

OPENNESS, LOBBYING AND PROVISION OF INFRASTRUCTURE

by

Ujjayant Chakravorty¹ and Joy Mazumdar²

Abstract

Casual empirical evidence suggests that infrastructure provision is higher in economies that are open to world trade. We develop a model of imperfect competition to show that open economies are likely to provide more infrastructure than closed ones. If infrastructure is financed by taxing a producer lobby, the open economy will over provide while the closed economy will under invest. An open economy approaches optimal provision when this lobby group is small in size. If financing of infrastructure is done by taxing the whole population, the closed economy outcome may be preferred relative to the open economy.

Keywords: Economic Development, Financing of Public Goods, Taxation, Trade and Growth

JEL Classification: F43, H11, O12

Revised Version April 07

¹ Corresponding author, Department of Economics, University of Central Florida, Orlando, FL 32816, uchakravorty@bus.ucf.edu, phone: 407 823 4728, fax: 407 823 3269.

² Formerly Visiting Assistant Professor, Department of Economics, Wellesley College, Massachusetts. Deceased.

1. Introduction

It is widely acknowledged that infrastructure is critical for a nation's growth and economic development. The World Development Report (World Bank (1994)) points out that "the adequacy of infrastructure helps determine one country's success and another's failure - in diversifying production, expanding trade, coping with population growth, reducing poverty, or improving environmental conditions." Many studies have found a strong correlation between infrastructure and productivity. For example, Hulten (1996) and Easterly and Rebelo (1993) find that the stock of infrastructure is strongly related to economic growth in a cross-section of countries. Munnell (1992) concludes from a survey that public infrastructure has a significant, positive effect on output and growth. The significant role of infrastructure in economic development suggests that an inquiry into the determinants of infrastructure provision may be important for development policy.

Both in developed and especially in developing countries, the public sector provides the bulk of infrastructure investments. In developing countries, the public sector provides about 80 percent of total infrastructure investment with the private sector contributing 7 percent and bilateral and multilateral aid another 12 percent (World Bank 1994). Not only does the government finance most infrastructure, in the developing countries it provides a significant portion of all public investment expenditures - rarely less than 30 percent and sometimes as high as 70 percent (World Bank, 1994). Therefore, any analysis of the determination of infrastructure provision needs to consider the incentives facing the government in providing this public good.

There is anecdotal evidence to suggest that infrastructure provision is significantly higher in open economies than closed ones. Mody (1997) suggests that infrastructure investment as a share of GDP in six major East Asian economies³ ranges from 6 to 8 percent while it averages about 4 percent for the typical developing country. These six countries also have relatively high trade (exports plus imports) to GDP ratios. He argues that an important reason for this commitment to infrastructure provision is "to maintain competitiveness in export markets."

³ These countries are Hong Kong, Japan, South Korea, Malaysia, Singapore and Taiwan.

Even within a country there may be significant differences in infrastructure provision across sectors. Sectors exposed to international trade may exhibit higher infrastructure investment than sectors that are closed to the international economy. For example, in India, government expenditure in the telecommunications sector has grown at a significantly higher rate than in other infrastructure sectors such as power, steel and roads. Research by Pingle (1999) suggests that this is due to the export-oriented software industry which relies heavily on telecommunications infrastructure.⁴ In recent years, government expenditure in the telecom sector actually exceeded planned targets, unlike in other sectors in which expenditures trailed substantially behind target levels (Ahluwalia, 1998).

The relationship between infrastructure investment and openness is evident in cross-country data, shown in Fig. 1. Here infrastructure investment is measured by the share of government expenditure on transport and communication in GDP. This data is obtained from the IMF (1986) Government Finance statistics and includes the construction of roads, water, air and rail transport and postal, telephone, telegraph, cable and wireless communication systems and communication satellites but excludes radio and television broadcasting systems. The openness variable on the x-axis is an exogenous measure that is a function of geography variables alone, originally proposed by Frankel and Romer (1999). It depends on exogenous country characteristics such as distance from other countries, country size (measured by population and area), whether or not they are landlocked and borders shared with other countries. Causality should, therefore, run from openness to infrastructure rather than in the reverse direction. The figure shows a clear positive relationship between these two variables. The correlation coefficient is 0.41 and is significant at the 5% level.

An important incentive to provide infrastructure, as Mody suggests, may stem from a desire to maintain the country's competitiveness in export markets. In particular, infrastructure investment may reduce costs for domestic firms which compete with foreign firms in export markets. In this paper we ask whether access to trade leads to higher infrastructure investment and whether such investment is welfare improving, under social planning as well as lobbying.

⁴ Approximately 75% of Indian software industry revenues are derived from exports (NASSCOM (2002)).

We develop a model of trade in which provision of infrastructure makes the domestic firm more productive and steal market share from a foreign firm in both the domestic and export markets.⁵ Both trading partners invest in infrastructure but this market-stealing effect provides an incentive to invest more in infrastructure in open economies compared to closed ones. We examine the equilibrium stock of this capital when the government invests to maximize national welfare and when its investment decision is influenced by producer lobbies. We consider two lobbying scenarios – when taxes are imposed only on the high income lobbying group and on the entire population.

We show that open economies invest more in infrastructure under all settings. However, infrastructure levels under the open economy compared to that under the closed economy can be welfare improving only when income and lobbying power is highly concentrated and the tax base is limited to the high income group. When the tax base is wide, an open economy always provides too much infrastructure relative to the optimal. This result is consistent with empirical findings, such as by Young (1995), who observes that there is excessive investment of capital in Singapore, a highly open economy. Our results are also consistent with Mohtadi and Roe (1998) who show that lobbying can be welfare improving, contrary to what is generally assumed. They use an alternative framework in which lobbying can lead to overprovision or underprovision of the public good depending on whether spillovers associated with lobbying activity are small or large, respectively.

Several studies have examined the interaction between infrastructure and trade. Bougheas, Demetriades and Morgenroth (1999) suggest that infrastructure reduces transport costs and therefore increases the volume of trade. They test this theory with data from the European Union countries and find strong empirical support for this relationship. Bougheas et al (2003) show that strategic behavior by countries in improving transport infrastructure may lead to overinvestment. The focus of both these papers is on transport-related infrastructure. Investment in infrastructure

⁵ Brander and Spencer (1985) first suggested this "rent shifting" effect in a model of export subsidies. In our paper, the subsidy takes the form of investment in infrastructure. Conrad and Seitz (1997) have also used the rent shifting argument to examine infrastructure provision that reduces costs of production. They show that strategic considerations will lead to over provision of infrastructure as well as input subsidies, when infrastructure provision is done through lumpsum taxation. However, if input taxation is used to finance infrastructure provision, overprovision of infrastructure may not occur. Our focus is to study how infrastructure provision in open and closed economies is affected by the social planner's objective function.

reduces the costs of doing trade and therefore benefits both foreign and domestic producers. We, on the other hand, focus on investments that reduce costs of production for domestic producers alone. This could include transport-related infrastructure such as internal road and rail networks but may be more relevant for non-transport infrastructure such as electricity which is likely to mostly benefit domestic firms. Moreover, the above papers focus on comparing infrastructure investment between trading countries with different endowments, determinants of infrastructure such as geography and the effects of infrastructure on the volume of trade. Our focus is on whether trade can be a determinant of infrastructure provision and how the decision making process affects this relationship. We compare investment in the open and closed economies under social planning and lobbying activity. In this sense the specific infrastructural issues we address are somewhat orthogonal to the above studies.⁶

Section 2 develops a simple model of infrastructure provision and compares open and closed economies under a social planner. Section 3 extends the model to a lobbying economy. Section 4 concludes the paper.

2. The Model

We examine the levels of infrastructure investment in an economy when it is open and when it is closed to international trade. Our focus is on the home country which trades with a foreign country. In both the open and closed economies, there are two firms producing in the home country. In the open economy, there is one domestic firm and it competes against a foreign firm in both the home and the foreign country. These firms produce only in their home country. There is no foreign direct investment. In the closed economy both firms produce in the home country. This framework allows us to focus on the key difference between the open and closed economies – the strategic advantage against foreign firms.⁷

We compare the outcomes in these two trade regimes in the home country under different decision making processes – when infrastructure is provided by a social planner and when it is

⁶ Other related papers deal with the choice of location by firms in countries with different levels of infrastructure (Martin and Rogers, 1995), the effect of infrastructure on productivity in manufacturing (Holtz-Eakin and Lovely, 1996) and competition among regions for public investment (Bucovetsky, 2005).

