Economic Integration and Infrastructure Deployment in Developing Countries*

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Abstract

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Keywords: market integration, regulation, competition, investment, electricity, transportation infrastructure, joint venture.

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1 Introduction

This paper presents a synthesis of a research contract ordered by the French Development Agency on the topic of infrastructure deployment in developing countries in the context of economic integration. Many developing countries are not on track to meet the infrastructure deployment millennium development goals (MDGs). Realizing the growth potential of the poorest regions in the world, which is large, is conditional on making substantial progress in the provision of essential public goods and infrastructure, notably transportation and electricity. In this context market integration may allow a better use of existing ressources and infrastructures. This project studies how market integration can, first, foster or hinder investment in infrastructure, especially in electricity (Auriol and Biancini, 2009 and Beradi and Seabright, 2009), and, second, how transportation infrastructures, especially railways, shape the development of the connected countries/regions (Calmette, 2009 and Friebel et al., 2009).

World electricity demand is projected to double by year 2030. The total cumulative investment in power generation, transmission and distribution necessary to meet this rise in demand is estimated to be $ 11.3 trillion. This amount covers investment in fast-growing developing countries, such as India and China. It also covers investments in OECD countries where ageing facilities need to be replaced and new facilities need to be built. Finally, it covers investments necessary to relieve the acute power penury experienced by some of the world's poorest nations, especially in Sub-Saharan Africa. The problem of how to finance the amount of capital required for these various investments is daunting. The deregulation and liberalization waves that swept throughout the world in the 1980s and the 1990s have eroded governments' ability to tax industry rents and to subsidize infrastructure deployment. In the logic of the reform, the private sector was to be the substitute provider of investment capital previously committed by public/regulated industry. However, in developing countries, private investment flows dried up after the collapse of Enron and the Asian financial crisis. Without cross-border trade, countries are obliged to rely on much more expensive sources of generation in order to respond to a growing demand. Cost complementarities constitute the engine of integration in the EU electricity market, in the Greater Mekong Subregion (GMS), in North, Central and South

American electricity regional markets[1] and in Africa.[2] Market integration may also allow the realization of projects that are not achievable by an isolated country. For instance less than a third of hydropower potential is currently exploited (mostly in advanced economies), because major hydroelectric-generation facilities are generally oversized for a single country. For West Africa, Sparrow et al. (2002) estimate between 5 and 20% the potential cost reduction associated with market integration (the estimation refers to the cost of expansion of the thermal and hydroelectric capacities).

The paper by Auriol and Biancini, 2009 shows that market integration has complex welfare implications in non-competitive industries controlled by national regulators. To be more specific, when the cost difference between two national champions is small, the negative business-stealing effect outweighs the efficiency gains: welfare decreases in both regions following integration. By contrast, market integration is welfare-enhancing when the cost difference is large between the two regions. First, if the foreign firm is significantly less efficient than the national firm, the benefits from increased export profit (due to the possibility of serving also foreign demand) increase total welfare in the exporting country. Second, if the foreign firm is significatively more efficient than the national firm, the inefficient country can benefit from the reduction in price caused by competition, which enhances consumer welfare in the importing country. The paper next studies investment incentives depending on the nature of the investment. Compared to autarky, market integration is shown to improve the incentives to invest in cost-reducing technology (e.g., hydroelectric power plant). Integration, by stimulating investment in more efficient generation sources, reduces some of the inefficiencies arising in closed economies. Nevertheless, the global level of investment remains suboptimal because the country endowed with the low-cost technology does not fully internalize the foreign country consumers' surplus (i.e., it only internalizes sales). By contrast, there is systematic under-investment in infrastructures that provide a public good, such as interconnection or transportation facilities. Free-riding behavior reduces the incentives to invest, and business stealing reduces the capacity of financing new investment, especially in the importing country. The

[1]Central American nations, Guatemala, Nicaragua, El Salvador, Honduras, Panama, Costa Rica, have established a common regulatory body, the Regional Commission of Electricity Interconnection (CRIE).

[2]In Africa there are several power pool: South African power pool (SAPP), West African power pool (WAPP), Central African Power Pool (CAPP), East African Power Pool (EAPP) and interconnection initiatives in North Africa with ties to the Middle East.

problem is sometimes so severe that global investment decreases, compared to autarky. The underinvestment problem has important policy implication. For instance, several programs supported by the World Bank in Bangladesh, Pakistan and Sri-Lanka have failed because of this problem. The Bank supported lending to generators through the Energy Fund, in the spirit of Public Private Partnerships. Investment in generation was made and the production of kilowatts rose. However, due to poor transmission and distribution infrastructures, the plants were kept well-below efficient production levels. On the one hand, power consumption stagnated because power was stuck at production sites. On the other hand, public subsidies to the industry rose because generation investment had been committed under take-or-pay Power Purchase Agreements. In the end both consumers and taxpayers were worse off.

To address the structural under-investment problems, Beradi and Seabright, 2009 study how joint venture mechanisms can help different countries to commit to a fair level of investment. Many large infrastructure projects involve international cooperation. Sometimes this cooperation is contractual - the owner of a productive asset simply sells the services it yields across international frontiers. Often, though, it takes the form of a joint venture: the establishment of a corporate governance structure characterized by joint ownership, with the owners located in different countries. In fact joint ventures are common in infrastructure projects, especially in poor countries. This is a puzzle: joint ownership is typically inefficient, because it subjects the managers of the project to the instructions of owners whose interests may not be aligned. So why does it happen? The answer Beradi and Seabright, 2009 explore in their paper is that joint ownership has advantages when it commits the parties to resisting certain kinds of lobbying to expropriate the fruits of investment in the project. Indeed the joint venture governance structure commits the parties to equality of treatment in respect of the revenues generated by the project. When revenues are realized the owners of the project are of course free to reinvest those revenues back into the project, or to distribute them as they see fit. Lobbying activity, will create a bias towards distribution and away from reinvestment. However, an economic agent who is only part-owner of the project will find that distribution become relatively expensive: choosing to distribute revenues implies a duty to distribute to the other owners as well. This greater cost may help, therefore, to redress the balance

and make reinvestment relatively more attractive again. This has potential important applications in other infrastructure projects, such as roads and railways.

Transportation infrastructure are crucial to developing countries growth, especially to landlocked ones. The need to export their production of natural ressources and the difficulty that they have to reach ports is a huge bottleneck for these regions. Calmette, 2009 paper shows, in an economic geography framework, that a regional regulation of transports, by decreasing transport costs, could help the landlocked regions to develop their activities. The analysis shows that a virtuous circle will follow the construction of such transportation infrastructure. Indeed not only will the landlocked region growth but the coastal region will growth as well. Services sector and port will benefit from the improved transportation infrastructure as more trade between the landlocked region and the rest of the world will follow. However the issue of how to finance the roads and railroads to better connect the landlocked and coastal regions is not trivial. Transportation infrastructure have a public good aspect that, as shown in the paper by Auriol and Biancini, 2009, leads to systematic under-investment. The implementation of international joint venture (hereafter JV), as analyzed by Beradi and Seabright, 2009, could be a way to alleviate this under-investment problem, if the different countries benefiting from the infrastructure and possibly international agencies were in the JV together.

The choice of the transportation infrastructure between road or railroad depends on the cost efficiency of both links and on the existing network. Yet over long distance railways is generally more cost effective than transportation by roads and it is also less polluting. In developing countries an important issue for the rehabilitation, extension and creation of railway, but also electricity, networks is whether the infrastructure should be created and managed separately from the service (i.e., generation or transportation). Friebel et al., 2009 studies this question in a theoretical framework, and by reviewing empirical studies for the railways industry. They conclude that in very poor countries with very low density of network, and thus increasing return to scale in infrastructure investment, the optimal structure is the vertically integrated structure: the same firm should build the network and exploit it. This is in contract with the policy favored by the World Bank in many infrastructure industries. It has indeed pushed for vertical de-integration of former national monopolies to foster competition in the service segment.

Friebel et al., 2009 suggest that this is a bad idea, at least in the railways industry.

The rest of the paper is structured as follows. Section 2 presents the paper by Auriol and Biancini, 2009 on economic integration and investment incentives in electricity. Section 3 presents the paper by Beradi and Seabright, 2009 on the financing of infrastructure deployment in developing countries through joint ventures. Section 4 presents the paper by Calmette, 2009 on how transportation issues shape economic geography in developing countries. Section 5 presents the paper by Friebel et al., 2009 on optimal industry structure for international rail transportation. Finally section 6 concludes.

2 Economic Integration and Investment Incentives in Electricity

The integration of market economies progresses unevenly across industries. In regulated markets, due to increasing returns to scale and the incumbency advantage, the main players of integrated markets are the top performers of the former national monopolies.[3] In theory, public intervention should mitigate the consequences of firms' market power and ensure that the efficiency gains generated by the reforms are passed along to consumers and taxpayers. However, market imperfections are harder to handle in an integrated market than in a closed economy because integration implies a loss of control for the national regulators. Economic integration removes barriers to trade so that the relevant market is regional, while regulation still acts nationally. Despite the potential benefits of market integration, sovereign countries focus on domestic welfare and tend to favor policy of energy independence. Yet in the absence of a legitimate supranational authority to regulate prices, production quantities or investment, competition among countries for the sector rents yields inefficiencies.

The paper by Auriol and Biancini, 2009 addresses the problems posed by infrastructure investment in liberalized regulated markets. It first analyzes the welfare implications

[3]For instance, in the European electricity market, economic liberalization has generated a wave of mergers and acquisitions so that two thirds of the European market is in the hands of eight large companies. Moreover, among the EU-15, the top three European generation firms have 60% of the market in ten different countries (European Commission 2007, Energy Sector Enquiry). http://ec.europa.eu/comm/competition/sectors/energy/inquiry/index.html

of an imperfect integration of regulated industries. It next studies how coordination problems between independent regulators affect supranational investments, such as interconnection facilities or infrastructures for the common market. Examples from the electricity sector, especially from the African region, illustrate the analysis.

2.1 International Experiences in Electricity Market Integration: Lessons for West Africa

Although Africa is endowed with abundant energy sources, including substantial oil, gas, coal, sunlight, hydro and geothermal power, access to electricity, estimated at 24% of the population by the International Energy Agency, is the lowest in the world. Since energy is one of the most significant engines of growth (see for instance Ayres, Ayres, and Warr, 2003), the lack of power acts as a brake on the African economy. This situation worsened in the last years, when the need for fiscal adjustment led to a reduction in public investment without a corresponding increase in private investment. The quality of infrastructure is very poor and seems even to be declining. Technical losses on the network are often estimated above 10%. Moreover, most African utilities operate below efficient level of scale, due to the limited size of their markets. Tovar and Trujillo (2004), studying electricity generation between 1998 and 2001 in 13 countries (mostly East African), show that inefficiencies of scale are in the order of 24%.

To overcome some of these problems and increase system efficiency, West African countries have started several market reforms, following nationally different approaches. Nigeria and Ghana have launched a full liberalization of their markets. Senegal, Mali and Burkina Faso are now considering moving to a more liberalized market, with a central buyer and independent distributors. Togo and Benin have preferred a hybrid system of "unbundling". In Côte d'Ivoire, Guinea, Niger, Senegal and Mali the industry is still vertically integrated and organized around single buyer. At the regional level, the countries have created the West African power pool (WAPP).[4] They are now working on the creation of a regional regulatory body, "Organe de Régulation Régionale" (ORR), which should promote market integration and cooperation among national regulators

[4]In Africa there are several power pool: South African power pool (SAPP), West African power pool (WAPP), Central African Power Pool (CAPP), East African Power Pool (EAPP) and interconnection initiatives in North Africa with ties to the Middle East.

