ADB Working Paper Series on Regional Economic Integration

What is Economic Corridor Development and What Can It Achieve in Asia's Subregions?

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Asian Development Bank

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No. 117 | August 2013

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The ADB Working Paper Series on Regional Economic Integration focuses on topics relating to regional cooperation and integration in the areas of infrastructure and software, trade and investment, money and finance, and regional public goods. The Series is a quick-disseminating, informal publication that seeks to provide information, generate discussion, and elicit comments. Working papers published under this Series may subsequently be published elsewhere.

Contents

Abstract

Economic corridors connect economic agents along a defined geography. They provide important connections between economic nodes or hubs that are usually centered in urban landscapes. They do not stand alone, as their role in regional economic development can be comprehended only in terms of the network effects that they induce. As the case studies in this paper show, there is no standard picture of what economic corridor development is and what it can achieve. What economic corridors can achieve for regional economic integration depends first on what characteristics the specific existing economic networks in which the economic corridors are embedded personify, and second on which characteristics corridor development are intended to introduce or strengthen. Corridor characteristics interact dynamically to create patterns of regional economic development. Models that make this interaction explicit have combined elements of the New Economic Geography (nonlinear and General Equilibrium elements). The Asian Development Bank (ADB) has a significant stake in the successful application of corridor development approaches with an annual investment of $2 billion or more in regional cooperation and integration.

1. Monitoring the Effects of Economic Corridor Development

It is increasingly clear to development practitioners that a new approach is needed to make effective use of economic geography toward the confluence of regional economic integration and inclusive growth. Large cumulative benefits not previously known by decision-makers can become apparent when potential growth-inducing investments that raise the production potential of integrated economic and geographic areas are modeled along economic corridors. An economic geography approach—which maps the economic landscape in a dynamic (over-time-cumulative) way and populates it with economic agents in employment, production, economic corridors, and environmental space—allows the distribution of benefits accruing across the region in various investment scenarios to be computed and displayed.

An initial review of the literature (Arvis 2011; Buiter and Rahbari 2011; Henning and Saggau 2012; Srivastava 2012; ADB 2013) does not reveal a standard picture of what economic corridors are. It is possible to distill characteristics of economic corridors that are more commonly accepted in the literature and in a sample of case studies. We can then speak of an emerging and fluid concept of what economic corridors are.

Economic corridors connect economic agents along a defined geography. They provide connection between economic nodes or hubs, usually centered on urban landscapes, in which large amount of economic resources and actors are concentrated. They link the supply and demand sides of markets.

It seems that no one economic corridor matches exactly the characteristics of another. This discussion paper frames a set of indicators for characteristics of broadly defined "economic corridors."[1] It then proceeds with a characterization of some sample economic and trade corridors. Case studies focus on questions like: What does it mean in practice to implement successful trade or economic corridors that result in market access improvements for peripheral regions? How will peripheral regions in world trade gain the capabilities to achieve more market access to central regions?

Economic corridors are not mere transport connections along which people and goods move. Economic corridors are integral to the economic fabric and the economic actors surrounding it. Economic corridors are not generating significant economic benefits in isolation, but rather they have to be analyzed as part of integrated economic networks, such as global and regional value chains and production networks.

2. Benchmarking Case Studies on a Set of Indicators Characteristic of Economic Corridors

Economic corridors are best defined by their characteristics, and it is through characteristics' measurement that economic corridor performance can be determined

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[1] Often the term "trade corridor" is used for "economic corridor." There is no clearly defined distinction between the two terms and they are used synonymously in this paper.

and monitored. The measurements used are commonly employed model parameters, as further detailed below and in the appendices.

2.1 Structural Characteristics

2.1.1 Industrial Structure, Trade, and Export Composition

Entering into trade, especially exports, requires significant upfront learning and investment in fixed costs. New exporters therefore have difficulty succeeding and their exit rate is high. Large traders and exporters have much better prospects of entering into new markets and expanding existing markets than small and medium-sized enterprises (SMEs). Freund and Pierola (2012) show that the top 1% of a country's exporters drive comparative advantage, export growth, and diversification in developing economies. Furthermore, new exporters if they are small, succeed when they grow quickly into "superstars" within an average of 3 years after entry into exporting. This is because these entrants are already the most productive in their domestic markets and can forego a steep learning curve and new fixed costs. Thus, the firm structure a country has along its economic corridors matters for the success of corridor development. For successful economic corridor development, it is essential to support a viable firm structure and ecology, which allows competitive entry (and exit), as well as innovation for rapid growth. A vibrant ecology of firms significantly contributes to increases in export complexities along economic corridors.

2.1.2 Export Complexity

High-income economies have a high share of complex products among their exports and therefore a high export complexity and a low share of less complex products. An increase in export complexity is the best predictor of income growth in an economy. It also predicts very well where in the global "product space" an economy will be located.[2] High-income economies are located at the center of the product space, whereas low-income economies stay at the periphery (Hidalgo et al. 2007). Economies like the [the People's Republic of] China (PRC), which rapidly gain in export complexity, are highly likely to move to the center of the product space and experience high-income growth. Country complexity is measured by the degree of diversification of the export basket (Felipe et al. 2012), which is determined by sectors of the global product space a country exports with revealed comparative advantage (RCA). A more complex economy has more capability to expand and diversify into new and adjacent sectors within the product space.

2.1.3 Agribusiness' Share of Exports

The costs and times of moving agricultural perishable goods along global value chains (GVCs) differ substantially from those that are not perishable. Determining the agri-business intensity of exports from a region is essential for determining the investment

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[2]   Hausmann and Klinger define product space as a collection of proximities, shown as a network connecting all pairs of products that are exported globally and are significantly likely to be co-exported by many countries.

required to establish and increase competitiveness over time in this part of the product space (ADB 2013).

2.1.4 Relative Unit-Labor Costs for Competitiveness

Competitiveness in product space is to a significant extent determined by labor productivity in relative terms. Usually a unit labor cost ratio is established by calculating on a purchasing power parity (PPP) basis the cost of labor relative to the value of output per worker. In trade, this ratio is attenuated by the quality of output reflecting technological capacity, which is related to the position of a produced output in relative product space and also by real exchange rate movement (Brunner and Allen 2005).

2.1.5 Regional Income Distribution

Trade network and agglomeration effects can disadvantage areas with low capabilities. In monitoring and evaluating economic corridor development, it is important to favor approaches that examine how such developments can be made inclusive. Connecting peripheral and lagging regions through physical corridors to central areas requires putting in place measures that induce the structural changes necessary to rapidly increase the diversity and competitiveness of the lagging areas. Simulations and case studies show the importance of this in the successful development of economic corridors, and they also illustrate the potentially deleterious effects of economic resource emigration to central areas fostered by narrowly focused accessibility investments (Brunner 2010; Roberts et al. 2012).

2.2 Network and Geographic Cohesion Characteristics

The effects of economic corridor improvements are not confined to the country or specific geography in which the improvements occur. It is therefore important to get measures of the cohesion of a larger geography in which an economic corridor is embedded. Generally, the more cohesive a geography is the more distributed the impacts tend to be. Conversely, in a low-networked geography with low economic cohesiveness, the effects tend to concentrate.

2.2.1 Population Density and Dynamics

Population densities and the change in densities through growth in working populations and in- and out-migration co-determine the density of networks of economic interaction, and they influence supply and demand in markets.

2.2.2 Prospects for Trade Diversification Along Value Chains

Methodologies developed by Hausmann and Klinger (2006) produce a map of a country's potential for progressing up the value chain. Their methodology assumes that each export commodity produced gives rise to specific opportunities for future diversification based on technological complexity and input–output relationships (Pula and Peltonen 2009).

2.2.3   Intra-Regional vs. Inter-Regional Trade Composition

Economic models have been used to project trade transformation on the basis of recent trends in world trade. Some models predict that the trade between today's high-income economies, or advanced economies (AEs), and the fast-growing Emerging Economies (EMs) will for the next 2 decades remain at about 50% of all world trade. However, in relative terms, intra-EM trade will rapidly outgrow intra-AE trade (Buiter and Rahbari 2011; Anderson and Strutt 2012). This is indicative of the increasing amount of intra-regional components trade in EMs.

2.2.4   Share of Components Trade

In today's world, vertical trade network integration is increasing, as GVCs involve components of goods and final goods (and even services) crossing national and regional border multiple times. In some regions, especially East Asia, growth in the components trade outstrips overall trade growth. With growing vertical integration, conventional measures of trade flows are harder to interpret, and in the future it will be important to look at growth figures from a value-added perspective. This has already been done based on input–output matrix calculus. (For input–output databases, see Cattaneo et al. 2013.)

