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Economic Integration and Investment Incentives in Regulated Industries

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Contents

Abstract

The paper studies the impact of market integration on investment incentives in non-competitive industries. It distinguishes between investment in transportation and production cost-reducing technologies. Each domestic firm is controlled by a national regulator in a common market made of two countries. When public funds are costly, and production costs in the two countries are not very different, business stealing effect decreases welfare in both countries. Welfare increases in both countries when the difference in production costs is large enough. Market integration tends to increase the level of sustainable investment in cost-reducing technology compared to autarky. This is in contrast with the systematic underinvestment problem arising for transportation facilities. Free-riding reduces the incentives to invest in these public-good components, while business-stealing reduces the capacity for financing new investment.

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Introduction

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.

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 (Jamasb and Pollitt, 2005).[1]

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. 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 present paper addresses the problems posed by infrastructure investment in liberalized regulated markets. It first analyzes the welfare implications 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 illustrate the analysis.

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 (see International Electricity Agency, 2006).

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. In advanced economies, liberalized electricity markets that have not been accompanied by regulated capacity markets do not generate enough revenues to support investment in new generating capacity (see Joskow, 2006). Power capacity reserve margins are hence falling in all OECD countries, a signal of under investment. In this context market integration may allow a better use of existing resources and infrastructures. 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

1 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

South American electricity regional markets[2] and in Africa.[3]

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).

Despite the potential benefits of market integration, sovereign countries focus on domestic welfare and tend to favor policy of energy independence. Most countries rely on public/mixed firms and regulation, to achieve these goals. Former national monopolies are generally under direct government control, while new entrants are not. In OECD countries, asymmetric regulation is hence the norm in electricity and Telecommunication markets (see Flacher and Jennequin, 2008).[4]

The paper 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, competition for market share is fierce. Prices decrease in both countries so that transfers rise. By eroding the rent extracted from the regulated sector, competition reduces the possibility of performing taxation via regulation. This is the case when 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 significantly 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. Even when the efficiency gains from integration are large enough so that both countries win from integration, opposition might still subsist internally. Indeed, market integration has redistributive effects. For instance, given small levels of opportunity cost for public funds, prices converge at some "average'' of the closed-economy prices. Consumers in the formerly low-price region are thus worse off after integration. 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. First, when one country is much more efficient than the other, a case where integration is particularly appealing, the level of sustainable investment increases with market liberalization. Moreover, the incentives to invest in obsolete technology decrease, and the incentives to invest in efficient technology increase. Supranational competition, by stimulating investment in more efficient generation sources, hence 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). Second, when the two countries' technologies are not sufficiently differentiated, in the open economy the firms have to fight for their market shares. They might overinvest compared to the optimal solution.

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 problem is sometimes so severe that global investment decreases, compared to autarky. That is, when the two firms are not sufficiently differentiated in terms of

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

[3] 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.

[4] In Europe, the Commission promotes the formation of an integrated market. However, in markets that are not competitive, the European Union allows national regulators to control operators with significant market power. Governments and national regulators retain jurisdiction over specific choices, while respecting the overall framework designed by the Commission. United States and Canadian regulators impose asymmetric interconnection obligations on incumbent firms, which are also required to unbundle and share network components. For instance, during the California deregulation experiment (significantly revised after the crisis of 2001), a ceiling was imposed on the retail price that incumbent suppliers charged for electricity.

productivity, the maximal level of investment in public-good facilities is not only suboptimal, but it is also smaller than under a closed economy. Business-stealing worsens the gap between the optimal investment level and the equilibrium one. Even when market enlargement increases the incentives to invest, which occurs when the two countries have significantly different productivity, the investment level remains suboptimal. 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 largely 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 (see Manibog and Wegner, 2003). In the end both consumers and taxpayers were worse off.

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 is estimated at 24% of the population (by the International Energy Agency), the lowest level 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 recent 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).[5] 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 (and/or governments). The ORR will be charged with 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 fewer generation options. They are obliged to rely on much more expensive sources of generation in order to respond to growing demand. This implies that a substantial portion of demand is not served at all. Sparrow et al. (2002) estimate that the cost of expanding thermal and hydroelectric capacities can be potentially reduced by between 5% and 20%, given market integration. 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 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.[6]

[5] In Africa, there are several power pools: 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.

[6] The region possesses some of the largest flows of water 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.

West Africa is not the only developing region that 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 with 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 projects have been started to exploit the potential gains from cross-border trade. In the region, Venezuela is an OPEC member with huge reserves 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 projects 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 (Organe de Régulation Régionale) 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 CRIE. For this purpose, a new company (EPL) was created in order to build a new regional interconnection line; it is controlled by the national transmission companies with participation by ENDESA, the Spanish utility company. EPL's investment program has been financed through loans obtained from several European banks, together with contributions by 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 should be quite similar to that of CRIE: it should create an environment capable of attracting investment, and it should also regulate cross-border exchange 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 electricity systems. The role of the ORR should be evaluated in a broad context: the integration of the existing infrastructure is not sufficient to stimulate development of the sector, if the problems related to transmission and generation capacity in the different countries are not addressed at the same time.

Despite the potential benefits of market integration, countries tend to favor the 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 North Pool (regional market of the Scandinavian countries). In the case of France, UK, Italy and Spain, the difference in generation costs is the engine for integration. Countries with high costs (Italy, Spain, UK) benefit from low prices, while the country with low costs (France) benefits from new profit opportunities. Regarding

the North Pool, the region is not characterized by marked differences in the average levels of production costs, but there is a form of technical complementarity between seasonal hydropower (Norwegian) and the thermoelectric production (Swedish). In addition, the development of an integrated Scandinavian market has certainly increased efficiency: national regulations do not seem to conflict.

While the North Pool regulators are cooperating rather efficiently, other countries are much less active in the development of cross-border networks, and more generally, they are less open to the entry of foreign producers (either directly or indirectly via the takeover 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 time of its creation in 1991, the energy market integration of its member countries (Argentina, Brazil, Paraguay and Uruguay). Several large, bi-national hydro projects have been started in the region,[7] and by 2025 the MERCOSUR nations are expected to complete the integration of their electricity grids. However, regulatory differences and governmental conflicts still appear as the major constrains on integration (Pineau et al., 2004).

[7] 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. Regulated firms in a common market: an economic model

2.1 How this study relates to existing literature

Starting with the seminal paper of Brander and Spencer (1983), the literature on the interaction between regulation and market integration considers the strategic effect of trade subsidization policies.[8] Subsidies have a rent-shifting effect that makes the domestic firm more aggressive in the common market. The increase in the national profits compensates for the value of subsidies. The strategic reaction of the rival government creates a prisoner's dilemma, with the consequence that countries stand to benefit from jointly reducing the subsidies. Brainard and Martimort (1996, 1997) show that the losses associated with the prisoner's dilemma can be mitigated in the case of asymmetric information, because competition reduces the agency costs of regulation. Combes, Caillaud, and Jullien (1997) add domestic production and national consumers to the analysis. In the absence of a budget constraint for the government, they show that market integration is always welfare- improving and subsidization desirable.[9] By contrast, when public funds are costly, Collie (2000) shows that subsidization policies can lead to welfare losses, offering a theoretical argument for their prohibition.

Since it focuses on investment issues, the present paper relates to the work of Haaland and Kind (2008), which looks at R&D subsidies for national firms competing in a third market. Haaland and Kind concentrate on the strategic motive for subsidies: governments could pay excessive subsidies in order to strengthen the position of the national firm in the common market. In a similar framework, Leahy and Neary (Forthcoming) find that subsidies could end up being too low, rather than excessive, if investment has positive spillovers (i.e. investment also increases the profits of the rival), and particularly if the social planner takes consumer welfare into account. Both papers follow the classical trade-policy approach in the sense that they concentrate on the strategic effect of unit subsidies when public funds are not costly.

By contrast, the present paper analyzes the interaction between regulatory and investment policies in open economies. As in Leahy and Neary (Forthcoming), we distinguish between different types of investments with different impacts on a competitor's costs and profits (i.e., transportation/interconnection infrastructures and generation technologies). The investments have to be financed either by consumers or by taxpayers. To find the right balance between the two, we need to take into account the opportunity cost of public funds. Taxation by regulation hence emerges when public funds are costly. The optimal regulated price is a Ramsey tariff. Unregulated competition can have the adverse effect of undermining the tax base (Armstrong and Sappington, 2005).[10] Market integration erodes the possibility of conducting taxation via regulation because regulators do not control foreign firms. They can tax and subsidize domestic firms more easily (e.g., public or mixed ownership).

[8] For more details about the strategic trade policy literature, see Brander (1997).

[9] As Neary (1994) shows, when public funds are costly and lump sum transfers not allowed, the optimal unit subsidy can be negative (i.e. an export tax), even in the case of quantity competition.

[10] As a consequence, taxation by regulation has to be replaced by other fiscal policies (e.g. targeted subsidies to the industry). These other policies do not come without a cost. Gasmi, Laffont, and Sharkey (1999, 2000) show that in telecommunications, cross-subsidies remain a powerful tool for financing universal service given competition in developing countries.

Thus, the relevant setting is that of incomplete or asymmetric regulation: national regulators control only domestic firms. The literature includes Caillaud (1990), who studies a regulated market in which a dominant incumbent is exposed to competition from an unregulated, competitive fringe, operating under asymmetric information and cost correlation. He shows that competition has a positive effect on overall effciency and helps to reduce the rent of the regulated firm. In Caillaud (1990), the competitive fringe prices are at marginal cost. Biglaiser and Ma (1995) extend the analysis to the case where a dominant regulated firm is exposed to competition from a single strategic competitor. Allowing for horizontal and vertical differentiation, they also find that competition helps to extract the information rent of the regulated firm, but allocative ineffciency arises in equilibrium. Both papers focus on new entry into a closed economy.

More recently, Calzolari and Scarpa (2007) have studied (in a model with costless transfers) the optimal regulation of a firm that is a monopoly at home but competes abroad with a foreign firm. Taking into account that economic integration is a process of reciprocal opening, Biancini (2008) has studied the case where the unregulated entrant is the incumbent of the foreign market.

The present paper follows the same modeling strategy as these more recent papers: it considers the possibility of the national leader being challenged in its formerly protected national market and simultaneously trying to expand its activity in the foreign market (e.g., liberalized electricity markets). To distinguish between transportation and generation costs, this paper extends the Biancini (2008) model to include more general cost functions. Moreover, this paper considers the impact of market integration on firms' capacity and their incentives to finance different types of investment. The next section presents the model.

2.2 A model of market integration with regulated firms

As in Biancini (2008), we consider two symmetrical countries, identified by $i = 1,2$. The inverse demand in each country is given by:

$$p_i = d - Q_i \quad (1)$$

Where Q_i is the home demand in country $i = 1,2$. Before market integration, there is a monopoly in each country. In a closed economy, Q_i corresponds thus to q_i, the quantity produced by the national monopoly, also identified by $i \in \{1,2\}$. When markets are integrated, Q_i can be produced by both firms 1 and 2 (i.e. $Q_i = q_{ii} + q_{ji}, i \neq j$, where q_{ij}, is the quantity sold by firm i in country j). Total demand in the integrated market is given by:

$$p = d - \frac{Q}{2} \quad (2)$$

where $Q = Q_1 + Q_2$ is the total demand in the integrated market, which can be satisfied by firm 1 or 2 (i.e. $Q = q_1 + q_2$).