(and/or governments). The ORR will be charged of establishing a harmonized institutional framework and promoting cross-border trade, as well as developing a sustainable regional electricity market and its gradual opening to competition. In an integrated market, the saturation of economies of scale may finally allow the realization of projects that are not achievable by an isolated country. Without cross-border trade, countries have reduced generation options. They are obliged to rely on much more expensive sources of generation in order to respond to a growing demand. This implies that a substantial portion of demand is not served at all. Sparrow et al. (2002) estimate between 5 and 20% the potential cost reduction associated with market integration (the estimation refers to the cost of expansion of the thermal and hydroelectric capacities). In addition, market integration would significantly reduce the cost of increasing reserve margins. Prospective efficiency gains appear to be substantial in the region especially because the potential for energy generation is very unevenly distributed across West African countries. Nigeria alone controls 98% of oil and natural gas sources in the region, while the 91% of the hydroelectric potential is concentrated in only five countries. Large hydroelectric projects, such as the projects for the Senegal River basin and the Grand Inga in the region of the Congo River, could be beneficial to all countries in the region.[5]

West Africa is not the only developing region which is trying to develop a regional market for electricity. For instance, electricity market integration is progressing fast in the Greater Mekong Subregion (GMS). The uneven distribution of energy resources in the GMS provides a strong motive for regional integration. Countries that have large demand, such as Thailand and Vietnam, do not have sufficient energy resources, while countries smaller markets, such as Laos and Myanmar, have large supply potential, in terms of hydropower and gas resources. Similarly, cost complementarities constitute the engine of integration among several Central and South American countries. In South America, many bilateral project have been started, to exploit the potential gains from cross-border trade. In the region, Venezuela is an OPEC's member with huges reserves

[5]The region possesses some of the largest water courses in the world (Nile, Congo, Niger, Volta and Zambezi river). The hydro potential of the Democratic Republic of Congo alone is estimated to be sufficient to provide three times as much power as Africa currently consumes. Oil and gas reserves are concentrated in the north and west, coal reserves are in the south. Geothermal resources are largely in the Red Sea Valley and the Rift Valley. Finally Africa is well exposed to sunlight so that solar energy could be useful in remote areas.

of heavy oil. For natural gas, Bolivia, Venezuela and Peru possess huge reserves, but their domestic market is too small and they need huge investments in order to monetize their reserves. On the other hand, the Brazilian domestic market is developing fast and Chile is already very dependent on imports. Several interconnection project have been launched to exploit these efficiency gains. An even more pertinent example is given by the six Central American nations (Guatemala, Nicaragua, El Salvador, Honduras, Panama, Costa Rica), participating to the Electric Interconnection Project of Central America (SIEPAC). These countries have established a common regulatory body, the Regional Commission of Electricity Interconnection (CRIE). The creators of the West African regulatory body ORR clearly take the experience of CRIE as a model, although they also refer to the experience of the North American Federal Energy Regulatory Commission (FERC). Indeed, CRIE appears to be the more relevant example, because it is a purely supranational body involving several developing countries. In this context, the problem of attracting investment to increase infrastructure capacity was central. For this purpose, a new company (EPL) has been created in order to build a new regional interconnection line: it is controlled by the national transmission companies with the participation of the Spanish ENDESA. EPL's investment program has been financed through loans obtained from several European banks, together with the contributions of the member countries. CRIE is now in charge of setting the access tariffs needed to repay the loans that financed investment. It is clear that the role of the regional regulator is important to ensure the viability of the infrastructure and to create a favorable environment for new investments. The future role of the ORR is quite similar to that of CRIE: it should create an environment capable of attracting investment both regulating cross-border exchange and through its audit, monitoring and coordination activities. An additional complication in the West African region is related to the fact that the majority of countries have major problems with their national electric systems. The role of the ORR should be evaluated in a broad context: the integration of the existing infrastructure is not sufficient to stimulate a development of the sector if the problems related to transmission and generations capacity in the different countries are not addressed at the same time.

Despite the potential benefits of market integration, countries tend to favor policy of energy independence. National governments are not indifferent between domestic and

foreign producers. In this sense, the European experience is close to the spirit of the West African project. In Europe, the Commission promotes the formation of an integrated market and defines the programmatic lines of action for member countries. However, governments and national regulators retain jurisdiction over specific choices, while respecting the overall framework designed by the Commission. Despite the common framework given in the Commission's directives, in practice electricity market integration proceeds at different speeds in different regions. The integration of electricity markets is advanced between France and neighbor countries (Italy, Spain, United Kingdom) and the Nord Pool (regional market of the Scandinavian countries). In the case of France, UK, Italy and Spain, the difference between generation costs is the engine of integration. Countries with high costs (Italy, Spain, UK) benefit from low prices, while the country at low cost (France) benefits from new profit opportunities. Regarding the Nord Pool, the region is not characterized by marked differences in the average levels of production costs, but there is some form of technical complementarity between seasonal hydropower (Norwegian) and the thermoelectric production (Swedish). In addition, the development of integrated Scandinavian market has certainly increased efficiency: national regulations do not seem to conflict. The north pool regulators are rather cooperating efficiently. Other countries are much less active in the development of cross-border networks and, more generally, less opened to the entry of foreign producers (either directly or indirectly by taking control of existing companies).

Conflicts between governments often arise and slow down the integration processes in many parts of the world. To evoke an example from a different region, MERCOSUR has also promoted, from the times of its creation in 1991, energy market integration of its member countries (Argentina, Brazil, Paraguay and Uruguay). Several large bi-national hydro-projects have been started in the region[6] and by 2025 this group of nations are expected to complete the integration of their electricity grids. However, regulatory differences and government conflicts still appear as the major constrains for integration (Pineau et al., 2004).

[6]Brazil and Paraguay share the Itaipu hydroelectric facility, the world's largest operating hydro complex. Argentina and Paraguay jointly own Ente Binacional Yacyreta (EBY) a hydroelectric dam on the Parana River and are also considering another hydro complex on the Parana River at Corpus.

2.2 The formal analysis

The paper by Auriol and Biancini, 2009 studies the impact of market integration on firms' incentives to finance different types of investment. It considers two symmetrical countries both endowed with linear demand. On the production side, firm $i = 1, 2$ incur a cost function: $C_i(q) = \theta_i q + \gamma \frac{q^2}{2} + K$. The fixed cost K measures the economies of scale in the industry. As it is fixed it does not play a role in the optimal production choices. The firms' linear cost parameter, θ_i, represents a production cost. The quadratic term, which is weighted by the parameter γ, is interpreted as a transportation cost. A relevant parameter for the analysis is the differential in production cost between the two countries: $\Delta = \theta_1 - \theta_2$. It can be positive (i.e., firm 1 is less efficient than firm 2) or negative (firm 1 is more efficient than firm 2).

The paper focuses on asymmetric regulation: the regulator of country $i = 1, 2$ has jurisdiction over the national monopoly i only. She regulates the firm and is allowed to transfer funds from and to it. In particular she taxes operating profits when they are positive. For simplicity, one can think of public ownership.[7] Each utilitarian regulator maximizes the home welfare, given by the surplus of national consumers plus the profit of the national firm minus the opportunity cost of the public transfers to the firm. The opportunity cost of public fund, denoted $\Lambda \geq 1$, can be interpreted as the shadow price of the government budget constraint. It captures the idea that public funds are raised through distortive taxation. Abandoning a positive subsidy to a regulated firm creates distortions in other sectors. Conversely, when the transfer is positive (i.e. taxes on profits), it helps to reduce distortive taxation or to finance investment. The assumption of costly public funds is a way of capturing the general equilibrium effects of sectoral intervention. Both countries have the same cost of public funds.

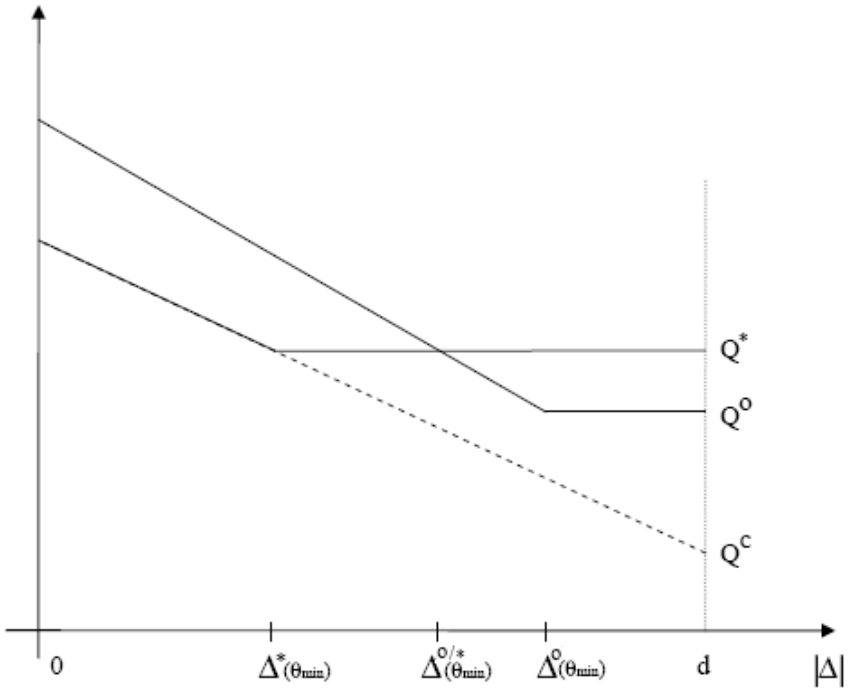
[7]Indeed in the case of electricity public and mixed firms are still key players in most countries. For instance Electricité de France (EDF), which is one of the largest exporter of electricity in the world, is owned at 87.3% by the French government. In 2007 the firm has paid more than EUR 2.4 billion in dividend to the government. However the paper assumptions are also consistent with the imposition of taxes on the rents made by private firms. For instance the outcry concerning the windfall gains to shareholders in the privatization of the UK electricity sector helped Tony Blair's Labour party regain power. It also led to the imposition of a special tax on the profit of the shareholders.

2.3 Market integration

When barriers to trade are removed, the two national monopolies can serve consumers in both countries. National regulators simultaneously fix the quantity produced by the national firm through the regulatory contract, maximizing expected national welfare. The system of reaction functions of the regulators determine the non cooperative equilibrium of the model. When $\Lambda = 0$, the quantity produced by the national firm is increased with respect to the quantity produced in a closed economy if and only if the foreign firm is less efficient (i.e., if $\theta_j - \theta_i > 0$). In this case, the foreign monopoly leaves some space to the more efficient competitor and consumers enjoy larger surplus. By contrast when $\Lambda > 0$ the regulator might choose to expand the national quantity with respect to the quantity produced in a closed economy even if the competitor is slightly more efficient. The reason is that competition decreases the net profits of the national firm without generating drastic increase in consumers surplus. In a closed economy, the regulator chooses a small quantity to enjoy high Ramsey margin. However, in the open economy, the Ramsey margin is eroded by competition and producing such a small quantity is no longer optimal. It only reduces the market share of the domestic firm. In his attempt to mitigate the business stealing effect the regulator increases the quantity of the domestic firm. Figure 2 illustrates the results. It represents in function of $|\Delta|$ and for a given $\theta_{\min} = \min\{\theta_1, \theta_2\}$, the quantity levels in the open economy Q^O, in the closed economy Q^C and in the benchmark case of perfect integration Q^*. The flat sections correspond to the shut down of the less efficient producer.

When $|\Delta|$ is smaller than $\Delta^{O/*}(\theta_{\min})$, the business stealing effect is strong. Regulators fight to maintain their market shares by boosting domestic production. Aggregate quantities are then larger in the common market than at the optimum, $Q^O > Q^*$. Symmetrically, when $|\Delta|$ is large the regulator of the most efficient country controls a large market share. The problem is that she does not internalize the welfare of foreign consumers. She chooses a suboptimal production level, $Q^O < Q^*$, whenever $|\Delta| > \Delta^{O/*}(\theta_{\min})$. Finally when the cost difference between the two firms is large, the less efficient producer is shut down and the most efficient firm is in a monopoly position (flat section in figure 1). The most efficient firm becomes a monopolist in the common market when $|\Delta| > \Delta^O(\theta_{\min})$.

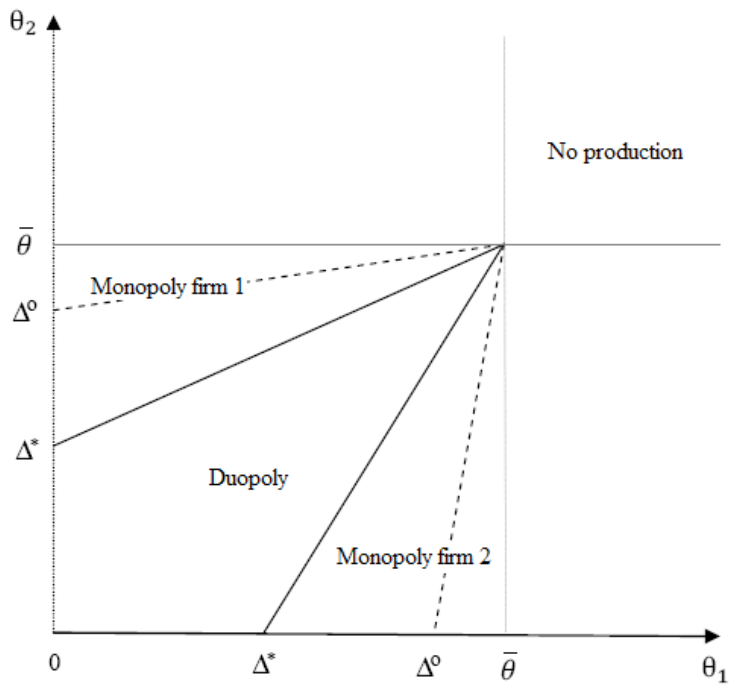
Figure 1: Total Quantities Q^*, Q^O and Q^C in function of $|\Delta|$



This implies that when there is no transportation cost, the first best contract always prescribes to shut down the less efficient firm. However the "shut down" result is upset with the introduction of transportation cost. When γ is positive both firms produce whenever the cost difference is small enough. The most efficient firm (i.e., the firm with the lowest cost parameter) has a larger market share than its competitor. The market share differences decreases with transportation cost.

Comparing the non cooperative equilibrium solution with the first best solution that would be chosen by a global welfare maximizing social planner (i.e., a case in which the two countries are fully integrated, even fiscally) one can show that the less efficient firm shuts down *less often* than the socially optimal solution (i.e., $\Delta^*(\theta_{\min}) < \Delta^O(\theta_{\min})$). This result is illustrated Figure 2. The dotted lines represent the equilibrium shut down threshold of the less efficient firm in the integrated market with independent regulators. The solid lines represent the optimal threshold.