2.2.5   Vertical Network Integration

Economic corridors generally do not prosper in and of themselves and become successful as part of an economic network of interactions. The characteristics and shapes of such networks are critical to the development of a particular corridor within this environment.[3] An increased network density increases economic interaction (Henning and Saggau 2012). The transformation of trade flows has important implications for locating economic activities along corridors. Production network agglomeration along economic corridors is likely to increase in a few favorable geographic locations, unless policies and investments are undertaken which improve trade capacities of outlying and lagging areas, and improve their physical and informational accessibility from and to the economic hubs.

2.2.6   Information Network Integration along Value Chains

Network characteristics shape the exchange of know-how, technology, and market information. Networks and value chains more effectively allow diffusion of knowledge not only with an increase in network density, but also with the existence of central, dominant players in a value chain. The Leipzig–Frankfurt economic corridor demonstrates how an innovation network and cluster develops strength as part of deliberate regional integration policies and investments. (See appended section for case summaries.) This innovation cluster has increased density and centrality, while increasing the strength of economic interaction among agents through diverse links (Cantner and Graf 2006). It also shows that dominant, central players can either be from within a region or outside

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[3]   A recent, well-presented and readily understandable quantitative theory of networks can be found in Easley and Kleinberg (2010).

the region under consideration. Furthermore, GVCs ease the transmission of know-how as they constitute collective processes of learning and absorption, often over very long distances. Innovation clusters and GVCs are tightly-knit structures. However, such structures can be kept separated from other tightly-knit structures. For instance, knowledge that is generated outside of established GVCs is generally much harder to absorb.

2.2.7 Transport Network Completeness

A transport network that has a high degree of completeness is also tightly-knit. Transport network completeness decreases the transaction length (in terms of cost and time) in an economic hub and network. Cooperation partners can be reached more frequently and more reliably. Network resilience increases dramatically with the higher completeness of a transport network. However, one tightly-knit network may be delinked from others, or may be inaccessible to outsiders, thus retarding knowledge transmission and growth.

2.2.8 Interconnectivity (Local to Global)

Establishing interconnectivity in transport networks and technologies, or via institutions, is essential for regional economic and trade integration. Increased intermodal connectivity adds to the completeness of a network and establishes lifeline linkages to the outside world (Figure 1). These important bridging links from the local to the global can beneficially influence corridor development. Transit links can be very important regional and inter-regional lifelines. As such, they have very high "betweenness," as defined in Easley and Kleinberg (2010) by the amount of transit or traffic flows these links carry.

3. Accessibility Characteristics

3.1 Combined Travel Times and Travel Costs Affect Logistics Chain Efficiency

Better overall logistics chain efficiency is strongly associated with trade expansion, export diversification, attractiveness for investment in productive capacities, and economic growth and poverty reduction.

3.2 Comprehensive Transit Arrangements and Capabilities

Establishing comprehensive transit agreements and capabilities is vital for the success of land-based economic corridors that span two or more countries. The European Union's (EU) development of an internal market space shows the significant positive impact of regional integration of hitherto peripheral economic areas, as evident from the case study of the Baltic countries. The Swiss case, as the world's foremost transit country, demonstrates the vital importance of best practice transit arrangements and facilities, even for a landlocked country existing as an island within the EU that ranks 4th out of 124 in the world in terms of export complexity (Felipe et al. 2012).

3.3 Market Access Capabilities Development

Countries and regions that are intent on exporting more products in more sectors, and especially more complex products in the global product space, have to both acquire more production capabilities and increase their capacity to coordinate more and more inputs and services required to gain and maintain market access in a growing number of markets.

3.4 Export Financing and Financial Market Capabilities

Market access also necessitates the development of financial markets to underpin investment in export capabilities, and to improve the viability of the export firm structure and ecology with the ready financing of SMEs that can grow quickly into the proverbial superstars of export. Many firms—especially in small, low-income economies—already manufacture products that are, in view of their price–quality nexus, competitive in foreign markets. However, due to financial frictions, these firms remain domestically focused. This is a result of market failure in the finance sector where institutional capabilities are lacking for competitive export financing and export credit insurance. Firms that do not have access to such financial services are at a disadvantage compared to foreign competitors in the competition for export markets, and thus they are restrained in their productivity growth.

4. Development and Regional Integration Challenges Along Economic Corridors (With a Focus on Asia)

4.1 Bridging a Divided Geography

East Asia is one of the most economically integrated regions in the world in terms of low barriers to trade and investment. It is openly linked into a supplier network residing in neighboring Southeast Asia. South Asia, on the other hand, is one of the least economically integrated regions in the world, with comparatively high barriers to trade and investment. Central Asia has historic linkages to the West, which are currently in a weakened state, and it has emerging ties to the East. Central Asia can become a transit region between East and West, and further develop its role as provider of commodities in both directions, including to the key production and manufacturing hubs of East Asia. Europe faces a geographic and economic division between North and South, whereas Asia is considerably more divided by geography and economics into Eastern, Southeastern, Southern, and Central–Western spheres divided by deserts, high mountains, climate, and historic diversity far beyond what is encountered in other parts of the world. This is made visible in the map of the Logistics Performance Index (World Bank 2012), which highlights the geographic gap between Asia's subregions. This makes integration more costly. Asia's economic networks are more concentrated and clustered around hubs, and these hubs are connected weakly by long distance links. Asia will have to concentrate its resources for economic corridor and network development in emerging hubs, while at the same making the long-distance links stronger and more resilient (i.e., increase network betweenness).

4.2 Development of Regional Markets

East Asia is tightly knit by supply chains in key manufacturing sectors with strong vertical integration across borders. South Asia, in contrast, has low complementarity of trade along supply chains. This is reflected in differentiated trade performance across different parts of Asia. A calculation of the ratio of realized versus potential trade illustrates the differentiation (Armstrong 2011). East Asian intra-regional realized trade increased between 1990 and 2006 from a ratio of 0.63 to a ratio of 0.67. In comparison, the EU-15 remained steady at a ratio of 0.54 over the same period. South Asia intra-regional realized trade between 1990 and 2006 decreased from 0.31 to 0.25. Pan-Asian integration has the potential to even out the regional imbalances through further economic integration measures.

4.3 Balancing Growth and Income Distribution (Geographically)

The least integrated parts of Asia, especially in South Asia, harbor countries and areas within countries that have lagged behind in terms of gross domestic product (GDP) growth and poverty alleviation. It remains a challenge to balance corridor development so that income and growth disparities narrow, while at the same time concentrating resources on those areas that generate the best cost-to-benefit ratio. Relating costs of investment to benefits is also very important for political economy reasons. In networked, nonlinear systems, investments can generate large benefits in other areas of the region. This may amount to a transfer of resources from one political unit to others. Very often, compensation arrangements can be envisaged that benefit all areas involved, once the disparities are identified across geographies. Economic hubs are important drivers of regional development and thus require focused sets of investment; however, in the parlance of networks, growth is enhanced when the benefits of regional development are distributed among clusters of different size.

4.4 Building Up Resilience to Interruptions of Movement of Economic Resources

Exports of goods accounted for 45% of Asia's GDP in 2006, up from 34% in 1998 (Pula and Peltonen 2009). As the ongoing financial crisis clearly demonstrates, the building of resilience to external market interruptions is increasingly important. The threat of physical disruptions to the movement of resources within regions is also increasing due to high disaster and climate change vulnerabilities in Asia. The Asia–Pacific region encompasses a wide diversity of physical and human geography, and patterns of vulnerability exhibit significant regional variation.

5. Dynamics of Economic Corridor Development

The listed economic corridor characteristics interact dynamically to create patterns of regional development, as is made explicit in various economic models in the literature (ADB 2013; Brunner and Allen 2005; ECORYS 2006; Henning and Saggau 2012; Roberts et al. 2012). These aforementioned hybrid models, which support the appended

case study findings, usually have combined elements of the New Economic Geography and nonlinear and General Equilibrium model. Such integrated models show superior performance in analyzing, monitoring, and projecting complex, nonlinear network impacts onto a specific economic geography that is structured under specific regional integration initiatives. Very importantly, through geo-coding and geo-referencing of networked resources, the long-range income and poverty distributional effects can be captured with hybrid approaches. However, due to their complexity, such models require extensive expert input and knowledge to keep them stable. Figure 2 below describes the overall model structure and complexity in a very stylized manner.

Simply put, the strengthening of trade capacities to access new markets and enter new GVCs, and the reduction of constraints to export competitiveness, helps set in motion a virtuous growth cycle. Greater connectivity and regional cohesion, combined with strengthening links among SMEs, and along value chains, leads to a rise in productivity and export diversification.

The spatial and temporal dimensions of economic activity and trade are critical for understanding the impact of economic corridor investments. In an agent-based model, the production of a good is physically dispersed, a variety of production chains are feasible, and there is also potential that trade infrastructure investments will reconfigure the value chains. This gives the model the strong advantage of the explicit representation of real space, as an economic geography can be matched along key variable dimensions with the actual geography of the region.

