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The "big push" in an open economy with nontradable inputs

Development economics as it appeared in the 1940s and 1950s in the writings of, among others, Rosenstein-Rodan, Nurkse, Prebisch, Hirschman, and Leibenstein, stressed the barriers to industrialization in less developed countries (LDCs). Industrialization was seen as an essential aspect of development, and successful industrialization could not, it was argued, be left to market forces. Deliberate policy intervention was needed to overcome various inhibiting factors, including the presence of externalities and some form of increasing returns to scale. Without a "big push"—using Rosenstein-Rodan's terminology—development would remain stunted.

Does the need for a big push survive in an economy that is open to international trade and capital movements? Or would openness to trade and capital movements be sufficient to overcome all poverty traps? Without exaggeration, we can say that these questions have daunted development economics since its inception.

The counterrevolution in development theory that began in the 1960s argued that, except for the (rather unlikely) event of very low price and income elasticities of export demand, free trade and free capital mobility were unambiguously good for developing countries and would obviate the need for a big push. In Bhagwati's interpretation of Rosenstein-Rodan's classic (1943) paper, for instance,

> The underdeveloped economy was trapped in a low level equilibrium with no effective inducement to invest: e.g., the entrepreneur investing in shoes was not sure about selling the shoes unless others invested simultaneously in textiles etc. This dilemma would, of course, disappear if the country faced constant terms of trade at which these entrepreneurs could atomistically sell what they wished. Therefore, a necessary condition for Rosenstein-Rodan's analysis and prescription is, of course, elasticity pessimism. [Bhagwati, 1985, p. 299]

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Thus, in the real world of open economies, big-push arguments and Nurksian poverty traps were, at best, intellectual curiosities that the bright pioneers of development theory happened to be interested in when they began to think about development problems. Because of their mistaken "export-elasticity pessimism," the pioneers had focused on closed economies and failed to notice that openness presented a solution to the problems of industrialization.[1]

Similar conclusions were reached from more sympathetic accounts of poverty-trap arguments that emphasized a "lack of demand" as the source of the problem.[2] Basu (1984) provides a formalization of the Nurksian vicious circle along these lines.[3] In his model, monopolistically competitive firms in the modern sector of the economy face kinked demand curves for their products and elastic supply of labor. The economy may get stuck in a low-level, demand-constrained equilibrium in which the expansion of modern firms is held back by the low real incomes associated with a low level of resource utilization. Not surprisingly, the vicious circle breaks down when international trade is considered and modern-sector firms face given terms of trade in international markets.

Arguably, it was this line of argument, more than the difficulties of formalizing models with increasing returns and imperfect competition (as claimed by Krugman, 1993), that led to the resurgence of the constant-returns-to-scale paradigm. For if, in an open economy, the existence of increasing returns does not play the crucial role that it may have in a closed economy, then, contrary to the beliefs of early development theorists, not much is lost by adopting the simpler assumption of constant returns. It is difficult, however, to reconcile this interpreta-

[1] On this interpretation, the pioneers would have little to add to Adam Smith. Indeed, Smith (1776, vol. 1, p. 413) explicitly noted that "By means of [foreign trade], the narrowness of the home market does not hinder the division of labor in any particular branch of art or manufacture from being carried to the highest perfection. By opening a more extensive market for whatever part of the produce of their labor may exceed the home consumption, it encourages them to improve its productive powers".

[2] This emphasis, along with a countervailing reaction to it, appears to have been widespread in the early postwar period. See, for example, Rao (1952) and his warnings against "a rather unintelligent application—not on Keynes's part—of what may be called Keynesian economics to the problems of the underdeveloped countries" (pp. 206–207).

[3] See also Taylor and Arida's (1988) survey of development theories which, following Basu, brings Rosenstein-Rodan and Nurkse's contributions under the heading "Demand-driven models."

tion based on elasticity pessimism with the original argument in the literature. One of the most influential papers, for instance, was Rosenstein-Rodan (1943). After discussing the self-sufficient "Russian model" and its "several great disadvantages," Rosenstein-Rodan (1943, pp. 203–204) argues that

> The alternative way of industrialization would fit Eastern and South-Eastern Europe into the world economy, which would preserve the advantages of an international division of labor, and would therefore in the end produce more wealth for everybody. . . . Clearly this way of industrialization is preferable to the autarkic one.