On the production side, firm incurs a fixed cost , which measures the economies of scale in the industry. The fixed cost is sunk so that it does not play a role in the optimal production choices. The firm also incurs a variable cost function given by:

$$c(\theta_i, q_i) = \theta_i q_i + \gamma \frac{q_i^2}{2}. \quad (3)$$

This is a major difference with Biancini (2008), who focused on constant marginal costs. Here, the variable cost function includes a linear and a convex (quadratic) term. 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. Indeed, the cost function (3) can be generated from a horizontal differentiation model in which Firm 1 is located at the left extremity and Firm 2 at the right extremity of the unit interval. The final price is uniform and firms have to cover

the transportation cost.[11] For example, in the case of electricity, θ_i can be interpreted as a generation cost, constant after some fixed investment, K, has been made, while γ is a measure of transportation costs (i.e., transport charges and losses). These costs are increasing with the distance.

In what follows we assume that γ and θ_i are common knowledge. This assumption is not very restrictive. Since γ is a common value, the regulator can implement some yardstick competition to learn freely its value in case of asymmetric information. By contrast, if the regulator does not observe the independent cost parameter θ_i, some rent has to be abandoned to the producer in order to extract this information. The cost parameter then is replaced by the virtual cost (i.e., production cost plus information rent). Our results are unchanged except for the inflated cost parameter. For the sake of simplicity, we focus on the symmetric information case. Any distortions occurring at the equilibrium can thus be ascribed to a coordination failure between the national regulators.
The profit of firm $i = 1,2$ is

$$\Pi_i = P(Q)q_i - \theta_i q_i - \gamma \frac{q_i^2}{2} - K - t_i \qquad (4)$$

where t_i is the tax it pays to the government (it is a subsidy if it is negative). The participation constraint of the regulated firm is:

$$\Pi_i \geq 0 \qquad (5)$$

The regulator of country i has jurisdiction over the national monopoly i. She regulates the firm and is allowed to transfer funds to and from it. In particular, she taxes operating profits when they are positive. For simplicity, one can think of public ownership. 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 exporters of electricity in the world, is 87.3% owned by the French government. In 2007, the firm had paid more than EUR 2.4 billion in dividends to the government.

However, this paper's assumptions are also consistent with the imposition of taxes on the rents created by private firms. For instance, in Britain 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 (see Birdsall-Nellis).[12]

In contrast, the regulator of country i does not control the production, the investment nor the profit of firm j (i.e. she is not allowed to size the rents of firm j). Rents extraction does not apply to foreign firms because they do not report their profits locally. For instance, between 1996 and 2000, 71% of foreign-based firms operating in the U.S. paid no U.S. income taxes (GAO). The assumption that firm j production and investment decisions escape regulator i control is consistent with a situation in which regulation is asymmetric. As explained in the introduction, asymmetric regulation is common in liberalized industries such as telecommunication, electricity, or railways.

Each utilitarian regulator maximizes the home welfare, represented by the surplus of national consumers plus the profit of the national firm minus the opportunity cost of public transfers. The welfare in country i is $W_i = S(Q_i) - P(Q)\,Q_i + \Pi_i + (1+\lambda)t_i$, where the consumer surplus function is

$$S(Q_i) = \int_0^{Qi} p_i(Q)dQ = dQ_i - \frac{Q_i^2}{2}$$. Substituting

$t_i = P(Q)q_i - \theta_i q_i - \gamma \frac{q_i^2}{2} - K - \Pi_i$ from (4) in the

[11] That is, each consumer, who is uniformly distributed over $[0,1]$, consumes one unit of the good if his/her constant valuation for it is higher than the price. Transportation costs associated with a consumer located at $q \in [0,1]$ is γq for firm 1, and $\gamma(1-q)$ for firm 2. The variable production cost of firm i with market share equal to q_i can then be written $c(Q_i, q_i) = \int_0^{q_i} (\theta_i + \gamma q)dq$, or equivalently $c_i(q_i) = \theta_i q_i + \gamma \frac{q_i^2}{2}$ ($i = 1,2$).

[12] More generally the US and the UK, where utilities are private, tax the overseas income of their corporations. However, profits of multinationals are easily reallocated through the movement of intangible property so that it is harder to tax private corporations than public firms. Taxation by regulation, which is a substitute for direct taxation, has hence always existed in countries where regulated firms are private (mainly the USA). For instance, a federal excise tax on US services in local and long-distance telephony was first created in 1898. It has been repealed occasionally and re-enacted ever since. The tax's opponents argue that it is regressive and distortive, while its proponents insist on the need for revenues. It is hard to get around this argument: at a tax rate of 3%, tax collection reached USD 5.185 billion in fiscal year 1999 (as reported in the budget of the United States Government, fiscal year 2000).

welfare function W_i it is easy to check that W_i is decreasing in Π_i when $\lambda \geq 0$. Since leaving rents to the monopoly is socially costly, the regulator always binds the participation constraint of the national firm (5): $\Pi_i = 0$. The utilitarian welfare function in country $i = 1,2$ is

$$W_i = S(Q_i) - P(Q)\,Q_i + (1+\lambda)P(Q)q_i - (1+\lambda)(\theta_i q_i + \gamma\frac{q_i^2}{2} + K) \quad (6)$$

Term $\lambda \geq 0$ 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. a tax 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. We assume that both countries have the same cost of public funds λ [13].

In what follows, it is convenient to express the results in function of $\frac{\lambda}{1+\lambda.}$. Let

$$\Lambda = \frac{\lambda}{1+\lambda.} \quad (7)$$

It is straightforward to check that Λ increases with λ so that $\Lambda \in [0,1]$ when $\lambda \in [0,+\infty)$.

We first briefly study the benchmark case of a closed economy.

2.3 The closed economy case

In a closed economy, marked C, each regulator maximizes expected national welfare (6) with respect to the quantity subject to the autarky production condition $Q_i = q_i$.

Solving this problem the optimal autarky quantity is:

$$q_i^C = \frac{d-\theta_i}{1+\gamma+\Lambda} \quad (8)$$

We deduce that the autarky price is $P(q_i^C) = \theta_i + (\Lambda+\gamma)\frac{d-\theta_i}{1+\gamma+\Lambda}$. When $\Lambda = 0$, public funds are costless and the price is equal to the marginal cost $P(q_i^C) = \theta_i + \gamma q_i^C$. When $\Lambda > 0$, the price is raised above the marginal cost under a rule which is inversely proportional to the elasticity of demand (Ramsey pricing): $P(q_i^C) = \theta_i + \gamma q_i^C + \Lambda\frac{P(q_i^C)}{\varepsilon}$. The optimal-pricing rule diverges from marginal-cost pricing in proportion to the opportunity cost of public fund Λ, because the revenue of the regulated firm allows for a decrease in the level of other transfers in the economy (and thus distortive taxation).

[13] Biancini (2008) considers the case of asymmetric λ s. Here, similar analysis is more challenging because both the equilibrium quantities and the welfare function are a non-linear function of λ. However, some local results can be drawn: increasing the cost of public funds in one country generally increases the negative impact of business-stealing and thus decreases its gains from trade. Conversely, the country with a relatively lower λ benefits more from market integration. As we will see in the following, increased gains from integration are generally associated with an increased willingness to invest.

3. The impact of market integration: taking ineffiencies into account

When barriers to trade are removed, firms can serve consumers in both countries. We first consider the solution that would be chosen by a global, welfare-maximizing social planner. This theoretical benchmark describes a process of integration in which the two countries are fully integrated, even fiscally.

3.1 The global optimum scenario

The supranational utilitarian social planner has no national preferences. He maximizes the sum of welfare function (6), marked $W = W_1 + W_2$,

$$W = S(Q_1) + S(Q_2) + \lambda P(Q)Q - (1+\lambda)(\theta_1 q_1 + \gamma\frac{q_1^2}{2} + \theta_2 q_2 + \gamma\frac{q_2^2}{2} + 2K) \quad (9)$$

with respect to quantities (Q_1, Q_2, q_1, q_2), under the constraint that consumption $Q = Q_1 + Q_2$ equals production $q_1 + q_2$. This problem can be solved sequentially. First of all, the optimal consumption sharing rule between the two countries $(Q_1, Q_2$ is computed for any level of production Q. This amounts to maximizing $S(Q_1) + S(Q_2)$ under the constraint that $Q_1 + Q_2 = Q$. Since $S(Q_i) = dQ_i - \frac{Q_i^2}{2}$ we deduce easily the next result.

Lemma 1 *Whatever* (q_1, q_2) *chosen at the production stage, at the consumption stage it is optimal to set* $Q_1 = Q_2 = \frac{q_1 + q_2}{2}$.

By virtue of Lemma 1, the supranational utilitarian objective

$$W = 2S(\frac{q_1+q_2}{2}) + \lambda P(q_1+q_2)(q_1+q_2) - (1+\lambda)(\theta_1 q_1 + \gamma\frac{q_1^2}{2} + \theta_2 q_2 + \gamma\frac{q_2^2}{2} + 2K) \quad (10)$$

Let $\theta_{\min} = \min\{\theta_1, \theta_2\}$ and $\Delta = \theta_2 - \theta_1$ be the difference in cost parameters between producer 2 and producer 1. It can be positive or negative. Optimizing (10) with respect to the quantities q_1 and q_2 yields the following result.

Proposition 1[14] *The socially optimal quantity is:*

$$Q^* = \begin{cases} \frac{2}{1+\Lambda+2\gamma}(d - \theta_{\min}) & \text{produced by a monopoly if } |\Delta| > \Delta^*(\theta_{\min}) = \frac{2\gamma(d-\theta_{\min})}{1+2\gamma+\Lambda} \\ \frac{2}{1+\Lambda+\gamma}(d - \frac{\theta_1+\theta_2}{2}) & \text{produced by a duopoly otherwise.} \end{cases} \quad (11)$$

The quantity produced by firm $i = 1,2$ given the duopoly solution is:

$$q_i^* = \frac{Q^*}{2} + \frac{\theta_j - \theta_i}{2\gamma} \qquad if\ |\Delta| \le \Delta^*(\theta_{\min}) \quad (12)$$

When the cost difference between the two firms is large (i.e., when $|\Delta| > \Delta^*(\theta_{min})$), the less efficient producer is shut down and the most efficient firm is in a monopoly position. This implies that when there is no transportation cost (i.e., $\gamma = 0$), the first-best contract always prescribes shutting down the less efficient firm. This corresponds to the linear case studied by Biancini (2008). However, the "shut down" result is upset with the introduction of

[14] All proofs are available on sequest.

transportation costs. When γ is positive, both firms produce whenever $|\Delta| \leq \Delta^{\sim}(\theta_{\min})$. The market share of firm $i = 1,2$ is: $\frac{q_i^*}{Q^*} = \frac{1}{2} + \frac{\theta_j - \theta_i}{2\gamma Q^*}$. The most efficient firm (i.e., the firm with the cost parameter $\theta_{\min}$) has a larger market share than its competitor. However, the market share differences decreases with γ.