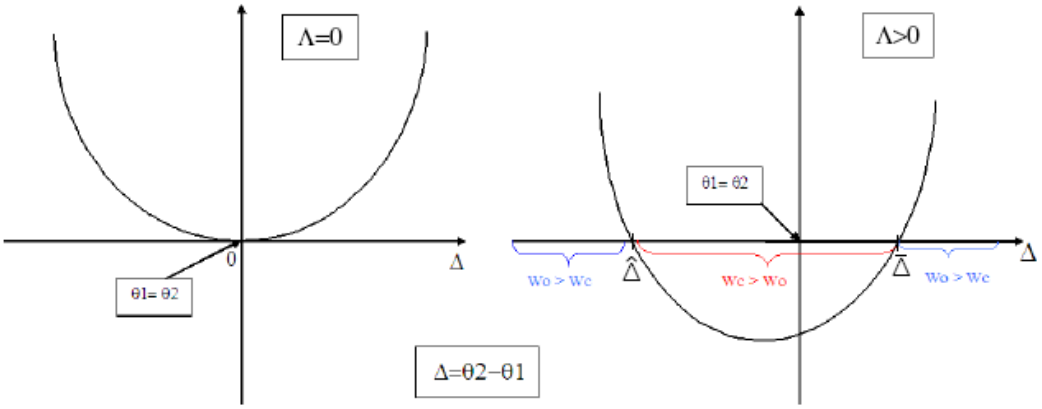
Figure 2: Shut down threshold of the less efficient firm. Solid line: optimal threshold, Dotted line: non-cooperative equilibrium.



Replacing the optimal quantities in the welfare function, the effect of market integration on welfare can be computed. For $\Lambda = 0$, market integration increases welfare in both countries. For any Λ strictly positive, market integration increases welfare in both countries if and only if the difference in the marginal costs $|\Delta|$ is large enough. Figure 3 illustrates this result. It shows the welfare gains of country 1 for $\Lambda = 0$ and $\Lambda > 0$ respectively (it is symmetric for country 2). When $\Lambda = 0$, taxation by regulation is not an issue and an increase in $|\Delta|$ increases the welfare gains identically in the low cost and high cost country. The less efficient country enjoys lower price while the more efficient country enjoys higher profits. Business stealing creates no loss because it is compensated by an increase in consumer surplus in the country with a smaller market share. When $\Lambda > 0$, the intercept, corresponding to $\Delta = 0$, is negative, which means that if $\theta_1 = \theta_2$ both countries loose from integration. To fight business stealing both countries increase their quantities. Price is decreased below the optimal monopoly Ramsey level and taxation by regulation decreases. Yet competition does not increase efficiency because the firms

have the same cost. The net welfare impact is negative for both countries. For $\Delta \neq 0$ the welfare gains of the two countries are asymmetric. For the most efficient country the gains are strictly increasing. For the less efficient country they are U-shaped. The welfare gains are first decreasing and then increasing. For $|\Delta|$ big enough, the welfare gains are positive in both countries.

Figure 3: Welfare gains from integration, $W_1^O - W_1^C$



Remark that $\hat{\Delta} \geq \overline{\Delta}$. It is clear that for Δ belonging to the interval $[-\overline{\Delta}, \overline{\Delta}]$, market integration achieved by two independent jurisdictions is inefficient. Each country welfare is decreased by integration.[8] The region as a whole is better off with the co-existence of two closed economies. The negative welfare effect arises because of the market share rivalry between the two countries. It is thus related to the literature on trade and competition. In the case of trade policy sustained by export subsidies, the result arises because of a prisoner dilemma between governments. Both countries would be better off if trade subsidies were forbidden. Here, the result depends on the negative public finance effect of competition.

For value of $|\Delta| \in [\overline{\Delta}, \hat{\Delta}]$ the most efficient country wins while the less efficient country loses. If one region loses while the other one wins, there will be resistance to integration. By contrast welfare is increased in both countries for values of Δ smaller than $-\hat{\Delta}$ and larger than $\hat{\Delta}$. In other words, the theory predicts that integration will be easier when

[8]The negative effect of business stealing on welfare, is not related to the assumption of a limited competition (i.e., duopoly) in the integrated market. Increasing the number of unregulated competitors would only worsen this effect.

the costs difference between the national champions is large.

2.4 Investment

One of the aims of market integration is to increase the incentives to invest by creating a larger and more efficient market in regulated industries. However, it is not clear that the model of integration with asymmetric regulation favored by many regions in the world, including the European and the African Union, provides an adequate framework for investment incentives. Unless the costs difference between two regions is large, market integration can decrease the aggregate capacity of financing new investment. This is a major concern in electricity because demand is on the rise everywhere, and in many regions aging generation and transportation facilities need urgently to be upgraded and expanded. Moreover, specific investment, such as transportation and interconnection facilities, are required to achieve market integration in emerging markets. For instance in Sub-Saharan Africa it is estimated that some 26 GW of interconnectors, for a cost of $ 500 million per year, are lacking for the creation of a regional power-trading market. Similarly the vast hydropower potential of the continent is unexploited because of the lack of investment.

This section studies the incentive to invest of national firms subjected to asymmetric regulation. Our analysis focuses on two types of investment. The first type decreases the transportation cost γ. We refer to this kind of investment as "transportation cost reducing" or "γ-reducing" investment. In the integrated market the competitor of the investing firm also benefit from the cost reduction. One can think of investment in transmission, interconnection, or interoperability facilities. The second type of investment reduces the production cost of the investing firm. It is referred to as "production cost reducing" or "θ-reducing" investment. This kind of investment only benefits the national producer and makes it more aggressive in the common market.

2.4.1 Transportation Cost Reducing Investment

We assume that country $i = 1, 2$ can reduce the collective transportation cost from γ to $t\gamma$ with $t \in (0, 1)$ by investing a fixed amount $I_\gamma > 0$. Since γ-reducing investment increases the efficiency of all firms, it has a public good nature. Examples are high tension

transportation power lines and cross border interconnection facilities.

We first consider the level of investment induced by the global welfare maximizer. Investment is optimal as long as the total benefit it yields in term of global social welfare, $W^{*I_\gamma} - W^*$, is larger than the social cost of the investment $(1+\lambda)I_\gamma$. The social cost of investment I_γ is weighted by $(1+\lambda)$ because devoting resources to investment increases transfers. The maximum level of investment chosen by a global welfare maximizer is $I^*_\gamma = \frac{1}{1+\lambda}[W^{*I_\gamma} - W^*]$. This optimal level is unlikely to be reached in an open economy.

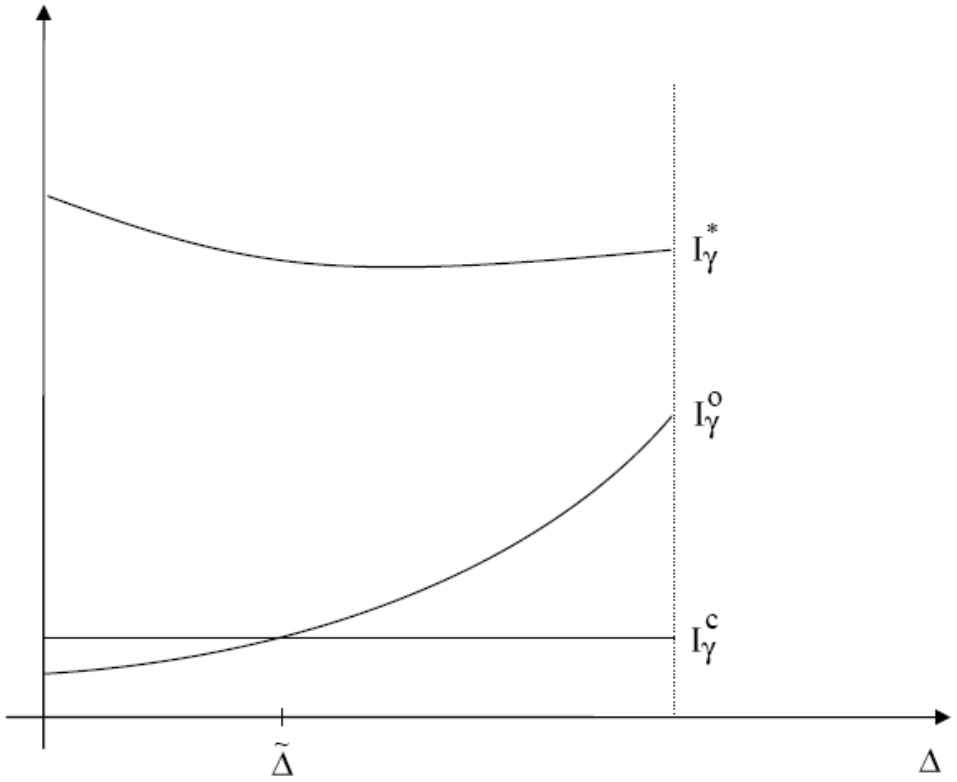
Intuitively transportation cost reducing technology increases the business stealing effect. Although this has an adverse effect on both countries, the negative impact is larger for the high cost firm. One can hence check that the market share of the less efficient country decreases after the investment. For this reason, the welfare effect generated by the transportation cost reducing investment in the less efficient country can be negative so that $I^O_{\gamma i}$ can be equal to zero. In particular, this occur for large values of Λ. By contrast the investment always increases the gross welfare of the most efficient country. The maximal level of investment for the more efficient firm (i.e., $\min\{\theta_1, \theta_2\}$), denoted $\overline{I}^O_\gamma$, is always positive and higher than the maximal level of investment for the less efficient one (i.e., $\max\{\theta_1, \theta_2\}$), denoted $\underline{I}^O_\gamma$. The maximum level of investment that country i is willing to make in the common market is $I^O_{\gamma i} = \max\left[0, \frac{1}{1+\lambda}[W_i^{OI_\gamma} - W_i^O]\right]$. Since γ-reducing investment benefit equally the two producers, in the common market the decision of the more efficient firm, $\overline{I}^O_\gamma$, determines the maximal equilibrium level of investment attainable in the common market.

Figure 4 illustrates the γ-reducing investment results for the case $\Lambda > 0$. Since it reduces the transportation costs both in investing and non-investing countries, a reduction in γ has a public good nature. It is thus intuitive that investment level $\overline{I}^O_\gamma$ is sub-optimal. The investing country does not take into account the impact of the investment on the foreign country. However the under-investment problem goes deeper than simple free-riding. Even if each country was willing to contribute up to the point where the cost of investment outweighs the welfare gains generated by investment (i.e., without free-riding on the investment made by the other) the total investment level $\overline{I}^O_\gamma + \underline{I}^O_\gamma$ would still be sub-optimal.

In fact when public funds are costly, the maximal level of investment sustainable in the

Figure 4: γ-reducing investment

$\theta_{\min}$ is fixed, $|\Delta|$ varies,



open economy is lower than in the case of autarky if Δ is small. Indeed investment reduces the costs of the competitor and makes it more aggressive in the common market. The business stealing effect, while reducing investing country total welfare, also reduces its capacity to finance new investment. Market integration may thus generate an insufficient level of γ-reducing investment for two reasons. The first reason is that investment has a public good feature. The investing country does not internalize the benefits on foreign stakeholders. The second reason is that investment decreases the costs of the competitor, worsening the business stealing effect.

Under market integration, when Δ is small (i.e., ($|\Delta| \leq \tilde{\Delta}$), the maximal level of investment is not only sub-optimal, but it is also smaller than under a closed economy. When the two regions' cost are not drastically different business stealing is fierce. It reduces the capacity of financing new investment worsening the gap between the optimal

investment and the equilibrium level. By contrast when one country has a drastic cost advantage (i.e., $|\Delta| > \tilde{\Delta}$), it is willing to invest more in the common market than under closed economy because the investment increase its market share and profits. Integration can then help to increase investment, although not up to the first best level. In the integrated market the investment level in transportation costs reducing technology is always suboptimal.

2.5 Production Cost Reducing Investment

We next focus on a production cost reducing, or "θ-reducing", investment. We assume that this investment is only possible in country 1, because of the availability of a specific input or technology. For instance in electricity the investment can be the construction of a dam, which reduces generation cost. Hydropower potential is unevenly distributed across countries. Country 1 can reduce the production cost from θ_1 to $c\,\theta_1$ ($c < 1$) by investing a fixed amount I_θ.

Let first consider the solution induced by the global welfare maximizer. She invests if and only if $W^{*I_\theta} - W^* \geq (1+\lambda)I_\theta$. The maximal level of investment which satisfies this inequality is $I_\theta^* = \frac{1}{1+\lambda}[W^{*I_\theta} - W^*]$.

