Openness, Lobbying, and Provision of Infrastructure

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Openness, Lobbying, and Provision of Infrastructure

Ujjayant Chakravorty* and Joy Mazumdar†

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 economies. If infrastructure is financed by taxing a producer lobby, the open economy will overprovide while the closed economy will underinvest; 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 that of the open economy.

JEL Classification: F43, H11, O12

1. Introduction

It is widely acknowledged that infrastructure is critical for a nation’s growth and economic development. The World Development Report (The 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, Easterly and Rebelo (1993) and Hulten (1996) 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.

In developed and especially in developing countries, the public sector provides the bulk of infrastructure investment. In developing countries, the public sector provides about 80% of total infrastructure investment, with the private sector contributing 7% and bilateral and multilateral aid contributing 12% (The World Bank 1994). Government not only finances most infrastructure but, in developing countries, provides a significant portion of all public investment expenditures—rarely less than 30% and sometimes as high as 70% (The 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.

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

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. In recent years, government expenditure in the telecom sector actually exceeded planned targets, while in other sectors expenditures trailed substantially behind target levels (Ahluwalia 1998).

The relationship between infrastructure investment and openness to trade is evident in cross-country data, as shown in Figure 1. Here, infrastructure investment is measured by the share of government expenditure, in GDP, on transport and communication. This data is obtained from IMF (1986) government finance statistics and includes construction of roads; water, air, and rail transport; postal, telephone, telegraph, cable, and wireless communication systems; and communication satellites; but it excludes radio and television broadcasting systems. The openness variable on the x axis is an exogenous measure that is a function of geographic 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 it is 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 that 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 activity.

We develop a model of trade in which provision of infrastructure makes the domestic firm more productive and steals market share from a foreign firm in both the domestic and the export markets. Both trading partners invest in infrastructure, but this market-stealing effect

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1 These economies are Hong Kong, Japan, South Korea, Malaysia, Singapore, and Taiwan.
2 Approximately 75% of Indian software industry revenues are derived from exports (NASSCOM 2002).
3 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 the costs of production. They show that strategic considerations will lead to overprovision of infrastructure as well as input subsidies when infrastructure provision is done through lump-sum taxation. However, if input taxation is used to finance infrastructure, overprovision of infrastructure may not occur. Our focus is on how infrastructure provision in open and closed economies is affected by the social planner’s objective function.
Openness and Infrastructure

Figure 1. The Relationship between Infrastructure and Openness

provides an incentive to invest more in infrastructure in open economies than in 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 when they are imposed on the entire population.

We show that open economies invest more in infrastructure in all settings. However, infrastructure levels under the open economy compared to those under the closed economy can be welfare improving only when income and lobbying power are 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 amount. This result is consistent with empirical findings, such as those 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, Demetriades, and Morgenroth (2003) show that strategic behavior by countries in improving transport infrastructure may lead to overinvestment. The focus of both of these papers is on transport-related infrastructure. Investment in infrastructure reduces the costs of trade and therefore benefits both foreign and domestic producers. We, on the other hand, focus on investment that reduces the 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 nontransport 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 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 open and closed economies under social planning and under lobbying activity. In this sense, the specific infrastructure issues we address are somewhat orthogonal to the above studies.4

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 the 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 the closed economies—the strategic advantage against foreign firms.5

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 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).6 The market for the numeraire good is assumed to be perfectly competitive. Infrastructure affects the productivity only of the X sector. It has public-

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4 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).

5 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.

6 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 investment 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. Thus, the gain in the 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 economy is, therefore, indeterminate. However, our results will continue to hold if the home country is small and takes world prices as given and if there is no loss due to terms of trade.
good characteristics in that 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.\(^7\) The market for good X is characterized by a duopoly\(^8\); that is, the domestic firm competes with the foreign firm both at home and in the foreign markets, which are segmented.\(^9\) Production of good X increases with the stock of infrastructure.