⁷ Assuming a monopoly in each closed economy would make the model more complicated – the lower output itself may cause lower investment in the closed economy, as will be clear later from the analysis.

provided by a government influenced by producer lobbies. The economy has two goods, X and Z , the latter being the numeraire good, both of which can be traded. Good X is produced under imperfect competition. The assumption of imperfect competition may be reasonable for manufactured differentiated goods which account for most exports, including those from developing countries (Rauch (1999)).⁸ The market for the numeraire good is assumed to be perfectly competitive. Infrastructure affects the productivity only of the X sector. It has public good characteristics i.e., it reduces the cost of all firms operating in the X sector in the country where the investment occurs.

We first consider the open economy scenario, which will be denoted by the subscript '1'. Both the home country and the foreign country are identical, invest in infrastructure and compete in each other's markets.⁹ The market for good X is characterized by a duopoly,¹⁰ i.e., the domestic firm competes with the foreign firm both at home and in the foreign markets, which are segmented.¹¹ Production of good X increases with the stock of infrastructure.

⁸ It is not clear that infrastructure provision will be higher in open economies under perfect competition. Under competition, infrastructure provision acts like a production subsidy and leads to a fall in the world price of the export good if the country is large. The reduction in price will involve a redistribution of part of the producer surplus to foreign consumers. This redistribution constitutes a net welfare loss for the country undertaking the investment. This is the standard trade theory result that under perfect competition subsidies lead to a welfare loss resulting from a reduction in the terms of trade. In a closed economy, however, any price reduction resulting from infrastructure investments will involve a redistribution of the surplus to domestic consumers only. This will not constitute a net welfare loss for the country. On the other hand, output is likely to be higher in an open economy. So the gain in producer surplus resulting from a decrease in costs may be higher in the open economy since it is spread over a larger volume of output. Whether the benefits are higher or lower in the open economy compared to the closed is, therefore, indeterminate. However, our results will continue to hold if the home country is small and takes world prices as given, there is no loss due to terms of trade.

⁹ Alternatively, the firms in the two countries could compete only in a third market. This may be a suitable model for developing countries since they compete with each other in large high income markets of industrialized nations. However, our framework helps facilitate comparison with the closed economy where we need to explicitly model the domestic market.

¹⁰ The open economy case may be modeled with multiple firms in each country without any effect on the results. More on the number of firms when we deal with the closed economy.

¹¹ Alternatively, one could assume a large number of imperfectly competitive sectors with one domestic and one foreign producer active in each industry. We would like to thank an anonymous referee for making this observation. Then infrastructure investment benefits more than one domestic firm, which makes the public good aspect of infrastructure investment more explicit. We retain our setup with only one X sector for simplicity. The public good nature of the capital stock will become clear when we discuss the closed economy in which we have two domestic firms and investment benefits both firms.

By reducing the cost of production of good X , investment in domestic infrastructure enables the domestic firm to steal market share from the foreign firm in both markets.¹² The utility function of each consumer is given by $U_1 = u(c_1) + z_1$ where c_1 and z_1 denote consumption of the X and Z goods, respectively. The sub-utility function $u(\bullet)$ is assumed differentiable, increasing and strictly concave. Labor is the only primary factor of production. The per unit labor requirement of the numeraire good is assumed unity.

Let K_1 denote the stock of infrastructure capital in the home country. Assume that capital is owned by the government and there is no capital market. Good X is produced at home with technology given by $x_1 = F(K_1)l_1$, where x_1 denotes output and l_1 is labor used by the firm. When we consider production of the foreign firm in the home country, the corresponding output is defined as y_1 . The production technology is assumed concave with $F' > 0$, $F'' < 0$ and $F(0) > 0$. Stock K_1 increases the productivity of the domestic firm producing the X good. In our framework the government is the sole provider of infrastructure capital.

We plan to show that the marginal return to investment is higher in the open economy compared to the closed one at any level of capital stock K_1 . The foreign country is identical to the home country in the sense that it has the same technology, population size and consumer preferences. Let K_1^* be the infrastructure stock in the X sector in the foreign country. Since the two countries are identical, the two capital stocks will indeed be the same in equilibrium, $K_1^* = K_1$.

Both firms, domestic and foreign, engage in Cournot competition.¹³ Their Cournot profits for good X are given by

¹² Infrastructure investment, as in ports, and roads to a lesser degree, will lower the cost of production for domestic as well as foreign firms. However, as long as these investments benefit the domestic firms more than they do foreign firms, our results are valid in the qualitative sense.

¹³ Because of the identical country assumption, Bertrand price competition between firms would result in the two countries sharing infrastructure investments such that price equals marginal cost. In general, our results will still hold. Only when countries exhibit cost heterogeneity, a single country may capture the whole market. The assumption of a Cournot model could be justified by the long-term nature of infrastructure investments, so that a capacity-constrained Bertrand model will yield Cournot quantities (Tirole, 1988, p. 217).

$$\pi_1 = x_1 p_1(x_1 + y_1) - \frac{x_1}{F(K_1)} \quad (1)$$

$$\hat{\pi}_1 = y_1 p_1(x_1 + y_1) - \frac{y_1}{F(K_1^*)}$$

where $x_1(\pi_1)$ and $y_1(\hat{\pi}_1)$ denote the output (profit) levels in the domestic market, respectively and p_1 is the output price of good X . Let x_1^* and y_1^* denote the corresponding output levels in the foreign market. Because of symmetry, the profit functions, π_1^* and $\hat{\pi}_1^*$ for the domestic and foreign firms in the foreign market are identical to the ones for the domestic market and are not written separately.

In the domestic market, the necessary conditions for profit maximization of the domestic and foreign firms are

$$\pi_{1x_1} = p_1 + x_1 p_1' - \frac{1}{F(K_1)} = 0 \quad (2)$$

and

$$\hat{\pi}_{1y_1} = p_1 + y_1 p_1' - \frac{1}{F(K_1^*)} = 0,$$

which can be solved to get equilibrium values of x_1 and y_1 .¹⁴ By totally differentiating these two conditions with respect to K_1 and solving them, we get the rate of change of equilibrium output with respect to the stock of infrastructure:

¹⁴ The sufficient condition for profit maximization can be written as $\pi_{1x_1x_1} = 2p_1' + x_1 p_1'' < 0$ where we make the simplifying assumption that $p_1'' \leq 0$. Quadratic utility functions, for example, will generate linear derived demand functions that yield $p_1'' = 0$. Since $p_1' < 0$ from the properties of the utility function, the above inequality holds. Moreover $\hat{\pi}_{1y_1y_1} < 0$, $\pi_{1x_1y_1} < 0$ and $\hat{\pi}_{1y_1x_1} < 0$. These assumptions imply that $\pi_{1x_1x_1} \hat{\pi}_{1y_1y_1} - \pi_{1x_1y_1} \hat{\pi}_{1y_1x_1} > 0$.

$$\frac{dx_1}{dK_1} = \frac{-F'(K_1)\hat{\pi}_{1y_1y_1}}{[F(K_1)]^2(\pi_{1x_1x_1}\hat{\pi}_{1y_1y_1} - \pi_{1x_1y_1}\hat{\pi}_{1y_1x_1})} \quad (3)$$

$$\frac{dy_1}{dK_1} = \frac{F'(K_1)\hat{\pi}_{1y_1x_1}}{[F(K_1)]^2(\pi_{1x_1x_1}\hat{\pi}_{1y_1y_1} - \pi_{1x_1y_1}\hat{\pi}_{1y_1x_1})}. \quad (4)$$

Since $\pi_{1x_1y_1} \equiv p'_1 + x_1p''_1 < 0$ (similarly $\hat{\pi}_{1y_1x_1} \equiv p'_1 + y_1p''_1 < 0$), we have $\frac{dx_1}{dK_1} > 0$ and $\frac{dy_1}{dK_1} < 0$.