He goes on to discuss the difficulties involved in the implementation of this process of industrialization. Primary among these difficulties, he argues, are externalities of various kinds and the presence of increasing returns to scale in many activities. At no point is it suggested that low export elasticities will be critical.[4]

[4] Export conditions appear at two points in the article. On p. 203 it is noted that

> International investment in the nineteenth century was largely self-liquidating, based on exchange of agrarian and industrial products. Nowadays liquidation can no longer be assumed to be "automatic," although the problem can be solved if it is properly planned.

On p. 209, he returns to this question:

> Liquidation will have to planned—i.e., one part of the industries created in Eastern and South-Eastern Europe will have to be export industries. . . . The placing of these exports has to be planned and foreseen in such a way as to minimise the burden of necessary adjustment in the creditor countries. Eastern and South-Eastern Europe will most probably cease to be an exporter of cereals. It will export processed foods and light industrial articles.
>
> International trade in the nineteenth century functioned more or less smoothly because all countries had a high income elasticity of demand for imports. On the higher standard of living in the rich countries of the twentieth century the income elasticity of demand for imports may be lower. There may be only one good for which the income elasticity of demand is high: leisure which does not require imports of material goods. Accordingly, the rich countries may have to accept a part of their share in economic expansion in the form of more leisure.

Nurkse, in turn, observed that capital does not flow to the poorest countries and argued that this was quite consistent with his argument: It is because poor countries are caught in a poverty trap that capital does not flow to them. He concluded that capital mobility was not a sufficient condition to overcome the poverty trap:

> The upshot is that external resources, even if they become available in the most desirable forms, are not enough. They do not automatically provide a solution to the problem of capital accumulation in underdeveloped areas. No solution is possible without strenuous domestic efforts, particularly in the field of public finance. [Nurkse, 1952, p. 583]

The essence of a big-push argument is a model with multiple equilibria in which, under certain initial conditions, the economy gets stuck in a poverty trap that can only be overcome through a "big push": No individual firm may have an incentive to expand on its own, even though the coordinated expansion by all firms will be profitable and welfare enhancing.

Murphy, Shleifer, and Vishny (1989) have provided a formalization of this argument. They consider a closed, multisectoral economy and assume the existence of two distinct techniques in each sector: a traditional technique with constant returns to scale and a modern technique with increasing returns to scale. The modern technique dominates the traditional technique at high levels of output but is unprofitable at low levels. It is shown that, if firms using the modern techniques have to pay a wage premium, two equilibria may exist and, in the absence of a coordinated big push, the economy may get stuck in a low-income equilibrium based on traditional techniques. A second example introduces dynamic aspects. It is assumed that the fixed costs associated with the use of modern techniques in the second of two periods are incurred already in the first period. Here again a lack of coordination between modern firms may leave the economy in a traditional low-income equilibrium. The third and final example focuses on infrastructure, which only modern firms will use. A large investment in infrastructure therefore fails to pay off unless the economy industrializes, that is, unless the subsequent coordination problem between modern firms can be solved.

As presented, all three examples relate to a closed economy, but Murphy et al. suggest that the infrastructure case "has the advantage of being important even in a completely open economy" (p. 1,006). Their model, however, does not substantiate this claim. They focus on the coordination problem among producers of final goods, and if final goods are traded at fixed world prices, then this coordination problem between modern firms is resolved: The model fails to produce multiple equilibria.[5]

This is not to deny that trade pessimism prevailed at the time. Low elasticities were seen as an obstacle to higher levels of economic development in LDCs, but elasticity pessimism applied largely to primary exports. In the present context, the important point is that this kind of elasticity pessimism does not seem to have played a significant role in the big-push argument.

[5] Formally, their equation (23) on p. 1,022 becomes irrelevant under free trade.

It is the purpose of this paper to examine the need for a big push in a simple model of a small open economy. The model, presented in the next section, differs from that of Murphy et al. in a number of ways. Technology, for instance, is specified somewhat differently, and we use a continuous-time framework and introduce capital accumulation in the final goods sectors. The main difference, however, from Murphy et al. is the introduction of a range of different, nontradable intermediate goods. It is shown that, if these intermediate goods are produced under conditions of (internal) increasing returns to scale, then free trade in final goods and free capital movements fail to solve the coordination problems. Thus, the argument for a big push remains valid under these conditions.