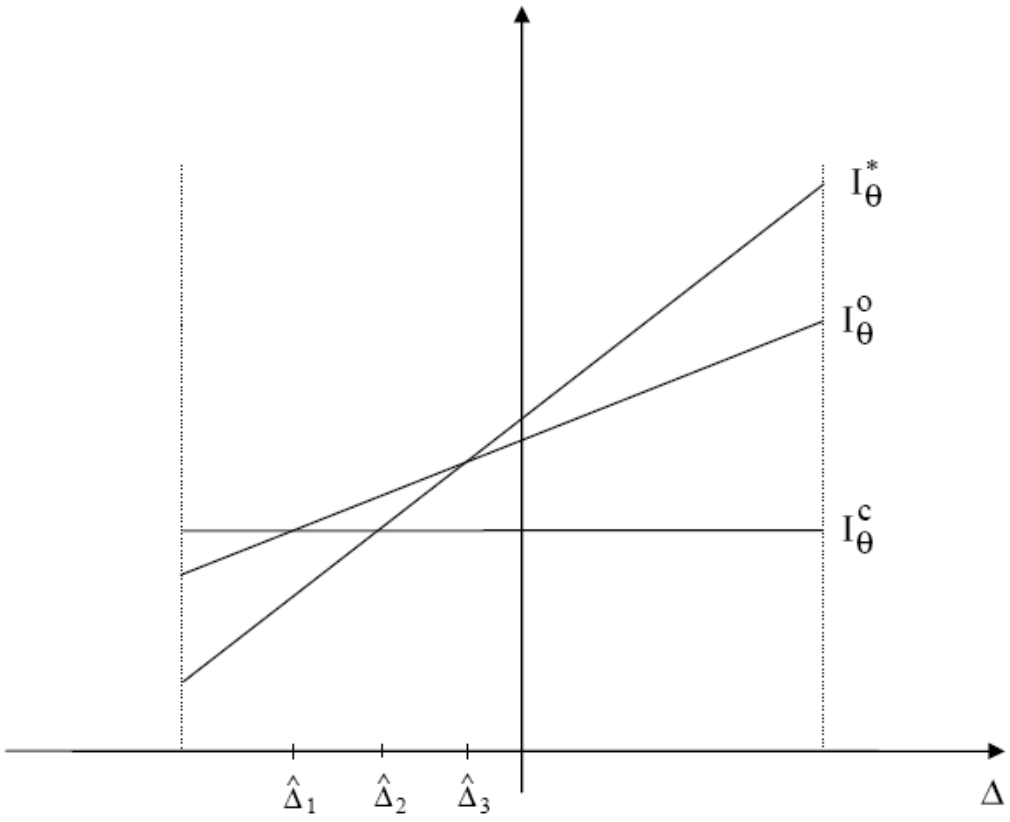
In the non cooperative equilibrium in the open economy, regulator of country 1 invests if and only if $W^{OI_\theta} - W^O \geq (1+\lambda)I_\theta$. Similarly in the case of a closed economy country 1 invests if and only if $W^{CI_\theta} - W^C \geq (1+\lambda)I_\theta$. The maximal level of investment that country 1 is willing to commit in the common market and in the closed economy is $I_\theta^k = \frac{1}{1+\lambda}[W_1^{kI_\theta} - W_1^k] \quad k = O, C$. Comparing the different levels of investment Figure 5 illustrates the results of the paper in the case $\Lambda > 0$. It is drawn for a fixed value of $c\theta_1$. The static comparative parameter is Δ.

When $\Lambda = 0$, business stealing has no adverse impact on national welfare so that $\hat{\Delta}_1 = \hat{\Delta}_2 = \hat{\Delta}_3 = \frac{(1-c)\theta_1}{2}$. In this case market integration unambiguously reduces the gap between optimal and equilibrium level of investment. However when $\Lambda > 0$, the threshold $\hat{\Delta}_1$ and $\hat{\Delta}_3$ shifts to the left and to the right respectively while $\hat{\Delta}_2$ is not affected (see Appendix 6).[9] When Λ is large enough Δ_3 becomes positive.

[9]When Λ increases, all thresholds I_θ^O, I_θ^* I_θ^C are shifted downwards because the social cost of investment increases. However, I_θ^O decreases less because investment becomes important to reduce business stealing effect in the common market. As a result, the region of overinvestment increases.

Figure 5: θ_1-reducing investment

θ_1 is fixed; Δ varies



In closed economy there is excessive investment if the investing firm is of a relatively high cost and under-investment otherwise. When the national firm is inefficient (i.e. $\Delta < \hat{\Delta}_2 < 0$), the only way to increase the level of consumption (and thus total welfare) in autarky is through the cost reducing investment. In the open economy the market can be served by the other firm, so that investing to improve the inefficient national technology is no longer optimal. When $\Delta > \hat{\Delta}_2$ the autarky equilibrium level of investment is too low because in the absence of trade the national regulator does not care about country 2. The investment level of country 1 is thus independent of firm 2, which explains the flat investment shape in Figure 5. Since regulator focuses on domestic consumers surplus and national firm rent, these inefficiency results are hardly surprising. A more interesting issue is whether economic integration can improve the autarky outcome or not.

For $\Delta > \hat{\Delta}_3$ and $\Delta < \hat{\Delta}_1$ market integration improves the situation with respect to the closed economy. When $\Delta > \hat{\Delta}_3$, country 1 chooses a level of investment in autarky that is too low. Without an access to the foreign market, the investment is oversized for the domestic demand. Market integration helps to increase the level of investment that country 1 is willing to sustain by enlarging the market size. Symmetrically, in the closed economy, when $\Delta < \hat{\Delta}_1$ country 1 overinvests in marginal improvements of its technology because it has no access to the foreign technology. In the common market, the national consumers can be served by the foreign firm at a lower price. Investing to improve the inefficient national technology is not attractive anymore. Market opening improves the situation with respect to autarky by reducing the level of wasteful investments. However it does not restore the first best level. When $\Delta > \hat{\Delta}_3$ the open market equilibrium of investment is too low because the investing country does not fully internalize the increase in the foreign consumer surplus. Symmetrically, when $\Delta \leq \hat{\Delta}_3$ the possibility to reduce its cost gap and to expand its market share by serving foreign consumers makes a high level of investment attractive. Incentives to invest improve compared to autarky but are still too high for inefficient firm and too low for efficient one compared to the optimum.

For $\hat{\Delta}_1 < \Delta < \hat{\Delta}_2$, there is excessive investment both under closed and open economy. However the over-investment problem is more severe in the open economy. When $\Delta > \hat{\Delta}_1$ a production cost reducing investment raises the relative efficiency of the national firm. It invests to strengthen its position in the common market and to reduce the business stealing problem. It does not internalize the cost it imposes on country 2 and overinvests. Markets integration thus improves incentives to invest in cost reducing technologies when the costs difference between the two regions is large and it leads to over-investment when the costs difference is small. This is in sharp contrast with transportation infrastructure investment, where integration leads to under-investment.

This paper, focusing on investment incentive in the context of regional integration, shows that decentralized benevolent regulators might systematically under-invest in essential infrastructure. The problem might be worse if one consider that in practice governments are not necessarily benevolent. The next paper by Beradi and Seabright, 2009 studies how governments might overcome under-investment problems due to commitment issues by choosing joint venture investment scheme.

3 Financing Infrastructure Deployment in Developing Countries through Joint Ventures

Infrastructure projects require important and sustained investments. As analyzed in the previous section these investments are problematic, even under the assumption of a perfectly benevolent and optimal national regulation. The problem get worse when one consider that the services they provide are highly visible and frequently subject to heavy political lobbying. This is especially true since the infrastructure sectors have a cost structure that is typically weighted towards fixed costs: firms may generate high (and therefore visible) operating profits while being barely able to cover fixed costs. What such projects have in common is that they require a sequence of investments which yield profits that are uncertain, variable over time and extremely sensitive to the regulatory and political context in which firms operate. Once investments are sunk such firms (whether public or private) are often subjected to strong political pressures to keep prices low. This not only reduces the profitability of those past investments but also limits the funds available for future investments, which can appear difficult to justify given other claims on scarce public funds. Poor countries often have particular difficulty resisting political pressures to claw back profits resulting from the success of initial tranches of infrastructure investment, even if those profits are often a signal that the very success of past investment makes further investment more important in the future.

To see how these circumstances may favor the development of joint ventures, consider a project such as a hydro-electric power plant. This involves large sunk investments with often uncertain returns, due to uncertainties both on the cost side and on the side of demand (the latter often particularly difficult to predict in poor countries). If the project succeeds and generates substantial net revenues, there are likely to be major political pressures to recoup some of the benefits. This may occur through repayments of dividends to the public budget, which has many other urgent claims on the revenues generated. Or it may occur through caps on tariffs in the name of allowing the citizens (even if this means mainly rich farmers and industrialists) to share in the prosperity generated by the investments. But it is precisely at the time when the project has succeeded that it is most important to re-invest some of its earnings, both in maintenance expenditures to

ensure that the benefits are maintained, and because the project's success is a positive signal that further hydro-power investments in similar conditions are also likely to be successful. Thus the political pressures set up by the project's success in the past may stand in the way of its continued success in the future.

In these circumstances Beradi and Seabright, 2009 show that a joint venture, particularly with a foreign government or firm, can play an important role in committing the project to reinvest revenues instead of paying them back under the pressures of political lobbying. First of all, repayment of dividends to the public budget would require symmetrical payments to be made to the joint venture partner; this would make the payouts more expensive from the point of view of the lobbyists because twice as much must be paid out to ensure the same benefits. Alternatively, if the clawing-back of the project's benefits is done not by distributing dividends but by capping tariffs, this will cost the joint venture partner, which can be expected to engage in some fierce lobbying of its own. In other words, the joint venture partner becomes a formidable source of countervailing pressure against payouts of revenues that would be better reinvested in the project. The presence of a joint venture partner, so often the source of inefficiencies in management structures (because of divergences in interests and strategies of the two partners), becomes here a positive source of strength because it allows the project to commit to a consistent pattern of investment over time.

3.1 The formal analysis

The formal analysis draws on a model due to Seabright, 2008 and applies it to the circumstances of infrastructure projects in developing countries. In the model, it is assumed that a number of countries have the opportunity to invest in a project that yields revenue in two stages. The behavior of countries rather than firms is modeled in order to capture more accurately the characteristics of most large infrastructure projects in developing countries, where states are the most important and often the only players. The results of the first stage are informative about the likely results of the second stage: a project that is successful in the first round is more likely to be successful in the second round. However, in these countries there are lobbies that demand payouts, and their demands are the more vociferous the higher are the revenues from the first round. A successful

first round therefore creates a tension: it implies a strong reason to reinvest the revenues, but it also gives rise to intense lobbying to distribute the revenues instead. As the analysis shows, this pressure is stronger when the lobbies are ones whose goals are at least partially shared by the decision makers in the country itself. In this context a joint venture with a second country helps the first one to resist such lobbying, not completely but to some extent. Because payouts to lobbies have to be matched by payouts to the other country, this makes giving in to lobbying pressure more expensive and less likely to occur; in response the lobbies will scale down their efforts at persuasion and waste fewer resources in such activities.

The model suggests that the corporate governance structure of JVs may contribute to the success of a project by engaging the parties to equality of treatment in respect of the profit generated by a project. When revenues are realized and the owners of the project choose whether to distribute them, or to reinvest them back into the project, the distribution option is relatively less attractive than in the case of a unique parent company that wholly-owns the project. The success of the project is enhanced for two reasons. First, investment per se tends to improve the likelihood that a project is doing well. Second, the credibility in committing to adequate reinvestment makes the initial undertaking of the project more likely.

The extent to which reinvestments per se and credibility of commitment in reinvesting are essential of course varies with the type of project. One case in which these are crucial is represented by infrastructure projects. Indeed, they usually require considerable investment over a long period of time. If early revenues are paid out, instead of being reinvested, infrastructure projects may be aborted, or at least not completed as originally planned. Therefore, even when the infrastructures remain operative, they are likely to function to a limited extent compared with their full potential.

The model shows that the existence of lobbying pressure reduces investments by harming the credibility that a project will benefit from the necessary reinvestment for a sufficiently long period of time. Various types of lobbies may feel tempted to seek a rent as soon as profits are realized. They may be roughly divided into two groups. First, there are lobbying groups inside the firm. For instance, jealous divisions in a parent company may exert internal pressure and try to treat a successful project as a cash cow. The second pos-

sibility, more relevant to the projects we review here, is that lobbying comes from outside the firm. External lobbying is particularly dangerous in contexts where institutions are weak and interest groups powerful, which is frequently the case in developing countries. Moreover, when parents of a JV are sovereign governments, as often in infrastructure projects and even more so in developing countries, the role played by political lobbying becomes of course central. Tough lobbying activity causes long delays and inefficiently low levels of investment. Moreover, in some extreme cases the potential threat of ex post rent-seeking by lobbies may be so serious, especially for infrastructure projects in developing countries, that they are not undertaken in the first place. The credibility of commitment against rent-seeking is indeed crucial for the creation and the expansion of infrastructures in developing countries. In particular, good reputation acquired through successful projects fosters the development of new infrastructure projects.

While we argue that JV's structure may serve as commitment device and may contribute to the success of infrastructure projects in developing countries and to the development of new ones, we do not pretend that JVs are a panacea for all problems. In reality many mechanisms are simultaneously into play and even the role of JV as commitment device is more complex than in the theoretical framework. There exist indeed several factors that are likely to weaken the credibility of JVs' structure as a commitment device against rent-seeking. In particular, the existence of asymmetries between JVs' partners may hinder credibility, as is discussed below.