Economic corridors each face unique challenges and each is built on the basis of different opportunities or comparative advantage. For successful development, it is important to generate a minimum scale so that spillover effects are of sufficient magnitude to generate positive nonlinear impacts and positive feedback effects which then maintain the virtuous growth cycle. It is an art in addition to a science to concentrate policy and financial resources on developing the critical characteristics that otherwise would constrain beneficial outcomes.

The appended case studies are intended to demonstrate this. In the case of the Baltic countries, the emphasis was immediately on both improving the structural characteristics of the European subregion and accessibility to and from the economic hubs located in Central Europe. First, it was important to rebuild technical capacities that allowed the best utilization of economic resources for growth in the Baltics and at the same time re-positioned this subregion within European value chains that had been severed in the post-war division of the continent. The Leipzig–Frankfurt (Rhein–Main) corridor faced the initial challenge of re-structuring itself quickly at the technology frontier and as a high-tech hub in the fiber optics, optical equipment, and precision tools sectors at the pinnacle of a GVC. The focus was on gaining competitiveness in a high-cost economy, and on building up the physical aspects of an economic corridor that historically was at the center of the world economy but was destroyed by the post-war division of Germany, and therefore needed rebuilding to meet best-practice standards.

This paper focuses on Asian case studies. The Greater Mekong Subregion (GMS), over 2 decades of development, has focused on building up its basic connectivity backbone.

This effort has been successful, yet the connectivity backbone is not yet complete. The subregion is well tied into Asian value chain networks; however, further inland in areas removed from the coasts, the widening of economic corridors remains the key challenge (Srivastava 2012). This cannot be said of the eastern South Asian subregion, which lacks value chain tie-ins and remains very much on the periphery of the global product space. South Asia Subregional Economic Cooperation (SASEC) is focusing on reconnecting the subregion's transport network, which was severed in the political partition of the South Asian subcontinent. Building inter-connectivity, locally and globally, remains crucial to success and so does re-building the economic cohesion of SASEC. Meanwhile, Central Asia sits at the center of the Eurasian landmass. This opens up for Central Asia Regional Economic Cooperation (CAREC) the opportunity for high-volume transit and to act as a value-added intermediary for trade between East and West, especially in bulk and in container on rail. In addition, CAREC could increase the role of suppliers of raw and processed inputs to the medium- to high-value added economic hubs in East Asia and Europe (including Russian Federation). These opportunities have only been captured partially by Central Asia's economies, as the investment focus so far has been on physical infrastructure improvement of corridors, and on border and customs systems improvements along the priority transport corridors.

6. The Role of Data and Economic Development Scenarios for Policy Making

A comprehensive assessment of economic corridor performance over time for investment and policy decisions requires data along three parameters: (i) the geographic-location-bound availability of economic resources, including human resources, natural resources, capital and financial resources, and physical resources such as infrastructure; (ii) movements over time of people, including their services and goods (mobility of resources), since these movements have a time and economic cost dimension; and (iii) the evolving relationships of economic resources over time and through space, and the changing density of their interactions, interaction reliability, and quality.

As part of the pilot study completed in 2011, ADB has developed a set of economic data baseline Geographic Information Systems (GIS) layers for South Asia, including point locations of agriculture production and industrial facilities, and locations of priority investments for regional coordination and integration. Such layers can be important inputs into further strategy development, investment coordination efforts (transport, trade facilitation, energy, environment), and monitoring and economic evaluation exercises. However, existing GIS baseline layers need review and updating. This is to be done under the established data protocol (the protocol), where data is recorded on a geographic tile basis—a tile being a partition of the geography being studied. Tiles can be reconciled with political boundaries, such as districts, through geo-coding and geo-referencing.

Climate change has to be integrated with development in a win-win approach. Global and regional climate change models, also known as General Circulation Models,

compute geographic, scientific models on the tile-based geographic grid (0.5 x 0.667 degrees); they use the same data protocol as pioneered in the South Asia study (ADB 2013). That standard grid is also mapped to countries' borders and districts. For example, a recent pioneering study by a [the People's Republic of] China–United States (US) consortium is devoted to (i) understanding the relationship between the [the People's Republic of] China's economic and energy growth, energy use, environmental pollution, and CO_2 emissions layers; and (ii) devising a policy to reduce environmental damages and increase human health and welfare (Jing, Ho, and Jorgensen 2011).

While such cross-sector coordination of investments improves the planning processes (prioritization, sequencing) and therewith facilitates the achievement of strategic impacts and outcomes, it often remains limited due to data gaps, fragmentation, incompatibility, and sharing restrictions.

Cross-institutional, open access web-based collaboration platforms can help in bridging this gap. In the Greater Mekong Subregion (GMS), under ADB technical assistance, an application based on webGIS has already been developed to strengthen coordination between the environmental sector and regional project interventions. An interactive webGIS can become an integral element for stakeholders in a region, to deliver investment components and connect the results from their efforts. GIS baseline layers can, with crowd-sourcing arrangements, be continuously verified and updated. The game-like qualities of the tool can motivate the players in their interactions with each other. With all of the above components the stage is set for further development of the "knowledge-tool" into an automated general purpose tool for the evaluation of investment sets across priority sectors. A scoping workshop, as proposed here, is an ideal platform to leverage the existing pioneering work to the advantage of a larger development and policy community, and an expanded number of economies across Asia (and beyond).

7. Distinguishing Corridors by Type and Parameter Dimensions: Distinct Initiatives, Benefits Derived, and Risks Taken into Account

As has been outlined, different types of economic corridors can be benchmarked along three sets of characteristic indicators. This exercise would then yield to an evaluation of which economic corridor characteristics need to be strengthened, with appropriate investments and policy actions. There are almost unending possibilities for combining a set of investments and actions under an economic corridor development program. Fitting an investment response to the specific challenges, which have to be overcome to successfully develop a corridor, or many corridors embedded within various economic networks, is as much an art as it is a science. It is an art to figure out the combinations and sets of possibilities that are likely to lead to the highest benefit–cost calculus for a select geography and the economic agents involved as a whole. The science part is in applying the combined elements of the New Economic Geography, nonlinear and General Equilibrium approach, in model simulations, which then identify the set of best possible options for boosting trade and incomes from economic corridor development. This needs to be done on a case-by-case basis, fitted to the specifics of the situation.

The corridor type and its specific, characteristic environment is then reflected in the calibrated parameters of a model (See attached section on parameters.)

Based on the six economic corridor case studies and on development lessons learned from them, this section will first outline which type of investments and actions can in general be deemed appropriate for a particular type of economic corridor. Next, from experience such an outline can then be associated with particular benefits and risks, which usually accompany their implementation. Table 1 categorizes policy and investment initiatives by corridor types (3), by model parameter dimensions (3, see section 2 for detail), and by model element (3, see section 4 for detail). The case study corridor types are informed by the need (i) to build a bridge for trade and transactions between regions and continents by filling soft and hard infrastructure gaps, and by fulfilling important transit and value-adding functions (Bridging + Transit, or B+T); (ii) to build dense economic exchange networks in a high-excellence, advanced technology hub (High Centrality, or High-C); and (iii) for corridors to (re)connect a remote geography of economic agents to economic centers to gain access to markets and technology (Connective + Cohesive, or C+C).

Appendixes

Appendix A. Parameters to be Measured (from Simulation, CGE, Nonlinear, Geographic Models)

A comprehensive assessment of economic corridor performance over time for investment and policy decisions requires data along three parameters: (i) the geographic-location-bound availability of economic resources, including human resources, natural resources, capital and financial resources, and physical resources such as infrastructure; (ii) movements over time of people, including their services, and goods (mobility of resources)—these movements have a time and economic cost dimension; and (iii) the developing relationships of economic resources over time and through space, and the changing density of their interactions, interaction reliability, and quality.

Measurements on parameter dimensions need to (i) take place at different stages of corridor development, (ii) be replicable, (iii) occur in different representative locations of the geography, and (iv) be efficient. From a sample of regional simulation models (ADB 2013; Brunner and Allen 2005; ECORYS 2006; Henning and Saggau 2012; Roberts et al. 2012), which are anchored in the literature of the New Economic Geography, nonlinear and General Equilibrium types, as well as applied to a set of relevant regional economic corridor–hub samples in this paper, it is possible to identify a set of applicable, monitorable parameters. Along the three identified parameter dimensions, these are the main findings:

(i) The available resources in a region determine its attractiveness to human resources, capital, and investment. Models express this attractiveness in parameters. Higher attractiveness increases the accumulation of resources and economic growth in the region.

(ii) The movement of resources across a network depends on the quality and strengths of the links between the nodes. Usually model parameters are included to describe the links and the cost and time it implies. Trade models make the typical "iceberg assumption," which expresses the portion of a shipment of goods that "melts" away from its overall value by moving from the producer to the consumer. Economic conditions in a region determine the strength of labor markets, which in turn influences migration and which is in turn influenced by some model parameters.

