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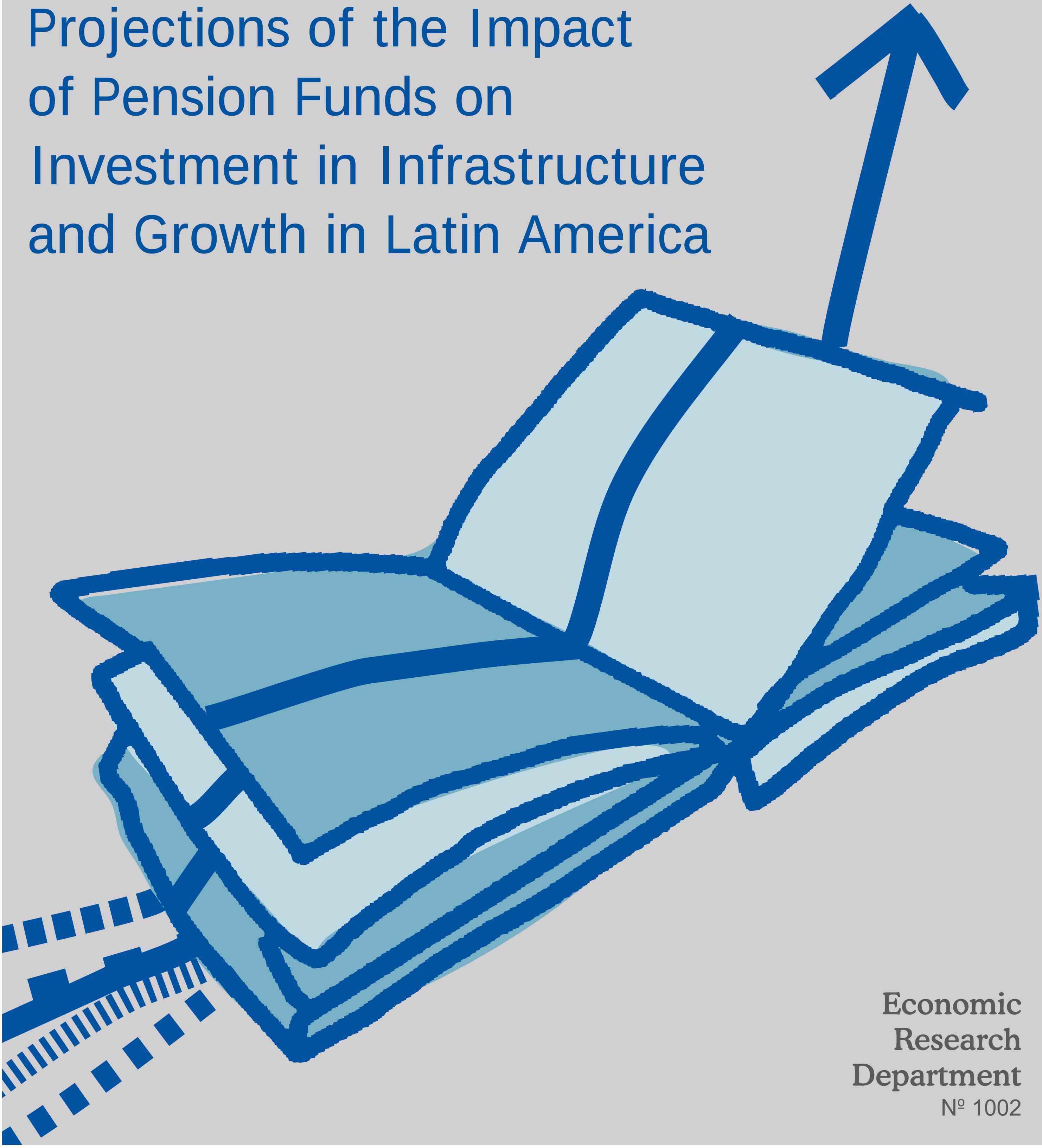

Economic
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Projections of the Impact of Pension Funds on Investment in Infrastructure and Growth in Latin America[1] [2]