In what follows some case studies of infrastructure projects in developing countries are reviewed to assess the concrete relevance of the issues raised in the theoretical analysis. Thirty-five cases of infrastructure projects in Africa, Asia and Latin America are investigated, mainly in sectors such as natural resources and renewable energies. More than two thirds of these projects were or still are run by a JV. Among these, the role played by reinvestment and by a reputation for credible commitments are explicitly mentioned in the documentation concerning only one fifth of the cases. However, the general feeling emerging from the analysis of infrastructure projects is that remarks on these aspects are not common because their importance is obvious. In more than one third of infrastructure JVs we found some evidence that lobbying pressure has been a problem. When JVs

are characterized by asymmetric benefits from profits generated by infrastructures, lack of commitment arises in all the cases we have analyzed.

3.2 Commitment to reinvest

Infrastructure projects need credible commitment to adequate investment over time, since they in general require sustained investment for several years. Such commitment ability is even more important when these projects concern countries where institutions are relatively weak and lobbies powerful. Several examples come from the hydro-power sector in Africa.

The importance of reinvestment in infrastructure projects is for instance evident in the rehabilitation of hydro-electric plants Inga I and II in the Democratic Republic of Congo (DRC). The run-of-river Inga I plant was commissioned in 1972 and Inga II followed a decade later. However, both have fallen into disrepair, partly due to civil war, and now only manage to produce about one quarter of their joint capacity of 1.7GW. The little power they generate is devoted to the mines of Katanga and does not reach local people in a country where 92% of the population is without electricity.[10] While the first revenues from the rehabilitation program are expected by late 2008, reinvestment is necessary in the next three years to complete the rehabilitation project. In fact, the project expects one additional turbine to be on stream in each successive year until 720MW production is reached in 2011.[11] The project is run by a JV between the Canadian MagEnergy, a subsidiary of MagIndustries, and South Africa's Industrial Development Corporation (IDC). Indeed, such corporate governance structure may provide the needed commitment device for adequate reinvestment.

Similarly, the infrastructure project of Bujagali needs credibility of commitment to sustained investments over about four years. It consists in the development, construction, and maintenance of a run-of-the-river power plant on the River Nile as it flows through Uganda from Lake Victoria towards the Sudanese border. Eight kilometers north of the existing Nalubaale and Kiira power plants, it would recycle the water flows released from these upstream hydro-power facilities to generate additional electricity reaching a

[10]Source: "Congo's Inga power projects seek new lease of life", Engineering News, 21st April 2008.
[11]Source: website of MagIndustries.

production of 250MW in one of the countries with the lowest rates of electrification in the world (only 5% of Ugandans have access to electricity at home)[12]. The US$ 799 million project would be undertaken by Bujagali Energy Limited (BEL), a JV between the US-based Sithe Global Power and the Kenyan Industrial Promotion Services (IPS).[13] The proposal is under review by the Ugandan government and by the World Bank Group and other potential lenders. The fact that Bujagali infrastructure project would be managed by a JV may again contribute to its success, by providing the necessary credibility of commitment.

3.3 Lobbying threat

Infrastructure projects are highly visible and thus an easy target of lobbying, especially in developing countries. Moreover, sovereign governments are often directly or indirectly participating in infrastructure projects and thus they are likely to suffer from political interference.

For instance, the success of the rehabilitation project of Inga I and II, that should provide power for the rapidly increasing industrial demand in the DRC (particularly in the Katanga Copper Belt), is likely to experience external lobbying to decrease energy prices.

Two examples of the delays that infrastructures may suffer because of strong lobbying activity are the hydro-power projects of Bujagali in Uganda and Yacyretá in Paraguay. Bujagali was first conceived in 1994 and was supposed to deliver power by 2004, but failed because of political interference and corruption. In 2002 the US-based Applied Energy Services (AES) uncovered a bribery scandal and a wrangle erupted over compensation funds. AES's main contractor would have bribed a Ugandan government official in 1999. The Wall Street Journal noted that former Energy minister Richard Kaijuka, who then represented Uganda as a sub-regional alternate director on the World Bank board, had been accused of taking a bribe on the dam in Ugandan newspapers.[14] The following year two construction firms participating in the project pulled out due to bribery and envi-

[12]Source: World Bank website.

[13]Source: "Unlocking African hydro potential", International Water Power and Dam Construction magazine, 4th July 2007.

[14]Source: Wall Street Journal, 3rd July 2002.

ronmental controversies.[15] Similarly, regional maneuvering, lobbying by the Argentine nuclear and oil industries, besides political instability in Argentina, caused more than ten years of delays to the Yacyretá hydro-power project in Paraguay.[16]

Strong lobbying activity may also cause inefficiently low levels of investment. A well-known case of heavy governmental interference is represented by Venezuela. Under altered Venezuelan regulations for the oil industry, companies operating in the country were ordered in 2005 to shift contracts to JVs with the Venezuelan state.[17] Of course, in this case the JV's structure does not soften the threat of ex post rent-seeking by Venezuelan government at all. In fact, the settlement of back-taxes has been required for the transition into JVs. Americaeconomy reported in 2006 that more than US$ 700 million had been received by the Venezuelan tax agency in back-taxes in 2005. "This bill forms part of Venezuela's oil sovereignty," said legislator Rodrigo Cabezas, using a phrase coined by Chavez.[18] The Venezuelan subsidiary of Harvest Natural Resources entered a JV with PDVSA, the state-owned Venezuelan oil company, and received a tax assessment from Venezuela's tax authority of approximately US$ 56 million in unpaid back taxes from 2001 to 2004. This represents US$ 13 million more than the price agreed three months before with Venezuela's tax authority. The subsidiaries of China National Petroleum Corporation (CNPC), of the French Perenco and of the Norwegian Statoil were respectively billed for US$ 11 million, US$ 2 million and US$ 700,000 in back income taxes.[19]

Since in the Venezuelan case JVs are completely unable to proved credible commitment against ex post expropriation, private foreign oil companies that work in Venezuela are increasingly loath to make long term investments in the context of growing state intervention. The consequences are severe: the number of partners willing to undertake the necessary, but extremely expensive, investments for technology, infrastructure and

[15]Source: "World Bank to decide on Bujugali dam", The New Vision, 22nd April 2007.

[16]Source: "Paraguay: A Country Study", Dannin M. Hanratty and Sandra W. Meditz, Washington: GPO for the Library of Congress, 1988.

[17]Source: "Venezuela bills Chinese and U.S. companies for back taxes", venezuelananalysis,com, 7th September 2006.

[18]Source: "Venezuela increases taxes, plans increased control over Orinoco Oil", venezuelananalysis,com, 30th August 2006.

[19]Source: "Venezuela bills Chinese and U.S. companies for back taxes", venezuelananalysis,com, 7th September 2006.

exploration of new, untapped, heavy oil fields is of course dramatically reduced. Those who still are willing to invest in Venezuelan infrastructures have their side objectives. For instance, the Chinese goal of their JV with Venezuela, which exploits the oil reserves in the Zumano region and the Orinoco oil belt, is securing a stable and plentiful source of oil to meet its skyrocketing domestic needs. The bilateral agreements signed by the Chinese and the Venezuelan governments have far reaching implications that go beyond the oil industry. In addition to the US$ 2 billion set aside for investment in energy, the Chinese government has pledged some US$ 9 billion for the construction of Venezuela's national rail system, an infrastructure plan intricately linked to the Venezuelan government's ambitious goals of import substitution and rapid domestic industrial development.[20]

The potential threat of ex post rent-seeking by lobbies may be so severe, especially for infrastructure projects in developing countries, that they are not undertaken in the first place. For instance, the strength of Indian farmers' lobby contributed to the failure of the government attempt to find investors for its power sector. Indeed, potential partners anticipated that ex post the government could have given in to farmers' pressure and conceded low prices for electricity.[21]

3.4 Reputation and new projects

If joint ownership helps the parties in committing to resist not only internal, but also external lobbying,[22] JV's structure may contribute to enhancing reputation of commitment ability and therefore may foster development of new infrastructure projects.

One outstanding case, among other examples that are provided below, is the role

[20]Source: "Venezuela and China: towards a multi-polar world", venezuelananalysis.com, 16th October 2006.

[21]Source: "Free power: farmers plan stir", The Tribune, 8th September 2002.

[22]A quite special example of external lobbying against which a JV's structure contributes to provide commitment is represented by the case of Alba Petroleos, a JV between the Venezuelan PDVSA and ENEPASA, the Inter-municipal Association of Energy for El Salvador. Actually, Alba Petroleos has no concerns of early distribution of revenues, because it is a no-profit JV. However, it needs commitment not to give in to Salvadorian lobbying against Venezuelan investment due to its political alliance with the United States (El Salvador was the first Central American country to implement the Central American Free Agreement and it is the only Latin American country to still have troops in Iraq). Indeed, Salvadorian President, Tony Saca, straightaway criticized the Alba Petroleos JV, while Hugo Chavez declared "We are looking beyond the pessimism of governments that have other ideas and other orientations, for alternative ways to help the people of the world... This is what we are doing with our brothers and sisters, the people of El Salvador... This is the epitome of Alba".

played by the success of the Inga III project, run by the JV WestCor, for the development of the Grand Inga, a hydro-electric plant in the western part of the Democratic Republic of Congo at about 300 km from Kinshasa and 165 km from the mouth of the Congo River with a potential capacity of 40GW, a project that is capital to the future of Africa. But there are several other examples in the hydro-power sector in both South America and Africa. We first analyze those and then turn to the Grand Inga.

In Chile good progress in the construction of the 155MW La Higuera hydro-plant, which started in 2005 and is expected to be completed in 2008, is not only crucial for the success of the project itself, but also for building a reputation of credibility of commitment necessary to undertake the project of another power plant. The final goal would be to generate 300 MW of clean renewable energy each year through a two-stage split scheme: after completion of La Higuera plant, plans are underway to build another power plant upstream, La Confluencia, to generate the remainder of the energy.[23] The fact that La Higuera project is undertaken by a JV formed in 2004 between Pacific Hydro Chile and the Norwegian Statkraft Norfund Power Invest (SNPI) may hopefully provide the credibility of commitment necessary to the success of the project. Then, the reputation built thanks to La Higuera should foster further infrastructure projects.[24]

Another example of the importance of the ability to build up a reputation of credibility is the potential development of Inga's hydro-power infrastructures. The next stage, known as Inga III, is indeed under consideration by WestCor, a JV which includes the power utilities of the DRC (SNEL), Angola (ENE), Namibia (Nampower), Botswana (BPC), and South Africa (Eskom). The construction of Inga III is expected to start around the end of 2010 and it would come on line in 2018 with a capacity of 4.3GW.[25] An agreement between shareholders was signed at the end of 2005 such that each participating utility agreed to own 20% of WestCor. Each committed US$ 100,000 to be used for the funding of feasibility studies.[26] The success of the rehabilitation project at Inga I and II plays of course an important role in convincing investors and the corporate governance structure

[23]Source: website of HydroPacific.

[24]Pacific Hydro CEO made explicit the role played by the JV with SNPI: "We look forward to a long and prosperous relationship with SN Power built on cooperation, understanding and the joint ambition of achieving positive social, environmental and economic outcome".

[25]Source: "Congo's Inga power projects seek new lease of life", Engineering News, 21st April 2008.

[26]Source: African Energy Legacy Project in Partnership for Sustainable Development on the UN website.

of a JV between MagEnergy and IDC running the rehabilitation project may contribute to a credibility reputation.

In turn, the JV structure of WestCor may contribute to providing reinvestment credibility to the Inga III project sufficient for it to be undertaken. Commitment ability is particularly important because several countries would participate, each one under the influence of different lobbying groups and probably with non-aligned objectives. This may threaten the undertaking and the success of Inga III.[27]

The failure of the Inga III project would be particularly harmful, because it would reduce investors' confidence for Grand Inga project,[28] which is capital to Africa. The final stage of Inga, known as Grand Inga, is in fact conceptualized at about 40GW.[29] The project will be approved or rejected in 2014[30] and it would be the world's biggest hydro-power generator. The project has been on the continent's electricity agenda for more than three decades. However, the potential confluence of several favorable circumstances may contribute to the undertaking of the Grand Inga project. Besides other crucial circumstances,[31] the credibility of WestCor in committing against rent-seeking by lobbying groups would contribute to the undertaking of the project.

One feature of WestCor that strengthens its commitment ability is the symmetric structure of the JV in terms of profit sharing. Symmetry is indeed an important condition for the JV to provide a commitment device, as discussed below.

[27]In particular, political lobbying to distribute early revenues and not to reinvest might be strong in South Africa. In fact, there may be several obstacles for South Africa's import of energy from Inga III. First of all, South Africa government and, therefore, Eskom, have a policy not to rely on imports for more than 15% of domestic power needs, which would be binding. Moreover, the cost of long-distance line (about US$ 3.2 billion) would make to expensive Inga III's energy, unless energy price in South Africa dramatically increases (about 46c/kWh by around 2012).

[28]The UN recognize that Inga III will support the objectives of Agenda 21 as well as relevant goals and objectives of the United Nation Millennium Declaration, in that investor confidence will also be required for implementation of Grand Inga, a key link in the vision of a Pan-African electricity grid.

[29]Source: website of MagIndustries.

[30]Source: "Congo's Inga power projects seek new lease of life", Engineering News, 21st April 2008.