(iii) Economic interconnection determines the diffusion and absorption of knowledge. Economic corridor and regional integration models include learning and absorption parameters in their equations. These parameters can change over space and time, according to institutional capacity. Another parameter usually describes the density, centrality, and connectivity (network characteristics) of the network of corridors and the distribution of economic hubs. Spillovers, positive and negative, in production and services sectors are generally represented in a model- externality parameter.

Appendix B. Case Studies

The Baltics—Structural Investment within Regional Cohesion

Since 1990, the economic integration of the former Soviet bloc, became the major focus of the EU's cohesion program and funding. Cohesion funding is the second-largest portion of the EU budget. The objective of this approach is the acceleration of regional development and growth, which when left alone to market mechanisms, is likely to remain partial, incomplete, and too slow to bridge development and technology gaps. These gaps would lead to intolerable economic disparities within the EU and consequent migration and labor market upheavals that would be unmanageable. Considering experience from around the world (e.g., Roberts et al. [2012] in the case of [the People's Republic of] China, which shows that the massive development of the transport network significantly accelerated regional disparities), the EU did not want to embark on an early infrastructure and connectivity investment program without developing the capacities of the lagging regions at the same time. Hence, a combined Cohesion Policy and Transport Infrastructure Investment Program was launched, which in addition to sharing the cohesion policy's objective had the second objective of improving the in-and-out accessibility of the lagging regions. Peripheral regions need integration into larger networks and production chains to become economically viable.

In the Baltic countries—Estonia, Latvia, and Lithuania—regional integration funding is combined with regional accessibility funding for infrastructure investment. It is also connected to the funding of regional growth hubs through improved labor productivity and employment growth, especially in SMEs and start-up firms, as illustrated in the SASI Model diagram below (Figure 1B). There is heavy emphasis on the "intermodality" of transport.

A country-wise impact assessment is accomplished with the SASI model, by comparing growth and accessibility indicators for several investment scenarios, over time until 2031, with a baseline scenario. The illustrative figure 2B shows the spread of network effects over a wide area beyond the investment in the Baltic States. While the Baltics were initially hard hit by the global financial crisis, they have in recent years been able to achieve significant growth rates in income and trade, with rapid integration along transport and trade corridors into the overall European product space. In the EU, the Baltic states have some of the highest export-to-GDP ratios, with Latvia at around 50% and Estonia at around 70% (Cuaresma et al. 2012). Measures of both export sophistication and vertical network integration show that trade within Europe is becoming more complex.

The Leipzig to Frankfurt Economic Corridor—A Sprint Up the Product Complexity Ladder

This corridor was historically at the center of Germany, but it was completely severed with the division of Germany into East and West. The task at reunification was to connect the corridor again, which was done with massive investment in the transport corridor, linking via road and rail the economic hubs of Leipzig and Frankfurt (Rhine-Main) via the old urban centers of Jena and Erfurt (both in the State of Thuringia). This

short case evaluation focuses on the economic development of Jena as an example of how an old industrial, high-technology cluster in the economic corridor has been restored following the devastation of German division. In the late 1800s, the Jena area became the center of a well-known optical industry with Carl Zeiss photography and research at the center. This area was at the technology frontier in lenses used for microscopes and space observatories. By the time of reunification in 1991, the technology and the production of lenses had moved with the factory of Carl Zeiss to the western part of Germany. A rump manufacturing capacity remained in Jena, with output orientation focused entirely on the former Eastern bloc countries.

Since 1991, the State of Thuringia, under strong leadership, reoriented the rump capacity of the eastern Carl Zeiss in Jena toward research capacity and manufacturing in the optical and fiber optics sectors (Figure 3B). A new corporation, Jenoptik AG, was established on old grounds. Over $2 billion was invested in a short period in the 1990s to build up research capacities around the historically famous and scientifically well-preserved University of Jena. The physical restoration of the university in the historic city center also became the focal point of an urban renewal drive, which extended to the revival of many cultural assets in the city and the area around it. This was helped by the location of the old cultural capital of Germany (Weimar) being in the vicinity of Jena. Overall, in the same time period after reunification, the eastern part of Germany experienced substantial reforms in financial markets and the renewal of venture capital financing and attracted start-up financing. KfW channeled SME financing and development programs toward Germany's eastern regions. By 2010, Jena alone had seven companies listed on the German stock exchange, all in related high-tech sectors. Jena is attractive to a highly educated and youthful science-oriented population, and it is one of the few urban areas in eastern Germany registering positive net in-migration.

The GMS (Transport) Corridors—Developing and Widening Regional Backbones on Land

In GMS, the economic corridor approach was adopted in 1998 as a means of achieving connectivity. Transport infrastructure forms the backbone of the key economic corridors that have been substantially completed over 15 years. The GMS corridor approach planned infrastructure by taking into account the economic potential of specific geographic areas around transport links.

The GMS corridor development effort has so far concentrated on three main corridors: (i) The East–West Economic Corridor (EWEC), running from Da Nang in Viet Nam through the Lao People's Democratic Republic (Lao PDR) and Thailand to Myanmar; (ii) the North–South Economic Corridor (NSEC), which covers the major routes running from Kunming in Yunnan, [the People's Republic of] China through the Lao PDR and Myanmar, and to Bangkok in Thailand (it has another arm that runs from Nanning in Guanxi, [the People's Republic of] China to Ha Noi and Hai Phong in Viet Nam) and (iii) The Southern Economic Corridor (SEC), which runs through the southern part of Thailand, Cambodia, and Viet Nam (ADB 2012).

These key economic corridors have expanded the benefits of improved transport links to remote and landlocked locations in the GMS. However, trade facilitation remains a key

constraint for international road transport (Thant 2013). Meanwhile, rail remains an underutilized transport mode in the movement of international trade. The increased connectivity has not yet translated into substantial international trade creation along land corridors. The linkage of the GMS region into East Asian production networks is accomplished by international shipping from the main ports located in the GMS. Land transport serves mostly in the role of feeder services from inland production sites to the ports.

Enhancing the inland feeder links into trade-creating economic corridors requires the "widening" of the corridors (Srivastava 2012). This means expansion and completion of the infrastructure base, establishment of multimodal and intermodal transport facilities, and the promotion of logistics development. It also means more intensive area development around the corridors, with capacity building in productive economic hubs.

A priority policy and investment plan is needed that prioritizes those operations that provide hard and soft capacity to offer inland access to new markets and to new GVCs, and that consider regional cohesion and cost–benefit distribution aspects. Such a plan needs to consider the network effect of investments along specific priority corridors. Evaluation and monitoring models that combine New Economic Geography, nonlinear network and General Equilibrium Effects, can make explicit the distribution of costs and benefits across a region, and associate them with specific sets of priority investments along economic priority corridors, thus determining the prioritization of investments along an inclusive cost–benefit calculus.

The SASEC–SAARC Corridors North–South and East–West—Economic Corridors that May Just (Not) Happen

The SASEC part of South Asia is only partially integrated into the world trading system, lacks adequate production networks and scale economies, and suffers agglomeration and information coordination failures (ADB 2013). To overcome these obstacles to the creation of more geographically balanced and significantly higher productive employment, income, and consumption, the four SASEC members—Bangladesh, Bhutan, India, and Nepal—have in the last decade embarked on investment measures and policies to restore cross-border corridors and transit links. This is happening at an initial stage with the closing of connectivity gaps along select corridors. Investment measures are for specific locations and are meant to link productive activities in the economic periphery to economic activities in both national and international economic hubs.

The hope is that diverse sets of projected investments and policy measures will enhance underdeveloped exports, leading to increased incomes and equitable growth in the region. While many modeling approaches can generate frameworks for measuring the potential benefits of alternative sets of investments in a regional economy, there was a need for an approach that proves flexible enough to account for the effect of attempts to optimize investment along an economic corridor and along specific product value chains.

ADB supported the deployment of a model approach that mapped the SASEC economic geography in a dynamic way (over-time-cumulative) by populating it with economic

agents in employment and the product space. Under various calibrated simulations, the distribution of benefits accruing across the region in various investment scenarios were computed and displayed.

The results of the modeling are very rich. Investment in hard and soft trade-related infrastructure across the northeastern subregion of South Asia is not just additive; the benefits from combined investment sets are multiplicative. This is as recent trade literature would predict: economic gains from being able to combine a larger and larger set of export-production capabilities that accrue from a larger set of (hard and soft) infrastructure investments—and opportunities to coordinate these capabilities with market demand—grow exponentially as the number of capabilities increases. Taken to its full potential across a region, the end result of such an assessment is a strategic framework for a set of priority investments on economic corridors, intended to drive growth in exports of specific products that enjoy RCA in production. Many parts of SASEC have an RCA in agriculture- and resource-based export sectors.