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.\(^10\) The utility function of each consumer is given by \(U_i = u(c_i) + z_i\), where \(c_i\) and \(z_i\) denote consumption of the X and Z goods, respectively. The subutility function \(u(*)\) 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 \(x_f = F(K_1)l_i\), where \(x_i\) denotes output and \(l_i\) is labor used by the firm. When we consider production of the foreign firm in the home country, the corresponding output is defined as \(y_i\). 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.\(^11\) Their Cournot profits for good \(X\) are given by

\[
\pi_i = x_i p_i(x_i + y_i) - \frac{x_i}{F(K_i)}
\]

\(\text{(1)}\)

\(^7\) 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 investment.

\(^8\) The open economy case may be modeled with multiple firms in each country without any effect on the results. There will be more discussion on the number of firms when we deal with the closed economy.

\(^9\) 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. For simplicity, we retain our setup with only one \(X\) sector. 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.

\(^10\) Infrastructure investments, 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.

\(^11\) Because of the identical-country assumption, Bertrand price competition between firms would result in the two countries sharing infrastructure investment such that price equals marginal cost. In general, our results will still hold. Only when countries exhibit cost heterogeneity may a single country capture the whole market. The assumption of a Cournot model could be justified by the long-term nature of infrastructure investment, so that a capacity-constrained Bertrand model will yield Cournot quantities (Tirole 1988, p. 217).
and

\[ \hat{\pi}_1 = y_1 p_1 (x_1 + y_1) - \frac{y_1}{F(K_1)} , \]

where \( x_1(\pi_1) \) and \( y_1(\pi_1) \) 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 \( \pi_1^* \) and \( \pi_1^* \) for the domestic and the foreign firms in the foreign market are identical to those for the domestic market and are not written separately.

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

\[ \pi_{1x_1} = p_1 + x_1 p'_1 - \frac{1}{F(K_1)} = 0, \]

and

\[ \pi_{1y_1} = p_1 + y_1 p'_1 - \frac{1}{F(K_1)} = 0, \]

which can be solved to get equilibrium values of \( x_1 \) and \( y_1 \). 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:

\[ \frac{dx_1}{dK_1} = \frac{-F'(K_1)\hat{\pi}_{1y_1} - \hat{\pi}_{1x_1}}{[F(K_1)]^2 (\pi_{1x_1} \hat{\pi}_{1y_1} - \pi_{1x_1} \hat{\pi}_{1y_1})} \]

and

\[ \frac{dy_1}{dK_1} = \frac{-F'(K_1)\hat{\pi}_{1x_1} - \hat{\pi}_{1y_1}}{[F(K_1)]^2 (\pi_{1x_1} \hat{\pi}_{1y_1} - \pi_{1x_1} \hat{\pi}_{1y_1})}. \]

Since \( \pi_{1x_1} = p'_1 + x_1 p''_1 < 0 \) (similarly, \( \pi_{1y_1} = p'_1 + y_1 p''_1 < 0 \)), we have \( dx_1/dK_1 > 0 \) and \( dy_1/dK_1 < 0 \). Higher infrastructure stocks decrease production costs of the domestic firm relative to those of the foreign firm, thereby increasing the market share of the home firm in the domestic market and reducing the market share of the foreign firm. The change in the domestic firm’s profits \( \pi_1 \) with respect to the stock of infrastructure \( K_1 \) is obtained from Equation 1 as

\[ \frac{d\pi_1}{dK_1} = \frac{\hat{\pi}_{1x_1} d\pi_{1x_1}}{dK_1} + \frac{\hat{\pi}_{1y_1} d\pi_{1y_1}}{dK_1} = x_1 p'_1 \frac{dy_1}{dK_1} + \frac{x_1 F'(K_1)}{[F(K_1)]^2}. \]

Both terms on the right side of the above equation are positive, so that \( d\pi_1/dK_1 > 0 \).

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12 The sufficient condition for profit maximization can be written as \( \pi_{1x_1} = 2p'_1 + x_1 p''_1 < 0 \), where we make the simplifying assumption that \( p''_1 \leq 0 \). Quadratic utility functions, for example, will generate linear-derived demand functions that yield \( p''_1 \leq 0 \). Since \( p'_1 < 0 \) from the properties of the utility function, the above inequality holds. Moreover, \( \hat{\pi}_{1y_1} < 0 \), \( \pi_{1x_1} < 0 \), and \( \hat{\pi}_{1y_1} < 0 \). These assumptions imply that \( \pi_{1x_1} \hat{\pi}_{1y_1} - \pi_{1x_1} \hat{\pi}_{1y_1} > 0 \).