Higher infrastructure stocks decrease domestic production costs relative to that of the foreign firm, thereby increasing the market share of the home firm in the domestic market, and reducing the share of the foreign firm. The change in domestic firm profits π_1 with respect to the stock of infrastructure K_1 is obtained from (1) as¹⁵

$$\frac{d\pi_1}{dK_1} = \frac{\partial\pi_1}{\partial x_1} \frac{dx_1}{dK_1} + \frac{\partial\pi_1}{\partial y_1} \frac{dy_1}{dK_1} + \frac{\partial\pi_1}{\partial K_1} = x_1p'_1 \frac{dx_1}{dK_1} + \frac{x_1F'(K_1)}{[F(K_1)]^2}. \quad (5)$$

Both terms on the right most side of the above expression are positive, so that $\frac{d\pi_1}{dK_1} > 0$.

Infrastructure capital increases profits of the domestic firm in the domestic market.¹⁶ These incremental profits come from two sources: a reduction in the output of the foreign firm (rent-shifting) given by the first time, and a reduction in cost due to higher investment in sector-specific capital given by the second term.¹⁷

¹⁵ where we use $\frac{\partial\pi_1}{\partial x_1} = 0$ from (2).

¹⁶ By symmetry there is a corresponding expression for profits of the same magnitude for the domestic firm in the foreign market. The domestic firm also increases its market share (and profits) at the expense of the foreign firm in the foreign market.

¹⁷ The latter is captured by the term $\frac{x_1F'(K_1)}{[F(K_1)]^2}$. Unlike in the Brander and Spencer case of an export subsidy, here the direct marginal benefits do not equal unity. If the cost of providing an additional unit of capital is unity, there may be a net benefit from providing infrastructure even if the "rent shifting" effect is ignored.

Consider the closed economy case, denoted by the subscript '2' and identical to the open economy except that there is no trading and two domestic firms compete Cournot in the home market.¹⁸ The corresponding utility function of the representative consumer U_2 is given by $U_2 = u(c_2) + z_2$ where c_2 and z_2 represent consumption levels of the X and Z goods, respectively. Denote the output of good X by each of the two firms as x_2 and y_2 . Let K_2 be the stock of infrastructure in the closed economy. Increases in K_2 will raise the productivity of both domestic firms. As in the open economy, production technology is given by $x_2 = F(K_2)l_2$ so that the symmetric profit function for each firm is $\pi_2 = x_2 p_2(x_2 + y_2) - \frac{x_2}{F(K_2)}$ and

$\hat{\pi}_2 = y_2 p_2(x_2 + y_2) - \frac{y_2}{F(K_2)}$.¹⁹ Since the two domestic firms face identical cost and demand conditions, their output and profits are identical, i.e., $x_2 = y_2$ and $\pi_2 = \hat{\pi}_2$. As before, solving the necessary conditions for profit maximization yield the change in output per firm with respect to the stock of infrastructure K_2 :

$$\frac{dx_2}{dK_2} = \frac{-F'(K_2)(\hat{\pi}_{2y_2y_2} - \pi_{2x_2y_2})}{[F(K_2)]^2(\pi_{2x_2x_2}\hat{\pi}_{2y_2y_2} - \pi_{2x_2y_2}\hat{\pi}_{2y_2y_2})} \quad (6)$$

Since x_2 and y_2 are equal by symmetry, $\frac{dx_2}{dK_2} > 0$ and $\frac{dy_2}{dK_2} > 0$.²⁰ Each firm's Cournot output of the non-traded good increases with stock K_2 . Comparing (3) and (6), the additional term $\pi_{2x_2y_2}$ in

¹⁸ We assume the same number of competing firms in the closed economy to facilitate comparison with the open economy case. Here the focus is on the nature of competition (domestic vs foreign) as opposed to the extent of it (i.e., the number of firms in the market). A smaller number of firms in the closed economy would make it more difficult to isolate the effect that is of primary interest in the paper. As a referee has pointed out, the GDP is lower in the case of the open economy since the domestic firm's exports must net out imports which equal the production in the home country by the foreign firm. Suppose the countries were completely identical, then in the open economy, the size of the home economy is halved. Since the focus of the paper is on the effects of strategic investments in infrastructure and how they are sensitive to the planner's decision-making processes, we abstain from considering this issue in the rest of the paper.

¹⁹ Differentiation yields $\pi'_2(x_2) = x_2 p'_2 + p_2 - \frac{1}{F(K_2)} = 0$ and $\pi''_2(x_2) = x_2 p''_2 + 2p'_2 < 0$. A similar expression holds for the second firm.

²⁰ $\hat{\pi}_{2y_2y_2} - \pi_{2x_2y_2} = (y_2 p''_2 + 2p'_2) - (x_2 p''_2 + p'_2) = p'_2 < 0$.

the numerator of (6) indicates that an increase in capital stock reduces the costs of the other domestic firm as well. Output per firm increases by a smaller amount in the latter, because in the closed economy there is no rent-shifting, i.e., both firms benefit from infrastructure provision.

The assumption of identical countries and capital stocks implies that the firms' Cournot problems are also identical in the open and the closed economy cases. The equilibrium quantities and prices will thus be equal. In this perfectly symmetric case, the increase in output for the domestic firm will be larger in the open economy than for a firm in the closed economy.²¹ In the open economy, the domestic firm gains from cost reductions as well as market-stealing. In the closed economy, both firms benefit equally from cost reductions but there is no market-stealing.

In Fig. 2 let R_x and R_y denote the reaction functions of the domestic and foreign firm in the domestic market when the economy is open. Infrastructure investment shifts R_x outward leading to an increase in the domestic firm's output from x_0 to x'_1 and a corresponding decrease in the foreign firm's output from y_0 to y'_1 . An identical shift (not shown) occurs in the foreign market. Now suppose R_x and R_y denote the reaction functions of the two duopolists in the closed economy. Then infrastructure investment shifts out *both* reaction functions, leading to an increase in each firm's output from x_0 to x'_2 and y_0 to y'_2 where x'_2 is less than x'_1 , i.e., *ex-post* firm output in the open economy will be higher than when it is closed.

Differentiating π_2 with respect to K_2 , using symmetry ($y_2 = x_2$) and substituting as in (5) yields

$$\frac{d\pi_2}{dK_2} = x_2 p'_2 \frac{dy_2}{dK_2} + x_2 \frac{F'(K_2)}{[F(K_2)]^2}. \quad (7)$$

²¹ From (3) and (6), $\frac{dx_2}{dK_2} < \frac{dx_1}{dK_1}$.

A comparison of (5) and (7) suggests that $\frac{d\pi_1}{dK_1}$ is greater than $\frac{d\pi_2}{dK_2}$.²² Marginal profits from infrastructure are higher in the open economy than in the closed economy at any given level of capital stock. In the open economy, the domestic firm increases output while the foreign firm reduces it, leading to a smaller reduction in price relative to the closed economy, where *both* firms increase output.

The stock of infrastructure is provided by a social planner who maximizes the sum of consumer and producer surplus net the cost of infrastructure capital. Assume L identical individuals in the home country with one unit of labor producing one unit of capital. First consider the open economy. The planner's objective is to maximize aggregate utility LU_1 subject to the full employment constraint and the trade balance constraint. The full employment constraint, assuming each individual contributes one unit of labor, is given by $w_1 + \frac{x_1 + x_1^*}{F(K_1)} + k_1 = L$ where w_1 is the output of the numeraire good in country I . Since foreign and domestic demands are identical, the equilibrium Cournot quantities in the domestic and foreign markets will be equal, i.e., $x_1 = x_1^*$. The price of good X will be equal in both the domestic and foreign markets. The trade balance condition is $p_1(x_1^* - y_1) = Lz_1 - w_1$. The value of net exports of good X must equal net imports of the numeraire good Z . The social planner solves

$$\text{Max}_{K_1} \Psi_1(K_1) \equiv \Phi_1(K_1) + 2\pi_1(K_1) - K_1 \quad (8)$$

where $\Psi_1(K_1)$ is the net social surplus in the open economy and Φ_1 is the consumer surplus in sector X .²³ By symmetry, total producer surplus in the X sector is twice the surplus earned in each market, domestic and foreign. Consumer surplus in the home country is given by $\Phi_1 = Lu(c_1) - p_1Lc_1$. Therefore,

²² The first term on the right hand side of (7) is negative since $\frac{dy_2}{dK_2} > 0$. The corresponding term on the right hand side of (5) is positive. The second term is positive and equal in both equations because of symmetry.