The supranational social planner exploits the gains from trade to maximize the sum of national welfare. The common market welfare, $W^* = W_1^* + W_2^*$, is thus higher than the sum of the two closed-economy welfares, $W^C = W_1^C + W_2^C$. Focusing on the interior solution, which arises when $|\Delta| \leq \Delta^{\sim}(\theta_{\min})$, the total welfare in the case of perfect economic integration W^* is obtained by substituting (11) in (10). Similarly, W_i^C, $i \in \{1,2\}$ is computed by replacing (8) with (6). Rearranging terms, one can check that the welfare gain from integration is:

$$W^* - W^C = \frac{\Delta^2}{4\gamma} \frac{1+\Lambda}{1+\gamma(1-\Lambda)} \geq 0 \qquad (13)$$

The welfare gain in (13) is an increasing function of the cost difference $|\Delta|$ and a decreasing function of the transportation cost γ. The higher the difference in the production cost, the higher are the gains related to the reallocation of production in the common market. However, when γ is large, expanding the production of the most efficient firm becomes costly. The gains from trade decrease with transportation costs.

The solution chosen by a global, welfare-maximizing social planner corresponds to perfect integration. In practice, such fusion of regulatory bodies and fiscal systems is rarely achieved. The German reunification is an exception. The East and West German economic systems have been unified under the same government. Consistent with the theory, many firms have been shut down in the East. The reallocation of production towards more efficient units has been sustained by transfers from the West. However, in most cases, economic integration excludes fiscal and political institutions, which remain decentralized at the country level. Sovereign governments and regulators do not share profits and tariff revenues among themselves; taxpayers enjoy taxation by regulation insofar as the taxed rents come from their national firms. This is likely to yield inefficiencies. The next section studies the non-cooperative outcome of economic integration given asymmetric regulation.

3.2 The non-cooperative equilibrium scenario

In the open economy, marked O, there is a single price. Since the demand functions are symmetric, this implies that the level of consumption is the same in the two countries: $Q_i = \frac{1}{2} Q^O$, $i = 1,2$. By contrast, the cost functions are different, which implies a different level of production in the two countries. National regulators simultaneously fix the quantity produced by the national firm through the regulatory contract, q_i^O, thus maximizing expected national welfare (6). The system of reaction functions of the regulators determines the non- cooperative equilibrium of the model.

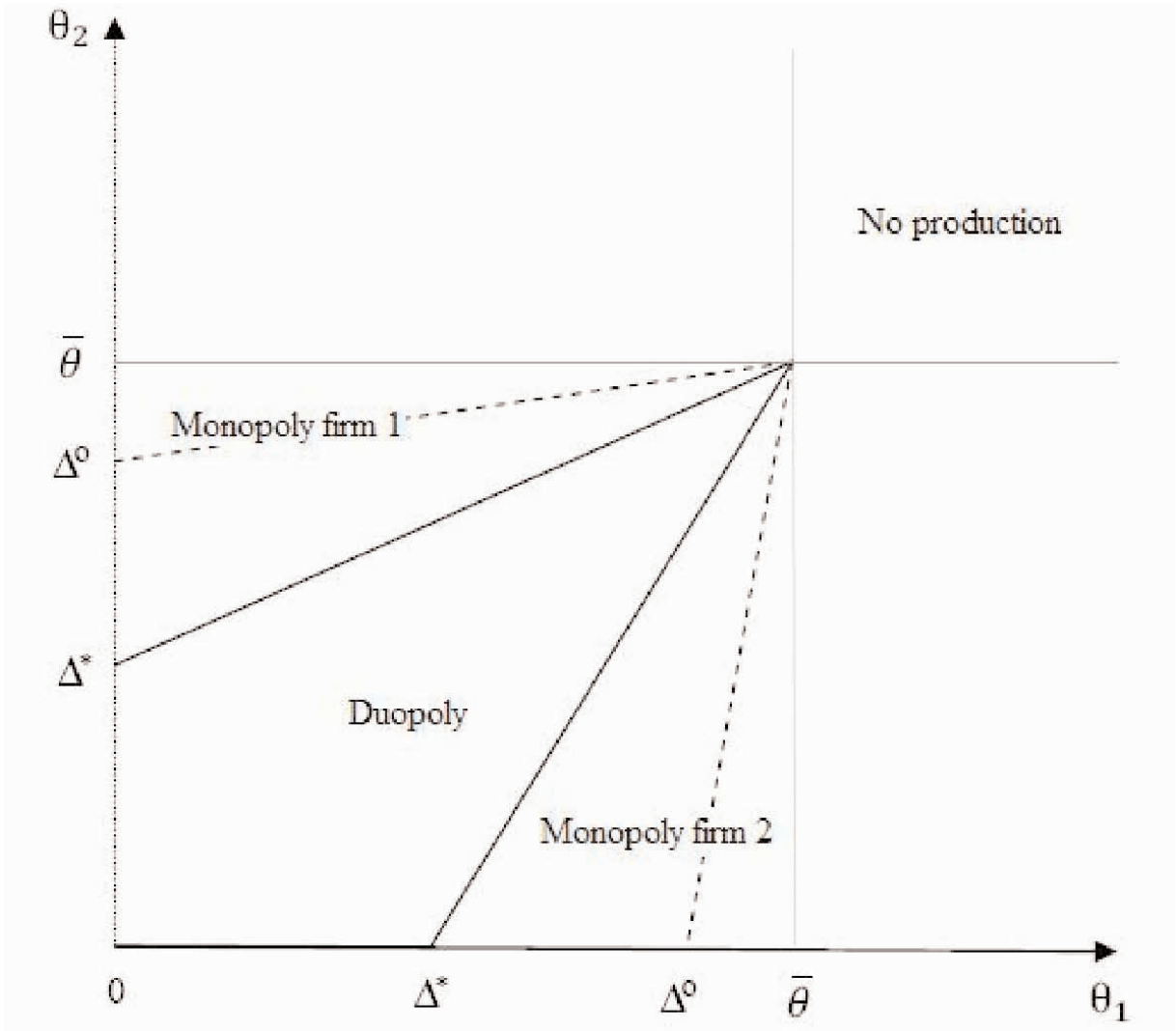
Proposition 2 *The quantity produced at the non-cooperative equilibrium of the open economy is:*

$$Q^O = \begin{cases} \frac{4}{3+4\gamma+\Lambda}(d-\theta_{\min}) & \text{by a monopoly if } |\Delta| > \Delta^O(\theta_{\min}) = \frac{2(1+2\gamma)(d-\theta_{\min})}{3+4\gamma+\Lambda} \\ \frac{4}{2(1+\gamma)+\Lambda}\left(d-\frac{\theta_1+\theta_2}{2}\right) & \text{by a duopoly otherwise.} \end{cases} \qquad (14)$$

The quantity produced by firm $i = 1,2$ at the duopoly solution is:

$$q_i^O = \frac{Q^O}{2} + \frac{\theta_j - \theta_i}{1+2\gamma} \qquad if \quad |\Delta| \leq \Delta^O(\theta_{\min}) \qquad (15)$$

Figure 1. Dotted line: equilibrium shut down threshold of the less-efficient firm at the non-cooperative equilibrium. Solid line: optimal threshold.



When $|\Delta| > \Delta^O(\theta_{\min})$, the less efficient producer shuts down. The quantity in (14) is thus a function of the low cost parameter $\theta_{\min}$. Comparing equations (14) and (11), the equilibrium solution implies the shutdown of the less-efficient firm *less often* than the socially optimal solution. That is, $\Delta^O(\theta_{\min}) \geq \Delta^*(\theta_{\min}) \ \forall \theta_{\min} \in [\underline{\theta}, \overline{\theta}]$. This result is illustrated in Figure 2. The dotted lines represent the equilibrium shut-down threshold of the less-efficient firm in an integrated market with independent regulators. The solid lines represent the optimal threshold.[15]

Comparing the quantities produced in the common market with the quantities produced in a closed economy, it is straightforward to check that Q^O as defined in equation (14) is always larger than $Q^C = q_1^C + q_2^C$ as defined in equation (8). The fact that the total quantity increases under market integration does not necessarily imply welfare improvement. Indeed, when $|\Delta| \leq \Delta^*(\theta_{\min})$, it is easy to check that $Q^C = Q^*$ as defined equation in (11).

We deduce that excessive production occurs in the common market. To be more specific, let us compare the production of firm $i = 1.2$ in the common market with its production under a closed economy. Substituting Q^O from

[15] The figure is plotted for $d = 1$, $\lambda = 0.3$, $\gamma = 0.5$, $\theta_i \in [0,1]$ with $\Delta^* = \Delta^*(0)$ and $\Delta^O = \Delta^O(0)$. The same shape is obtained for any support such as $\overline{\theta} - \underline{\theta} > \frac{2\gamma(d - \theta_{\min})}{1 + 2\gamma + \Lambda}$.

equation (14) in equation (15) and comparing it with equation (11), yields:

$$q_i^O > q_i^C \quad \Leftrightarrow \quad \theta_j - \theta_i \geq -\frac{\Lambda(d-\theta_i)(1+\gamma)}{(1+\gamma+\Lambda)^2} \qquad j \neq i \; i=1,2 \quad (16)$$

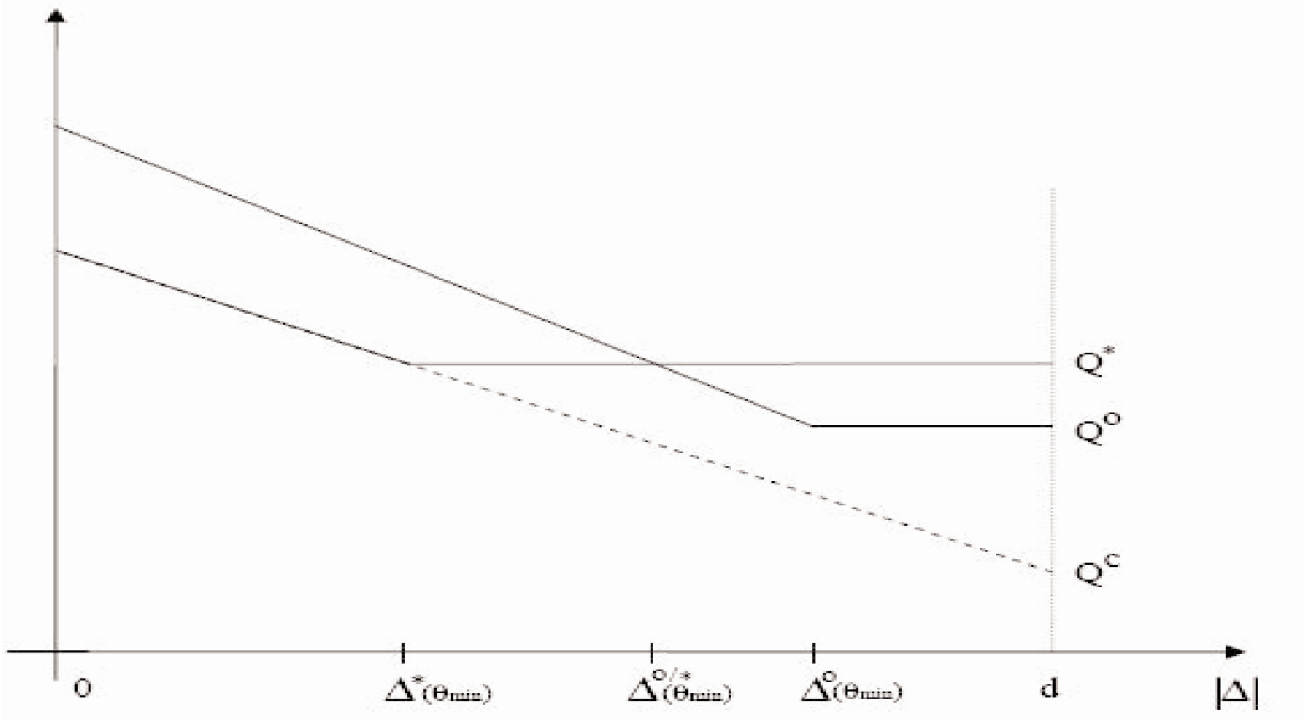
When $\Lambda = 0$, the quantity produced by the national firm increases with respect to the quantity produced in a closed economy, if and only if, the foreign firm is less efficient (i.e., if $\theta_j - \theta_i > 0$). In this case, the foreign monopoly leaves some space for the more efficient competitor and consumers to enjoy a larger surplus. By contrast, when $\Lambda > 0$, the regulator might choose to expand the national quantity produced 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 a drastic increase in consumers' surplus. In a closed economy, the regulator chooses a small production quantity in order to enjoy a high Ramsey margin. However, in an open economy, the Ramsey margin is eroded by competition, and producing such a small quantity is no longer optimal; this only reduces the market share of the domestic firm. In his attempt to mitigate the business-stealing effect, the regulator increases the quantity produced by the domestic firm.