Corridor-related investments under the strategic framework fall into two sets. The first consists largely of hard physical transport and trade infrastructure that would initially enable additional trade in nonperishable export products across the region. The second set of investments consists of those that make it possible to bring quality goods to markets in a reliable and predictable amount of time. Time-sensitive goods spoil if they are delivered to the market either too late or if their quality does not meet required photo-sanitary, technical, or other such standards.

With the model approach, three scenarios are simulated in accordance with the need for a benchmark in which changes with no additional infrastructure are described and a starting point in the computational methodology for assessing the potential effects of project and policy investments on data tiles across a value chain. The three scenarios are:

(S1) The existing (present day) network of roads and trains—the benchmark.

(S2) The transport network in S1 is enhanced by a set of nonperishable road and rail infrastructure investments such as additional road lanes alongside precise digital locations, the cost of investments, and a "guestimate" of their impact on reducing travel times.

(S3) The transport network in S2 is enhanced by a set of infrastructure improvements in perishable [P] trade supporting infrastructure improvements (e.g., refrigerated or automated warehouses or stockpile storage locations).

The results of comparisons between the three scenarios are described for administrative districts at the level of individual tiles and in aggregate for the entire population affected by economic corridor investments (Figure 4B). They can be made both in final equilibrium outcomes (e.g., costs, welfare) and in the dynamics leading up to equilibrium.

CAREC—Bringing Economic Corridors in from the Cold?

As an earlier evaluation initiative from a General Equilibrium Perspective has indicated, if CAREC is to realize its full economic potential, effective trade integration within the region and with the rest of Eurasia is essential (Norojono et al. 2010). CAREC has high economic potential as a naturally located bridge and transit region between the east of Asia and the European end of the Eurasian continent. Russian Federation has historically been the main trading partner for Central Asian economies. Trade connections between Russian Federation and the EU are being strengthened and trade is intensifying. Xinjiang Province in the [the People's Republic of] China now accounts for the bulk of CAREC's trade with the [the People's Republic of] China, and with the growing integration of the [the People's Republic of] China's western provinces with the east coast, the importance of and opportunities for extending production networks into Central Asia are rising.

Trade structure in the region is highly undiversified in terms of sectors of exports, markets, and exporting firms. Kazakhstan and Turkmenistan are the biggest exporters and together account for 80% of exports from the entire region. And most of this is exported to countries within the region and to traditional trade partners to the west. Only trade with the neighboring regions of the [the People's Republic of] China is growing and slowly increasing its share. The region's export product space is concentrated mainly in natural resources with little value-added content, and to a lesser extent, agriculture-based products. This is reflected in the CAREC countries' complexity indices in 2008, which ranged from a very low score of –0.26 to –1.25. For comparison, Japan has the world's highest reading at 2.36 and Mauritania the lowest at –1.96. (Felipe et al. 2012; Hausmann and Klinger 2006).

Furthermore, low economic density[4] suggests opportunities for hub-and-spoke economic corridor development approaches. The World Development Report 2009 section on Reshaping Economic Geography features an economic density index that factors travel times between large population centers and economic agglomerations. Not surprisingly, the Central Asian economies rank low on this index at around 39, compared to the OECD average of 60, which includes, for instance, Canada. Richer economies tend to have more concentrated economic mass and a higher degree of network clustering and centrality, though not to the point that overconcentration becomes a problem. The key agglomeration and other growth benefits in Central Asia come from hub development around the key urban centers, and possibly in newer secondary centers, whereas the transportation network links are completed in specific segments and the quality characteristics of these network links are improved in critical locations along the way. Figure 5B presents the traffic density on road and rail lines along the corridors, visually indicating that road transport is critical to trade among CAREC economies over shorter distances, whereas railway links largely carry the long-distance traffic, fed to some extent by the more localized road traffic. This is a function of the transport cost characteristics. According to the CAREC Corridor Performance Measurement and Monitoring Report for the third quarter of 2012, the cost to cross 500 km was $1,258 for

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[4] Defined as economic mass per unit of land area in World Bank (2009).

roads and $613 for railways. Road transport has the advantage in flexibility and short-distance services, whereas rail can move goods efficiently over longer distances.

Given the transit and bridging potential of the region from East to West this long-distance intermediary function might be enhanced further. Pomfret (2010) compares container freight tariffs from the [the People's Republic of] China to Europe by sea (Shanghai–St. Petersburg) and by rail (Shanghai–Moscow). The cost of shipping a 40-foot container by sea is about one-half the cost of shipping via rail. However, rail can move the container in one-half the time. So far, the CAREC investment program has been focused on increasing the completeness and the travel speed of the transport corridor network.[5] Supplementary investments could be examined that would make the transit and bridging function of the region a competitive success, on a cost, time, and quality basis.

The Switzerland of Transit (Clockwork)

Switzerland has a very diverse and complex manufacturing economy in its own right. As a landlocked economy, it is well connected along the Rhine valley via road, rail, and barge to the main port of Rotterdam. The aspect we will highlight is the important function of transit in the country. Switzerland serves as a transit country between the northern European manufacturing centers and the industrial economies of Italy, France, and Spain. In 2002, the Land Transport Agreement between Switzerland and the EU came into force, introducing the distance-related Heavy Vehicle Fee (HVF) for transit (Swiss Federation 2010). The main treaty is supported by another six EU–Switzerland treaties. A comprehensive treaty system with the EU allows Switzerland to utilize the EU's common transit procedure, which is a single procedure from the starting point of a good in transit to its end point. Transit is implemented with the New Computerized Transit System (NCTS), and it consists of an Automated Import System, and Automated Export System, economic operators' registration and identification systems, a Single Electronic Access Point, a Risk Management Framework, and an Integrated Tariff Environment, among others (EU 2001). The NCTS and the HVF together constitute an effective modern electronic-based, environmental friendly road and rail transit system. The systems are fee-based and avoid congestion, while at the same time they support investment in the infrastructure that allocates traffic between rail and road in an environmentally friendly manner.

For instance, a 40-ton EURO 3 truck transiting over 300 km pays on average CHF325. The fees cover the operating and investment costs of the HVF. The surplus revenues are shared between the federal (two-thirds) and local (one-third) governments, and are invested in new roads and road maintenance. Fee income is over CHF5 billion annually. The federal government invests most of the surplus proceeds in key rail transport projects to further entice transit traffic to move off the road and onto rail. (Switzerland also offers a roll-on, roll-off service for trucks on trains.) As a result, transit movements across Switzerland have been lowered, the use of fuel-efficient trucks has increased, and transit volumes on rail have increased relative to road.

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[5] See www.carecprogram.org for more information on investment projects.

Appendix C. ADB Regional Investments

The ADB Charter gives "priority to those regional, subregional, and national projects and programs which contribute effectively to the harmonious growth of the region as a whole." In 2006, ADB formalized a Regional Cooperation and Integration (RCI) Strategy with four priorities: (i) improve cross-border physical connectivity, (ii) increase international trade and investment with regional and non-regional economies, (iii) contribute to regional macroeconomic and financial stability and financial market development, and (iv) improve regional environments and social conditions. "Regional integration here refers to a process through which economies in a region become more interconnected. Such economic interconnection can result from market-led and private-sector-driven actions, and/or government led policies and collective initiatives in a region. The latter—collective policies and initiatives by the governments which, in turn, could be either formally embodied in an intergovernmental treaty or informally agreed upon by the participating countries—is regional cooperation (ADB 2006)." From 2008 to 2010, ADB financing for such RCI activities amounted to over $1.5 billion, and this figure has grown to well over $2 billion since 2011.