²³ To prevent tax-induced distortions, we assume that capital investment is financed by lump sum taxes.

$$\frac{d\Phi_1}{dK_1} = Lu'(c_1) \frac{dc_1}{dK_1} - p_1 L \frac{dc_1}{dK_1} - Lc_1 \frac{dp_1}{dK_1} = -Lc_1 p_1' \left(\frac{dx_1}{dK_1} + \frac{dy_1}{dK_1} \right) \quad (9)$$

since $u'(c_1) = p_1$ from utility maximization of the consumer. Differentiating Ψ_1 with respect to K_1 and using (9) and (5) gives

$$\frac{d\Psi_1}{dK_1} = -Lc_1 p_1' \left(\frac{dx_1}{dK_1} + \frac{dy_1}{dK_1} \right) + 2 \left\{ x_1 p_1' \frac{dy_1}{dK_1} + \frac{x_1 F'(K_1)}{[F(K_1)]^2} \right\} - 1. \quad (10)$$

Similarly, for the closed economy, the net social surplus Ψ_2 is maximized as

$$\text{Max}_{K_2} \Psi_2(K_2) \equiv \Phi_2(K_2) + 2\pi_2(K_2) - K_2. \quad (11)$$

Differentiating Ψ_2 and using $Lc_2 = x_2 + y_2 = 2x_2$ from the symmetric duopoly in the market for the X good, we get

$$\frac{d\Psi_2}{dK_2} = -Lc_2 p_2' \left(\frac{dx_2}{dK_2} \right) + 2x_2 \left(\frac{F'(K_2)}{[F(K_2)]^2} \right) - 1. \quad (12)$$

From (10) and (12), we have $\frac{d\Psi_1}{dK_1} > \frac{d\Psi_2}{dK_2}$.²⁴ The marginal return is higher in the trading economy relative to the non-trading economy. Producer surplus goes up by a bigger margin in the former. This happens because of the market stealing effect in the open economy.²⁵ Thus market stealing

²⁴ Adding (3) and (4) yields $\frac{dx_1}{dK_1} + \frac{dy_1}{dK_1} = \frac{-F'(K_1)(\hat{\pi}_{1y_1y_1} - \hat{\pi}_{1y_1x_1})}{[F(K_1)]^2(\pi_{1x_1x_1}\hat{\pi}_{1y_1y_1} - \pi_{1x_1y_1}\hat{\pi}_{1y_1x_1})}$. By symmetry,

$\hat{\pi}_{1y_1y_1} = \hat{\pi}_{2y_2y_2}$, $\hat{\pi}_{1y_1x_1} = \pi_{2x_2y_2}$, and all the corresponding second partials will be equal. Using (6) we get

$\frac{d(x_1 + y_1)}{dK_1} = \frac{dx_2}{dK_2}$. Now compare (10) and (12). The right hand side is the same except for an additional term

$2x_1 p_1' \frac{dy_1}{dK_1}$ in the former. Since $p_1' < 0$, and $\frac{dy_1}{dK_1} < 0$, this term is positive, and therefore $\frac{d\Psi_1}{dK_1} > \frac{d\Psi_2}{dK_2}$.

²⁵ The larger increases in consumer surplus in the closed economy resulting from steeper declines in price (since both firms increase output) is exactly compensated by the decrease in producer surplus resulting from this price fall.

leads to a higher return to social welfare in the open economy case. Investment in the open economy enables the domestic firm to gain market share at the expense of the foreign firm, while investment in a closed economy yields no such benefit for the domestic duopolists.

To examine whether a higher marginal return to investment in the open economy translates into a higher capital stock, let us assume consider linear demand for the X good with parameters

$p_i = a - b(x_i + y_i), i = 1, 2$. Then $p_i'' = 0, i = 1, 2$. First consider the open economy. We assume that consumer preferences are identical in the domestic and the foreign country so that $a (= u'(0))$ is the same. Consider an identical population size, i.e., $L = L^*$ (and therefore, $b = b^*$).²⁶

Define the unit cost of production for the domestic firm in the open economy as $v_1(K_1) = \frac{1}{F(K_1)}$

so that $v_1' < 0$ and $v_1'' > 0$. Similarly, the cost of the foreign firm is $v_1^*(K_1^*)$. For now, we assume that there is no reaction from the foreign country, so that K_1^* and therefore v_1^* is fixed.²⁷ Let

$g(K_1) = \frac{F'(K_1)}{(F(K_1))^2} > 0$.²⁸ Aggregate consumption of the X good is given by $Lc_1 = x_1 + y_1$.

Substitution of terms in (10) and normalizing $L = 1$ yields the following expression for the net marginal return to capital:²⁹

²⁶ Since $p_i = u'(c_i) = u'(\frac{x_i + y_i}{L})$, $b = -\frac{dp_i}{d(x_i + y_i)} = -\frac{u''(c_i)}{L}$. A higher L^* implies a lower b^* .

²⁷ Output and prices for the linear Cournot model are $x_1 = \frac{a + v_1^* - 2v_1}{3b}$, $y_1 = \frac{a + v_1 - 2v_1^*}{3b}$ and $p_1 = \frac{a + v_1 + v_1^*}{3}$.

Similarly $x_1^* = \frac{a + v_1^* - 2v_1}{3b}$, $y_1^* = \frac{a + v_1 - 2v_1^*}{3b}$ and $p_1' = p_1^* = p_2^* = -b$. For an interior Cournot solution, we must have $a > \max\{v_1, v_2, v_1^*\}$, i.e., maximum valuation must exceed unit production costs.

²⁸ Then $\frac{dx_1}{dK_1} = \frac{2g(K_1)}{3b}$, $\frac{dy_1}{dK_1} = -\frac{g(K_1)}{3b}$, $\frac{dx_2}{dy_2} = \frac{g(K_2)}{3b}$ and $v_1' = -g(K_1)$.

²⁹ Substituting in (10) gives

$$\frac{d\Psi_1}{dK_1} = -\frac{(a + v_1^* - 2v_1 + a + v_1 - 2v_1^*)}{3b}(-b)\left(\frac{2g}{3b} - \frac{g}{3b}\right) + 2\left[\left(\frac{a + v_1^* - 2v_1}{3b}\right)(-b)\left(-\frac{g}{3b}\right) + \left(\frac{a + v_1 - 2v_1^*}{3b}\right)g\right] - I.$$

Simplifying and rearranging terms yields (13).

$$\frac{d\Psi_1}{dK_1} = \frac{[10(a - v_1) + 7(v_1^* - v_1)]g(K_1)}{9b} - 1. \quad (13)$$

We have so far assumed that the foreign country is passive and does not invest in infrastructure. Now suppose that *both* countries invest in the public good. Equation (13) gives the marginal return to investment given v_1^* , the unit cost of production in the foreign country. When the two countries are identical, we have $v_1 = v_1^*$ in equilibrium. Then (13) becomes

$$\frac{d\Psi_1}{dK_1} = \frac{[10(a - v_1)]g(K_1)}{9b} - 1. \quad (14)$$

The same analysis can be repeated for the closed economy for which $Lc_2 = 2x_2$. Substituting terms in (12) gives

$$\frac{d\Psi_2}{dK_2} = \frac{8(a - v_2)g(K_2)}{9b} - 1. \quad (15)$$

Comparing (14) and (15) yields $\frac{d\Psi_1}{dK_1} > \frac{d\Psi_2}{dK_2}$. The graph of $\Psi_1'(K_1)$ lies everywhere above the graph of $\Psi_2'(K_2)$ (see Fig. 3). Since returns to infrastructure investment are higher in the open economy relative to the closed economy, and both $\Psi_1'(K_1)$ and $\Psi_2'(K_2)$ can be shown to be downward sloping under plausible conditions,³⁰ the equilibrium stock is higher in the former. To

