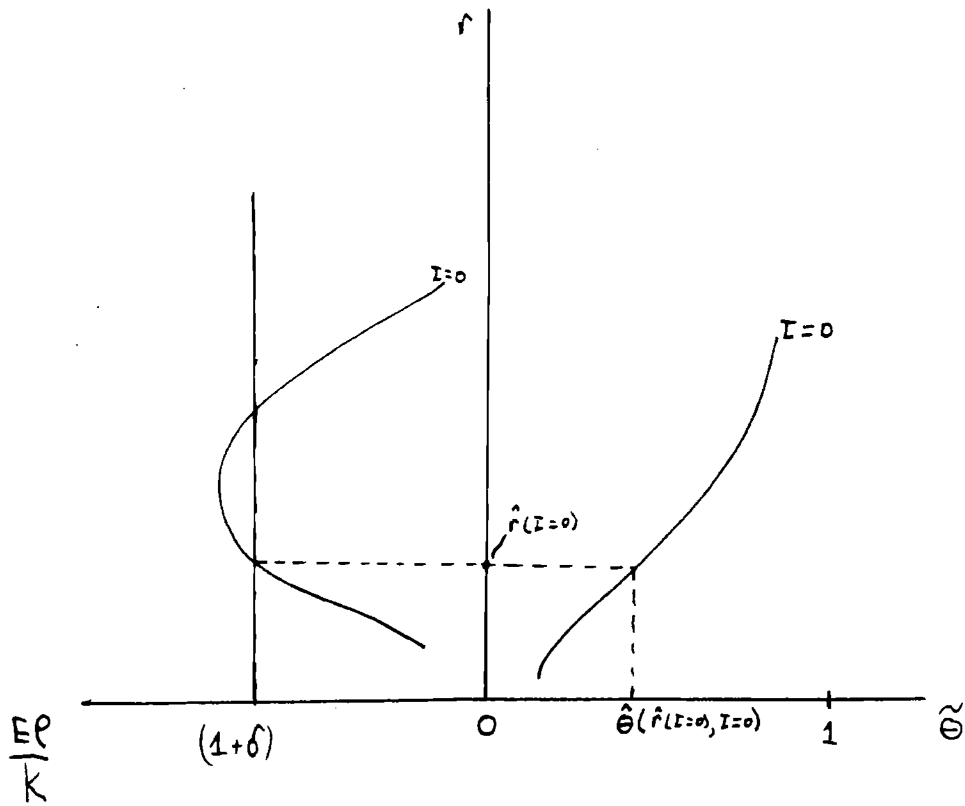

Figure 2