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Figure 1: Local to Global Connectivity
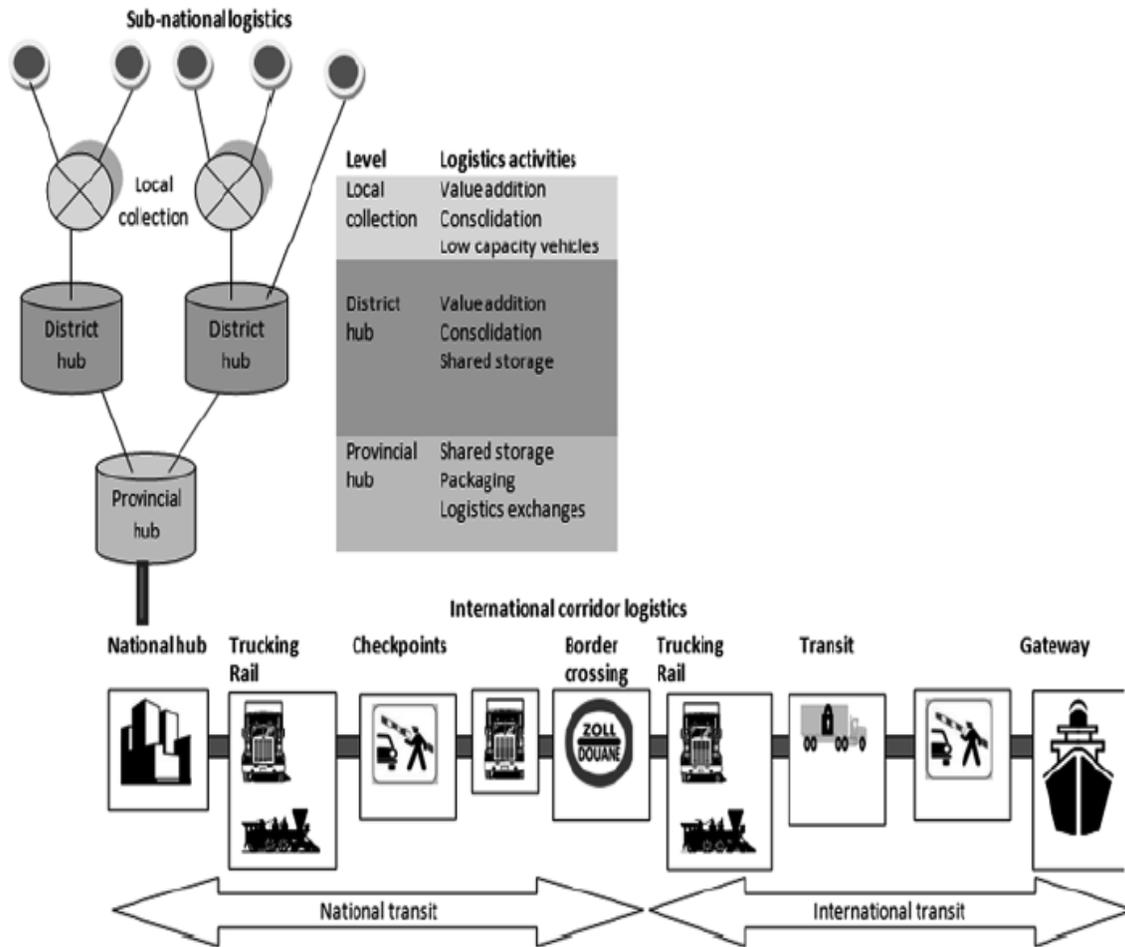
Source: Kunaka (2011).

Figure 2: Economic Corridor and Growth Economics
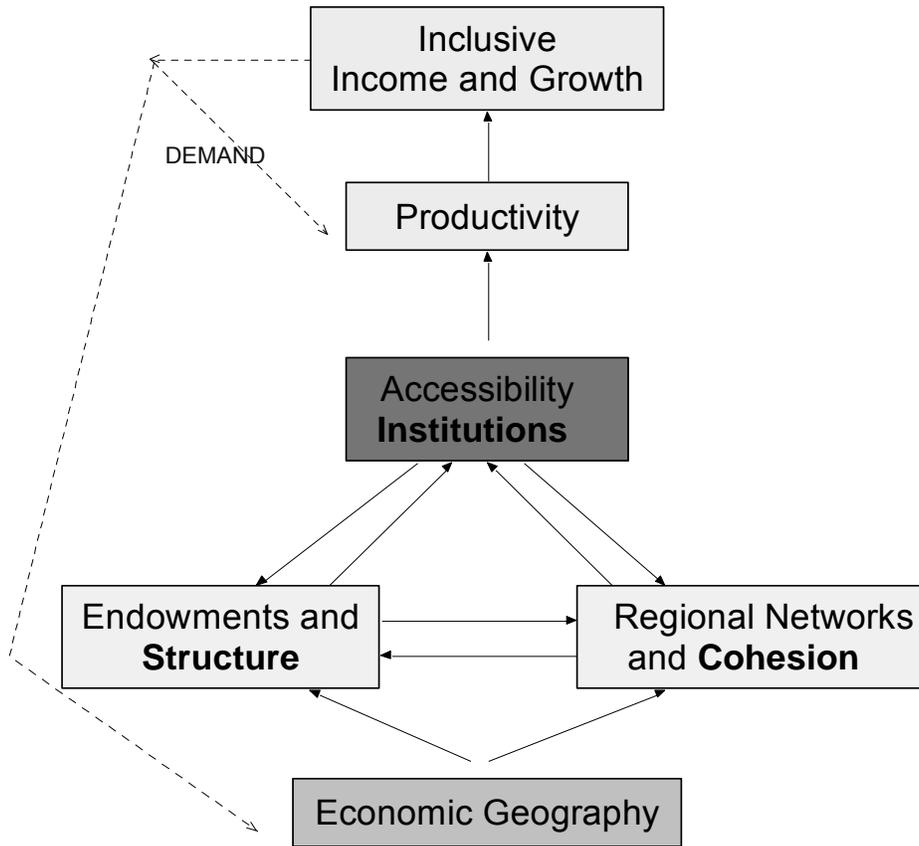
Source: Author's illustration.

Table 1: Monitoring Corridor Types Along Layered Dimensions Related to Benefits and Risk

Parameter Dimensions	Corridor Types		
	B + T 1	High-C 2	C + C 3
Access			
• Initiatives	S Physical inter-modal connectivity S Increasing network completeness	C High quality information network completion	S Physical inter-modal connectivity
Travel character	I Building capacity and for comprehensive transit arrangements	I Financial market deepening and broadening, inclusive of venture capital	I SME market access capacity building and finance of export diversification
Transit	I Strengthen hub development institutions; develop distribution nets, standards, and traceability for market access		C Finance priority joint ventures to gain improved access to know-how
Market access	C SME exporter cluster development initiatives and finance	Active participation in the lead development of GVCs	C Open up regional cross-border investment, especially in services sectors
Export finance	C Open up regional cross-border investment, especially in services sectors	Immigration of risk-takers and entrepreneurs validate clustering of high value support services	
• Benefits			Decrease of intra- and inter-regional economic distance
Bridging	Higher connectivity with transit throughput (high "betweenness")	Financial market imbalances, stress disrupts investment flows	Out-migration of economic resources
Structural	Increased safety, reliability, and transparency of goods movement		Introduction of economic volatility from external shocks
Cohesion network	Higher centrality of inter-regional trade net		
• Risks			
Bridging	Insufficient volume and scale persists		
Structural			
Cohesion network			
Structure			
• Initiatives	S Build up infrastructure, soft and hard for perishables export	I Strengthen institutions for competition and innovation policies, and implementation S Build up excellent national and regional quality infrastructure	S Building soft and hard infrastructure
Competition for central places in product space	I Improve vocational training and institutions	C Standards, SPS and TBT capacity	I Improve vocational training and institutions C Establish linkages to new GVCs and markets
Export complexity	S Diversify into GVCs		C Establish and finance SME clusters related to GVCs to

Model Elements I, S, C

Perishables		I Positive business environment for entrepreneurs, promotion of FDI	exploit emerging comparative advantage
Labor productivity		I Competency development in higher education	I Build standards capacity and information links for (SME) learning
Regional inclusiveness	Quality bridging of distance to markets	C Professional and R&D cluster strength	Increasing scale economies and increasing demand feedback (regional and inter-regional)
• Benefits	Increase of export complexity and diversification	S Urban environment and beauty	
Bridging	Clustering of productive resources increases income and attractiveness of hubs	C Regional public goods focus	
Structural			
Cohesion network			Uncompetitive structures retained
• Risks	Building bridges to markets that get stuck in nowhere	Increased density of tightly-knit high-tech knowledge and production nets leads to competitiveness and high centrality in trade nets	
Bridging	Transition function saps value added function of region		
Structural		Building "cathedrals" in the desert	
Cohesion network		Fostering regional imbalances in incomes	
Cohesion Network			
• Initiatives	S Build comprehensive, information-intensive transit infrastructure	I Sponsor high quality work environment for inward migration	I Increased institutional coordination across agencies, and between government and the private sector for value chain development
Population and economic agents and dynamics	I Adopt comprehensive transit and related legal agreements	C Strengthening of high-end services clusters	C Foster regional value chain integration to gain economies of scale
Value chain development, information nets, and component trade geography	I Accede to all key international conventions in transport, logistics and trade	S Integrate to the high-end complex product part of the value chain	I Strong focus on trade facilitation measures, especially logistics integration
Regional network integration	C Buildup of logistics cum energy hubs tied into regional production hubs	S Maintain a diversified firm ecology	

	Bridging	Structural	Cohesion network
Higher transport net completeness			
Local to global interconnectivity (corridor logistics and border measures and harmonization)	Local to global feedback leading to scale lowering cost and time of transport services	Increased trade centrality in tightly-knit nets High value-added in a knowledge intensive economy, with the help of (scale-free) learning nets	Improved access to new technology, finance, and capacities generates income growth and leads to increased trade diversification and volume
• Benefits	Increased diversity, density of hubs for agglomeration of resources Increased cost, time, quality competitiveness		
• Risks	Overinvestment in unmanageable transit technology Cost, time competitiveness is not achieved due to external shocks Information and coordination barriers retained Socio-economic disparities emphasized	Disruption of component trade and disconnection with trade network sections Technology diffusion and dissipation of tightly-knit cluster structure Isolation of network elements	Connectivity leads to out-migration of resources when growth dissipates

Labels (left column, in order): Higher transport net completeness; Local to global interconnectivity (corridor logistics and border measures and harmonization); • Benefits — Bridging, Structural, Cohesion network; • Risks — Bridging, Structural, Cohesion network

Source: Author.