13 We use \( \hat{\pi}_{1x_1} = 0 \) from Equation 2.
Infrastructure capital increases profits of the domestic firm in the domestic market. These incremental profits come from two sources: a reduction in the output of the foreign firm (rent shifting), given by the first term, and a reduction in cost due to higher investment in sector-specific capital, given by the second term.

Consider the closed-economy case, denoted by the subscript 2 and identical to the case of the open economy except that there is no trading and two domestic firms compete in a Cournot model in the home market. 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 the symmetric profit function for each firm is $\pi_2 = x_2p_2(x_2 + y_2) - [x_2/F(K_2)]$ and $\pi_2 = y_2p_2(x_2 + y_2) - [y_2/F(K_2)]$. Since the two domestic firms face identical cost and demand conditions, their output and profits are identical: $x_2 = y_2$ and $\pi_2 = \pi_2$. As before, solving the necessary conditions for profit maximization yield the change in output per firm with respect to the stock of infrastructure $K_2$:

$$\frac{dx_2}{dK_2} = \frac{-F'(K_2)(\pi_2 - \pi_1)}{[F(K_2)]^2(\pi_2 - \pi_1)}.$$  \hspace{1cm} (6)

Since $x_2$ and $y_2$ are equal by symmetry, $dx_2/dK_2 > 0$ and $dy_2/dK_2 > 0$. Each firm’s Cournot output of the nontraded good increases with stock $K_2$. Comparing Equations 3 and 6, the additional term $\pi_2$ in the numerator of Equation 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 than in the Equation 3 situation, because in the closed economy there is no rent shifting; 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 symmetrical case, the increase in output for the domestic firm will be larger in the open economy than it would be in the closed economy. In the open economy, the domestic firm gains from cost reductions as well as from

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14 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.

15 The latter is captured by the term $x_2F'(K_1)F(K_1)$\(^2\). 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.

16 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). We assume the same number of competing firms in the closed economy to facilitate comparison with the open-economy case. The GDP of the home country remains the same whether the economy is open or closed. To see this, suppose infrastructure is fixed at some level $K$. Let $q$ be the output produced by a Cournot duopoly in a closed economy. With two firms, total output in the closed economy is $2q$, price is $p(2q)$, and domestic profit to the two firms is $2q(p(2q) - 2q/F(K))$. In the corresponding open economy, there is one domestic firm and one foreign firm operating at home and in the foreign market. Domestic consumption and production are each $2q$, the price at home and abroad is $p(2q)$, and total profit to the single domestic firm from both markets is $2q(p(2q) - 2q/F(K))$. In both the open and the closed situations, the GDP of the home country remains the same. We thank an anonymous referee for this important insight.

17 Differentiation yields $\pi_2^1(x_2) = x_2p_2' + p_2 - 1/F(K_2) = 0$ and $\pi_2^2(x_2) = x_2p_2^2 + 2p_2' < 0$. A similar expression holds for the second firm.

18 $\pi_2^{2x_2} = -p_2^2 + 2p_2' + (x_2p_2' + p_2) = p_2^2 < 0$.

19 From Equations 3 and 6, $dx_2/dK_2 < dx_1/dK_1$. 

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market stealing. In the closed economy, both firms benefit equally from cost reductions but there is no market stealing.

In Figure 2, let $R_x$ and $R_y$ denote the reaction functions of the domestic and the 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 that $R_x$ and $R_y$ denote the reaction functions of the two duopolies in the closed economy. In this case, infrastructure investment shifts 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 $x_1'$; that is, ex post output will be higher in the open economy than in the closed economy.