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Summary

This research study has various objectives. First, to highlight the importance of investment in infrastructure on economic growth. Second, to underscore the need for a competitive and transparent process to implement these investments, which must be aimed at efficiency and obtaining a proper balance between private and social benefits. Third, to identify the potential of pension funds as a flow of resources that can be channeled toward the development of infrastructure. And finally, to quantify the impact that the destination of these funds could have on the long-term growth projections of a country. To this end, we conducted an experiment to calculate per capita GDP growth in Latin America if the share of pension fund portfolios in assets related with direct infrastructure investment was increased. For this, we compared an inertial scenario (taking into account the current diversification of portfolios), versus one in which these were increased toward a higher level, in accordance with the regulatory framework of each country. These scenarios are incorporated in an expanded neoclassical growth model, in which GDP depends on the accumulation of traditional factors, plus the introduction of the infrastructure capital stock, which depends in part on the contributions of pension funds. The results of the model show substantial improvements in infrastructure investment and per capita GDP in Peru and Chile by more than 3% by 2050, and by 1.1% in the case of Mexico, and 2.16% in Colombia. The results of this study gives new light to the double importance that pension fund investment in infrastructure might have, generating a complementary relation between the objectives of the pension industry in providing workers with a profitable portfolio with limited risks, and at the same time generating an important contribution to growth in the country, which in the end would result in a greater development of pension funds, in brief, a virtuous circle that is necessary to strengthen.

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1. Introduction

According to the definition of the Royal Academy of the Spanish Language, infrastructure is understood as being the elements or services that are considered necessary for the creation and operation of a given organization. From our standpoint, we will consider economic infrastructure projects as those that have as their objective, contributing to the production of goods and services (for example, highways, ports, airports, railroads, conduits for water services, gas, electric power, etc.). On the other hand, we will consider social infrastructure projects as those that participate in an indirect manner in the productive process and which enhance its social value (for example, hospitals, schools and universities, prisons, etc.).

Historically, a considerable proportion of infrastructure financing in the world has had the direct participation of the state, as part of its responsibilities, which has led to its being the exclusive administrator of the entire process, including its financing. However, the real situation has generated an evolution of this perspective, influenced by two important trends.

- First, a greater sensitivity toward efficiency, transparency and a rendering of accounts of the resources managed by the state. This has led to a greater belief in the importance of market incentives, the role of property rights as a key motor for efficiency, without disregarding the fact that the state has to essentially comply with objectives in favor of society.
- Second, budgetary restriction, imposed by the structural growth of key components of public spending and the difficulty of continuing to raise the tax burdens to stabilize the financial balance, while also taking into account that countries have a greater sensitivity to excessively increasing deficits.

The above notwithstanding, the state continues to have the responsibility of guiding the development of infrastructure in a country, of managing the information regarding the needs of the economy (society and markets) in terms of greater infrastructure, planning how these projects should be executed over time and defining the manner in which the different economic agents can participate, whether this be the public or the private sector.

Additionally, it is interesting to note that public-private interaction in the financing of infrastructure has the potential of deriving mutual benefits that surpass the alternative of non-collaboration. In general terms, the success of the participation of the private sector is produced when both the private and the public sector comply with the expectations vested in the investment:

- *Expectations of the state*: The public sector expects private collaboration to provide quality infrastructure at a reasonable price. At the same time, it expects a more efficient management of infrastructure than it could provide itself, given the specialization of the promoting company. To achieve this, it must transfer to the private sector part of the inherent risks of the concession itself.
- *Expectations of the promoter/financier*: The promoter aspires, as any enterprise does, to maximize benefits while controlling risk. These aspirations are the same ones that affect the financial entities that participate in the financing of the project, especially with regards to risks.

The fulfillment of these expectations can only be met through an optimum design of all the phases of the investment project: planning, bidding, execution and management.

A well-designed infrastructure process is therefore understood to be one that complies with the criteria mentioned above, and which has an important impact on the economic growth of the countries. However, it is seen that in emerging countries, the level of infrastructure accumulation has been quite deficient. Particularly significant is the case of Latin America, which unfortunately has lagged behind in this objective, as a consequence of continuous budget adjustments that give priority to reductions in infrastructure investment over current expenditures. As of the nineteen nineties, privatization processes provided greater access to private capital which improved the quality of infrastructure, however this was not enough to offset the drop in public investment. For a better idea of the existing gaps, it suffices to mention that in the seventies, infrastructure levels in Latin America were comparable to those of several of the so-called Asian Tigers. In fact, while the most flourishing Asian countries have been investing more than 5% of GDP, Latin America barely surpassed 2% recently. This is even more alarming if we consider that in the eighties, investment in infrastructure in the region was close to 3.5% of GDP.

