European Bank
for Reconstruction and Development

An analytical framework for evaluating transition impact of infrastructure projects

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Abstract

This paper provides a *non-technical* summary of a framework for evaluating the transition impact (social returns) of any infrastructure investment that reduces transaction costs and thereby intensifies product market competition. The framework applies both to physical and institutional infrastructure. We show that infrastructure generates welfare gains by improving the ability of the market to weed out existing inefficient firms ("market selection"), by changing the incentives for firms to lower their costs by restructuring, and by providing greater (less) incentives to enter for low (high) cost potential entrants. We illustrate by simulation analysis that conventional cost-benefit analysis is not likely to capture these dynamic transition impacts of infrastructure.

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Keywords: infrastructure, market selection, restructuring, entry, cost-benefit analysis

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1 INTRODUCTION

There is a widespread recognition that creating competitive markets is an essential part of the transition process. The potential for developing competitive markets in transition economies had been inhibited by the inadequacy of both the institutional and physical infrastructure inherited from the socialist era. There were virtually no market-oriented institutions, including legal and regulatory frameworks to enforce contracts, protect private property, and preserve a level playing field for competition and entry, nor were there developed financial markets to finance private investment. Moreover, physical infrastructure, such as transport and telecommunications, had been designed to meet the needs of a highly vertically integrated production and distribution system. Under central planning, there were very few small and medium-sized enterprises, little horizontal communication between enterprises, and relatively limited provision of information to buyers and suppliers.

As part of the ongoing research programme in the Office of the Chief Economist (OCE) at the EBRD, we have developed a formal economic model designed to analyse some key aspects of the "transition impact" of infrastructure that reduces transaction costs and thereby intensifies product market competition. This paper provides a non-technical summary of the main results in that research, together with some simulations that illustrate both the quantitative importance of these dynamic transition impacts and the extent to which standard cost-benefit analysis is likely not to capture them.

The types of investments to which our analysis applies include any physical infrastructure that reduces search costs and transportation costs and thereby limits the scope for (local) monopoly power, such as transportation, telecommunications and other information-enhancing investments. But our analysis also applies to institutional infrastructure such as competition agencies, regulatory frameworks for banking and securities markets, bankruptcy institutions, and contract enforcement mechanisms, which also contribute to enhance the "competitive process" in (emerging) market economies. By "competitive process" we mean competition among incumbent firms, the entry of new and more efficient firms, and the restructuring or exit of the less efficient.

We emphasise three main economic (welfare) contributions of market-enhancing infrastructure. The first is *market selection*: by intensifying product market competition, infrastructure investments that lower communication, transportation, information and other types of transaction costs, help weed out (or reduce the market share of) higher-cost firms. This in turn increases average production efficiency in the economy. Second, infrastructure investments that increase product market competition change the incentives for firms to reduce their costs by engaging in restructuring. And third, by increasing the (expected) market share of lower-cost firms, infrastructure that lowers transaction costs makes entry *more attractive* for low-cost potential competitors (compared with high-cost potential entrants) because low-cost firms know that they will be able to compete more effectively following entry. In short, market-enhancing infrastructure generate a *selection effect* that improves the average performance of incumbent firms and encourages the entry of new, more efficient private businesses.

The concept of "transition impact" was first introduced by the OCE in an effort to capture the dynamic, indirect contributions of investment projects to market development (Burgess, Schankerman and Stern, 1995). Our main purpose in this short paper is to spell out the idea of transition impact, and to propose a framework for assessing the transition impact of infrastructure projects over and above the static measures provided by standard "cost-benefit analysis". There is an extensive literature on cost-benefit analysis that provides a coherent framework and practical guidance in treating static externalities in project appraisal. But it has

not produced a framework capable of analysing dynamic, indirect social returns to infrastructure investment, or one in which the relationship between infrastructure and dynamic competition can be formally discussed.

Our research is the first attempt at filling this gap. We develop a simple model of imperfect competition (oligopoly) in which there are differences in production cost among firms (cost asymmetry): that is, there are both high-cost and low-cost firms producing differentiated products which engage in price competition. The intensity of product market competition is measured by the unit "transport" cost, which a consumer incurs when going from home to the firm he/she purchases from.[1] The focus of our analysis is on the static and dynamic welfare effects of infrastructure investments aimed at reducing that cost.