Differentiating $\pi_2$ with respect to $K_2$, using symmetry ($y_2 = x_2$), and substituting as in Equation 5 yields

$$\frac{d\pi_2}{dK_2} = x_2 P_2' \frac{dy_2}{dK_2} + x_2 \frac{F'(K_2)}{[F(K_2)]^2}.$$ (7)

A comparison of Equations 5 and 7 suggests that $d\pi_1/dK_1$ is greater than $d\pi_2/dK_2$.\(^{20}\) Marginal

\(^{20}\) The first term on the right side of Equation 7 is negative, since $dy_2/dK_2 > 0$. The corresponding term on the right side of Equation 5 is positive. The second term is positive and equal in both equations because of symmetry.
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 \( LU \), 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

\[
W_1 + x_1 + x_1^* + k_1 = L,
\]

where \( W_1 \) is the output of the numeraire good in country 1. Since foreign and domestic demand are identical, the equilibrium Cournot quantities in the domestic and the foreign markets will be equal, \( x_1 = x_1^* \). The price of good \( X \) will be equal in the domestic and the 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

\[
\text{Max}_{K_1} \Psi_1(K_1) = \Phi_1(K_1) + 2\pi_1(K_1) - K_1,
\]

where \( \Psi_1(K_1) \) is the net social surplus in the open economy and \( \Phi_1 \) is the consumer surplus in sector \( X \). 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 \( \Phi_1 = Lu(c_1) - p_1 L c_1 \). Therefore,

\[
\frac{d\Phi_1}{dK_1} = Lu'(c_1) \frac{dc_1}{dK_1} - p_1 L \frac{dc_1}{dK_1} - L c_1 \frac{dp_1}{dK_1} - L c_1 p_1' \left( \frac{dx_1}{dK_1} + \frac{dy_1}{dK_1} \right),
\]

since \( u'(c_1) = p_1 \) from utility maximization of the consumer. Differentiating \( \Psi_1 \) with respect to \( K_1 \) and using Equations 9 and 5 gives

\[
\frac{d\Psi_1}{dK_1} = -L c_1 p_1' \left( \frac{dx_1}{dK_1} + \frac{dy_1}{dK_1} \right) + 2 \left( x_1 p_1' \frac{dy_1}{dK_1} + x_1 F'(K_1) \left( \frac{F(K_1)}{F'(K_1)} \right)^2 \right) - 1.
\]

Similarly, for the closed economy, the net social surplus \( \Psi_2 \) is maximized as

\[
\text{Max}_{K_2} \Psi_2(K_2) = \Phi_2(K_2) + 2\pi_2(K_2) - K_2.
\]

Differentiating \( \Psi_2 \) and using \( L c_2 = x_2 + y_2 = 2x_2 \) from the symmetric duopoly in the market for the \( X \) good, we get

\[
\frac{d\Psi_2}{dK_2} = -L c_2 p_2' \left( \frac{dx_2}{dK_2} \right) + 2x_2 \left( \frac{F'(K_2)}{[F(K_2)]^2} \right) - 1.
\]

\(^{21}\) To prevent tax-induced distortions, we assume that capital investment is financed by lump-sum taxes.
From Equations 10 and 12, we have $d\Psi_1/dK_1 > d\Psi_2/dK_2$.\textsuperscript{22} The marginal return is higher in the trading economy relative to the nontrading economy. The producer surplus increases by a larger margin in the trading economy. This happens because of the market-stealing effect in the open economy.\textsuperscript{23} Thus, market stealing 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 duopolies.

To examine whether a higher marginal return to investment in the open economy translates into a higher capital stock, let us assume linear demand for the $X$ good with parameters $p_1 = a - b(x_i + y_i)$, $i = 1, 2$. 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, $L = L^*$ (and, therefore, $b = b^*$).\textsuperscript{24}

Define the unit cost of production for the domestic firm in the open economy as $v_1(K_i) = 1/f(K_i)$, so that $v_1' < 0$ and $v_1'' > 0$. Similarly, the cost of the foreign firm is $v_2^*(K_i)$. For now, we assume that there is no reaction from the foreign country, so that $K_i^*$, and therefore $v_i^*$, are fixed.\textsuperscript{25} Let $g(K_i) = F(K_i)l[F(K_i)]^2 > 0$.\textsuperscript{26} Aggregate consumption of the $X$ good is given by $LC_1 = x_1 + y_1$. Substitution of terms in Equation 10 and normalizing $L = 1$ yields the following expression for the net marginal return to capital\textsuperscript{27}:

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

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 $v_i^*$, the unit cost of production in the foreign country. When the two countries are identical, we have $v_1 = v_1^*$ in equilibrium. Then Equation 13 becomes