³⁰ A sufficient condition for $\Psi_i''(K_i) < 0$ is when $\frac{v_i'}{v_i''}$ is constant, which is true for cost functions such as e^{-zk} ,

where z is a constant parameter. From (13) observe that $\Psi_1''(K_1) < 0$ if $\frac{10a + 7v_1^* - 17v_1}{17v_1'} < \frac{v_1'}{v_1''}$. Similarly,

$\Psi_2''(K_2) < 0$ if $\frac{a - v_2}{v_2'} < \frac{v_2'}{v_2''}$ holds.

summarize, the equilibrium stock of infrastructure in the open economy will be higher than in the closed economy.³¹

We have shown that the capital stock in the open economy is higher when both countries behave strategically. We now ask if this stock is optimal. For the open economy, we define the *globally optimal* vector of stocks as the one that maximizes the joint aggregate welfare of the two countries. We call it the *global planner* case to distinguish it from the scenario in which the government maximizes the welfare of its own country. We define the latter as the *national planner* case and the equilibrium stock as *nationally optimal*. In the closed economy, there is only one country and so what is nationally optimal is also globally optimal. The maximization problem of this global social planner can be written as

$$\text{Max}_{K_1, K_1^*} \Psi_1(K_1, K_1^*) \equiv \Phi_1(K_1, K_1^*) + 2\pi_1(K_1, K_1^*) - K_1 + \Phi_1^*(K_1^*, K_1) + 2\pi_1^*(K_1^*, K_1) - K_1^*$$

which yields the marginal net social surplus to investment as follows:

$$\frac{d\Psi_1}{dK_1} = \frac{d\Phi_1}{dK_1} + 2\frac{d\pi_1}{dK_1} - 1 + \frac{d\Phi_1^*}{dK_1} + \frac{2d\pi_1^*}{dK_1} \quad (16)$$

and

$$\frac{d\Psi_1}{dK_1^*} = \frac{d\Phi_1}{dK_1^*} + 2\frac{d\pi_1}{dK_1^*} + \frac{d\Phi_1^*}{dK_1^*} + \frac{2d\pi_1^*}{dK_1^*} - 1. \quad (17)$$

Using (5) and (9) and given identical preferences and population, $\frac{d\Phi_1}{dK_1} = \frac{d\Phi_1^*}{dK_1}$ and

$$\frac{d\pi_1^*}{dK_1} = y_1 p_1' \frac{dx_1}{dK_1} \text{ gives}$$

³¹ The same result may be obtained by assuming that the home country is a small open economy. Infrastructure investment would be higher because of the rent-shifting effect, even though there would be no foreign firm selling in the home country.

$$\frac{d\Psi_1}{dK_1} = -2Lc_1p'_1 \left(\frac{dx_1}{dK_1} + \frac{dy_1}{dK_1} \right) + 2 \left\{ x_1p'_1 \frac{dy_1}{dK_1} + \frac{x_1F'(K_1)}{[F(K_1)]^2} \right\} + 2y_1p'_1 \frac{dx_1}{dK_1} - 1. \quad (16')$$

Since $Lc_1 = x_1 + y_1$ and $x_1 = y_1$ because of symmetry and imposing linear demand as before we get

$$\frac{d\Psi_1}{dK_1} = \frac{8(a-v_1)g(K_1)}{9b} - 1. \quad (18)$$

Comparison with (15) shows that the *globally* optimal stock of infrastructure in the open regime is the same as the optimal stock in the closed economy. But there is overinvestment in the open economy. The intuition is that the national social planner invests in infrastructure partly to steal market share from the foreign country. When both countries invest, this is a zero sum activity and does not enhance global welfare. There is overinvestment from a global welfare point of view. That is, while open economies may invest more in infrastructure, it is not necessarily a “good” thing. We can summarize the main results of this section as follows:

Proposition 1: An open economy has a higher stock of infrastructure than a closed one when the planner maximizes national welfare. However, the open economy capital stock is higher than what is globally optimal.

There is a negative jurisdictional externality from infrastructure. Infrastructure in the open economy is higher than globally optimal because at the margin, infrastructure investments in one country have a negative effect on the other. More specifically, infrastructure investments in the home country lead to increased output of the domestic firm in the foreign market, which leads to a higher consumer surplus in the foreign country. This is given by the term

$Lc_1p'_1 \left(\frac{dx_1}{dK_1} + \frac{dy_1}{dK_1} \right)$ in equation (16'). However, the foreign firm loses market share in the

foreign country, which in turn is given by $y_1p'_1 \frac{dx_1}{dK_1}$. With linear demand and identical

countries, each of these terms equal $\frac{2(a - v_1)g(K_1)}{9b}$. That is, the gain to consumers is exactly offset by the loss to producers in the foreign market.³² However, the foreign firm also suffers an equivalent loss in the home country market. The net effect of the investment on aggregate welfare in the foreign country is negative and equals $\frac{-2(a - v_1)g(K_1)}{9b}$.

3. Infrastructure Provision in a Lobbying Economy

In this section we ask how the above results change when the capital stock is determined by a government that is influenced by lobbies instead of one that maximizes national or global welfare. We compare the equilibrium stocks in the lobbying case with those derived earlier.

In the lobbying economy, special interest groups make political contributions to influence the government's decision to invest in infrastructure. We study the following scenario. Let there be two income groups in the economy – high and low. Suppose only the high income group can lobby and earn profits from the industry for good X . In addition, the government can levy taxes only on the high income group. This is a realistic scenario because the tax burden is often borne by a small fraction of the population in many developing countries because of several factors including the existence of a large informal sector, the high cost of administering an effective tax system and concerns about distributional issues.³³ Auriol and Warlters (2005) provide a related explanation as to why only the rent earning sector may pay taxes in developing countries. If the government can collect taxes only from the formal sector then it has an incentive to restrict entry into this sector to create rents. These rents can then be captured through taxation. Later we will consider the case in which taxes are imposed on the entire population.

To examine infrastructure investment under lobbying, we adapt the Grossman-Helpman (1994) framework in which the government maximizes a linear objective function G given by

³² As pointed out by a referee, this implies that if domestic and foreign firms are identical and countries are equal in size, imposing a small quota on the foreign firm has no first order effect on domestic welfare. The loss to domestic consumers is exactly offset by increased profits to the domestic firm.

³³ For example, only 2% of the population pays income tax in India (BBC, 2004). The tax revenue to GDP ratio is 18.2% in a sample of developing countries compared to 37.9% for OECD countries, according to Auriol and Warlters (2005).

$G = C(K_i) + \beta\Psi(K_i)$ where C represents lobbying contributions and Ψ denotes aggregate welfare. The parameter β denotes the weight the government attaches to aggregate welfare. For simplicity, let us assume β to be zero. That is, the government only cares about its lobbying revenues. Bernheim and Whinston (1986) have shown that there is an equilibrium in this model in which agents behave truthfully, that is, make contributions equal to the utility they receive from the government's actions. This implies that the contributions G that the government receives will equal the aggregate producer surplus of the lobbying group plus their share of the aggregate consumer surplus, net of their contribution to infrastructure investment. That is,

$$G = \Pi_i + \alpha\Phi_i - K_i \quad (19)$$

where α denotes the fraction of the population that is in the high income group, Π_i and Φ_i denote aggregate producer and consumer surplus, respectively and $i = 1,2$ denote the open and closed economy cases. In other words, contributions equal the profits accruing to the high income group plus their share of the aggregate consumer surplus minus their tax payments, which is the entire cost of infrastructure capital.³⁴

Comparing the expression for G in (19) with the objective function of the country social planner under the open and closed economies (given by (8) and (11), respectively), we observe that the return to investment will be lower under this lobbying scenario. This is because while G takes into account the entire cost of capital, it includes only part of the consumer surplus.