Appendix B

Figure 1B: SASI Model – European Development
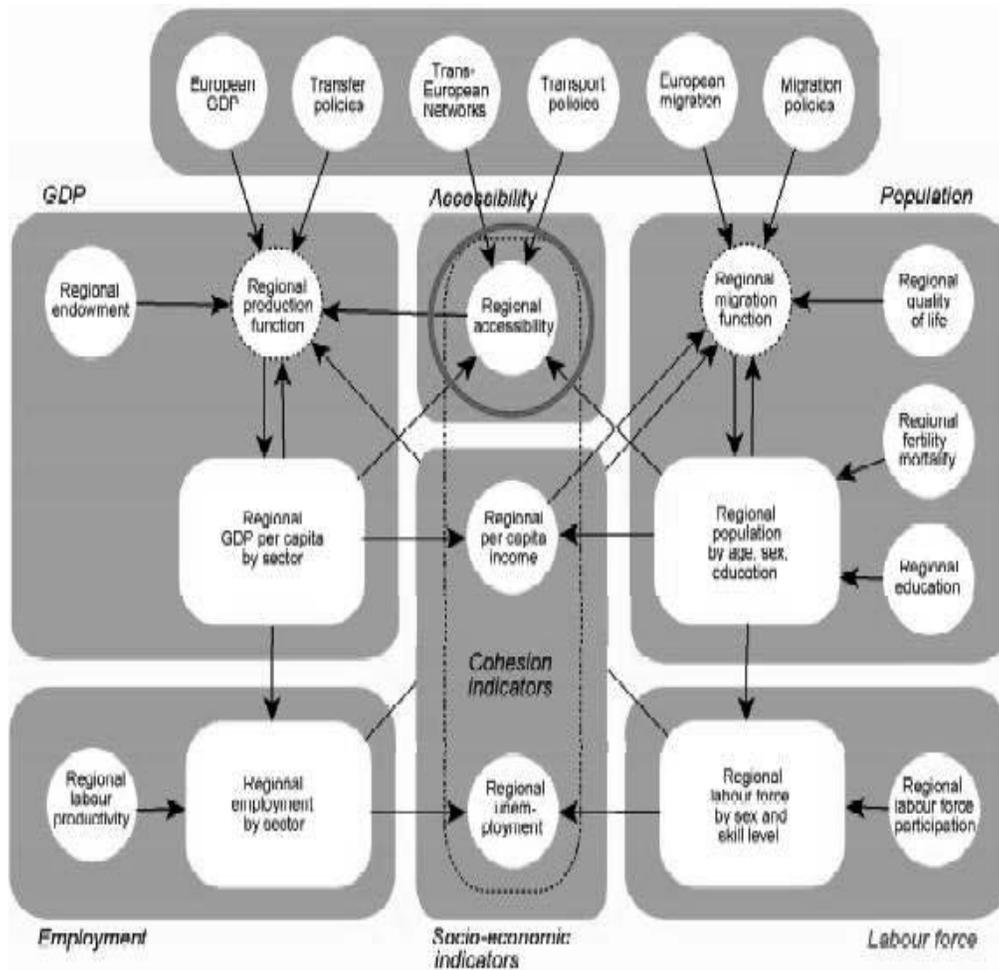
Source: ECORYS (2006).

Figure 2B: EU Corridor from Latvia to Frankfurt

GDP per capita (in 1,000 Euro of 2005)
Difference between Balanced Scenario
and Reference Scenario (%)
Latvia
2031

2.4 - 3.0
1.8 - 2.4
1.2 - 1.8
0.6 - 1.2
0.0 - 0.6
-0.6 - 0.0
-1.2 - -0.6
-1.8 - -1.2
-2.4 - -1.8
-3.0 - -2.4

0   100   200 km
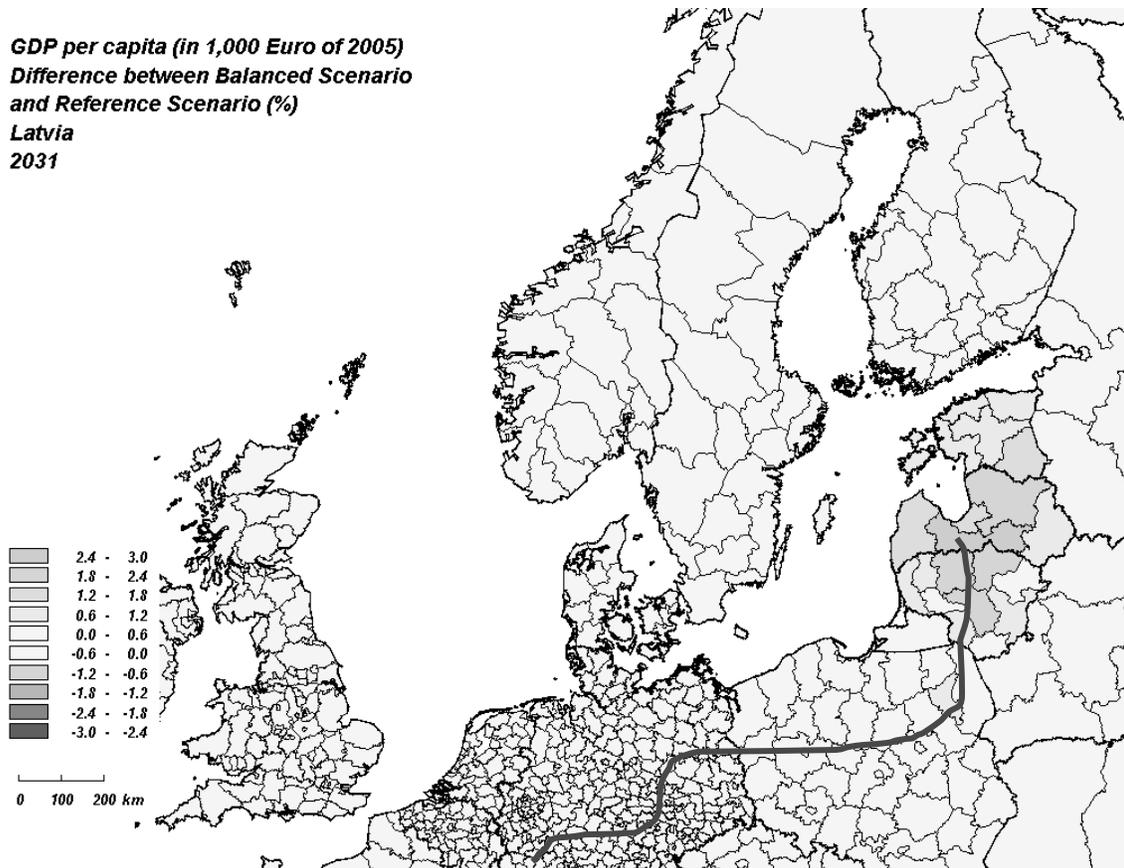
EU Corridor from Latvia to Frankfurt, Germany

Source: ECORYS (2006).