[31]Among favorable factors there are the electricity crisis in South Africa, the desire among development-finance institutions to bankroll low-carbon electricity initiatives, and the emerging peace and stability in the sub region.

3.5 Asymmetric joint ventures

The equal sharing of costs and benefits is crucial in providing incentives against distribution of early revenues or ex post expropriation.[32] If profits benefit one parent firm more than another, the JV's structure may be insufficient as a commitment device.

Itaipú Binacional in Paraguay, for example, is a JV between Paraguay and Brazil. This hydro-plant, located on one of the world's five largest river systems, is capable of generating 14GW of electricity and used to be the world's largest hydro-electric power plant. At the time of construction, Brazil bore most of the costs[33] in terms of financial and technical contributions. Both countries signed an accord on repayment of Itaipú and that agreement previewed that no profit would have been made by the dam until the loan were completely paid off. Initial arrangements benefited Brazil in that they stated that each country has the right to use 50% of the energy produced, but if not, the exceeding must be sold to the other partner on cost basis.[34] Because Paraguay uses only a tiny fraction of its power (about 7%), it sold most of its share back to Brazil at a predetermined low rate. Brazil purchases 97% of the plant's power, which accounts for about 20% of its energy consumption. The major debate over Itaipú in the late 1980s revolved around the low prices that the countries had negotiated in the original treaty.[35] After twelve years of indecision about how to adjust the treaty of Itaipú, in 1985 Paraguay and Brazil signed five revisions to cover matters of financial compensation. Paraguay gained significantly from the 1985 revisions, but most analysts believed Paraguay deserved still greater compensation for its electricity.[36] Ten years from now and the loan will be paid off so that each country would be free to charge market prices. However, President Lugo threaten to end contractual obligations that require Paraguay to sell its unused electricity to Brazil at well below the market rate[37] and wants to earn seven times more from Itaipú

[32]The fact that in industries such as oil, gas, and telecommunications the existence of a key stakeholder in a JV often implies frequent and extensive influence was already shown by Keith D. Brouthers and Gary J. Bamossy ("The Role of Key Stakeholders in International Joint Venture Negotiations: Case Studies from Eastern Europe", Journal of International Business Studies, Vol. 28, No. 2, 1997).

[33]Source: Encyclopedia of the Nations.

[34]Source: "Old hydroelectric deals faces choppy waters", Now Public, 27th June 2008.

[35]What Brazil paid Paraguay for electricity was one-ninth what Paraguay was scheduled to receive from Argentina under the Treaty of Yacyretá, signed just seven months after Itaipú.

[36]Source: "Paraguay: A Country Study", Dannin M. Hanratty and Sandra W. Meditz, Washington: GPO for the Library of Congress, 1988.

[37]Source: "Power struggles loom in Paraguay", BBC News, 21st April 2008.

energy.

Something similar happens between Paraguay and Argentina for the hydro-plant of Yacyretá.[38] While none of the electricity produced by Yacyretá was intended for use by Paraguayans, the energy that it produces provides the 15% of the total energy demand in Argentina. In the words of a BBC reporter "Argentina has good reason to be worried too, as it has its own Yacyretá hydro-electric JV with Paraguay".[39]

The asymmetry in benefits from infrastructures dramatically weakens the commitment ability of the parties not to ex post rent-seek. The lack of commitment in turn hinders the undertaking of new infrastructure projects. If Paraguay decides to break Itaipú contractual obligations with Brazil, various projects along the Río Paraná will be threatened. Among those, the Corpus plant, expected to be comparable in size to Yacyretá, and several smaller hydro-electric power plants downstream from Yacyretá, including Itatí-Itá-Corá and others.[40]

The rest of the paper focuses on transportation infrastructure. Calmette, 2009 studies the impact of a regional transport policy on economic activities in developing countries, while Friebel et al., 2009 focuses on railroads industry and their optimal industrial organization.

4 Economic Geography in Developing Countries

The economic literature has already well shown (see for example Lucas, 1988 that in all countries, but more noticeably in developing countries, transportation infrastructures play a key role in growth and development. Nevertheless in these countries, transportation infrastructures are scarce and poor and transport costs are very high. Most of the time countries are not able to invest by themselves in efficient transportation infrastructures because of the fixed costs such networks required. Moreover, transportation infrastructures should be coordinated between neighbor countries. Trade, which is a major factor of growth, requires transportation infrastructure. Roads and railroads cannot stop at the

[38] Source: "Old hydroelectric deals faces choppy waters", Now Public, 27th June 2008.
[39] "Power struggles loom in Paraguay" by Robert Plummer, 21st April 2008.
[40] Source: "Paraguay: A Country Study", Dannin M. Hanratty and Sandra W. Meditz, Washington: GPO for the Library of Congress, 1988.

nations' borders. As a consequence of these constraints, it seems worthwhile to consider a regional regulation of transportation infrastructures, aiming at reducing trade costs inside and between countries. That is, a regulation among a club of countries with common boarders which have chosen to cooperate in transportation infrastructure sector. Such a regulation should be sustainable in the sense that all participants should gain from it.

In her study, Calmette, 2009 focuses on the effects of such a regulation leading to a decrease in transport costs in developing countries. This paper is the first attempt to investigate the impact of a regional transport policy on economic activities in developing countries. The analytical framework is adapted from the economic geography model that illuminates the conditions under which geographic concentration of activities occurs Krugman, 1991, a, Krugman, 1991, b. In Krugman model the market size effect leads to agglomeration of industries in the larger region, the "Core", and is detrimental to the "Periphery", when transport cost decreases in regions where the share of activities tied to land is small. By contrast Calmette, 2009 argues that a decrease in transport costs in developing regions is expected to increase both the periphery and the urban activities. Indeed these countries are often endowed with abundant natural resources (cacao, coffee, cotton, minesà) most of the time located in landlocked regions. Poor transport infrastructure isolates such regions. Limao, 2001 have underlined that "in 1995 landlocked countries on average had an import share in GDP of 11 percent, compared with 28 percent for coastal economies". Moreover, "poor infrastructure accounts for 40 percent of transport costs for coastal countries and up to 60 percent for landlocked countries".

The market for natural resources is the world market. Natural resources must be exported, generally through ports. This requires services such as banks, insurance, storages, container facilities and others activities tied to ports. The lack of such services is a source of inefficiencies. Clark et al., 2004 have analyzed transport cost inefficiencies at the port level considering activities that depend on port infrastructure but also activities related to customs requirements as determinants of port efficiency.

4.1 The formal analysis

In a simple partial equilibrium model, Calmette, 2009 analyzes a circular process of agglomeration of activities in developing countries. The paper focuses on two countries (or regions) separated by a distance. There is a landlocked region, by convention Region 1, which produces only natural resources (NR). There is also a region with a sea access and a port, by convention Region 2, which produces only services (s_j) used exclusively by the import-export activities. The circular process is due to the fact that each activity needs the other to increase. There is no need to provide services (port facilities) if there is nothing to export. Symmetrically there is no point in producing natural resources if there are no infrastructures to export them (no transport to the city, no ports). This framework is thus related to Krugman P., 1995 where the circular process is the result of industries using other industries as intermediates. What is new in this model is, first, that the circular process occurs because natural resources use services as intermediates in order to reach the world market through exportation. Second, the model does not assume full employment: in each region there is a stock of unemployed labor living in self-sufficiency so that the level of wage is always at its minimum.

The model follows closely the model of Krugman, 1991, a, Krugman, 1991, b. That is, there are two regions, $i = 1, 2$, with two categories of agents, mobile workers and immobile farmers. The overall number of workers (respectively farmers) is μ (respectively $1 - \mu$). In each region there are an equal number of farmers, $(1 - \mu)/2$. The regions differ in the number of mobile workers. Let $L_1 = f\mu$ and $L_2 = (1-f)\mu$, with $0 \leq f \leq 1$ be the number of mobile workers in each region. Farmers and workers have different activities and therefore incomes but have identical Cobb-Douglas preferences On the production side there are increasing returns to scale. This implies that each firm produces a single product and each region is specialized in a given set of varieties. The firms are Chamberlinian monopolistic competitors. Moreover the model considers iceberg transportation cost, where a share r of what is exported is consumed in transportation cost. The equilibrium of the Krugman's model is a concentration of all the industrial activities in only one region so that in the end $f = 1$. The market size effect is often amplified by backward and forward linkages between firms: as a result, firms cluster. Concentration of industrial

activities in only one region is detrimental to the other region where agents tied to land become poorer and poorer because they have to import (then to pay transport cost on) all the industrial goods. The question addressed here is whether, focusing on the problem of a regional regulation among developing countries, is it still true that a decrease in trade costs leads to an agglomeration of industrial activities in only one region as in the Krugman core-periphery model?

The key parameters in the standard economic geography model are transport costs captured by r, market size and the share of activities tied to land. In developing countries, activities tied to land are important (the following table shows this importance for countries belonging to the UEMOA).

[Table 1 here]

Transport costs are also high because of poor and scarce infrastructures built often during the colonial period. The following maps show for instance railway and road infrastructures in West Africa.

[Figures 6 here]

Because economic conditions are different in developed and developing countries, there is a need to adapt economic geography models to developing countries. Calmette, 2009 assumes that, in Region 1, land and thus NR are owned by a group of landlords. Labor, production of NR and services are immobile. For simplicity, NR and services are supposed to use the same kind of labor. Workers import all the goods they consume. The import good sector is not formalized. Because of the balance of payment equilibrium, imports and exports are supposed to use the same quantity of each differentiated service. In Region 2, each service is produced with labor with an increasing returns to scale technology. It implies that each firm produces a single service. Monopolistic competitors, in equilibrium, set a price equal to marginal cost times a mark-up. Usually, in economic geography models, full employment condition determines the number of firms in each region. In this model, since there is a stock of unemployed labor living in self-sufficiency, the number of firms is variable. In Region 1, one unit of labor is used to produce one unit of natural resource. When produced, this natural resource is sent to Region 2. Transport costs for

natural resource take Samuelson's iceberg form. It follows that, in order to export one unit of natural resource through Region 2, it is necessary to have produced $1/r$ units in Region 1. To be exported, the natural resource unit must use a quantity of a composite service, denoted S. The composite service is obtained from a CES function of the n differentiated services.

In this simple model, quantity and prices of services are given by the firms' chamberlinian behavior, world price of NR is given, wage is fixed because of the stock of unemployed labor, demand by NR sector for each service is given by the necessary equality between produced and demanded quantity. The number of services is the only variable that needs to be determined to close the model. The paper next analyzes the effects of a decrease in transportation cost on the equilibrium. When r is low (high transportation costs), n is also low and S is small. Yet the produced quantity of natural resource increases with the number of differentiated services. Exporters of NR are limited by services and port inefficiency. In this case it takes time to export and there is congestion at the port. If transportation cost decreases, exporters of NR are able to demand and pay for more services, n, and therefore S, increase and the constraint is relaxed. Region 1 then produces and exports more. In Region 2, there are more services, more firms, and more employment. Employment in Region 2 increases with the number of services when transport costs decrease.

Region 1 uses and pays half of the services to export the natural resources. The other half is used and paid by the world for imports which are also increasing with employment. Concerning the evolution of employment in Region 1, the result depends on the level of r. The impact of a decrease in the transportation cost on the quantity of labor used in the NR production is not trivial. Two opposite forces play when r increases: first, a larger quantity of NR may be produced, increasing the demand for labor. Second, the waste due to transport is lower and this decreases the demand for labor. The results of these forces are illustrated in the next Figure. It strongly suggests that there is a positive long term relation between the development of activities tied to land and the long run decrease in transport cost (r increasing from 0 to 1).

[Figure 7 here]

For high values of transport costs, the first effect dominates and employment in Region 1 increases with r (i.e. decreases with transportation cost). For a lower value of transport costs, the second effect dominates and employment decreases in Region 1 for further increases in r. Two results are important: First, the value of transport costs at the threshold where the second effect dominates, increases with σ the elasticity of substitution among services. For sufficient complementarities among services (low value of σ), the positive effect on employment may still dominate for the whole range of relevant r. Second, even in the cases where the negative effect dominates, the decrease in employment in the second phase is lower than the employment gain during the first phase. At $r = 1$ employment reaches always a higher level than the ones obtained with high transport costs.

4.2 Empirical implications of the theory

The formal analysis reveals that there are two phases when transportation costs decrease. first a phase where both regions win, and next a phase where the core wins while the periphery loses. Developing countries are most likely at the beginning of the first phase. A decrease in transport costs should profit both the landlocked/countryside area (producing NR) and the countries/regions with port (providing services). Developed countries are presumably in the second phase. It follows that a regional regulation leading to a decrease in transportation costs in developing countries should be accepted by all the participants. Both regions should gain from such a regional integration.

The paper aims next at testing the empirical relevance of the formal analysis. Two sets of countries are studied. According to the World Bank classification the first set concerns 28 developing countries in Sub-Saharan Africa,[41] and the second 25 high income countries.[42] For both sets, the growth rate (for the 1990-2003 period) of total road networks (kms per inhabitant) is used as the proxy for transport cost. With 0.0045 kilometer of road on average per inhabitant, there is a clear deficit of road infrastructures

[41] Angola, Benin, Botswana, Burkina Faso , Cameroon, Central African Republic, Chad, Congo Rep., Côte d'Ivoire, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Senegal, Sierra Leone, Swaziland, Tanzania, Togo, Zambia, Zimbabwe.