Comparing Q^O and Q^* hence yields

$$Q^O \geq Q^* \quad \Leftrightarrow \quad |\Delta| \leq \Delta^{O/*}(\theta_{\min}) = \frac{(2\gamma+\Lambda)(d-\theta_{\min})}{1+2\gamma+\Lambda}. \quad (17)$$

When $|\Delta|$ is smaller than $\Delta^{O/*}(\theta_{\min})$, the business-stealing effect is strong. Regulators fight to maintain their market share by boosting domestic production. Aggregate quantities are then larger in the common market than at the optimum. Symmetrically, when $|\Delta|$ is large, the regulator of the most efficient country controls a large market share (the firm even becomes a monopolist in the common market when $|\Delta| > \Delta^O(\theta_{\min})$). The problem is that the regulator does not internalize the welfare of foreign consumers. She chooses a suboptimal production level, $Q^O < Q^*$, whenever $|\Delta| > \Delta^{O/*}(\theta_{\min})$. Figure 2 illustrates the results. It represents for a given $\theta_{\min}$ the quantity levels Q^*, Q^O and Q^C in function of $|\Delta| \in [0,d]$. The flat sections correspond to the shutdown of the less-efficient producer.

Figure 2. Total Quantities and as functions of $|\Delta|$



3.3 Welfare analysis of market integration

Replacing the optimal quantities in the welfare function, we compute the effect of market integration on welfare. Proposition 3 is reminiscent of Proposition 1 in Biancini (2008). It shows that the welfare-degradation result of integration is robust to the introduction of transportation costs (i.e., to $\gamma > 0$).

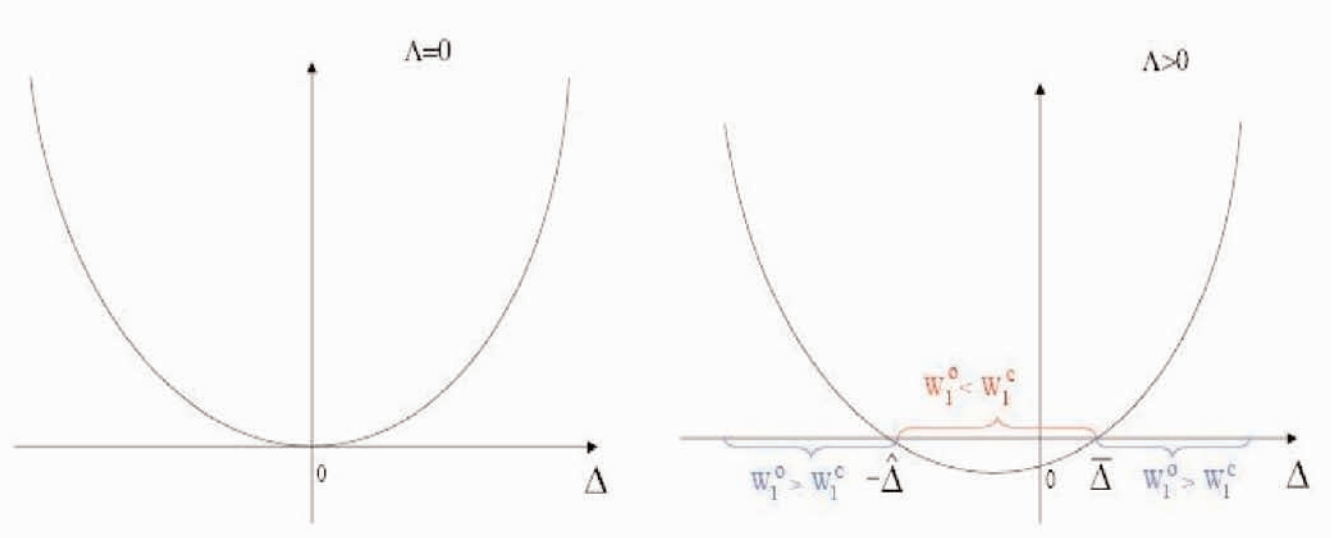
Proposition 3 *For $\Lambda = 0$, market integration increases welfare in both countries. For any Λ strictly positive, market integration increases welfare in both countries, if and only if, the difference in the marginal costs $|\Delta|$ is large enough.*

Figure 3 illustrates Proposition 3; it shows the welfare gains of country 1 for $\Lambda = 0$ and $\Lambda > 0$ respectively.

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 prices 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 the smaller market share.
However, the equilibrium quantities (14) do not correspond with the optimal levels (1): not all gains from trade are exploited. When $\Lambda > 0$, the intercept, corresponding to $\Delta = 0$, is negative, which means that if $\theta_1 = \theta_2$ both countries lose from integration. To fight business-stealing, both countries increase their quantities. Price is decreased below the optimal monopoly (Ramsey) level, and taxation via regulation decreases. Yet competition does not increase efficiency because the firms have the same costs. The net welfare impact is thus 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.

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's welfare is decreased by integration.[16] 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

Figure 3. Welfare gains from integration, $W^o - W^c$



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

the literature on trade and competition (starting with Brander and Spencer 1983, see Section 1.2). In the case of a trade policy sustained by export subsidies, the result arises because of the prisoner dilemma faced by the two governments: both countries would be better off if trade subsidies were forbidden. Here, the result depends on the negative public-finance effect of competition.[17]

For value of $|\Delta| \in [\underline{\Delta}, \hat{\Delta}]$, 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 the cost difference between the national champions is large.

In addition to the global welfare impact, the creation of an integrated market with common price $P(Q^O)$ has redistributive effects. Indeed, substituting Q^O from equation (14) in the inverse demand function yields the equilibrium price $P(Q^O) = \dfrac{d(\frac{\Lambda}{2}+\gamma) + \frac{\theta_1+\theta_2}{2}}{1+\gamma+\frac{\Lambda}{2}}$ if $|\Delta| \leq \Delta^O(\theta_{\min})$. Comparing this price with the price in the closed economy, $P(q_i^c) = \theta_i + (\Lambda+\gamma)\dfrac{d-\theta_i}{1+\gamma+\Lambda}$, one can check that market integration induces a price reduction in country $i = 1,2$ if and only if, the cost difference is not too large. That is,

$$P(Q^O) \leq P(q_i^c) \quad \Leftrightarrow \quad \theta_j - \theta_i \leq \frac{\Lambda(d-\theta_i)}{1+\gamma+\Lambda} \qquad j \neq i \; i,j = 1,2 \quad (18)$$

Price convergence is usually considered positively, because it is a sign of effective market integration. However, for some countries, it can imply that prices are higher after integration than in the closed economy. Indeed, equation (18) shows that if $|\Delta| > \dfrac{\Lambda(d-\theta_{\min})}{1+\gamma+\Lambda}$ then the price decreases in the less-efficient region and *increases* in the more efficient one.[18] Consumers of the relatively efficient region are then worse off after integration. This can be a source of social discontent and opposition towards market opening. Empirical evidences from the EU electricity market are consistent with these results. The integration of electricity markets is advanced between France and neighbor countries (Italy, England, Spain); the difference between generation costs is the engine of integration. Countries with high costs (Italy, England, Spain) benefit from low prices, while the country with low costs (France) benefits from new profit opportunities.

Consistent with the theory, empirical evidence shows that prices rise in the domestic electricity market of EU exporting countries, such as France.[19] The interests of the national firm/taxpayers are conflicting with the interests of the local consumers. Market integration increases the profit opportunities of the efficient firm, by increasing the number of potential consumers. If the government is able to extract a fair share of these new market rents, it can use this to finance new investments or cross subsidize for the benefit of taxpayers. If the government is unable to size the firm's rents, both domestic taxpayers and consumers are worse off (shareholders are the only winner).

By contrast, if the firms are not drastically different (i.e., if $|\Delta| \leq \dfrac{\Lambda(d-\theta_{\min})}{1+\gamma+\Lambda}$) prices decrease in *both* countries because of the business-stealing effect. Benevolent regulators are willing to increase their transfers to the national firm to sustain low prices, so that taxation by regulation decreases. This result is consistent with Laffont and Tirole's (2000) claim that pro-competitive reforms in telecommunications may have had the effect of increasing the total transfers paid to the industry. The negative fiscal effect is a major concern in developing countries where

[17] It is not directly related to asymmetric regulation. For instance, Biancini (2008) shows that a similar effect arises in a laissez-faire framework in which both firms are deregulated so that there is no asymmetric regulation of the quantities.

[18] For instance, when $\Lambda = 0$ the price in the integrated market is equal to the average marginal cost. Since the average marginal cost is the average of the prices in the two closed economies, prices increase in the more-efficient country and decrease in the less-efficient one.

[19] France is the world's largest net exporter of electricity due to its low-cost nuclear generation. Electricité de France (EDF) gains over EUR 3 billion per year from this trade. The French government which is the main shareholder of EDF, manages to reap a fair share of its profit each year (more than EUR 2 billion in 2007). The French electricity market is extensively discussed and documented in Finon and Glachant (2008).

tariffs play an important role in raising funds (see Auriol and Picard, 2007 and Laffont, 2005). When public funds are scarce and other sources of taxation are distortive or limited, market integration, which has a negative impact on taxpayers and on the industry's ability to finance new investments, induces welfare losses. This can be a major problem in infrastructure industries such as electricity, where massive investments are needed.

4. How market integration affects investment incentives

One of the aims of market integration is to increase investment incentives 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 cost difference between two regions is large, market integration can decrease the aggregate capacity of financing new investment. This is a major concern for the electricity sector because demand is on the rise everywhere, and in many regions, especially in Asia and in Africa, aging generation and transportation facilities urgently need to be upgraded and expanded.

Moreover, specific investment, such as for transportation and interconnection facilities, is required to achieve market integration. For instance, in Sub-Saharan Africa, the annualized investment costs required to simply maintain the current access rate (less than 30% of the population) are estimated to be around 5% of the region's GDP in 2015. Focusing on the creation of a regional, power-trading market, it is estimated that some 26 GW of interconnectors, at a cost of $500 million per year, are lacking (Rosnes-Vennemo). Similarly, the vast hydropower potential of the continent is unexploited because of the lack of investment.