Figure 3B: The Network through Interpersonal Relations in Jena
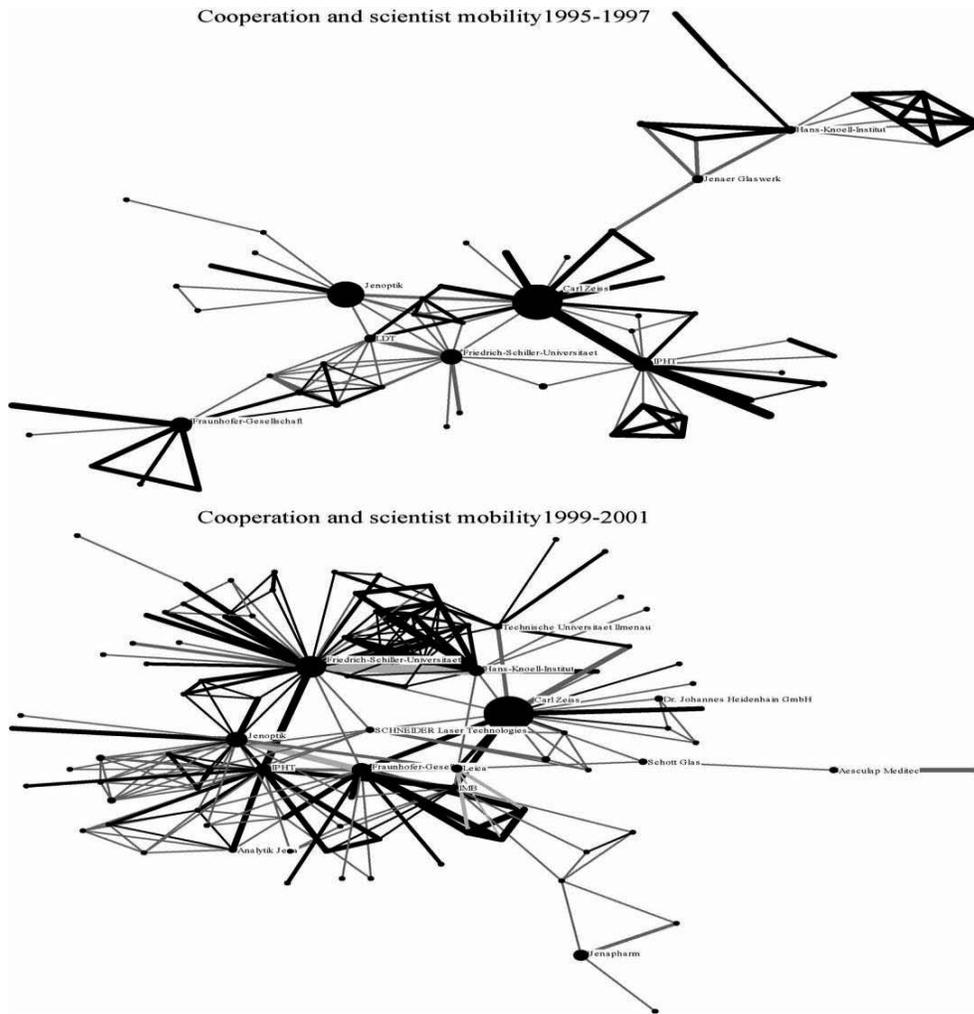
Note: Cooperation = Black, Scientist mobility = Gray

Source: Cantner and Graf (2006).

Figure 4B: District Income Growth above Baseline from Full Investment Package
(S3)
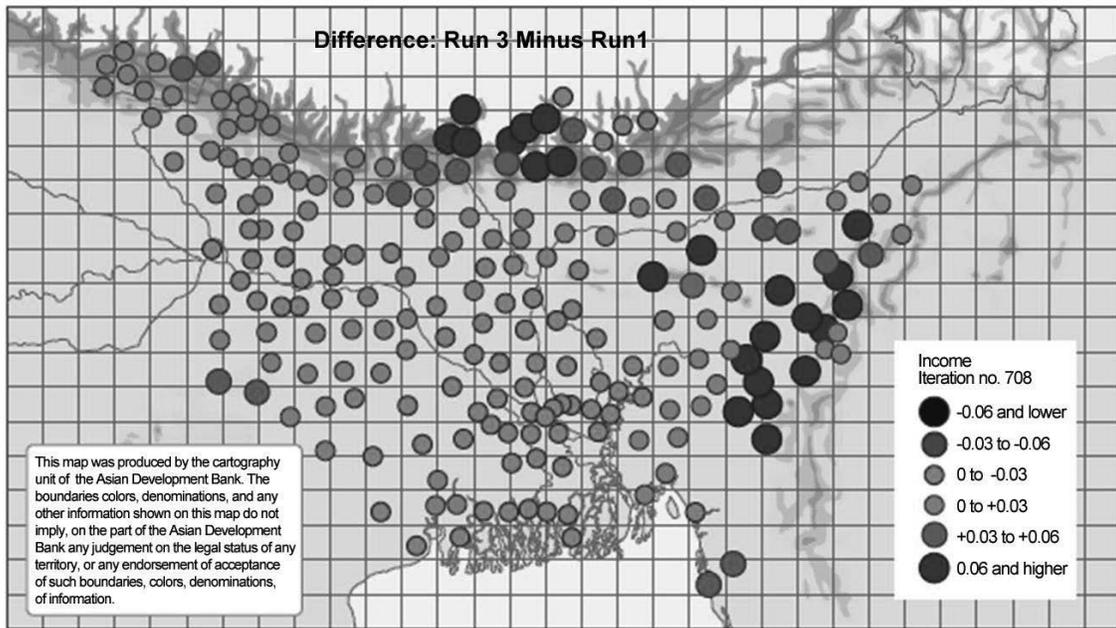
Note: Color shading reflects attitudes.

Source: ADB (2013).

Figure 5B: Traffic Density on Road and Rail Links in the CAREC Region

Map 2.1: Road
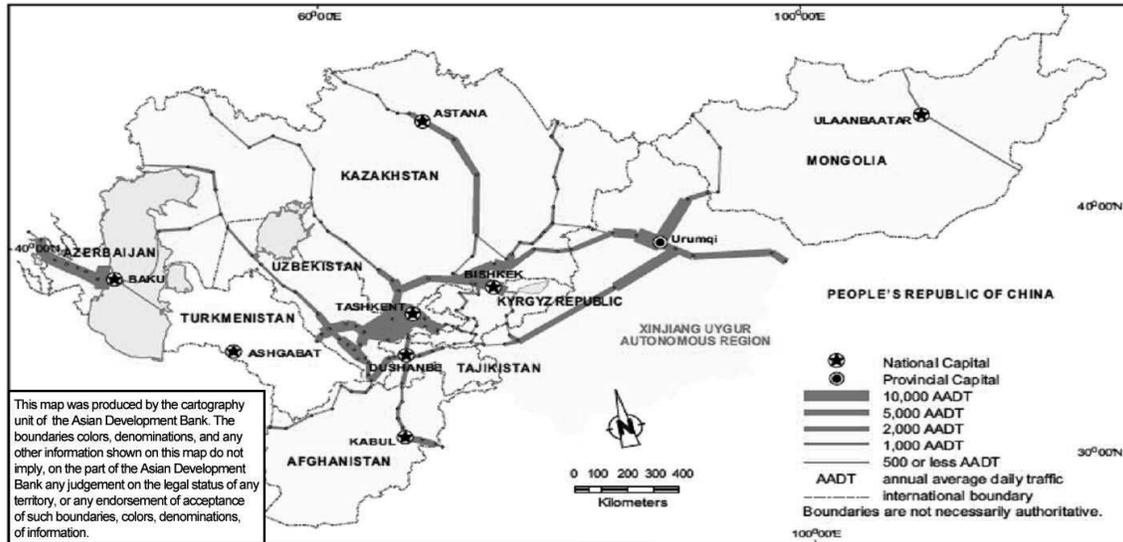
Map 2.2: Railway
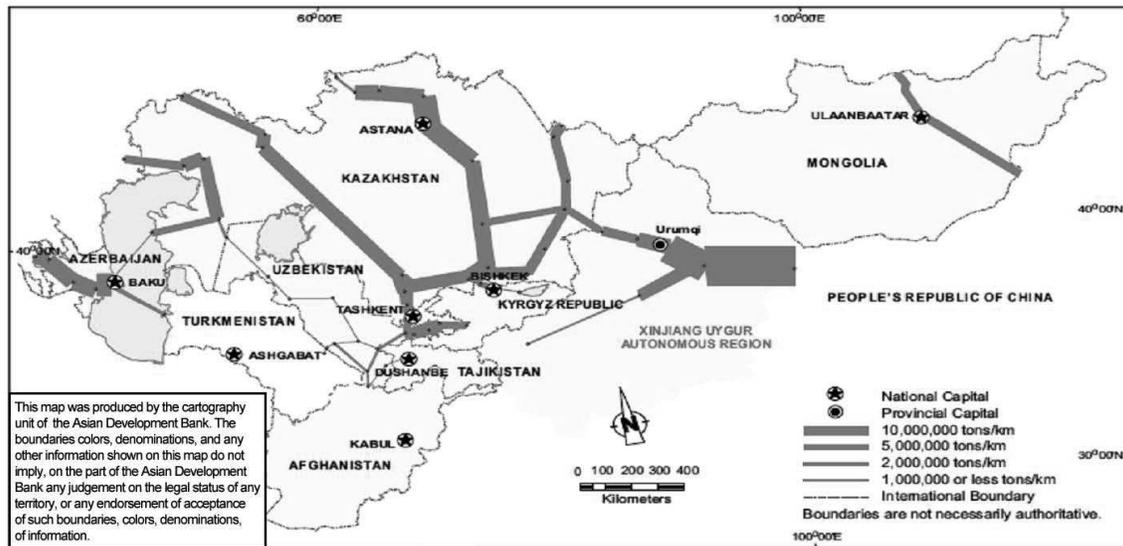
Source: Asian Development Bank.

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