The model

Basic assumptions

There are two *tradable* goods, A and M, with given world prices, p_A, p_M.[6] The production functions for both goods have constant returns to scale:

$$A = L_A. \tag{1}$$

$$M = K^{1-\beta} S^{\beta} \quad 0 < \beta < 1, \tag{2}$$

where L_A denotes labor input in the A sector, and K, the capital good, is produced by the M sector. S represents the input of a set of *nontradable* infrastructural goods,

$$S = \left(\sum_{1}^{n} \frac{1}{n} S_i^{-\delta} \right)^{-\frac{1}{\delta}} ; \; -1 < \delta < 0. \tag{3}$$

Production of these infrastructural goods is subject to internal increasing returns,

$$S_i = L_i^{1+\gamma} \quad ; \quad \gamma > 0, \tag{4}$$

where L_i is labor input.

[6] Alternatively, the A good could be nontradable. As long as the A good is a "good" substitute for the M good, the qualitative results will be unchanged. In the limit, with A and M perfect substitutes, it makes no difference whether A is nontraded. Or more precisely: If M is tradable and they are perfect substitutes, then *de facto* A is also tradable.

Input prices are taken as parametrically given by all firms in all sectors, and A- and M-sector firms also face parametric output prices. Producers in the S sector, however, operate under conditions of monopolistic competition. We assume a given number of nontradable infrastructural goods. A Dixit-Stiglitz-Ethier type specification (Dixit and Stiglitz, 1977; Ethier, 1982) with an infinitely expanding set of intermediate goods could be used to derive qualitatively similar results. Our focus, however, is on nontradable infrastructural inputs, and, although intermediate inputs have been proliferating, the subset of nontradable inputs does not appear to be undergoing the same kind of expansion. The present specification therefore seemed preferable.

Producers maximize profits. Looking first at the M sector, the capital stock is predetermined in the short run, and, since producers in this sector are atomistic, a firm's future demand and supply conditions will be independent of its own short-run decisions. Hence, there are no intertemporal complications and the short-run maximization problem becomes

(5)
$$\max p_M M - \sum p_i S_i$$
s.t.
$$M = K^{1-\beta}\left(\sum \frac{1}{n} S_i^{-\delta}\right)^{-\frac{\beta}{\delta}}$$

This implies

(6)
$$S_i = (\beta p_M)^{\frac{1}{1-\beta}} K n^{\frac{\beta}{\delta(1-\beta)}} \left(\sum p_j^{\frac{\delta}{1+\delta}}\right)^{\frac{-(\beta+\delta)}{\delta(1-\beta)}} p_i^{-\frac{1}{1+\delta}},$$

and, at a symmetric equilibrium with $p_i = p_j$, we get

(7)
$$s = \left(\sum \frac{1}{n} S_j^{-\delta}\right)^{-\frac{1}{\delta}} = S_i = (\beta p_M)^{\frac{1}{1-\beta}} K n^{\frac{-1}{1-\beta}} p_i^{-\frac{1}{1-\beta}}$$
$$= (\beta p_M)^{\frac{1}{1-\beta}} K p_s^{\frac{-1}{1-\beta}}$$

where p_S (= np_i under symmetry) is the (minimum) cost of a bundle of infrastructural goods yielding $S = 1$.

In the S sector, the demand for S_i is given by equation (6). Hence, at a

symmetric equilibrium with $p_k = p_j$ for all j,k we have

$$(8)\quad \frac{\partial \log S_i}{\partial \log p_i} = \frac{-(\beta+\delta)}{n(1+\delta)(1-\beta)} - \frac{1}{1+\delta} = -\left(\frac{n-1}{n}\frac{1}{1+\delta} + \frac{1}{n}\frac{1}{1-\beta}\right) < -1$$

where the inequality in (8) follows from the parameter restrictions $0 < \beta < 1$ and $-1 < \delta < 0$. Assume, therefore, that individual producers have the following conjectured demand function:

$$(9)\quad S_i^D = B p_i^{-\rho}, \qquad \rho > 1$$

With a single intermediate good ($n = 1$), the monopoly producer of this good would clearly face an intertemporal optimization problem: The current price p_S would affect the profitability of the M sector, which in turn could influence capital accumulation in the M sector and thereby future demand for the S good. With multiple S goods, this intertemporal link is weakened and the decisions of an individual producer have only minor effects on the aggregate output of S and profitability in the M sector. To simplify, we assume that the number of nontradable inputs is large enough to ignore intertemporal aspects. Using the conjectured demand function (9) and the production function (4), we then get the following maximization problem for the S_i producer:

$$(10)\quad \max p_i^{1-\rho} B - w\left(B p_i^{-\rho}\right)^{\frac{1}{1+\gamma}}.$$