As pointed out above, this model allows us to capture three main contributions of such investment:

(i) direct market selection – the extent to which a reduction in unit transport cost increases the relative market share of lower-cost firms;

(ii) restructuring – the extent to which a reduction in unit transport cost changes the firms' incentives to invest in lowering their production costs; and

(iii) entry – the extent to which a lower transport cost encourages entry (i.e. innovation) by lower-cost firms.

Our framework allows us to quantify these various impacts of infrastructure investments, and to evaluate the fraction of these social returns that would – or would not – be captured by traditional cost-benefit analysis. It also enables us to compare the welfare effects of three different types of infrastructure investments: those aimed at reducing unit transport costs, those directly aimed at reducing the cost of restructuring, and those directly aimed at reducing the cost of entry.

[1] This is simply an analytic device that allows us to study how changes in the intensity of competition affect the economy. The interpretation of "Infrastructure" is broader than the particular formalisation we use to study it.

2 BASIC FRAMEWORK AND MARKET SELECTION

Consider an economy populated by firms with high and low (unit) production costs. Think of the high-cost firms as the production units inherited from the socialist era, and of the low-cost firms as being either new private businesses or restructured enterprises (Aghion and Blanchard, 1994). Firms compete in prices, but because products are differentiated and/or because consumers are geographically dispersed, those firms that set a higher price can still capture some part of the market (they still attract those customers who strictly prefer their differentiated product and those who live nearby and therefore save on transportation costs by purchasing from a local firm). If we assume for simplicity that total demand for all the differentiated goods is fixed, then maximising total social surplus is equivalent to minimising the sum of production costs incurred by firms and transport costs incurred by consumers. We can then analyse the effects on welfare of new infrastructure investment that reduces the unit transport cost. This reduction in unit transport costs will obviously intensify product market competition, in the sense that a firm which charges a higher price will now lose more customers to other firms in the economy. This, in turn, will lead to lower prices in equilibrium, which is good for consumers but reduces profits. What is more interesting are the following fundamental effects of such infrastructure investment.

There is first a *direct cost reduction effect*: a lower unit transport cost reduces the expected transport cost incurred by consumers located between identical firms, i.e. between firms with identical costs. This direct effect would typically be captured by traditional cost-benefit analysis, as it does not affect the competitive process. For example, if new transport infrastructure lowered the cost of shipping goods by 5 per cent, the direct cost effect would be 5 per cent times the cost of all goods shipped. Alternatively, if improved legal systems reduced the transaction cost of enforcing contracts, this would generate a direct cost saving on all existing contracts.

But this misses the dynamic effects of such infrastructure. Reducing unit transport costs also induces a *selection effect*. A lower transport cost increases the market advantage – and therefore the market share – of firms with lower production costs, since those firms that set lower prices in equilibrium will be able to attract more consumers away from other firms. The fact that a higher share of the market is being served by low-cost firms implies that aggregate production costs will be reduced and this further increases aggregate welfare. This effect works through the resulting change in equilibrium market shares. For this reason, this indirect effect is not likely to be captured by standard cost-benefit analysis, which usually takes the current market shares of existing firms as given.

Infrastructure investment increases aggregate welfare both through the direct effect and the selection effect. The welfare gain will be larger when the cost differences among firms are greater, because the selection effect is stronger in that case. This point is confirmed by formal analysis in the companion, technical paper (Aghion and Schankerman, 2000), and by the simulations summarised in Section 4. There are strong reasons to believe that the degree of cost asymmetry will be larger in transition and developing economies than in more highly industrialised ones, and particularly in economies that are at an earlier stage in the transition process.

One important remark to conclude this section: we have argued that infrastructure will help weed out less efficient (i.e. high-cost) firms while increasing the market share of more efficient (i.e. low-cost) firms. This, in turn, has implications regarding the *demand for infrastructure* by different types of firms. We show in this research that new private businesses (and incumbents) with lower production costs will be in favour of more market-

enhancing infrastructure if they have a large enough cost advantage over less efficient firms. High-cost incumbents will unambiguously oppose such infrastructure investments. In practice, the decision to improve competition-enhancing infrastructure will hinge on these considerations, and also on the design of institutions that determine how "voting" and public decision-making take place. For example, in the absence of coordinated side-transfer payment mechanisms, an economy can remain stuck in a low infrastructure trap because the infrastructure-driven loss of profits for high-cost incumbents exceeds the increase in profits for low-cost firms. This point takes on particular interest when one considers the problems of improving competition-enhancing, *institutional* infrastructure in countries where there are strongly entrenched, vested interests.[2]

[2] In our analytical framework, these entrenched interests are represented by the high-cost firms that unambiguously lose from such infrastructure investment.