This section studies the investment incentives of national firms subject 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 an integrated market, the competitor of the investing firm also benefits from the cost reduction. One can think of investment in transmission, interconnection, or interoperability facilities. The second type of investment reduces the production costs 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. In both cases, the analysis focuses on an interior solution. Cost difference is assumed to be small enough so that the production of the two firms is positive in the common market. As illustrated by the analysis of market integration in Section 1, this assumption is not crucial to the results (i.e., they are preserved when shut-down cases are considered).[20] However, it simplifies their exposition.

4.1 Transportation cost-reducing investment

We assume that country $i = 1,2$ can reduce the collective transportation costs 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. For the sake of simplicity, we rule out the corner solution (i.e., shut-down cases). This intuitively requires that the difference in firms' costs is not too large. Assumption A1 implies that the optimal production of the two firms is positive.

[20] Computations are available on request.

A1 $|\Delta| \leq \Delta_i^*(\theta_{\min}) = \dfrac{2t\gamma(d-\theta_{\min})}{1+2t\gamma+\Lambda}$.

We first consider the level of investment induced by the global welfare-maximizer of Section 1.1. Let $q_i^{*I_\gamma}$ be the quantity produced by firm $i=1,2$ in the case of investment. The optimal quantities are obtained by substituting $t\gamma$ in equations (11) and (12). The gross utilitarian welfare in the case of investment is the welfare function defined in equation (10) evaluated at the actualized quantities: $W^{*I_\gamma} = W(q_1^{*I_\gamma}, q_2^{*I_\gamma})$. The welfare gain of the investment, $W^{*I_\gamma} - W^*$, has to be compared with 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 decreases the operating profits, thus increasing transfers. The global welfare-maximizer chooses to invest if, and only if: $W^{*I_\gamma} - W^* \geq (1+\lambda)I_\gamma$. Let I_γ^* be the maximal level of investment which can satisfy this inequality:

$$I_\gamma^* = \frac{1}{1+\lambda}[W^{*I_\gamma} - W^*] \qquad (19)$$

We next study the non-cooperative equilibrium investment level in the case of market integration. The quantity produced by firm i after investment, $q_i^{OI_\gamma}$, is obtained by substituting $t\gamma$ in equation (14).

Let $w_i^{OI_\gamma}$ be country $i=1,2$ welfare function (6) evaluated at $(q_1^{OI_\gamma}, q_2^{OI_\gamma})$. Investment is optimal in country i if, and only if, $W_i^{OI_\gamma} - W_i^O \geq (1+\lambda)I_\gamma$. The maximum level of investment that country i is willing to make in the common market is:

$$I_{\gamma i}^O = \max\left[0, \frac{1}{1+\lambda}[W_i^{OI_\gamma} - W_i^O]\right] \qquad (20)$$

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 equation (6) 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 $I_{\gamma i}^O$ can be equal to zero.

In particular, this occurs 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., $\min\{\theta_1, \theta_2\}$), is always positive and higher than the maximal level of investment for the less efficient one (i.e., $\max\{\theta_1, \theta_2\}$). Since reducing investment benefits equally the two producers, in the common market the level of investment that each country is willing to finance depends on the investment choice of the other country.

Lemma 2 *Let* $\bar{I}_\gamma^O$ *be the maximal level of investment for the more efficient firm and* $\underline{I}_\gamma^O$ *the maximal level of investment for the less-efficient one as defined in (20). Then, if* $I_\gamma > \bar{I}_\gamma^O$ *there is no investment. If* $\underline{I}_\gamma^O < I_\gamma \leq \bar{I}_\gamma^O$, *the more-efficient firm invests and the less-efficient one does not. If* $I_\gamma \leq \underline{I}_\gamma^O$ *there are two Nash equilibria in pure strategies in which one of the firms invests and the other does not.*[21]

By virtue of Lemma 2, the decision of the more-efficient firm determines the maximal equilibrium level of investment attainable in the common market. Comparing the maximum investment level in an open economy with the optimal level yields the following result.

Proposition 4 *In the integrated market, the investment level is always suboptimal:*

$$\bar{I}_\gamma^O \leq \bar{I}_\gamma^O + \underline{I}_\gamma^O \leq I_\gamma^* \qquad \forall \Delta, \Lambda \geq 0 \qquad (21)$$

[21] We focus on pure strategies. Yet there is a mixed strategy equilibrium in which firm i , $i \neq j$ invests with probability $\pi_i = \dfrac{W_j^{CI} - (1+\lambda)I_\gamma - W_j^C}{W_j^{CI} - W_j^C}$. This equilibrium is inefficient because with positive probability both firms invest, or alternatively, no firm invests.

In our specification, γ-reducing investment increases the efficiency of all firms. 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 $\bar{I}_\gamma^O$ is sub-optimal. The investing country does not take into account the impact of the investment on the foreign country. However, the underinvestment problem goes deeper than simple free-riding. Even if each country were 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 $\bar{I}_\gamma^O + \underline{I}_\gamma^O$ would still be sub-optimal. To analyze the origin of this inefficiency, we study countries' incentives to invest in a closed economy.

Let $q_i^{CI_\gamma}$ be the quantity produced by firm i in the case of investment in a closed economy. It is obtained by substituting $t\gamma$ in equation (8). Let $W_i^{CI_\gamma}$ be the country $i = 1,2$ welfare function (6) evaluated at $(q_1^{CI_\gamma}, q_2^{CI_\gamma})$. Investment is optimal in country i, if and only if, $W_i^{CI_\gamma} - W_i^C \geq (1+\lambda) I_\gamma$ so that:

$$I_{\gamma i}^C = \frac{1}{1+\lambda}[W_i^{CI_\gamma} - W_i^C]. \qquad (22)$$

Comparing (22) with (20) yields the next proposition.

Proposition 5

Let $\bar{I}_\gamma^C$ be the maximal amount that the most efficient country is willing to invest to reduce transportation costs in the closed economy, and $\bar{I}_\gamma^O$ be the maximal amount it is willing to invest in the common market.

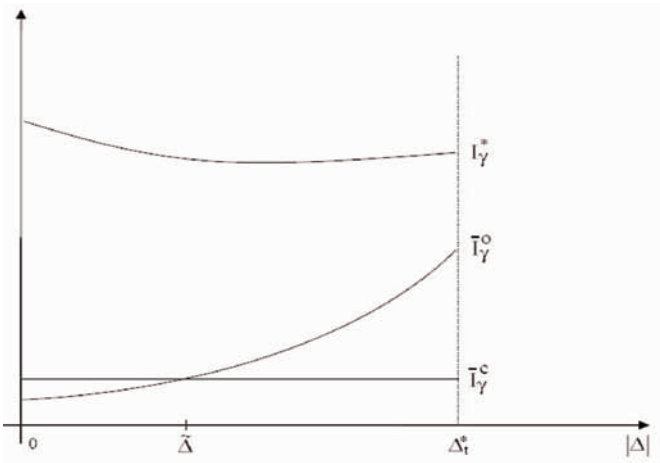
- For $\Lambda = 0$, $\bar{I}_\gamma^O > \bar{I}_\gamma^C \ \forall \Delta \geq 0$ and $\bar{I}_\gamma^O - \bar{I}_\gamma^C$ is an increasing function of .
- For $\Lambda > 0$, there exists $\tilde{\Delta} > 0$ such that $\bar{I}_\gamma^O > \bar{I}_\gamma^C$ if and only if $|\Delta| > \tilde{\Delta}$.

Figure 4 illustrates the results of Propositions 4 and 5 for the case $\Lambda > 0$. When public funds are costly, the maximal level of investment sustainable in the 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 of foreign stakeholders. The second reason is that investment decreases the costs of the competitor, worsening the business-stealing effect.

Under market integration, when it is small, the maximal level of investment is not only sub-optimal, but it is also smaller than under a closed economy. When the two regions' costs are not drastically different, business-stealing is fierce. It reduces the capacity to finance new investment, worsening the gap between the optimal investment and the equilibrium level.

By contrast, when one country has a drastic production-cost advantage ($|\Delta| > \tilde{\Delta}$), it is willing to invest more in the common market than under a closed economy because the investment increases its market share and profits. Integration can then help to increase investment, although not up to the first-best level. Similarly, when $\Lambda = 0$, public funds are free. Business-stealing is no longer a problem, so market integration increases the level of sustainable investment compared to a closed economy.

Figure 4. γ-reducing investment θ_{min} is fixed, $|\Delta|$ varies



4.2 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 costs. Hydropower potential is unevenly distributed across countries. Country can reduce the production cost from θ_1 to $c\theta_1$ ($c<1$) by investing a fixed amount I_θ. We focus on cases in which both firms produce in the common market.

The following assumption ensures that there is no shutdown in equilibrium.

A2 $|\theta_2 - c\theta_1| \leq \dfrac{2\gamma(d - c\min\{c\theta_1, \theta_2\})}{1+2\gamma+\Lambda}$.

We first consider the solution induced by the global welfare-maximizer of Section 1.1. Let $q_i^{*I_\theta}$ be the quantity produced by firm $i=1,2$ in the case of θ-reducing investment by firm 1. The optimal quantities are given by equations (11) and (12), where θ_1 is replaced by $c\theta_1$. Substituting the quantities $q_i^{*I_\theta}$ ($i=1,2$) in the welfare function defined in equation (10), the gross utilitarian welfare is $W^{*I_\gamma} = W(q_1^{*I_\theta}, q_2^{*I_\theta})$. The global, welfare- maximizing regulator invests if, and only if, $W^{*I_\theta} - W^* \geq (1+\lambda)I_\theta$. Let I_θ^* denote the maximal level of investment that satisfies this inequality:

$$I_\theta^* = \frac{1}{1+\lambda}[W^{*I_\theta} - W^*] \qquad (23)$$

We derive next the non-cooperative equilibrium quantities in the open economy, $q_i^{OI_\theta}$, from equation (14), where θ_1 is replaced by $c\theta_1$. Substituting the quantities $q_i^{OI_\theta}$ ($i=1,2$) in the welfare function defined equation (2), the gross utilitarian welfare in the case of investment by firm 1 is $W^{OI_\gamma} = W(q_1^{OI_\theta}, q_2^{OI_\theta})$. The regulator of country invests if, and only if, $W^{OI_\theta} - W^O \geq (1+\lambda)I_\theta$. Similarly, the quantities in the case of a closed economy are derived from equation (8), where θ_1 is replaced by $c\theta_1$.