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

\textsuperscript{22} Adding Equations 3 and 4 yields $\frac{dx_1}{dK_1} + \frac{dy_1}{dK_1} = \frac{-F(K_1)(\hat{\pi}_{1,xy} - \hat{\pi}_{1,x})}{[F(K_1)]^2(\hat{\pi}_{1,xx} - \hat{\pi}_{1,xy} - \hat{\pi}_{1,y})}$. By symmetry, $\hat{\pi}_{1,yy} = \hat{\pi}_{2,2yy}$, $\hat{\pi}_{1,yy} = \pi_{2,2yy}$, and all of the corresponding second partials will be equal. Using Equation 6, we get $dx_1 + y_1/dK_1 = dy_1/dK_1$. Now compare Equations 10 and 12. The right side is the same except for an additional term, $2x_1p_1' + dy_1/dK_1$, in the former. Since $p_1' < 0$ and $dy_1/dK_1 < 0$, this term is positive, and therefore $d\Psi_1/dK_1 > d\Psi_2/dK_2$.

\textsuperscript{23} The larger increases in consumer surplus in the closed economy resulting from steeper declines in price (since both firms increase output) are exactly compensated by the decrease in producer surplus resulting from this price fall.

\textsuperscript{24} Output and prices for the linear Cournot model are $x_1 = (a + v_1' - 2v_1)/3b$, $y_1 = (a + v_1 - 2v_1')/3b$, and $p_1 = (a + v_1 + v_1')/3$. Similarly, $x_2 = (a + v_1' - 2v_1)/3b$, $y_2 = (a + v_1 - 2v_1')/3b$, and $p_1' = p_2' = p_2'' = -b$. For an interior Cournot solution, we must have $a > \max\{v_1, v_2, v_1'\}$: that is, maximum valuation must exceed unit production costs.

\textsuperscript{25} Then, $\frac{dx_1}{dK_1} = \frac{2g(K_1)}{3b}$, $\frac{dy_1}{dK_1} = \frac{g(K_1)}{3b}$, $\frac{dx_2}{dK_2} = \frac{g(K_2)}{3b}$, and $v_1' = -g(K_1)$.

\textsuperscript{26} Substituting in Equation 10 gives $\frac{d\Psi_1}{dK_1} = \frac{1}{3b} \left[ \frac{a + v_1' - 2v_1 + a + v_1 - 2v_1'}{3b} \right] - b - \frac{g}{3b} + (\frac{a + v_1' - 2v_1}{3b}) |1| - 1$. Simplifying and rearranging terms yields Equation 13.
The same analysis can be repeated for the closed economy, for which \( Lc_2 = 2x_2 \). Substituting terms in Equation 12 gives

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

Comparing Equations 14 and 15 yields \( d\Psi_1/dK_1 > d\Psi_2/dK_2 \). The graph of \( \Psi_1'(K_1) \) lies everywhere above the graph of \( \Psi_2'(K_2) \), as shown in Figure 3. Since returns to infrastructure investment are higher in the open economy relative to the closed economy, and since both \( \Psi_1'(K_1) \) and \( \Psi_2'(K_2) \) can be shown to be downward sloping under plausible conditions, the equilibrium stock is higher in the open economy. To summarize, the equilibrium stock of infrastructure in the open economy will be higher than in the closed economy.\(^{29}\)

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\(^{28}\) A sufficient condition for \( \Psi_1''(K_1) < 0 \) is when \( v'/v'' \) is constant, which is true for cost functions such as \( e^{-zk} \), where \( z \) is a constant parameter. From Equation 13, observe that \( \Psi_1'(K_1) < 0 \) if \( (10a + 7v_2') - 17v_1') < v_1'/v_2' \). Similarly, \( \Psi_2'(K_2) < 0 \) if \( (a - v_2)/v_2' < v_1'/v_2' \) holds.