3 LESSONS REGARDING INFRASTRUCTURE INVESTMENT

The companion, technical paper (Aghion and Schankerman, 2000) proves a number of formal propositions that relate to the effects of infrastructure investment on social welfare, restructuring behaviour by firms, and the entry of new firms. In this section we summarise these propositions non-technically in the form of "lessons" that can help in the evaluation of infrastructure projects. A brief intuitive explanation of each lesson is also provided.

Lesson 1.

Infrastructure investment increases economic welfare in two main ways: the *direct savings* in the cost of using infrastructure, and *dynamic gains* in productivity due to making the more efficient firms more able to compete and to gain market share (*the selection effect*. The dynamic gains are larger when there are large differences in the cost levels of different firms.

Remark. The direct savings in the cost of using the infrastructure (or improvements in its quality) are generated, but by all types of physical infrastructure, including transport, telecommunications, electric power and water, as well as to institutional infrastructure such as improved financial systems, and legal and regulatory institutions. The savings due to the selection effect are particularly important for infrastructure investment whose main effect is to intensify competition.

Lesson 2.

Improved infrastructure reduces the profit margin for all firms because it intensifies competition, but it can increase the overall profitability of the private sector by increasing the market share captured by the more efficient firms. This is especially likely when there are large differences in the cost level across firms in the economy. Since capital investment decisions are linked to profitability, infrastructure investment can stimulate overall capital investment in the private sector, even though the high-cost firms may shrink as a consequence.

Remark. This perspective implies that, in making infrastructure investment decisions, the EBRD should not give much weight to the fact that some incumbent firms may lose market share as a consequence of the intensification of competition. This is a social benefit, not a social cost.

Lesson 3.

High-cost (less efficient) firms have an economic interest in blocking improvements in infrastructure. The more efficient firms will support such investment when the cost differences between them and the high-cost firms are large.

Remark. This implies that there is no guarantee that enlarging the scope of the private sectors (such as through privatisation) will necessarily create its own demand for market-enhancing infrastructure, either physical or institutional. This depends critically on how different types of firms, and consumers, can "vote" for or against infrastructure investments in the political arena.

Lesson 4.

The fact that low-cost firms have a larger market share in a market economy gives them a stronger incentive than high-cost firms to invest in restructuring activities. This relatively stronger incentive is intensified by infrastructure investment.

Remark. This implies that infrastructure investment may well increase the differences between high-cost and low-cost firms, rather than shrink them. Better infrastructure may contribute to growth by enhancing the relative position of low-cost firms and low-cost new entrants, rather than by stimulating efficiency gains by the high-cost firms. The intensification of competition will narrow the differences in cost levels only in cases where it is much less costly for high-cost firms to restructure than for low-cost firms, or if there is some market penalty associated with having a low market share (such as effective bankruptcy rule or an active managerial market based on good information about past performance).

Lesson 5.

Infrastructure investment discourages the entry of high-cost firms, but it increases the incentives for low-cost firms to enter whenever there is a large enough proportion of high-cost firms in the economy and/or when the low-cost entrants have a sufficiently large cost advantage. These conditions are more likely to be present in economies at less mature stages of transition.

Remark. This difference arises because infrastructure investment has two countervailing effects. It reduces the profit margins of both low-cost and high-cost new entrants, and thus discourages both types. But infrastructure also make it easier for the low-cost entrants to gain market share, and this selection effect gives them a greater incentive to enter (and the high-cost firms an even stronger incentive not to enter).

4 WHAT DOES STANDARD COST-BENEFIT ANALYSIS CAPTURE? SOME NUMERICAL ILLUSTRATIONS

In theory, cost-benefit analysis could incorporate all of these dynamic transition impacts, but in practice it will not capture these effects. To appreciate how difficult it would be to do so, notice first that a "complete" cost-benefit analysis would have to be based, not on the observed market shares of different firms, but on the market shares that *would occur* in equilibrium after the infrastructure investment had been made. Moreover, infrastructure changes incentives for restructuring and entry. A complete cost-benefit evaluation would have to be based on the *new (post-restructuring)* cost levels and on the *new (post-entry)* number of firms in the market. These indirect effects take time to appear, and such information would be very hard to obtain.