The first-order condition for this problem can be written[7]:

$$(11)\quad S_i = \left[\frac{(1+\gamma)(\rho-1)}{\rho}\frac{B^{\frac{1}{\delta}}}{w}\right]^{\frac{\rho(1+\gamma)}{1+\gamma-\rho\gamma}}$$

or, equivalently, using (9),

[7] The inequality restriction $1-(1/\rho) < (1/(1+\gamma))$ (or $1+\gamma-\rho\gamma > 0$) is needed to ensure that the second-order conditions will be satisfied. This inequality also implies positive profits (at the solution to the first-order condition). Since empirically γ is likely to be small—probably less than 0.1—the restriction leaves a wide range of permissible values for the conjectured demand elasticity. A reversal of the inequality would imply the possibility of unbounded profits for $S_i \to \infty$.

(12) $$\left(\frac{p_i}{B^{\frac{1}{\rho}}}\right) = \left(\frac{w}{B^{\frac{1}{\rho}}}\right)^{\frac{1+\gamma}{1+\gamma-\rho\gamma}} \left(\frac{\rho}{(1+\gamma)(\rho-1)}\right)^{\frac{1+\gamma}{1+\gamma-\rho\gamma}}$$

Short-run equilibrium

In order to derive a short-run equilibrium, the M-sector demand function (7) is combined with equations (11–12) describing the price/output decisions in the S sector. Assuming symmetry ($p_i = p_j$ and $S_i = S$), these three equations can be solved for S, p_S, and B, and hence for S/K. We get:

(13) $$\frac{S}{K} = D \cdot w^{-a} K^{\frac{\gamma a}{1+\gamma}}$$

where

$$D = (\beta p_M)^a n^{-a} \left(\frac{(1+\gamma)(\rho-1)}{\rho}\right)^a$$

$$a = \frac{1+\gamma}{1-\beta(1+\gamma)} > 0.$$

Equation (13) describes a symmetric, short-run equilibrium solution for S/K. Given a conjectured valued of the multiplicative constant B, the first-order conditions for profit maximization determine (p_i, S_i) as a function of B. The actual value of B (determined using equations (6) and (9)) depends on the pricing decisions of the firm's rivals. Thus, if B^a and B^c denote the actual and conjectured values of B, then B^a is a function of B^c, $B^a = f(B^c)$. In industry equilibrium, the conjectured and actual values of B coincide. But when $1-\beta(1+\gamma) < 0$, the adjustment process toward the equilibrium would be unstable if $B^a > B^c$ implies an upward revision in the conjectured value B^c. Stability considerations therefore dictate the (empirically plausible) condition $1-\beta(1+\gamma) > 0$. This condition implies $a > 0$.

Turning to the labor market, let the total work force be L and assume uniform wages and no unemployment. Then, in equilibrium with $S_i = S_j$, we have

(14) $$L = L_A + L_S.$$

(15) $$L_S = \sum L_i = \sum S_i^{\frac{1}{1+\gamma}} = n S^{\frac{1}{1+\gamma}} = L_S(w, K),$$

and, since $A = L_A$ and p_A is given by the world market,

(16) $$w \geq p_A$$

with equality if $L_A > 0$. In other words, the supply of labor to the S sector is perfectly elastic at $w = p_A$ for $L_S < L$.[8]

The labor demand from the S sector is determined by (13) and (15). Combining these equations with the elastic supply at $w = p_A$ for $L_S < L$, short-run equilibrium in the labor market implies that

(17) $w = p_A$ and $L_S = L_S(p_A, K)$ if $L_S(p_A, K) < L$;

(18) $L_S = L$ and w is given by $L_S(w, K) = L$ if $L_S(p_A, K) > L$.

With L_S determined, we also have the solutions for $S = (1/n\, L_S)^{1+\gamma}$, $A = L - L_S$ and $M = K^{1-\beta} S^{\beta}$.