The marginal return to investment (either in an open or closed economy) is given by

$$\frac{dG}{dK_i} = \frac{2d\pi_i}{dK_i} + \alpha \frac{d\Phi_i}{dK_i} - 1. \quad (20)$$

When the economy is *closed*, under linear demand, from (20) and (7), we get

³⁴ Since there are two domestic firms in the closed economy and only one in the open economy, lobbying under the closed economy may be less effective because of free rider problems. However, in the specific case in which the government auctions off its policy as in the Grossman-Helpman model, these free rider problems will not exist.

$$\frac{dG}{dK_2} = \frac{4(a-v_2)g(K_2)}{9b} + \frac{4\alpha(a-v_2)g(K_2)}{9b} - 1. \quad (21)$$

Since $\alpha \leq 1$, comparing (21) with (18), we see that lobbying leads to underinvestment in infrastructure in the closed economy.

In the *open* lobbying economy, using (20) and (5), the marginal return to investment is given by

$$\frac{dG}{dK_1} = \frac{8(a-v_1)g(K_1)}{9b} + \frac{2\alpha(a-v_1)g(K_1)}{9b} - 1. \quad (22)$$

Comparing (22) with (21), the marginal return to investment and therefore the equilibrium stock of infrastructure will be higher in the open economy under lobbying as well. Also, comparing (22) with the solution for the global social planner given by (18), we observe that there will be overinvestment under lobbying as long as α is strictly positive.

However, if α , the proportion of high income people in the population is small, then (21) and (22) show that the degree of underinvestment will be large in the closed economy case and the degree of overinvestment will be small for the open economy. That is, for small α , the equilibrium stock will be close to optimal in the open economy case and away from the optimal in the closed economy case. We can summarize:

Proposition 2. When investment is influenced by producer lobbies and taxes are levied only on the lobbying group, the stock of infrastructure is higher in the open economy relative to the closed. There will be underinvestment in infrastructure in the closed economy and overinvestment in the open economy relative to the globally optimal stock. This deviation from the optimal is large in the closed economy and small in the open economy if the lobby members constitute a small fraction of the population.

The implication is that when income and lobbying power are highly concentrated, the stock of infrastructure may be close to optimal under the open regime but far below optimal under the closed. That is, trade rectifies the underinvestment problem associated with a high degree of income concentration. In the closed economy, the full benefits of investment do not accrue to the lobbyist. Only a fraction of the consumer surplus accrues to the high income group that participates in the lobbying. Therefore the stock of infrastructure is lower than optimal. The smaller the value of α , i.e., the fewer the members of the lobbying group, the larger is this deviation. When the country is open, the market stealing effect of investment counteracts the underinvestment that occurs under the closed economy. For small values of α , the two effects may almost cancel each other and the stock will be close to the optimal in the open economy. As α approaches zero, the stock of capital in the open economy approaches the optimal stock while the stock in the closed economy moves away from the optimal.³⁵ Conversely, as α approaches unity (its maximum value), the stock in the closed economy approaches the optimal stock while that of the open economy moves further away from the globally optimal stock.³⁶

We now compare the above results to a lobbying economy in which taxes are levied equally on all agents while profits still accrue only to the high income group which alone can lobby. The contributions to the government in this case will equal

$$G = \Pi_i + \alpha(\Phi_i - K_i). \quad (23)$$

Taking derivatives with respect to the stock of capital, we get

$$\frac{dG_i}{dK_i} \left[\frac{1}{\alpha} \right] = \left(\frac{1}{\alpha} \right) \left(2 \frac{d\pi_i}{dK_i} \right) + \frac{d\Phi_i}{dK_i} - 1. \quad (24)$$

³⁵ When $\alpha = 0$ note from (19) that the government only cares about firm profits minus the cost of infrastructure. The government neglects three other global effects of its infrastructure investment – benefits to domestic consumers, benefits to foreign consumers and to the foreign firm in both markets. Under linear demand and costs and symmetry across countries, benefits to domestic and foreign consumers together equal the loss to the foreign firm in the two markets.

³⁶ A natural interpretation of α may be that different groups in the economy may simply be better at lobbying than others. Lobbying and political decision-making processes without any direct costs to lobbying activity as in the Grossman and Helpman (1994) framework may also lead to similar outcomes.

The right hand side of (24) is just a modified form of $\frac{d\Psi_i}{dK_i}$ with the weight $1/\alpha$ attached to the producer surplus term (check (8) and (11)). Since $1/\alpha \geq 1$, the government attaches a greater weight to producer surplus under this lobbying scenario. Comparing this to the case of the country social planner (obtained by differentiating (8) and (11)), it is clear that the marginal return to investment in infrastructure stock will be higher under lobbying compared to the national planner case in both the open and closed economies. The high income group gets a larger fraction of the benefits and shares a smaller fraction of the costs. Therefore, they will lobby the government in favor of overinvestment in infrastructure capital.

Substituting for $\frac{d\pi_i}{dK_i}$ and $\frac{d\Phi_i}{dK_i}$ in (24) we get for the closed economy,

$$\frac{dG}{dK_2} \frac{1}{\alpha} = \frac{4(a-v_2)g(K_2)}{9b\alpha} + \frac{4(a-v_2)g(K_2)}{9b} - 1. \quad (25)$$

For the open economy, we have

$$\frac{dG}{dK_1} \frac{1}{\alpha} = \frac{8(a-v_1)g}{9b\alpha} + \frac{2(a-v_1)g}{9b} - 1. \quad (26)$$

Comparing (25) and (26) suggests that the positive terms on the right hand side of (25) will be less than or equal to $\frac{8(a-v_1)g}{9b\alpha}$, which is the first term on the right hand side of (26). Thus the right hand side of (26) is greater than that of (25) at any given level of K . So, the equilibrium stock will be higher in the open economy.

Comparing (25) and (26) with (18), we can see that the return to investment is higher compared to the optimal in both the closed and open economies since α is less than or equal to 1.

Therefore, there will be overinvestment in both the open and closed economies. The gap between

the equilibrium stock and the optimal stock will be greater in the open economy compared to the closed. In this case with lobbying, openness exacerbates the problem of overinvestment. These results are summarized as follows:

Proposition 3. When investment is influenced by producer lobbies, and taxes are levied on the entire population, the infrastructure stock is higher in the open economy compared to the closed. There will be overinvestment in both the closed and the open economies. The extent of overinvestment is greater in the open economy.

Our main results are summarized in Fig. 4. In the absence of producer lobbies, the closed economy provides the same level of infrastructure as the globally optimal open economy, but the nationally optimal open economy provides too much infrastructure (see panel (a)). This is because in the latter, the Nash Equilibrium implies overinvestment in order to steal market share from the foreign firm. In the presence of producer lobbies, however, when only members of the lobbying group are taxed to finance infrastructure provision, the closed economy under-provides infrastructure while the open economy provides too much (see panel (b)). The lower the share of the lobbying group in the total population, the closer is the open economy to the globally optimal stock. In the limit as this share goes to zero, the open economy becomes globally optimal. However, the closed economy stock declines away from the optimal with a lower share of the lobbying population. An implication of this result is that if the tax base is relatively small, the open economy is preferred to the closed economy. When the lobbying group constitutes a large fraction of the population, investment in the closed economy is closer to the optimal. Finally, when infrastructure is financed by the whole population, both the closed and the open economies overinvest, with the latter further away from the optimal stock (see panel (c)). With a wide tax base, investment outcomes in the closed economy may be more desirable.

4. Concluding Remarks

In this paper we investigate the relationship between openness of an economy and the stock of infrastructural capital. Governments may have a higher incentive to provide infrastructure when domestic firms compete with foreign firms since such investment helps domestic firms to steal market share from the foreign firm. Using a model in which firms in the home country engage in

Cournot competition with firms from an identical foreign country, we show that an open economy will always have a higher stock of infrastructure than a closed one. This is true regardless of whether the government maximizes national welfare or if its investment decisions are influenced by producer lobbies.

However, whether or not the higher investment in the open economy is welfare improving depends on the mechanics of the decision making process. When the government maximizes national welfare or when the government's decision is influenced by lobbies but taxes that finance investment in infrastructure are imposed on the entire population, then investment in the open economy is higher than what is globally optimal. This overinvestment result is similar to that of Bougheas et al (2003) although in their paper, overinvestment stems from the fact that investment in public goods in a country reduces the capacity to produce consumption goods in that country and therefore affects consumption in both countries since they trade with one another.