[42] Australia, Austria , Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States. Poland and Bulgaria, the higher income countries among the Upper-Middle income economies, have been added to the sample.

in the 28 Sub-Saharan countries relatively to the high income countries sample, where there is on average 0.0111 kilometer of road per inhabitant. The growth rate of urban population in percentage of the total population (World Bank Data) is used to proxy the services production.

For activities tied to land, different proxies are used for developing and developed countries. For developing countries, an index combining the export data of 12 products has been constructed.[43] For developed countries the percentage of agricultural land (over total land) is used as proxy. Figure 3 suggests that the growth rate of activities tied to land (ΔRN_i) depends on prior deviations from the long run relations as well as prior changes in the explanatory variables and the RN value itself. Our model then (in its empirical form) can be estimated in an error correction framework (Engle and Granger, 1987. Barnerjee et al., 1993) and has the following form:

$$\Delta RN_i = \alpha_1 \Delta Roads_i + \alpha_2 \Delta Upop_i + \beta_1 RNIn_i + \beta_2 RoadsIn_i + \beta_3 UpopIN_i + \gamma Sea_i + \epsilon_i \quad (1)$$

Where α_1 and α_2 represent the short-run effects, $RNIn_i$, $RoadsIn_i$ and $UpopIN_i$ are the initial values of each variable (1990).[44] We perform several tests for heteroscedasticity and they do not reject the homoscedasticity hypothesis. The final results are reported in table 2.

[Table 2 here]

The empirical analysis confirms that there is a short term positive relation between the increase in road networks in developing countries, the growth of urban population and the growth of NR production, while these short run effects are not significant in developed countries. The empirical evidence hence indicates the need to improve transport infrastructures in and between poor countries. The paper results contain several important messages regarding regional integration.

First the regional character of the regulation of infrastructure is important : a more integrated and coordinated transport network may reduce the number of trans-shipments,

[43] Cocoa, coffee, copper, cotton, groundnuts, iron, oil and palm products, phosphates, sisal, sugar, tea, tobacco.

[44] We have introduced a dummy variable Sea = 1 if the country has access to sea, 0 otherwise. It is not significant.

transit time and border delays, which both increase insurance costs. Moreover, there is a lot of heterogeneity between countries/regions. Port efficiency varies from one region to the other and national (or regional) legal constraints (like special licences) affect ports (in)efficiency. Clark et al., 2004 have shown that in Southeast and West Africa the median number of days to clear customs is 12 but this rise up to 30 days in Ethiopia. In comparison in north America the median is 3.5 days. A regional regulation should help unifying and normalizing port procedures and port regulations.

Second in the model the effects of a decrease in transportation costs depend on the predetermined exogenous parameters, which are standard parameters in economic geography models. It follows that a regional integration of transportation network, leading to a decrease in transport costs, will have stronger positive effects on the number of services in the coastal region, on the production of NR in the landlocked region and on employment in both regions if:

i) Port services are complementary rather than substitute (low elasticity of substitution among services).

ii) Fixed costs in service activities are high (increasing returns to scale).

iii) Marginal costs in service activities are low.

iv) International price of the exported resource is high.

Third the analysis shows the impact of modifying hinterland access conditions on rival ports. Zhang (2008) examines the interaction between hinterland access conditions and ports competition in an example of three areas: Le Havre-Hamburg, Vancouver-Montreal and Shangai. He shows how a change in corridor facilities and inland roads modify ports competition. This suggests some results in the present analysis in the case of more than two regions. For example, assuming one landlocked region and two coastal regions, it is clear that a regulation of transport network between the landlocked and one of the two coastal regions will imply a huge comparative disadvantage for the region excluded from the integration. Evidence of such mechanism is given by the impact of the crisis in Côte d'Ivoire on the west Africa port activities. Following the colonial logic, Abidjan was the "natural" port of the landlocked countries of this region (Mali, Burkina Faso, Niger). In 2001, 63% of the Malian import-exports and 35% of Burkina ones were transiting through Abidjan. Lome, Cotonou, Tema represented only 23%, 0.38% and

10% of this traffic. After the war of September 2002, most of the traffic of the landlocked regions transited through Dakar, Tema, Lome and Cotonou. Following this increase in traffic, these cities have invested in port capacity. In order to increase port productivity they have invested in ports' capacity and have modernized their infrastructures. The hinterland access were also improved, particularly in the North corridors. These facts are consistant with the positive circular links between activities in landlocked and coastal regions illuminated in the formal analysis.

5 Competition and Industry Structure for International Rail Transportation

As stressed in the previous section, poor transportation infrastructure severely limits development opportunities in Sub-Sahara Africa. Landlocked regions suffer from their isolation, while coastal regions development is limited by this lack of trade with the periphery. Until recently most investment on transport infrastructure has been devoted to competing road and air transport services. African railways have been left behind. Mainly structured by the old colonial powers they were not perceived as relevant for the economic development. This has changed lately. A recently published World Bank report on railway concessions in Africa states: "*Railways still offer the most economical solution to transporting non time-sensitive bulk freight on distances over 500 km.*" Rail is an excellent transport mode for landlocked countries. It is cheap and it involves limited amount of atmospheric pollution which makes it compatible with sustainable development. The World Bank has pushed in many cases for vertical de-integration of infrastructure industry such as railroads. The idea would be to create an independent entity that would deal with the infrastructure (i.e., the rails and their management) while several firms would compete to provide transportation services while paying a fee to use the rails. Friebel et al., 2009 explore in their paper under which circumstances such strategy is optimal. They tend to conclude that vertical integration is the best option for Sub-Sahara African railroad companies.

Huge investments are required to push African railways from their poor state to a new age of development. For this reason, both new construction and rehabilitation are taking

place across the continent with funding from a mixture of public and private sources. For instance last year saw the award of contracts on Gautrain in South Africa and the Mombasa to Kampala railway line. Gautrain is a newly-build passenger link between Tshwane (Pretoria) and Johannesburg, with a spur to OR Tambo International Airport. The Bombela International Consortium, comprising Bombardier, Bouygues, Murray & Roberts and the Strategic Partnership Group, won the 15-year concession after an extended bidding and negotiation process. The total project cost is US $3 billion, split between Gauteng Provincial Government and the consortium. Railways are cost effective for moving heavy, non time-sensitive goods. Yet to attract private sector investment, concessions need to be structured to give operators a fair return on equity to cover their risks. Weak infrastructure and low traffic volumes could prevent the privatisation of some rail networks in the short to medium term. Other African railways are simply too small to be commercially viable. In these cases, subsidies may be needed if the private sector is to be engaged. Then some experts are looking at projects to improve existing networks and extend interconnections between railways using alternative sources of funding than the private sector. Some governments have also adopted this approach.

In many cases, cross border connections could help boosting traffic and thus make investments more attractive to the private sector. The British once dreamt of building a rail link from Cairo to the Cape, and failed. But modern Africa might succeed. However, it is not just a case of laying down parallel lines of steel. The practicality of interconnecting various national railways must be evaluated. Many issues need to be tackled, including the lack of harmonized regulatory frameworks, and commercial policies, such as ticketing and timetabling, between countries, as well as many technical problems. Cross-border cooperation is essential to ensure free movement of goods so that there are numerous political problems to overcome.

In this context, the European experience is valuable. Since 2010, international passenger services is open to competition within the European Union. This decision, which is part of the so-called Third Railway Package, is aimed at fostering this rail activity which represents a significant part of railways' revenues and market shares - more precisely, ten percent of railway undertakings' passenger turnover and twenty per- cent of international traffic. While international rail services face a fierce competition from low-cost airlines,

it is deemed that they would profit from the enlargement of the European high-speed network and its interconnection if intramodal competition is implemented. To do so, it is required that all Member States grant the right of access to their rail infrastructure. This opening raises the question of designing what could be the optimal organization of a regionally integrated rail industry, i.e., the industrial structure that would yield the highest level of consumer welfare.

This paper provides some insights on this key question by developing a model allowing explicitly for an international competition in the railway industry. The traditional model of railway organization involves a single firm in charge of both the fixed infrastructure, i.e., the network of rail tracks and its associated equipment of signals and stations, and the rolling stock management, i.e., the operational services. More precisely, the firm is vertically integrated. The main reason advanced to support this organization is that there is a strong need for cooperation between the two layers. Concerning the international services, whether it is for freight or passengers, the incumbents of different countries have cooperative agreements to provide combined services whose they share revenues based on some rule in a transparent way for the users. In some sense, the traditional model also favors a form of horizontal integration through these agreements. Technologically speaking, there are indeed good reasons to plead for vertical integration. It is well known that the wheels of railroad wagons and locomotives work best when they are round. This is not a surprising statement, but unfortunately, the longer a wagon is operating, the more irregular the shape of wheels becomes. This is expensive because it increases the wear-and-tear on tracks, and more importantly, it increases the risk of accidents.[45]

Econometric analysis of railroad cost functions document the existence of strong cost complementarities between infrastructure and operations. Ivaldi and McCullough, 2001, manage to account for the vertical structure of railroads, which allow them to evaluate the cost cross-elasticities between the infrastructure output and the different service operations by fitting a translog cost function to a panel dataset of US freight railroads. A recent article by Ivaldi and McCullough, 2008 tests for sub-additivity in the cost function

[45]To identify irregularities, one can make use of novel technologies that have sensors in the track and transponders on the wagons and locomotives. This allows railroad managers to generate precise and standardized data and focus maintenance efforts on irregular wheels. However, the new technology involves substantial investments above and below the wheels, which are far too expensive for poor countries.

between infrastructure and freight operations. The results indicate that firms running each activity separately would have up to 24 percent higher operational costs than a vertically integrated firm. A study by Cantos, 2001 undertakes a similar approach to Ivaldi and McCullough, 2001 for European services. Using a translog cost function, the author analyzes economies of scope between infrastructure output and transport operations (passenger and freight) for 12 major European railways along the 1973-1990 period. The main finding is that the marginal cost of passenger output is in- creasing with the level of infrastructure value while the opposite result is obtained for freight operations. Other evidence comes from Mizutani and Shoji, 2001, who studied the case of Kobe-Kosoku Railway in Japan. They found that vertically separated firms cost 5.6 percent more than an integrated system. These results indicate that vertical disintegration might be costly from a technical point of view. They must be balanced with gains that could be expected from managing the rail infrastructure separately from the different rail service operations. In particular, from a regulatory perspective, it could be more difficult for authorities to obtain the information required for effective regulation of access to the rail network than in the disintegrated case. With separation, all firms that would enter the market are treated on an equal footing and face the same rules of access. Moreover, it could be easier to compare productivity and performance of the firms operating on the same track. Separation is viewed as a way to foster competition to the benefit of customers, not in the sense that all prices would be lowered but in the perspective of a higher level of consumer surplus. It remains that a well-known advantage of vertical integration is its diminished incentives for double marginalization, so it may be that some kinds of anti-competitive behavior become less likely under integration even though the authorities' ability to monitor them is diminished. This is probably why most countries apart a few examples like France, The Netherlands, UK have still maintained an integrated industry or have adopted a partial disintegration where the vertically integrated incumbent is challenged by new entrants.

With these economic results and facts in mind, the paper question the relevance of the type of reform contained in the Third Railway Package for international rail service. More precisely, the objective is to shed light on the working of competition for the international rail services, i.e., to provide a theoretical setup to understand and explain the issues at

stake. In the perspective to draw some inferences on liberalization and unbundling, which, in particular, allows for different degrees of separation, a model in which two (downstream) railroad operators compete on a final market to provide transport services to end-users is developed. Since inter-modal competition is important, it is assumed that end-users can also travel by another transport mode, for instance roads. The focus is on international transport services, that is, transport services from one country to the other. Therefore, to provide one unit of transport services, transport operators have to get access to both infrastructures; the pricing of a given network is under the control of a country-specific (upstream) infrastructure manager. The analysis emphasizes two elements: the nature of the returns-to-scale and the nature of the final services provided by the transport operators. More precisely, it is assumed that either the upstream segment (network) or the downstream segment (transport operator) can exhibit some increasing or decreasing returns-to-scale. The analysis shows that the optimal industry organization depends on these returns-to-scale, in particular at the level of the upstream sector.

Two polar cases are studied. In the first case, final transport services are purely local: to complete one unit of services, each transport operator must access only one network. In the second case, services are purely international in the sense that in order to complete one unit of transport services, each operator must access both networks. Contrasting these two scenarios allows to understand how the railway organization should be amended with the development of international transportation and economic integration.

The analysis undertaken in the paper shows that, when the industry features downstream returns-to-scale only, then vertical integration ought to be favored with respect to any other organizational choices which would imply some form of separation. This holds true whatever the nature of the final transport services. That is, whether purely local or purely international services are considered.

With upstream returns-to-scale, the analysis becomes less clear-cut. With purely local services, integration is preferred to separation when the returns-to-scale parameter, weighted by the intensity of competition on the final market, is not too large. With purely international services, a somewhat similar conclusion emerges: integration (in both countries) dominates provided that that parameter is not too large; when it increases, a mixed industry organization, in which one firm is integrated whereas the other is sepa-

rated, becomes optimal; when it further increases, separation in both countries becomes optimal.