Substituting the quantities $q_i^{CI_\theta}$ ($i=1,2$) in the welfare function defined equation (10), the gross utilitarian welfare in the case of investment by firm 1 is $W^{CI_\gamma} = W(q_1^{CI_\theta}, q_2^{CI_\theta})$. In a closed economy country, 1 invests if, and only if, $W^{CI_\theta} - W^C \geq (1+\lambda)I_\theta$. We deduce the maximal level of investment that country 1 is willing to commit in the common market and in the closed economy:

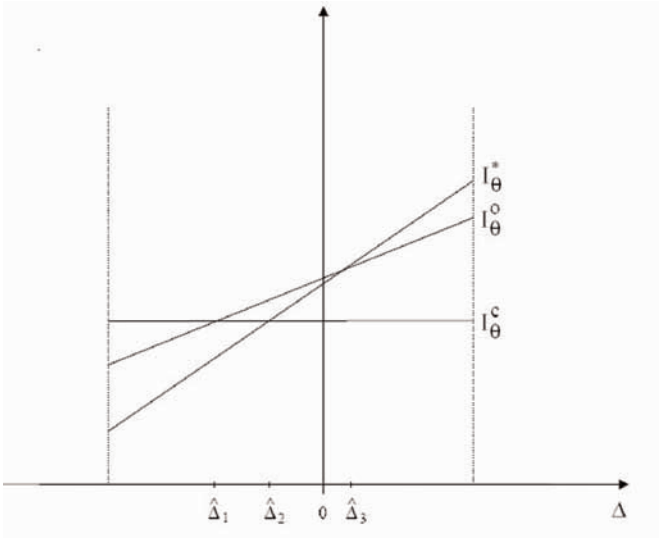
$$I_\theta^k = \frac{1}{1+\lambda}[W_1^{kI_\theta} - W_1^k] \qquad k = O, C \qquad (24)$$

Proposition 6 *Let I_θ^C, I_θ^O and I_θ^* be defined equation (24) and (23) respectively. Let $\Delta = \theta_2 - \theta_1$. Then, there exist 3 threshold values $\hat{\Delta}_1 = \hat{\Delta}_2 = \hat{\Delta}_3$ for $\Lambda = 0$, and $\hat{\Delta}_1 < \hat{\Delta}_2 < \hat{\Delta}_3$ for all $\Lambda > 0$ such that $\forall\ c \in (0,1)$:*

- $I_\theta^O > I_\theta^C \Leftrightarrow 0 > \Delta > \hat{\Delta}_1$.
- $I_\theta^* > I_\theta^C \Leftrightarrow 0 > \Delta > \hat{\Delta}_2$.
- $I_\theta^* > I_\theta^O \Leftrightarrow \Delta > \hat{\Delta}_3$.

Proof:

Figure 5. θ_1 reducing investment θ_1 is fixed; Δ varies



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 the optimal and equilibrium level of investment. However, when $\Lambda > 0$, the threshold $\hat{\Delta}_1$ and Δ_3 shifts to the left and to the right, respectively, while $\hat{\Delta}_2$ is not affected.[22] When Λ is large enough Δ_3, becomes positive. Figure 5 illustrates the results of Proposition 6 in the case $\Lambda > 0$. It is drawn for a fixed value of $c\theta_1$. The static comparative parameter is Δ.

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 cost-reducing investment. In an 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 the 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 access to the foreign market, the investment is oversized for domestic demand. By enlarging the market size, market integration helps to increase the level of investment that Country 1 is willing to sustain. Symmetrically, in the closed economy, when $\Delta < \hat{\Delta}_1$, Country 1 overinvests in marginal improvements to its technology because it has no access to the foreign technology. In a 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 of reducing its cost gap and expanding its market share by serving foreign consumers makes a high level of investment attractive. Incentives to invest improve compared to autarky, but they are still too high for an inefficient firm and too low for efficient ones, compared to the optimum.

For $\hat{\Delta}_1 < \Delta < \hat{\Delta}_2$, there is excessive investment under both closed and open economies. However, the overinvestment 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. However, it does not internalize the cost it imposes on Country 2 and overinvests. We conclude that market integration improves incentives to invest in cost-reducing technologies when the cost difference between the two regions is large. When the cost difference is small, there is overinvestment. In other words, there is never underinvestment related to integration. This is a major difference with transportation infrastructure investment.[23]

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

[23] When the initial level of cost difference between the two regions is not large enough, the business-stealing effect tilts the investment incentives in the wrong direction. For instance, if $-\hat{\Delta}_2 < \theta_1 - \theta_2 < \min\{\tilde{\Delta}, -\hat{\Delta}_2\}$ with $\tilde{\Delta}$ being defined in Proposition 5, then under market integration Country 2 underinvests in γ -reducing technology, while Country 1 overinvests in θ -reducing technology. The latter investment reduces the gap between the two regions' production costs, which reduces further the incentives for Country 2 to invest in transportation and interconnection facilities. By virtue of Proposition 3, welfare decreases in both regions.

Conclusion

Market integration has complex welfare implications in non-competitive industries controlled by national regulators. Unless the difference in production costs between two regions is large enough, economic integration achieved by sovereign countries is unlikely to be successful. When the two national champions are not sufficiently differentiated in terms of productivity, the competition for market shares induced by the integration process is welfare-degrading in both countries. Even when the efficiency gains from integration are large enough so that both countries win from integration, opposition might still subsist internally. Indeed market integration has redistributive effects. For instance, when the cost difference between the two countries is large enough, the possible adverse impact of price convergence on consumers in the low-price region will be a source of opposition and discontent toward the integration process.

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 paper 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 power (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.

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Comments

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Introduction

The purpose of these comments is to provide a complementary view on the possible future extensions of the model presented by Auriol and Biancini. We think that both from the point of view of the engineering of the electricity system and from the experiences of the electricity reforms in Europe that we have extensively studied, the paper paves the way to a better understanding of the economic consequences of integration in the electricity market. We have structured the comments in five sections points.

First, we will overview the place and role of the paper in what we call the "market design for electricity" literature and we will show how it allows regeneration of the debate on a single market by adding the integration parameter in the field. Second, we will show how it is worth the cost to add more striking electricity features to the economic modeling and how an "electrification of the paper is possible". The third section will be devoted to some institutional remarks and insights on regulatory second-best options and to a quick overview of the difficulties in creating a market-friendly environment in the electricity sector. The purpose of the last section is to pave the way for the extension of Auriol & Biancini's paper to more policy-oriented conclusions in a weak institutional environment. The last section will provide conclusions in brief.

1. Position of the paper regarding the existing literature

This paper is of great interest for at least three reasons. First, it sheds light on the welfare impact of market integration using basic but straightforward economic modeling. The advantage of the simplification used in the paper by Auriol and Biancini is that the subject of generation investment incentives in integrated electricity markets is tackled clearly. We will show hereafter that this point opens new questions in the debate about incentives for generation investment.

The second element making this paper interesting is that the results of the model permit better understanding of three key issues in electricity market integration. (1) the positive effects of market integration are limited to some supply conditions in the industrial structure. (2) Coordination at the international level is necessary so that market integration improves welfare; and lastly, (3) market integration can reduce the incentive to invest in electricity transmission assets.

The last point of interest in the paper is that it provides an analytical terrain for the progressive introduction of new factors affecting the market integration welfare analysis.

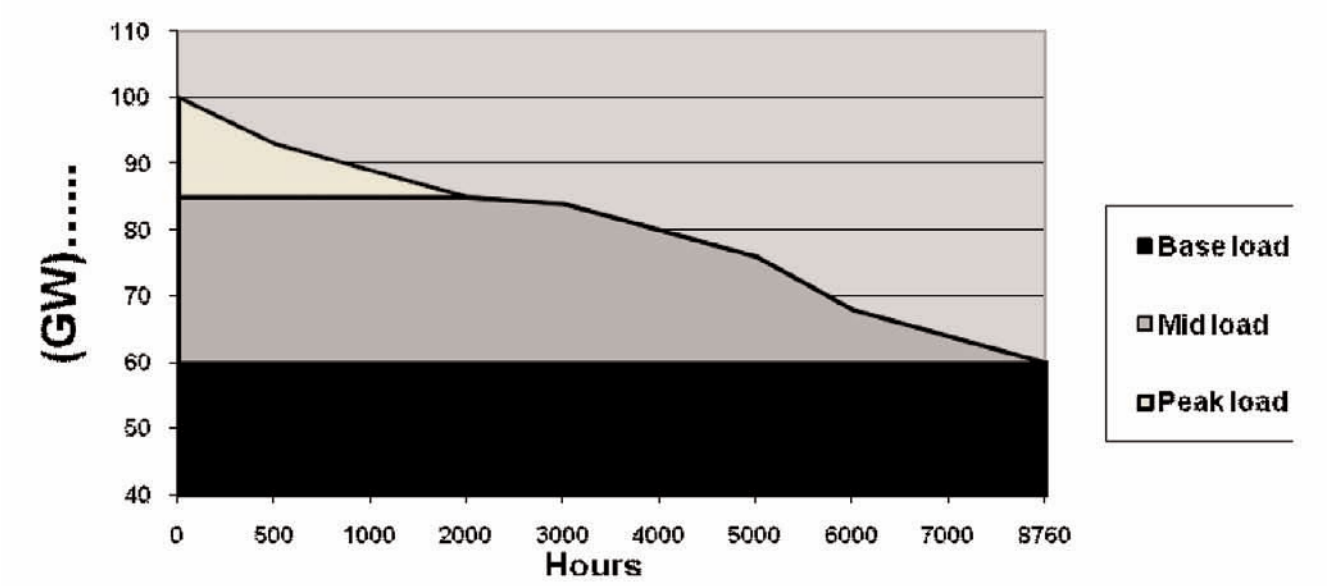
The last two points being very new in the field, we focus on the first point.

1. A. Literature on incentives for investment

Regarding generation investment incentives, the paper is complementary to the existing literature and invites reconsideration of the results for the process of market integration.

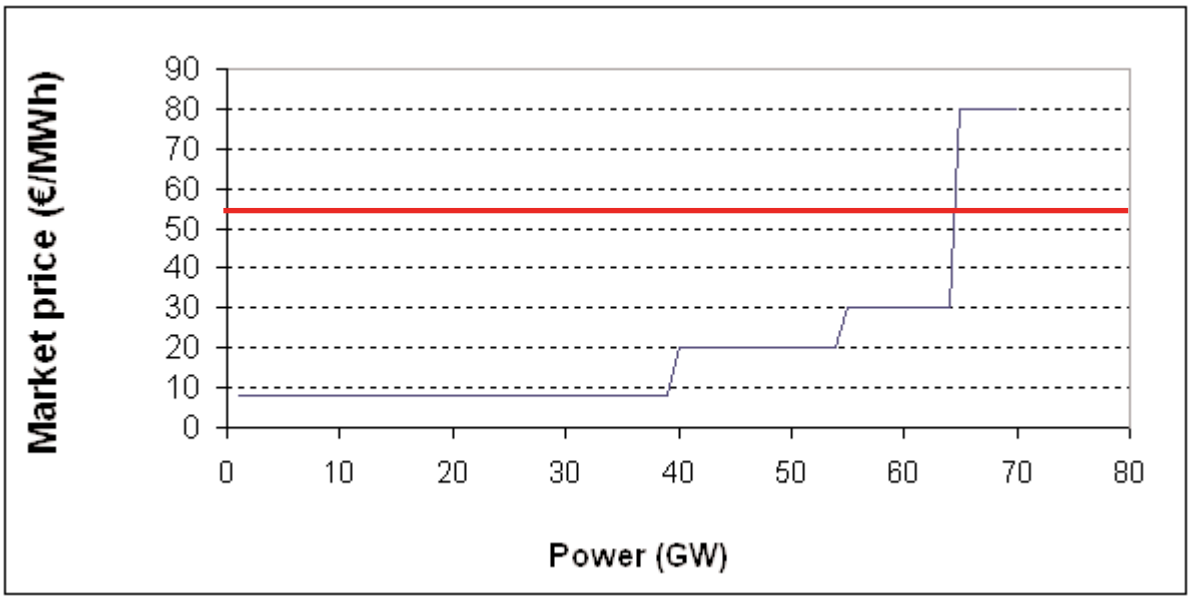
For a single market, Joskow (2006), Cramton and Stoft (2006), Pignon and Finon (2006) have highlighted the missing money problem in peak generation investment. The argument for Joskow (2006) and Cramton and Stoft (2006) is twofold. First, the risk of underinvestment exists particularly for the Peaking units. Peaking power stations are essential to satisfy the highest levels of electricity consumption. These units are operated only a very small number of hours per year. This increases the share of fixed costs in their annual total costs. Their profitability thus depends on very high peak electricity prices during a very low number of hours per year.