When the government is influenced by producer lobbies and taxes are levied only on the members of the lobbying group, then investment may be higher than optimal in the open economy and lower in the closed economy. However, the open economy stock converges to the optimal, the smaller the size of the lobbying group. On the other hand, the smaller the size of the lobbying group, the larger the divergence of the closed economy stock of infrastructure from the optimal.

If in the real world government decisions are influenced by producer lobbies then our paper implies that closed economies will underinvest in infrastructure if the lobbying power and the tax base is confined to a small elite. Trade may correct the underinvestment problem in this case. That is, openness will lead to better outcomes in countries with a high degree of inequality and an ineffective tax administration system. However, openness leads to less desirable outcomes with respect to investment in countries with high inequality but with an effective tax administration system. The overinvestment problem becomes worse in the latter set of countries when they are engaged in international trade.

A possible alternative interpretation of our model is related to the extent of spillovers from public investment across countries. Our closed economy scenario is like the case of perfect spillovers from public investments, while our open economy setup may be thought of as one in which spillovers across countries are imperfect or non-existent. In that case, our analysis suggests that investment is low when the spillovers are perfect while investment is likely to be high when spillovers are imperfect.

References

- Ahluwalia, Montek S. (1998), "Infrastructure Development in India's Reforms," in Isher J. Ahluwalia and I.M.D. Little, eds., *India's Economics Reforms and Development: Essays for Manmohan Singh*, Oxford University Press, 87-121.
- Auriol, Emmanuelle and Michael Warlters (2005), "Taxation Base in Developing Countries," *Journal of Public Economics* 89, 625-46.
- Barro, Robert and Xavier Sala-i-Martin (1998), *Economic Growth*, Cambridge: The MIT Press.
- Bougheas, Spiros, Panicos O. Demetriades and Edgar L.W. Morgenroth (1999), "Infrastructure, Transport Costs and Trade," *Journal of International Economics* 47, 169-89.
- _____ (2003), "International Aspects of Public Infrastructure Investment," *Canadian Journal of Economics* 36(4), 884-910.
- Brander, James A. and Barbara J. Spencer (1985), "Export Subsidies and International Market Share Rivalry," *Journal of International Economics* 18, 83-100.
- British Broadcasting Corporation (2004), *BBC News*, World Edition, Online, July 5.
- Bucovetsky, S. (2005), "Public Input Competition," *Journal of Public Economics* 89, 1763-87.
- Conrad, Klaus, and Helmut Seitz (1997), "Infrastructure Provision and International Market Share Rivalry," *Regional Science and Urban Economics* 27, 715-34.
- Easterly, William and Sergio Rebelo (1993), "Fiscal Policy and Economic Growth - an empirical investigation," *Journal of Monetary Economics*, 32, 417-458.
- Frankel, Jeffrey, and David Romer (1999), "Does Trade Cause Growth?" *American Economic Review*, 89(3), 379-99.
- Grossman, Gene M., and Elhanan Helpman (1994), "Protection for Sale," *American Economic Review* 84(4), 833-50.
- Holtz-Eakin, Douglas and Mary E. Lovely (1996), "Scale Economies, Returns to Variety and the Productivity of Public Infrastructure," *Regional Science and Urban Economics* 26, 105-23.
- Hulten, Charles R. (1996), "Infrastructure Capital and Economic Growth", Working Paper 5847, Cambridge: NBER.
- International Monetary Fund (1986), *A Manual on Government Finance Statistics*. Washington, D.C.

Martin, Philippe and Carol Ann Rogers (1995), "Industrial Location and Public Infrastructure," *Journal of International Economics* 39, 335-51.

Mody, Ashoka (1997), *Infrastructure Strategies in East Asia: the Untold Story*, Washington, D.C.: The World Bank.

Mohtadi, Hamid and Terry Roe (1998), "Growth, Lobbying and Public Goods", *European Journal of Political Economy* 14(3), 453-73.

Munnell, Alicia (1992), "Infrastructure Investment and Economic Growth," *Journal of Economic Perspectives*, 6(4), 189-98.

NASSCOM (2002), "Indian Software Exports Grow by 65% in 2000-01," <http://www.nasscom.org>, National Association of Software and Service Companies.

Pingle, Vibha, (1999), *Rethinking the Developmental State*, St. Martin's Press.

Rauch, James (1999), "Networks versus Markets in International Trade, " *Journal of International Economics* 48, 7-35.

Tirole, Jean, (1988), *The Theory of Industrial Organization*, Cambridge: The MIT Press.

World Bank (1994), *World Development Report*, Washington DC: The World Bank.

Young, A., (1995), "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience," *Quarterly Journal of Economics* 110, 641-80.