\(^{29}\) 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.
We have shown that 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 \textit{globally optimal} vector of stocks as the one that maximizes the joint aggregate welfare of the two countries. We call it the \textit{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 \textit{national planner} case and the equilibrium stock as \textit{nationally optimal}. In the closed economy, there is only one country, so what is nationally optimal is also globally optimal. The maximization problem of this global social planner can be written as

$$
\max_{K_1,K'_1} \Psi_1(K_1,K'_1) = \Phi_1(K_1,K'_1) + 2\pi_1(K_1,K'_1) - K_1 + \Phi_1'(K_1,K'_1) + 2\pi_1'(K_1,K'_1) - K'_1,
$$

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

$$
\frac{d\Psi_1}{dK_1'} = \frac{d\Phi_1}{dK_1'} + 2\frac{d\pi_1}{dK_1} - 1 + \frac{d\Phi_1'}{dK_1'} + 2\frac{d\pi_1'}{dK_1'}
$$

and

$$
\frac{d\Psi_1}{dK_1} = \frac{d\Phi_1}{dK_1} + 2\frac{d\pi_1}{dK_1} + \frac{d\Phi_1'}{dK_1'} + 2\frac{d\pi_1'}{dK_1'} - 1.
$$

Using Equations 5 and 9 and given identical preferences and populations, \(d\Phi_1/dK_1 = d\Phi_1'/dK_1\) and \(d\pi_1'/dK_1 = y_1p'_{1x}dx_1/dK_1\), gives

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

Since \(Lc_1 = x_1 + y_1\) and \(x_1 = y_1\) because of symmetry, and imposing linear demand as before, we get

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

Comparison with Equation 15 shows that the \textit{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. Intuitively, 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:

\textbf{Proposition 1:} An open economy has a higher stock of infrastructure than a closed economy when the planner maximizes national welfare. However, the amount of 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 what is globally optimal because, at the margin, infrastructure investment in one country has a negative effect on the other. More specifically, infrastructure investment in the home country leads 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 \(Lc_1p'_1(dx_1/dK_1 + dy_1/dK_1)\) in Equation 16'. However, the foreign firm loses market share in the foreign country; this is given by the term \(y_1p'_{1x} dx_1/dK_1\). With linear demand and identical
countries, each of these terms equals \( [2(a - \nu_1)g(K_1)]/9b \); that is, the gain to consumers is exactly offset by the loss to producers in the foreign market.\(^{30}\) 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 \( [-2(a - \nu_1)g(K_1)]/9b \).

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.\(^{31}\) 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, 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 \( G = C(K_i) + \beta \Psi(K_i) \), where \( C \) represents lobbying contributions and \( \Psi \) denotes aggregate welfare. The parameter \( \beta \) denotes the weight the government attaches to aggregate welfare. For simplicity, let us assume \( \beta \) to be zero, meaning that the government cares only 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, they 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 lobbyists plus their share of the aggregate consumer surplus, net of their contribution to infrastructure investment. The contributions are given by

\[
G = \Pi_i + \alpha \Phi_i - K_i, \tag{19}
\]

where \( \alpha \) denotes the fraction of the population that is in the high-income group, \( \Pi_i \) and \( \Phi_i \) denote aggregate producer and consumer surplus, respectively, and \( i = 1, 2 \) denotes the open- and closed-economy cases. In other words, contributions equal the profits accruing to the high-

\(^{30}\) 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.

\(^{31}\) For example, only 2% of the population pays income tax in India (British Broadcasting Corporation 2004). The ratio of tax revenue to GDP is 18.2% in a sample of developing countries, compared to 37.9% for OECD countries, according to Auriol and Warlters (2005).
income group, plus its share of the aggregate consumer surplus and minus its tax payments; and this sum equals the entire cost of infrastructure capital.\footnote{32}

Comparing the expression for $G$ in Equation 19 with the objective function of the country social planner under the open and the closed economies (given by Equations 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 (in either an open or a closed economy) is given by

\[
\frac{dG}{dK_i} = \frac{2d\pi_i}{dK_i} + \alpha \frac{d\Phi_i}{dK_i} - 1. \tag{20}
\]

When the economy is \textit{closed}, under linear demand, from Equations 20 and 7, we get

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

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

In the \textit{open} lobbying economy, using Equations 20 and 5, the marginal return to investment is given by

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

Comparing Equation 22 with Equation 21, we see that 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 Equation 22 with the solution for the global social planner given by Equation 18, we observe that there will be overinvestment under lobbying as long as $\alpha$ is strictly positive.