Graph 1: Load duration curve and participation of generators in supplying load in the year



For Joskow (2006) and Cramton and Stoft (2006), the second argument leading to the missing money problem is the following: The above prospects for profitability can still be reduced if the authorities impose a maximum market price (in red in the next graph) because of suspected strategic behavior. Capping market prices then results in a lack of income for the peaking units (represented by a cost of €80/MWh in the graph below).

Graph 2: The impact of price caps on peak-power units



One could think of ways to reduce this problem through market integration with neighboring countries, as in Auriol and Biancini's paper. A possible insight from future work is discovering under what conditions the integration of different market structures mitigates the missing money problem.

Finon and Perez (2008) extend this incentive problem in generation units for baseload investment incentives and insist on practical ways to secure electricity investments in a single electricity market. Theoretical and practical considerations on generation investment have largely focused on incentives to develop peak generation capacity and on ensuring a reserve margin to guarantee reliability, i.e. short-term security of supply. But the paper by Finon and Perez (2008) shows that little attention was paid to the conditions for other investments in baseload and semi-baseload equipment. The lack of attention to this problem was caused by a strong belief that the price signal on the hourly markets and the subsequent infra-marginal rents for low variable-cost equipment would have incentivized investment in baseload and semi-baseload power stations (see for instance Hunt, 2002; Oren, 2003 and 2008). In this paper, Finon and Perez explore the various "real life" solutions found in the competitive market to secure investment risk by sharing it with some counterparts in a single market. They survey some solutions based on securing investment in baseload generation units from both the side of industrial consumers and from the side of suppliers.

From the large industrial consumer's side, three solutions are used:

Large consumers can seek to obtain more stable terms and avoid movements in wholesale prices with long-term supply contracts. But their interests do not completely converge with those of investors in generation units. From the generator's point of view, long-term supply contracts are interesting to invest in for a new power station only if there is sufficient volume and duration to be associated with the construction cost recovery of the station. Moreover, the industrial consumer must be a creditworthy counterparty, in particular with limited risk of relocation or of bankruptcy and disincentives for opportunism. From the industrial consumer's point of view, there is always a risk of losing the opportunities for electricity purchase at a price lower than the contractual one, during the stage of low prices on the market.

Another way for large consumers to proceed is through horizontal arrangements in a consumer's cooperative for production or a consortium for electricity purchase. The example of the Finnish TVO consortium, which ordered a large nuclear plant in 2005, is illustrative of that way to share risks for a new generator installation in order to control their electricity supply cost. A particular arrangement is implemented, namely an electric cooperative for generation owned by several very large consumers (pulp and paper) and local distributors. It was already established well before the 1996 market liberalisation reform. Its purpose was to construct and operate large generating facilities yielding benefits from electricity sold at the cost-price in the framework of long-term contracts (40 years) signed ex ante, which give off-take rights to each participant. After the reform, this type of long-term arrangement was reproduced to allow the order of a three-billion-euro nuclear reactor of 1700 MW in 2005[1].

A last solution is based on the principle of the virtual power plant (VPP) contract. These VPP contracts are more flexible because they are not linked with new equipment and the payment may be structured as if the consortium were itself to build a new plant. The consortium pays a fixed initial upfront payment at the beginning of the contract and then a fixed price corresponding to the variable costs[2].

The supplier solutions to secure investment

The supplier solution to secure investment relies on the following situation. In some US and European markets, in the

[1] The large consumers want to be unaffected by the effects of random hydro inflow situation, by future CO2 prices and to be protected against the market power risk. Fixed-price purchase agreements independent of the NordPool market price and harmonized with the levelized cost of around €30/MWh at low cost of capital of 5% were signed for "ribbon" deliveries, allowing the generator to obtain corporate financing with a high leverage ratio (75% of debt) and borrow at low rates (Tampere University, 2004).

[2] We can refer to the French example of a cooperative for long-term purchases created in 2006 by the seven largest consumers (under the name of Exeltium) to acquire blocks of a fixed amount of electricity (35 TWh /year) at the cost-price of nuclear production (i.e., near the cost of generation of large capital intensive equipments not exposed to CO2 cost) in the framework of one or several tendered contracts covering 15 to 20 years. A similar arrangement exists in Belgium under the name of Blue Sky.

household and commercial customer segments, there are a number of inactive customers who have never switched and are still supplied by the local incumbent. Besides, these customers prefer flat-price contracts or else the standard variable contract where the supplier may adjust the contract price at regular intervals.

Given the fact that this large part of consumers does not want to manage the price risk, the incumbent suppliers should bear this function for them. But, in exchange, the supplier can pass a major part of their sourcing risks on to the consumers. And it converges with the producers' interest to meet suppliers able to commit to long-term purchase contracts at a fixed price.

Newbery (2002) and Green (2004) develop a stronger position. They advocate retaining consumer franchises and reverting to monopoly in retail supply to households, this in order to ensure a stable customer base and facilitate investment. They argue that the complete opening of retail to competition does not induce any improvement in short-term efficiency, since wholesale price movements are not reactively transmitted to retail prices and competition is only exercised on the already reduced margins of supply. However, total retail competition extends risk quantity for the intermediary and contributes to hampering their commitment to investment. Rothkopf (2007) recommends that auctions must be under the control of the regulator, and new capacity should be procured in a way that forbids entities with significant ties to the supplier from participating in the auction. It is only if no independent candidate can be selected that these entities could compete.

This literature is then well-challenged by Auriol and Biancini's paper because it opens the door to multiple market solutions for managing the investment problem not only in a single market, but also in the case of integration of markets. How are the studies done in a single market affected by market integration? We are unable to conclude clearly here, but we think that a precise assessment of investment incentives during the process of market integration is clearly needed.

1. B. Literature on benefits from market integration

The benefits from the integration of neighboring markets are widely recognized by economists and engineers (Joskow and Schmalensee, 1983; Hogan, 2002). In the case of electricity, these benefits come from both the operation and the improvement of competitive conditions. First, from the operation point of view, a coordinated operation of several power systems is beneficial for several reasons. The coordinated operation allows more efficient use of the power plants and the transmission network, taking advantage of the difference in load and generation in the different areas, etc.

Besides, in the context of competition beginning with very concentrated generation structures in each zone, the stimulation of competition through expanding the power market is relevant. By favoring cross-border exchanges, the implementation of regional markets can ensure more effective competition between power generators and avoid the risk of market power abuse. This point is particularly important in the case of electricity, given that industrial structures are generally very concentrated at the beginning of reforms. The expected objective is that these regional power markets induce pressure to make power prices decrease (Boucher-Smeers, 2001). This is the goal of the reforms in Europe with the Internal Electricity Market (Finon, 2001; Glachant, *et al.,* 2005; CE, 1996; CE, 2003; CE, 2004; CE, 2005) and in the USA with the Regional Transmission Organization (RTO) (FERC, 1999).

The paper by Auriol and Biancini still challenges this literature as it shows that the benefits from market integration are not so straightforward. Extracting full benefits from market integration may require a common regional regulatory framework. In our minds, to reinforce this statement in the case of power markets, the technical characteristics of electricity and their direct economic consequences still need to be added to Auriol and Biancini's model.

2. How to add more electricity features in the market integration evaluation?

We agreed with the paper's insights regarding market integration, namely the impact of industrial structures, the international coordination requirement and the reduction of incentives to invest in electricity transmission assets. Furthermore, we would like to emphasize them, by considering additional electricity features. This probably goes in the same direction as Auriol and Biancini's results.

2. A. The real-time constraint

One of the characteristics of electricity markets is that at all times, production must equal consumption in real time. If this constraint is not satisfied, a blackout leading to the disconnection of all generators and consumers occurs. One of the consequences of this constraint is that even small producers can have market power. Indeed, when load is high, small producers are as essential as any other to balancing load and generation.

We think that the paper could gain by distinguishing two market scenarios. In the first scenario, supply and demand meet in the baseload part of the supply curve. In the second scenario, they meet in the peak load part, where few supply alternatives exist. In these two parts, technical constraints and companies' market power are very different and could differently impact welfare-sharing between the two integrating regions, depending on their relative proportion of baseload and peak load distribution of generation units.

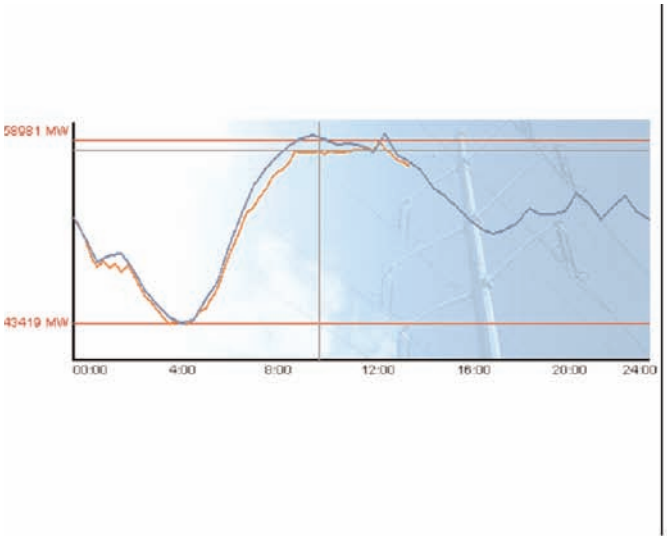
The case of the integration of France with the rest of Europe highlights this point. In France, the fuel mix is not optimal because there are few peak generation units and too much nuclear baseload generation. This leads to very beneficial integration in baseload periods, and conversely, very expensive peak shaving costs when we have to import German or Belgian electricity (examples are the August 2003 and winter 2006 peak prices).

2. B. The difference in demand curve structure

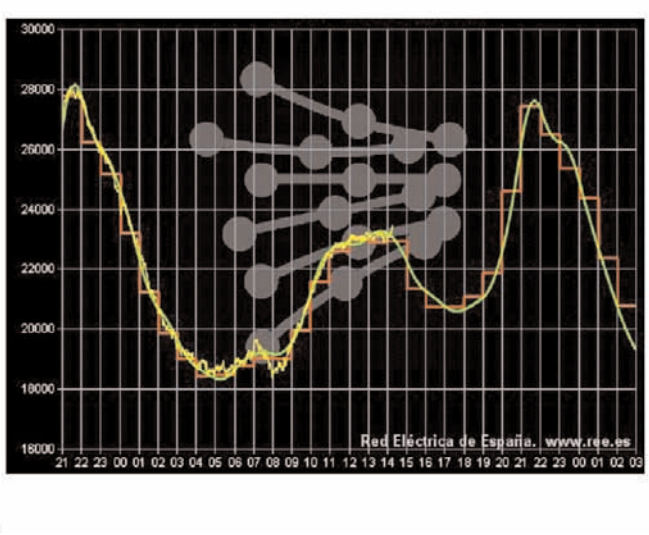
In the same vein, the potential benefits and costs of integration have to be assessed when different countries experiment with different demand profiles. It is well known that two neighboring countries can face different electricity use habits and have different peak load times within the day. For instance, the moment of maximal French and Spanish loads within a day can be different due to different weather conditions or collective behaviors in the two countries (see the two following curves).