Capital accumulation

So far we have taken the capital stock as given. In the long run, however, the capital stock changes, and taking into account adjustment costs, we assume a simple formulation in which the rate of accumulation $\hat{K}$ is determined by the rate of profits, r, relative to an exogenously given, risk-adjusted international profit rate r^*. Algebraically, let

(19) $$\hat{K} = f(r) \quad ; \quad f' > 0 \quad f(r^*) = 0,$$

where

(20) $$r = \frac{p_M^{\cdot M} - \sum p_i S_i}{p_M K} = (1-\beta)\left(\frac{S}{K}\right)^{\beta},$$

and S/K is determined by the condition for short-run equilibrium.

Equations (19–20) imply that

(21) $$\hat{K} = F\left(\frac{S}{K}\right) \quad ; \quad F' > 0, \quad F\left(\left(\frac{S}{K}\right)^{*}\right) = 0.$$

[8] It would be straightforward to include a wage premium in the S sector.

Using (13), (17), (18) and (21), it follows that S/K is increasing in K for $K < \tilde{K}$ and decreasing in K for $K > \tilde{K}$ where $\tilde{K}$ is determined by the condition that

(22)
$$\tilde{K} = \left[\left(\frac{1}{n} L \right)^{1+\gamma} \quad p_A^a D^{-1} \right]^{\frac{1}{a(1-\beta)}}.$$

There are now two cases:

Case 1:
$$\frac{S}{K} < \left(\frac{S}{K} \right)^* \text{ for } K = \tilde{K}.$$

In this case, $\hat{K} < 0$ for all $K > 0$ and $K \to 0$. That is, there is a unique and stable long-run equilibrium with $K = 0, L_A = L, L_S = 0$.

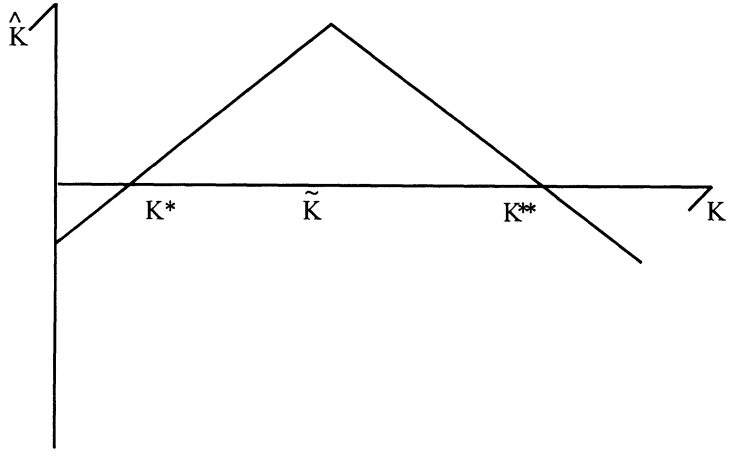
Case 2:
$$\frac{S}{K} > \left(\frac{S}{K} \right)^* \text{ for } K = \tilde{K}.$$

Since $S/K \to 0$ for $K \to 0$ and for $K \to \infty$, and since S/K is increasing in K for $K < \tilde{K}$ and decreasing for $K > \tilde{K}$, it follows that there are two values of K, K^* and K^{**}, with $0 < K^* < \tilde{K} < K^{**} < \infty$, such that $S/K = (S/K)^*$ for $K = K^*$ or $K = K^{**}$. That is, we get two long-run equilibria with strictly positive values of the capital stock as well as an equilibrium with $K = 0$ and $S = 0$. It is readily seen that K^* is locally asymptotically unstable. Of the two equilibria, the low equilibrium without an M sector has an income per worker equal to p_A, while the equilibrium at K^{**} necessarily features $w > p_A$. Thus, the real wage and the level of per-capita income are unambiguously higher in the industrialized economy. The phase diagram in figure 1 illustrates the dynamics.

For present purposes, case 1 is of no interest: It implies that the size of the labor force is so small that industrialization will never be worthwhile, given the specification of the production possibilities. The concluding section focuses, therefore, on the second case.

[9] If S goods were produced under constant returns, or if they were traded internationally, their production costs would be independent of the size of the M sector. This would eliminate the low-K intersection in figure 1 and dispense with the need for a big push.

Figure 1



Conclusions

We have shown in this paper that the Nurksian trap and the need for a big push remain largely intact in an open economy if there are nontradable intermediate goods produced under increasing returns to scale.[9] The presence of these inputs implies that production decisions in the S sector and investment decisions in the M sector have important external effects. An increase in the output of S_i affects the current demand for other intermediate inputs adversely but reduces the price index p_S and raises both the combined input S and the rate of profits in the M sector. Aside from these static effects, there is a dynamic externality: Higher profits in the M sector lead to increased accumulation and thus to an increase in the future demand for all S goods. On the investment side, atomistic producers of M goods consider all prices given and fail to take into account the external effects of a higher capital stock on increased future demand for S goods and a lower future price p_S.