However, if $\alpha$, the proportion of high-income people in the population, is small, then Equations 21 and 22 show that the degree of underinvestment will be large for the closed economy and the degree of overinvestment will be small for the open economy. In other words, for small values of $\alpha$, the amount of equilibrium stock will be close to optimal in the open-economy case and less than optimal in the closed-economy case. We can summarize as follows:

\textbf{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 economy. 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 regime; 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

\footnote{32 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 (1994) model, these free-rider problems will not exist.}
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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 $\alpha$ (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 $\alpha$, the two effects may almost cancel each other out and the stock of capital will be close to optimal in the open economy. As $\alpha$ approaches zero, the stock of capital in the open economy approaches the optimal amount while that in the closed economy moves away from the optimal amount. Conversely, as $\alpha$ approaches unity (its maximum value), the stock of capital in the closed economy approaches the optimal amount while that of the open economy moves further away from the globally optimal amount.

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

$$G = \Pi_t + \alpha (\Phi_t - K_t).$$

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

$$\frac{dG}{dK_t} = \frac{1}{\alpha} \left( \frac{d\Pi_t}{dK_t} \right) + \frac{d\Phi_t}{dK_t} - 1.$$  (24)

The right side of Equation 24 is just a modified form of $d\Psi/dK_t$, with the weight $1/\alpha$ attached to the producer surplus term (check Equations 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 Equations 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 the closed economies. The high-income group gets a larger fraction of the benefits and shares a smaller fraction of the costs. Therefore, it will lobby the government in favor of overinvestment in infrastructure capital.

Substituting for $d\Pi_t/dK_t$ and $d\Phi_t/dK_t$ in Equation 24, we get for the closed economy

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

For the open economy, we have

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

Comparing Equations 25 and 26 suggests that the positive terms on the right side of Equation 25 will be less than or equal to $8(a - v_1)g/9b\alpha$, which is the first term on the right side of

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33 When $\alpha = 0$, note from Equation 19 that the government cares only 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 benefits 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.

34 A natural interpretation of $\alpha$ 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.
Equation 26; therefore, the right side of Equation 26 is greater than that of Equation 25 at any given level of $K$. Thus, the equilibrium stock will be higher in the open economy.

Comparing Equations 25 and 26 with Equation 18, we can see that the return to investment is higher compared to the optimal in both the closed and the open economies, since $\alpha \leq 1$. Therefore, there will be overinvestment in both the open and the closed economies. The gap between the equilibrium stock and the optimal stock will be greater in the open economy than in the closed economy. 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 than in the closed economy. 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 Figure 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 4a). This is because, in the latter, the Nash Equilibrium implies overinvestment in order to steal market share from the foreign firm. However, in the presence of producer lobbies, when only members of the lobbying group are taxed to finance infrastructure provision, the closed economy provides too little infrastructure while the open economy provides too much (see panel 4b). The
fewer the members of the lobbying group as a share of the total population, the closer the open economy is to the globally optimal stock. As this share goes to zero, the open economy stock becomes globally optimal. However, the closed-economy stock declines away from the optimal with a smaller lobbying-population share. An implication of this result is that, if the tax base is relatively small, the open economy is preferable to the closed economy. When the lobbying group constitutes a large share of the population, investment in the closed economy is closer to 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 4c). With a large 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 infrastructure capital. Governments may have a greater incentive to provide infrastructure when domestic firms compete with foreign firms, since such investment helps domestic firms to steal market share from the foreign firms. 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 economy. This is true regardless of whether the government maximizes national welfare or whether 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 infrastructure is financed by taxes imposed on the entire population, then investment in the open economy is higher than the globally optimal stock. This overinvestment result is similar to that of Bougehas, Demetriades, and Morgenroth (2003), although in their paper overinvestment stems from the fact that a country’s investment in public goods reduces its capacity to produce consumption goods in that country, which affects consumption in both the home country and the country with which it trades.

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

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 are confined to a small elite. Trade may correct the underinvestment problem in this case. In other words, 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 an effective tax administration system. The overinvestment problem becomes worse in the latter 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 investment, while our open-economy setup may be thought of as one in which spillovers across countries are imperfect or nonexistent. 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.

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