Graph 3: Comparison of the French and Spanish load curves (for 10th April 2009).

French load curve



Spanish load curve



On these two graphs, one can see that peak loads in the two countries do not coincide for the considered day. Over an entire year, peak loads seldom coincide in different countries. Market integration then allows the aggregation of demands and the use of their diversities to realize economies. For instance, the aggregation of zonal load with different profiles allows using bigger and more efficient power plants rather than several small and less efficient power plants to supply power needed to several areas. In this case, to complete the results from Auriol and Biancini, the supply structure is only one of the determinants of the welfare variation due to market integration.

2. C. The other point we want to challenge somewhat is the role of transmission and the impact of coordination between two Transmission System Operators (TSO).

In Auriol and Biancini's paper, the TSOs are seen as neutral actors, and the authors consider that this assumption has no major impact. But it has been shown in the literature that TSOs can be opportunistic. It is now well known in the electricity sector that TSOs can use the diversity of congestion mechanisms to benefit from a lack of international coordination. For instance, in the Nordic Market in Europe, Glachant and Pignon (2005) have shown that TSOs may use different mechanisms to increase their unregulated revenues in managing the network congestions.

There are essentially two types of congestion management schemes leading to incentives fundamentally different for market participants and the TSO. On the one hand, methods based on the *ex post* adjustment of generation and consumption schedules entail costs for the TSO which could be beneficial, but the grid users are not incited to use the grid efficiently. On the other hand, methods based on the *ex ante* market separation, using zonal and even nodal pricing, lead to electricity prices that convey efficient signals to grid users, but result in a profit for TSOs, who benefit from the differences in power prices. The conflict of interest that could result for TSOs from incentives rooted in congestion management mechanisms then has to be taken seriously.

3. The treatment of institutional settings

In the paper, two opposite cases are taken into account: the absence of regulation between zones and unified regulation. Of course, the absence of regulation is the worst case and unified and efficient regulation is the best. Moreover, the paper demonstrates why. But if we look at the diversity of existing solutions, it is puzzling that nearly every conceivable variant on the definition and allocation of regulatory functions has already been tried somewhere and that none of them is perfect. Regulatory functions can be shared between federal and local regulators (United States, Belgium); between the federal executive power, the association of local regulators and representatives from local governments in a formula called "Comitology" (European Union); between stakeholders who administer a mandatory Bulk Energy market and a strong regulator (England-Wales); among transmission and system operators who own a voluntary exchange, stakeholders, and ministers from local governments (the Nord Pool of the four Scandinavian countries); between stakeholders administering the Independent System Operator and a strong local regulator (Texas); between a weak or semi-weak regulator and the minister of energy (Spain and France); between a weak regulator and the transmission and system operator (Sweden); self-regulation by a national committee of stakeholders overseen by the competition watchdog and the courts (Germany). It is noteworthy that none of these structures has proven able to provide adequate *ex ante* guarantees to simultaneously manage the classical risks of "*regulatory capture*"[3] and governmental opportunism (Holburn and Spiller, 2002), while effectively countering the exercise of market power by the dominant operators (Smeers, 2004).

Here we want to focus on two issues: first, we think it could be interesting to look at some intermediary regulation cases

[3] Thus, proponents of the theory of capture demonstrate how repeated exchanges between the regulatory agency and the firms can culminate in collusion between them.

of when perfect coordination is not given and to see that the solutions are ways to upgrade the existing quality of regulation and permit a departure from the "*status quo low-level equilibrium*" (Guash and Spiller, 1999). Second, we will argue, and try to explain why, in order to implement sound policy support action in the integration of electricity markets, technical, economic and institutional parameters need to be analyzed in depth.

3. A. Identification of regulatory second-bests to move from the status quo

According to the experiences in energy markets, we can illustrate three different regulation options as intermediary "second-best" cases which can be studied or compared in the framework developed by Auriol and Biancini: 1- the case of self-regulation by stakeholders; 2- the case of regulation by long-term contract and 3- the case of "regulation" with merchant lines.

- Glachant and all (2008), based on the German reform with no regulator (1998-2005), show that it is possible to organize the management of grid access through a voluntary stakeholder self-regulation bargaining under the *ex post* supervision of the Competition authority. Of course, this self-regulation solution is a second-best, but in the case where lobbies block an optimal regulation solution *ex ante*, the self-regulation option could help to move from the worst situation (no regulation) to some competitive improvements.

- Hallack and Glachant (2009) study the case of two different national public companies in Bolivia and Brazil building a huge common pipeline infrastructure based on a long-term contract solution. This contract provides incentives for the development of gas industry infrastructure with neither *ex ante* nor *ex post* regulatory agencies, but with the help of the contract clauses. In the paper they show that this long-term contract is relatively efficient because, in the first phase of the contract cycle when it is signed, it allows investments to begin. The second phase then starts when the investments have been completed and the actual trade in gas begins. The third phase of the contract cycle begins when the increasing flow comes close to saturating capacity and the projected goals for downstream market volume have been reached. The interests of the parties are best aligned during the two first phases, when they are stable and bounded by bilateral self-enforcement interests. However, during the third phase there is a significant deterioration of this alignment of interests, creating an opening for an institutional space in which a third party can intervene to mediate conflicts. Here again this case is a second-best according to perfect *ex ante* regulation. But Hallack and Glachant show that lon- term contracts could help to make a smart move toward more efficient solutions.

- In Hautecloque and Rious (2008), the useful idea is the following: Based on the EU's absence of coordination between TSOs to build new transmission lines, the authors suggest that allowing the construction of private Merchant Lines by low-cost generators is a possible second-best solution to overcome national local interests against the development of these infrastructures. Merchant lines are not a first-best solution (coordination between TSOs for building would be better), but as they are allowed as "exemptions" in the EU legal system, private investors request them and transform the "exemption right" into a new *de facto* rule. Besides, the authors argue that exemptions to build merchant lines should also be granted to dominant generators since they have currently more incentive than TSOs to build cross-border lines. However, recognizing that unregulated merchant transmission investment by generators would be problematic, they show also that efficient mitigation of these problems is possible and that the current allocation of regulatory powers in Europe, despite its shortcomings, is able to achieve it.

3. B. Why do technical, economic and institutional parameters have to be analyzed in order to foster economic integration of energy markets?

Previously, the unique characteristics of electricity industries appeared to set them apart from most other industries, deemed "competitive". Electricity industries notably feature:

significant economies of scale or scope (extending to natural monopolies); far-reaching externalities (positive or negative) in production or consumption; and extensive vertical and horizontal integration (either under a single corporate umbrella or in the form of long-term *ad hoc* contracts). Within this very specific framework, the successful introduction of competitive mechanisms, substituting for administered regulation or internal corporate management hierarchies, along with the creation of open markets either up- or downstream of the formerly integrated networks, created disruptions and innovations in equal measure.

Following Glachant and Perez (2009), we want to recall here that the launch of a competitive reform in a country will not result in a credible industrial structure without the creation of a governance structure adapted to support both competition in generation and retail, and regulation of networks. In the context of the study by Auriol and Biancini, this problem is even more complex because it includes two countries, and the creation of an international governance structure faces important challenges. Thus, "introduce competition only where this is readily feasible" is not a simple recipe for successful competitive reform. The lines between regulated and competitive activities are not always purely technical. They may originate from contingent decisions reflecting the complex technical nature of electricity industries both at the local and international levels. Boundaries between monopolistic activities and potentially competitive activities, like the boundaries between the firms themselves, between their respective tasks, and between their real or potential transactions and the corresponding markets, are thus not given once and for all prior to the launch of the competitive reform. Quite the contrary, these boundaries are primarily defined over the course of the long process of creating the reform. They are the result of segregating the industry into new operational modules.

In this context, the sequential character of decisions and interaction effects makes it difficult, *ex ante*, to define a governance structure that is truly able to evolve and provide prolonged guidance to a lengthy process of competitive reform at the two levels. The difficulty is to define a governance structure *ex ante* that will remain adaptable *ex post*, allowing for imperfections and failures in the competitive reforms to be corrected nicely. Theoretically and empirically, the enormous requirement for successive "coordinated adaptations" of the competitive reforms of electricity industries creates a recurring problem of multilateral bargaining to periodically redefine existing property rights and institutional arrangements, both at the national level, and even more at the level of multilateral integration within the broader economic zone. Thus, it is important to recall that "veto players" exist in all institutional and industrial arrangements for piloting these competitive reforms at the national level. These veto players are agents with "*status quo*" power over any subsequent changes to local reforms. But as shown in Auriol and Biancani's paper, integration always creates redistribution effects and, according to the relative distribution of local veto rights in a country, looseness in the process can impede any efficient move toward a more market-friendly solution locally. But it can also have an impact internationally by preventing any transfer of competencies or by making this transfer only formal with no real enforcement power, as with Europe in the case of energy policies.

Building a governance structure for reforms that is perfect in the long term essentially consists of defining and allocating the rights to future implementations of the reforms. This is how the governance structure is able, when the need arises, to define and allocate new rights. These new rights, which would be obtained in the future and could be useful for steering the course of the reforms after the start-up period, might combine with pre-existing rights — already defined and allocated and protected by assorted institutional guarantees.

The institutional hurdle to implementing the new orientation encountered here is that all rights having existed for a long period are anchored in strong guarantees entrenched in their institutional environments. Thus, the notion of creating a perfect governance structure *ex ante* to steer the reforms over a long time horizon seems contradictory. Over the course of the long implementation of these reforms, the various stakeholders, whether private or public, and the new governance structure, can only sequentially uncover the exact character and relevance of the existing rights. Therefore, they can only intervene sequentially in the

redefinition and reallocation of these rights in order to sequentially adapt the various modules of the industry and the markets[4] (Prosser, 2005). This is because, in North's (1990, 2005) view, we only discover the long-term properties of existing rights and institutional changes by a process of trial and error, and sometimes by pure chance.

4. Conclusions

Why it is worth carefully reading Auriol and Biancini's paper? We have argued that the paper provides some very interesting insights both in the formal expression of the ideas on market integration and in policy oriented advice toward policy projects for market integration. The purpose of these comments was to provide a complementary view on the possible extensions of the model presented. We think that from the point of view of both the engineering and the economics of the electricity system, the paper opens the way to better understanding of the economic consequences of integration in the electricity market.

Our main point is to highlight two possible improvements: first would be the introduction of more electricity features in the model to provide a clearer picture of the potential pitfalls and opportunities of market integration; the second point is the need for complementary analysis of feasible institutional alternatives in the framework of the original model developed by Auriol and Biancini. We have argued that in order to have a clearer view of the impact of a market integration solution in concrete situations, an in-depth analysis of the institutional settings coupled with engineering and economic analysis of alternative options will be the road to more efficient policy advice or actions.

[4] Prosser argues that the early legal structures adopted for UK utility regulation did have elements of a regulatory contract. However, with the growth of competition and social regulation, a different model, that of a network of stakeholders, has largely replaced it.

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