Importantly, note that the competitive environment must be taken into account in such a reasoning. The analysis departs from the traditional analysis of vertical integration by considering, first, increasing or decreasing returns-to-scale at the various segments of the industry, and, second, final services which may require the access to several networks whose access is controlled by non-cooperative infrastructure managers.

As an implication, when the share of international services becomes greater with respect to the total level of transport services, the paper shows that some kind of separation tends to be preferred when the infrastructure is characterized by decreasing returns-to-scale; integration is optimal, by contrast, under increasing returns-to-scale at the infrastructure level. Since Sub-Sahara Africa railway network is dramatically under-developed, it is very likely that returns-to-scale are increasing at the African infrastructure level. This clearly suggests that the regional integration of African railways networks, which would boosts growth both of landlocked and coastal countries, should be achieved with vertically integrated firms at the national level. Separation is not a good option for African railways companies.

6 Conclusion

Integration of market economies is generally perceived to be a powerful tool in stimulating investment in infrastructure industries. Intuitively, some investments that are oversized for a particular country should be profitable in an enlarged market. This research project shows that market integration has complex welfare implications in non-competitive industries.

The paper by Auriol and Biancini, 2009 shows that with cost-reducing technology, market integration tends indeed to increase the level of sustainable investment. When one country is much more efficient than the other, integration stimulates investment in the cost-reducing technology. However, the investment level remains suboptimal because the countries endowed with cheap ressource (e.g., hydropower) do not fully internalize the surplus of the consumers in the foreign countries. They internalize the sales only.

It remains the case that with generation facilities, the only problem to fear, compared to autarky, is overinvestment. This is in contrast with the systematic underinvestment problem arising for interconnection and transportation facilities, and other public-good components of the industry, such as reserve margins. Free-riding reduces the incentives to invest, while business-stealing reduces the capacity for financing new investment, especially in the importing country. This result is important for policy purposes. The issue of how to collectively finance these essential facilities needs to be addressed upfront. This is clearly a case where international organizations/agencies can play an important role in coordinating sustainable level of investment.

One important mechanism to overcome in practice the infrastructure under-investment problem and the coordination gap is joint venture, as shown by Beradi and Seabright, 2009. Several case studies, in particular from the hydro-power sector in Africa, support the idea that JVs may provide a commitment mechanism enabling more efficient levels of investment. The credibility of such commitment is particularly important for the undertaking and the success of infrastructure projects in developing countries, because these projects are likely to be threatened by both internal and external tough lobbying. The pressure of interest groups may cause delays, or inefficiently low levels of investment, or even prevent a project from being undertaken. If the rule of equal profit sharing makes distribution more costly and lobbying less attractive, JV's structure contributes to building a reputation of credibility and thus fosters the development of new infrastructure projects. For JV's structure to be a credible commitment device, however, symmetry is crucial. When the parties do not equally benefit from profits generated by the infrastructures, lack of commitment arises and may entail rent-seeking. This asymmetry may lead to renegotiations, conflicts, and even to the failure of other infrastructure projects.

For transportation infrastructure, the problem is as bad as for interconnection and transportation facilities for electricity. Although Calmette, 2009 suggests that the negative result of agglomeration of economic activities at the core (i.e., coastal regions) to the detriment of the periphery (i.e., landlock regions), might not hold in very poor regions such as Sub-Sahara Africa, due to its strong natural ressources export biais, the question of how to finance the roads and the railroads necessary to integrated the African economies is not settled. There is a public good aspect of transportation infrastructure. As for inter-

connection facilities in the electricity market, this leads to a systematic under-provision of the infrastructure, especially when the decision to finance it is taken nationally. This is especially bad for the railways industry which generate sales. The analysis by Friebel et al., 2009 on the optimal industrial structure for the railroad industry indeed suggests that in the African context vertical integration at the national level is the most sensible option for railroads companies. Since in may cases public subsidies will be requires to upgrade and expand the network, the temptation for politicians to interfere with the pricing strategy and redistribution of variable profits of the national railroad company is a very serious threat on the viability of railroad deployment in the long term. The task of international organizations, such as the French Development Agency (AFD) should be to implement a mechanism that supports the socially optimal level of investment in transportation infrastructure and the optimal management structure, namely vertical integration. Joint ventures might then be helpful to mitigate political interference while providing adequate funding, at least for the most profitable routes.

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Countries	% pop working in agri	% of agriculture in GDP
Bénin	n.d.	40%
Burkina-Faso	80%	32%
Côte d'Ivoire	68%	27%
Mali	80%	44%
Niger	90%	40%
Sénégal	77%	18,3%
Togo	80%	42%

Table 1: The share of activities tied to land in UEMOA countries

Figure 6: Existing railroads (in black) and projects of interconnection (in red) in West Africa (2005).

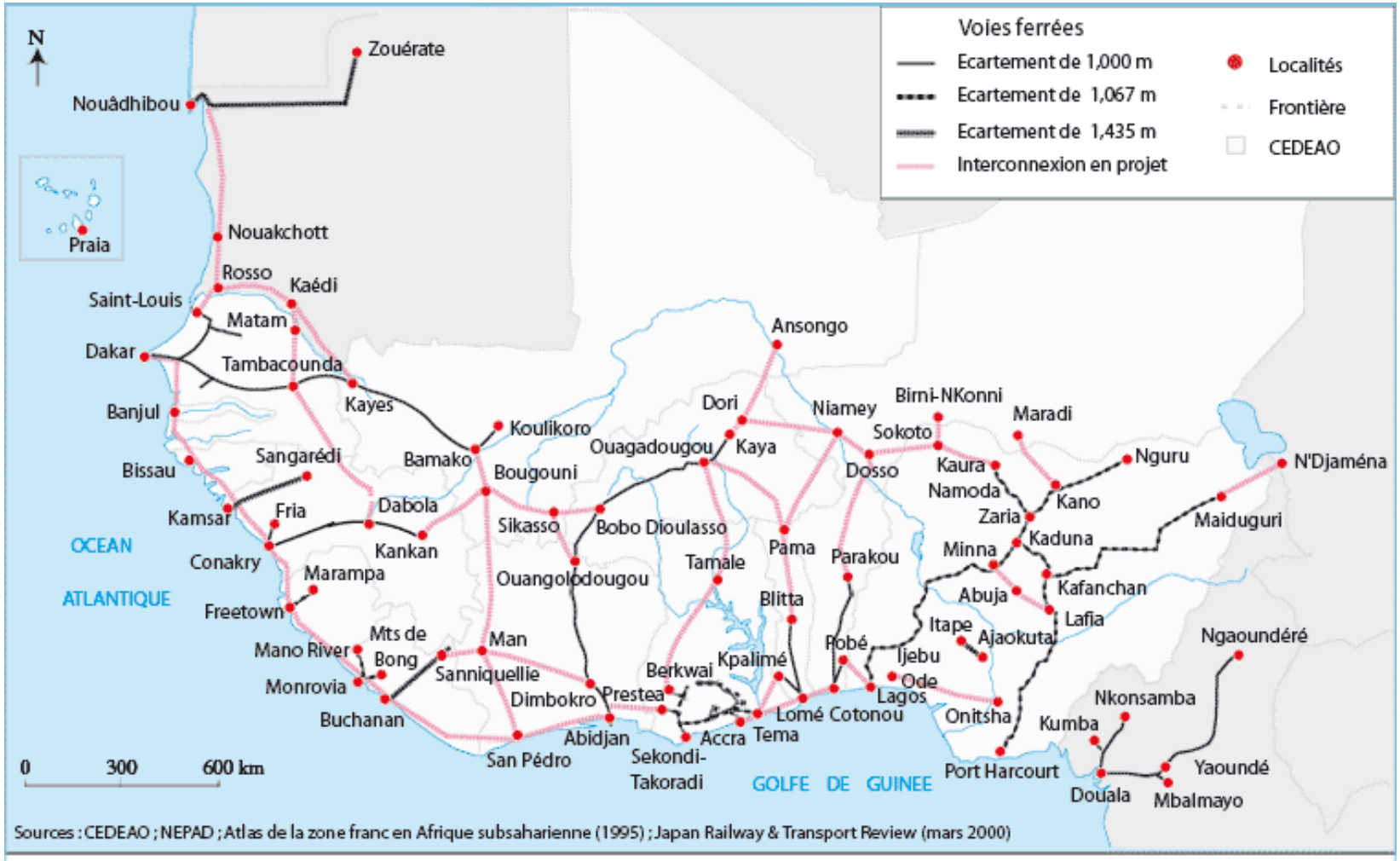

Figure 6 cont.: Main Roads in West Africa (2005)

Figure 7 : The evolution of employment in region 1 according to the level of transport costs

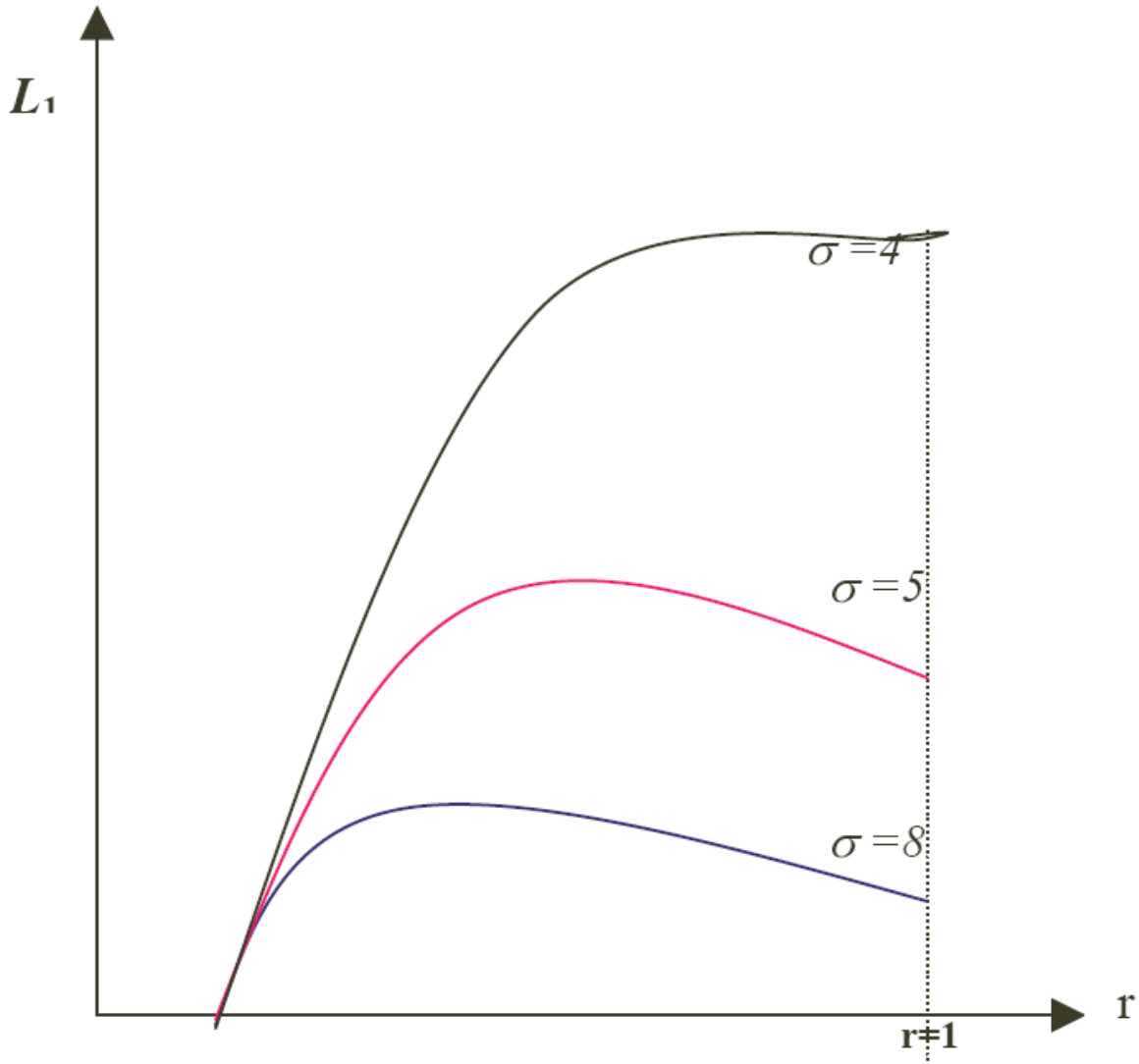

Table 2: Empirical results for developing and developed countries.

Developing countries

Variable	Parameter	T-Ratio
Intercept	0.26	2.30
ΔUpop	3.49**	1.38
ΔRoads	1.37**	0.50
Log(Upop In) [12]	- 0.38	0.43
Log(RoadsIn)	- 0.34	0.22
Log (RN In)	- 0.13*	0.083

** denotes significance at 5%,* at 13%

Developed countries

Variable	Parameter	T-Ratio
Intercept	-0.336	-2.99
ΔUpop	0.285	0.99
ΔRoads	0.011	0.17
Upop In	0.004**	3.05
Roads In	-0.612	-0.42
RNIn	-0.001*	-1.77

** denotes significance at 5%,* at 10%