As a result of these dynamic pecuniary externalities, an initial capital stock below the critical level K^* leads to cumulative contraction when all firms follow behavior that is individually rational. Because the initial capital stock is small, the demand for S goods becomes low and S goods can only be produced at high cost. As a result, profitability in the M sector is so low that the capital stock contracts. This further increases production costs in the S sector and reduces profitability in the M sector, moving the economy toward the low-level equilibrium without M and S sectors. This low-level equilibrium is a trap in the sense of being only

locally stable. A coordinated effort—a big push aimed at increasing the rate of accumulation above the individually rational level and/or at raising the supply of S goods—may take the capital stock above K^*, at which point individual incentives as mediated by the market become sufficient to ensure full industrialization.[10]

It is worth noting that the problem does not arise because of a lack of demand. We have, in fact, deliberately made the rather extreme assumption of infinite price elasticities of demand for traded goods. Thus, it is not a Keynesian effective demand problem. Nurkse, above all, could not be more explicit about the fact that he was assuming Say's law. And rightly so. No matter how valid Keynes' insights, the development problems emphasized by Nurkse and Rosenstein-Rodan would remain even if Keynesian problems were successfully overcome. Increasing returns to scale (or, alternatively, the existence of technological externalities not considered in this paper) are essential to the development problem (and irrelevant to the Keynesian argument), and the presence of an elastic labor supply need not arise from a low level of resource utilization. In the particular model presented here, the elastic labor supply facing the S sector results from the existence of a labor-intensive A sector that produces an internationally traded good.[11]

In order to achieve a successful big push in the present model, there are at least three sets of policy options. One may use subsidies, price controls, or other forms of monopoly regulation to raise the production of S goods above the equilibrium level determined by individual profit

[10] Rosenstein-Rodan (1984) provides an open-economy example of the coordination problem involved:

> Low wages should have been a sufficient incentive to create a textile industry in India in the post-Napoleonic era and not in Lancashire, England. Indian wages were 50 or 60 percent lower than the low wages in England. . . . Further analysis revealed, however, that in order to build a factory one would have to build a bridge or finish a road or a railway line or later an electric power station. Each of these elements in the so-called social overhead capital requires a minimum high quantum of investment which could serve, say, fifty factories but would cost far too much for one. [p. 208]

[11] It follows that openness can cut both ways on the question of multiple equilibria. In order to generate the low-K intersection and the associated pecuniary externalities and coordination problems, the increasing-returns sector must face downward-sloping demand curves and elastic factor supplies. Openness makes demand curves more elastic, thus facilitating a solution to the coordination problem if the increasing returns sector produces traded goods, but it also increases the elasticity of factor supplies and, on this account, tends to generate multiple equilibria.

maximization under laissez-faire. Alternatively, one could stimulate the demand for S (at any given level of the capital stock) by subsidizing M production. Finally, M sector investment could be enhanced through, for instance, the provision of cheap credit to this sector. Needless to say, advocacy of these policies needs to be balanced by an appreciation of the possible dangers involved (e.g., associated with rent-seeking behavior). The implementation of the policies also raises many difficult questions. A discussion of these issues is beyond the present paper. Our purpose has been merely to present a stylized model[12] that, we would argue, captures important aspects of the traditional verbal argument for a big push. The S sector includes infrastructure such as power, transport, communications, and training facilities, all part of the multidimensional "social overhead capital" which, according to Rosenstein-Rodan (1961, pp. 60–61), is the "most important instance of indivisibility and hence of external economies on the supply side" and "cannot be imported." The model shows that, in the presence of these externalities and nontradable inputs, an open economy is not enough to overcome the need for a big push.

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[12] One way in which the model oversimplifies the problems concerns the specification of the set of nontradable intermediate goods. For reasons discussed earlier, we do not favor an alternative approach with an ever-expanding set of intermediate goods, but the assumption of well-defined symmetric demand conditions for the S goods is questionable. As pointed out by Rosenstein-Rodan (1943, p. 208), a "general vision of the future economic structure is necessary in order to know where to build communications, how much of them, and what for."

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