Therefore, it is important to get some idea as to how large these indirect effects of infrastructure projects can actually be, relative to the direct effects. In Aghion and Schankerman (2000), we conduct numerical simulations to study this question. The simulations are based on the formal analytical model, and have been calibrated so that the model implies characteristics of the economy that are broadly consistent with the observed features of transition and developing economies. These features include the profit margins of firms, the cost differences between "high-cost" and "low-cost" firms, the cost reductions due to restructuring, the frequency of entry by new firms, and the level of industrial concentration.

We ask the following question: What percentage of the total welfare gains from a marginal increase in infrastructure is accounted for by the direct effect, which is what standard cost-benefit analysis *is* likely to capture?[3] We conduct the simulations using different starting levels of infrastructure (intensity of competition measured by equilibrium profit margins) and of the cost differences between low-cost and high cost firms. The key findings are summarised in Table 1.

Table 1: Proportion of welfare gains from infrastructure investment accounted for by the direct effect (cost reduction) effect

Initial level of infrastructure (intensity of competition)	Difference between unit cost of high and low cost firms (%)		
Low	98	93	83
Medium	90	67	46
High	42	14	nc

Notes: The infrastructure investment is defined so that it generates a 1 per cent change in aggregate profits in the economy, after both the direct and indirect effects (including restructuring and entry) are accounted for. "nc" denotes that the new equilibrium in the model could not be computed with the given parameters because second order or boundary conditions were violated. For details of the calibration of parameters for the simulations, see Aghion and Schankerman (2000).

[3] "Marginal" here refers to the reduction in unit transport cost, not the size of the investment project. The required investment would of course depend on the type of "infrastructure" under consideration.

When there is 25 per cent difference between the cost of high-cost and low-cost firms, and the initial level of infrastructure is good (a "high" degree of competition), the direct effect only accounts for about 42 per cent of the total welfare gains from infrastructure investment. In economies with much poorer infrastructure (a "low" degree of competition), the direct effect accounts for most of the total welfare gains. In other words, standard cost-benefit analysis misses factors that are especially important when the initial level of infrastructure is *good* (i.e., the more advanced transition countries). This may seem counter-intuitive, but the explanation is simply that an initially good infrastructure makes the selection effect that lies behind the dynamic transition impacts. But this does *not mean* that infrastructure investment is ineffective in low-transition countries where the initial level of infrastructure is poor. What it implies is that *marginal* infrastructure projects in such economies are likely not to generate strong transition impacts. What it implies is that, in early transition economies, it is necessary to undertake infrastructure projects that have a substantial effect on unit "transport cost" in order for the market selection effect to be effective.

When the degree of cost asymmetry between high-cost and low-cost firms is larger – 50 per cent – the direct effect of infrastructure accounts for even less of the total welfare gains. In economies with good initial infrastructure, the direct effect is only about 14 per cent of the total gains. Even with only moderate initial infrastructure, the direct effect is only 67 per cent of the total.

Although not shown in the table, we have also confirmed by simulation that the selection effects are stronger when the initial proportion of high-cost firms in the economy is higher, which is likely to be the case in countries at earlier stages of transition. The reason for this result is simply that there is greater scope for low-cost firms to gain market share from their cost advantage. The implication is that standard cost-benefit analysis is likely to capture a smaller proportion of the overall welfare gains from infrastructure investment in such countries.

In summary, the table tells us that the selection effects of infrastructure projects are substantial in economies in which there is greater cost asymmetry and a larger proportion of high-cost firms, which we interpret to be key indicators of countries at an earlier stage of transition. In addition, countries with a low initial level of infrastructure will require more intensive infrastructure investment in order to make selection effects operate on a substantial scale.

5 ADDITIONALITY: IS THERE A NEED TO SUPPLEMENT PRIVATE MARKET FINANCE?

Our research provides a framework for analysing and quantifying the dynamic transition impacts of infrastructure investment, and to compare them to other types of financial support such as finance for restructuring or entry by new businesses. But under the EBRD's mandate, project finance is also supposed to be “additional”. What does our analysis suggest about the additionality of infrastructure, restructuring and entry support?