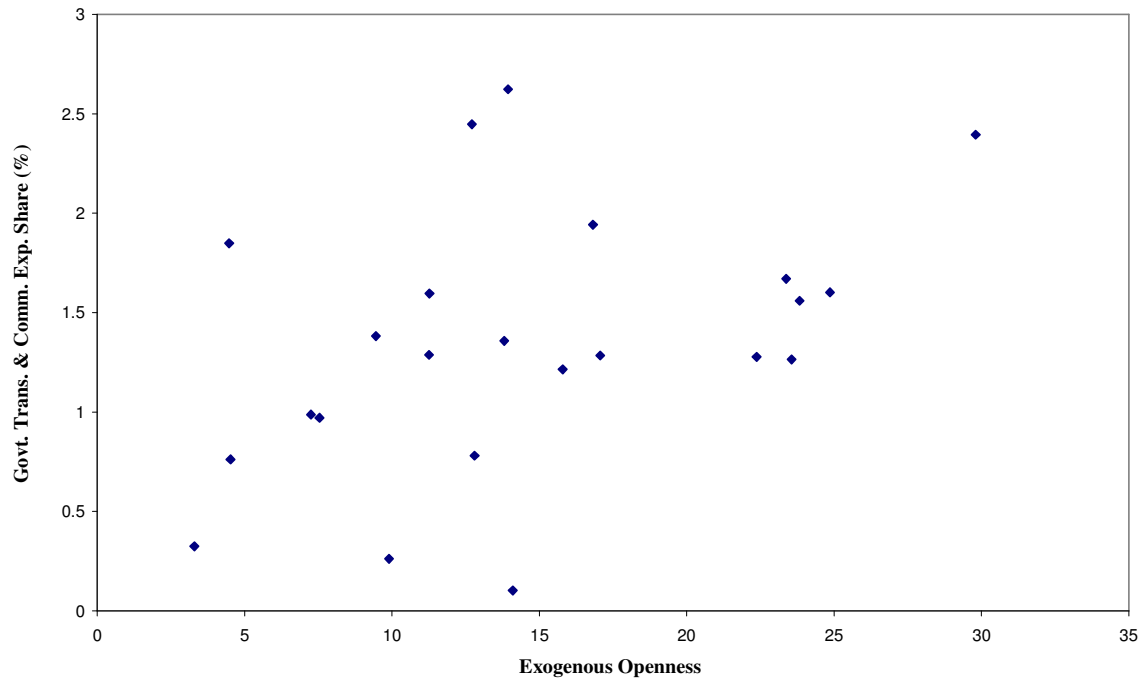


Fig.1. The Relationship between Infrastructure and Openness

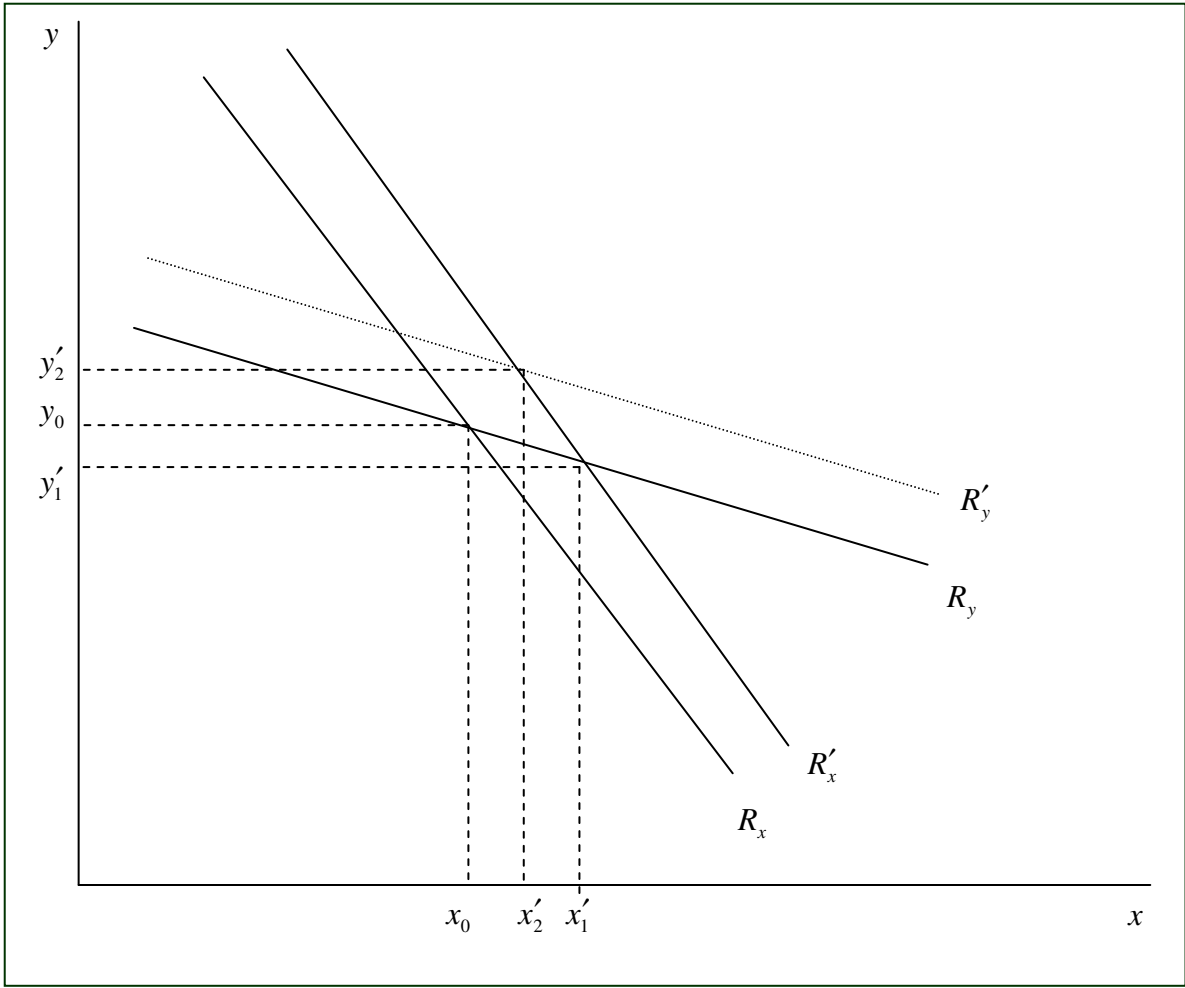


Fig. 2. Market Stealing in the Open and Closed Economy

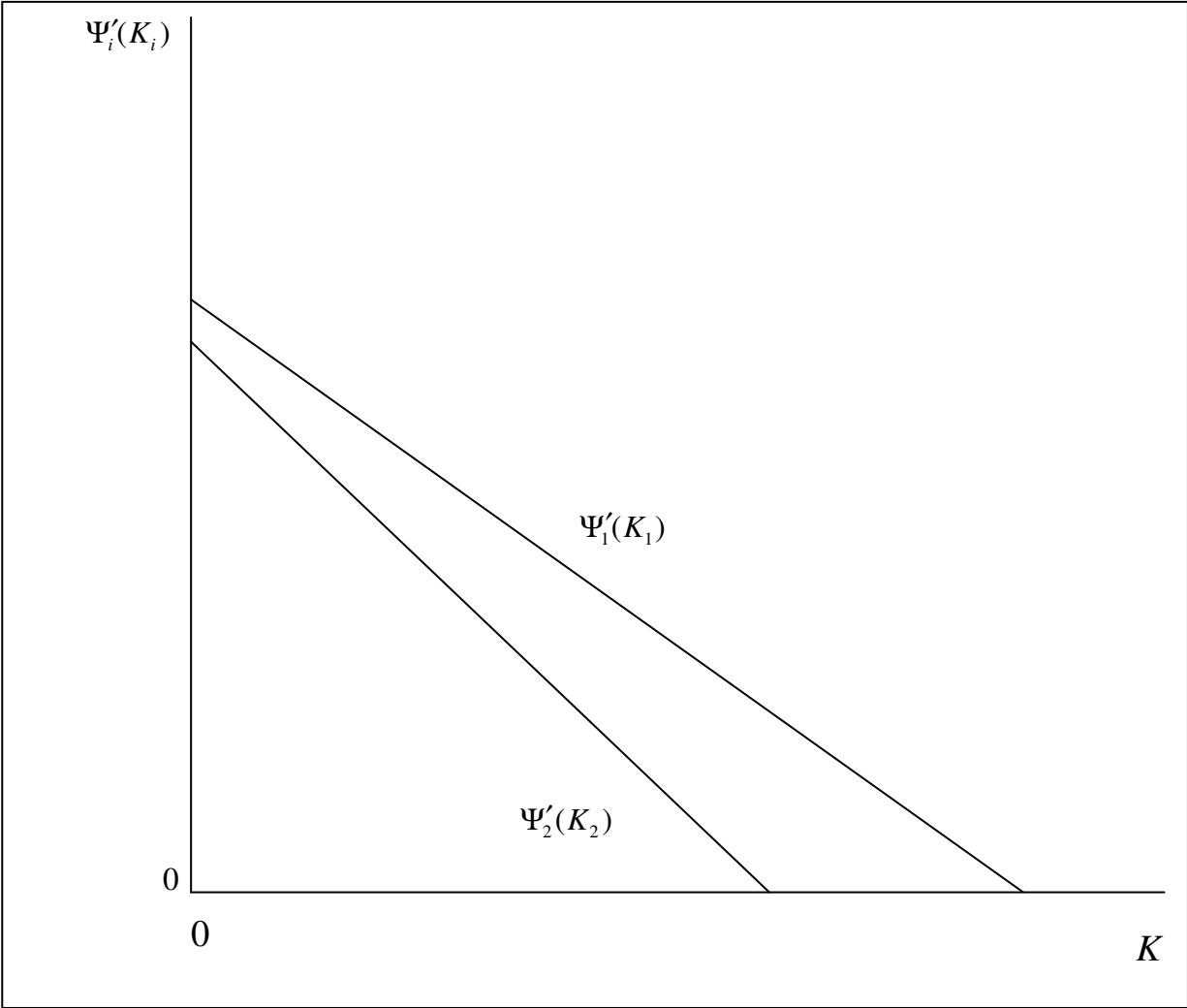
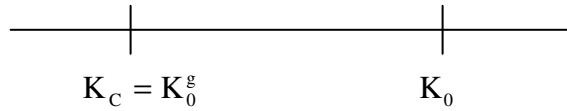
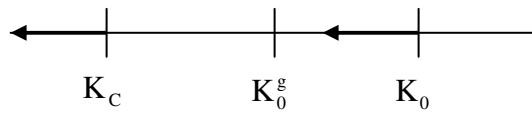


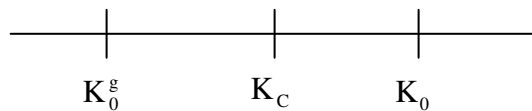
Fig 3. Marginal Returns to Infrastructure in the Open and Closed Economy



4(a) Government maximizes national welfare.
 Investment in the closed economy is globally optimal. Openness leads to overinvestment.



(b) A lobbying economy: taxes levied on producers.
 When the lobbying population (α) is small, investment in the open economy approaches the optimal, while it diverges in the closed economy.



(c) A lobbying economy: taxes levied on the entire population.
 Both open and closed economies overinvest, but the latter is closer to the optimal.
 (K_0^g = globally optimal; K_C = closed; and K_0 = open economy stock of infrastructural capital)

Fig. 4. Infrastructure Investment in the Open vs Closed Economy