There would be no additionality if private financing sources for infrastructure investment could fully recoup the social surplus (welfare gains) that such investment generates. Our research identifies a series of dynamic, indirect benefits that infrastructure (or the public agency that financed privately) to price infrastructure services in a way that appropriates all of these benefits. But it would be extraordinarily difficult to design pricing of such services that would allow the infrastructure firm to recoup the gains arising from better market selection, from the restructuring induced by the infrastructure, and from the intensified entry by new low-cost firms. *Thus, as a practical matter, the dynamic transition effects we study themselves provide a prima facie case for believing that EBRD support for such infrastructure investment would be additional.*

Moreover, our simulations indicate that these indirect effects can be very large relative to the direct effects of infrastructure, especially in economies where there is a large proportion of high-cost firms, a high degree of cost asymmetry, and relatively good initial level of infrastructure. The first two conditions point to countries at an early stage of transition. The third condition is likely to be present in countries more advanced in the transition. Thus, there is reason to believe that infrastructure investment can be additional at all stages of transition. Equally important, the analytical framework can be used to study in more detail how the relative importance of transition impacts depend on the general characteristics of economies at different levels of transition.

6 IMPLICATIONS FOR THE STRATEGIC INVESTMENT FOCUS: FINANCING INFRASTRUCTURE, RESTRUCTURING AND ENTRY

Subject to limitations imposed by the supply of the possible projects, the EBRD faces a strategic decision as to how to allocate its overall portfolio among different types of investment. Three generic categories that capture most of what the Bank does are: infrastructure investment, support for restructuring activities and entry support for new firms (support for banks and other financial markets can be thought of as related primarily to restructuring and entry). Each of these categories of investment generates dynamic, indirect transition effects. We have discussed infrastructure at length. But restructuring support is designed to facilitate cost reduction for selective firms, which should increase that firm's market share and thus changes the level of aggregate efficiency. In short, it too generates a "selection" effect. The same is true for investment support that facilitates entry.

The central difference between infrastructure and support for restructuring or entry is that infrastructure investment improves the ability of the market in reward the more efficient firms ex post. There is no need to identify which firms will be more efficient ex ante (at the time of the infrastructure project). By contrast, restructuring and entry financing requires identifying specific firms to support, and thus in effect picking "winners". These may or may not be the most efficient firms, or the best targets for improving cost levels. Obviously, this depends critically on the ability of the EBRD and its co-financing partners to identify such firms *ex ante.* Among other things, this will depend heavily on the availability of good, verifiable information about such firms (hence on the prevailing accounting practices and other factors) and on the monitoring capacity of the EBRD. These characteristics will vary substantially across transition economies. Consequently, the relative attractiveness of infrastructure projects compared with restructuring and entry support, measured in terms of its transition impacts, should be expected to differ across transition economies. Given the mandate of the EBRD, this implies that the strategic focus of the Bank should itself vary across countries, as a matter of policy.

To assist in the formulation of the EBRD's strategic focus, it would be helpful if we knew whether the transition effects triggered by restructuring and entry projects are as large as with infrastructure investments, and how this depends on characteristics of the economy in question. The related technical research paper conducts some preliminary analysis of this question, using the analytical framework we have developed. But further development is needed to study this question fully.

We have focused on dynamic transition impacts that arise from the market selection effect. From the perspective of the EBRD, one important extension of our work would be to incorporate into the analytical framework the effects of infrastructure on the ability of firms to *learn*, both from their own experience and by observing the relative performance of other firms. Physical and institutional infrastructures that intensify competition make it easier for those firms to achieve profitability. In this way, infrastructure may enhance the ability of firms to learn from their observation of market outcomes. This remains an unexplored area of research.

REFERENCES

P. Aghion and M. Schankerman (2000), "A Model of Market Enhancing Infrastructure," Centre for Economic Policy Research (CEPR) Discussion Paper No. 2462.

P. Aghion and O. Blanchard (1994), "On the Speed of Transition in Central Europe," NBER Macroeconomics Annual, pp.283-320; MIT Press: Cambridge, Mass.

R. Burgess, M. Schankerman and N. Stern (1995), "Investment Projects and the Transition Projects," EBRD mimeo.