As we shall see in this study, the optimum use of domestic savings, redirecting them toward investment in infrastructure, could help to reduce the existing lags and with this, generate an important impact on economic growth. In this sense, it should be stressed that some Latin American countries (particularly Chile, Colombia, Mexico and Peru) have been able to incorporate important levels of savings thanks to the accumulated flows in the private pension systems, which are invested in different types of financial assets, depending on the regulations existing in each country. We believe that it would be most advisable to consider the possibility of private pension funds in the region to participate more actively in the financing of infrastructure. In recent years Chile has taken interesting steps in this regard. Also, the international experience provides outstanding evidence, not only regarding the impact that this type of financing can have on the economy, but also with regard to the clear advantages that the participants in pension funds could obtain in return for incorporating infrastructure-related financial assets in their portfolios. Infrastructure investments tend to show outstanding profitability, while allowing for the reduction of global risk and at the same time balancing the horizons of long-term assets and liabilities managed by these industries.

Based on the points noted in the previous paragraphs, we can say that this study has multiple objectives. First, to highlight the importance of investment in infrastructure on economic growth. Second, to clarify the need for an infrastructure design process aimed at an efficient use of resources to generate a greater impact on the economy. Third, to identify the potential of pension funds to provide resources for the development of infrastructure. And finally, to quantify the projected long-term impact that the destination of such funds could have on growth in the country. To this end, the structure of this study has been divided into seven sections.

Following this introduction, the second section analyzes the existing relationships between economic cycles, budgetary policies and the development of infrastructure in the Latin American countries. This part begins with a theoretical discussion of the characteristics of the economic cycles and the different effects of fiscal or budgetary policy. The effectiveness of developing infrastructure policy through spending policies or public investment is also discussed. Then, considering that this development of public infrastructure is, in the end, very dependent on the structural financial equilibrium of the country, we observe how its adjustment during the nineteen nineties had enormous negative repercussions on infrastructure investment in the countries, and how this could have had an unfavorable impact on their potential growth. This occurred in a context where, at the beginning of the nineteen nineties, foreign direct investment began to channel considerable resources toward infrastructure in the region, although later, as a consequence of the global crises, this investment was reduced and in the end, it was not possible to compensate for the decline in public infrastructure investment.

In part 3, we review the different theories of economic growth, focusing on the importance given to infrastructure in economic literature. For example, various studies are cited that stress the impact that this variable has had on growth, under specific circumstances, which can be applied to the situation of developing countries. Additionally, we focus on the role of infrastructure in the solution of basic needs of the population, and how this, in turn, has an impact on the improvement of income, and consequently on growth in a country.

In section 4, the document presents a detailed discussion on programs for developing infrastructure investments. Thus, we begin by noting the characteristics by which an investment in infrastructure is granted in concession, describing the different forms considered in the markets. Further on, we analyze the different elements that comprise the concession process, considering the phases of classification of the potential participants, the bidding processes and the risks to be evaluated and mitigated. Finally, the main forms in which these concessions operate are set forth, either through project financing programs or public-private participation (PPP).

In the fifth chapter, the discussion centers on the importance that pension funds can have on infrastructure. For this, we have conducted a brief review of the logic of these resources, the manner in which they are channeled toward different investment assets, the space that the different regulations have given to the formation of portfolios that incorporate financial assets related with infrastructure projects, as well as the potential that these could have in a context that allows for the expansion of portfolios destined for those resources.

In order to round out everything discussed in the previous chapters, evaluating the impact that pension funds might have on infrastructure investment is still pending, and with this, the effect on productivity and growth in the country. To this end, in chapter six we conduct an experiment under which we calculate the difference in the evolution of per capita GDP in Chile, Colombia, Mexico and Peru, under the assumptions that these countries grant the same percentage of pension fund contributions currently allocated for investment in new infrastructure, compared with the alternative hypothesis of an increase of said percentage to an adequate and legally feasible level in accordance with current regulations. This will be measured based on the projection of an expanded neoclassical growth model, in which GDP depends on the accumulation of traditional factors plus the introduction of the infrastructure capital stock, which depends in part on the contributions of pension funds, in addition to making the increase of total factor productivity through investment in infrastructure partially endogenous. In chapter seven, we finally show the results, and in the eighth chapter, we present the main conclusions of this study.

We hope that this study will provide additional insight to the dual importance of pension fund investment in infrastructure. In the case that sufficient conditions exist for pension funds to consider a greater investment in infrastructure, the complimentary objectives of the pension industry and the state to provide workers with a profitable portfolio with limited risks, while at the same time generating an important contribution to the country's growth, can simultaneously be achieved; consequently this would result in a greater development of pension funds, thus briefly creating a virtuous circle that is mutually beneficial to strengthen.

2. Economic cycles, fiscal policy and its effects on infrastructure investment in the Latin American context

Infrastructure plays a leading role in the analysis of the economic cycle as a result of the fiscal policy recommended by Keynes in the mid twentieth century. In general terms, the main approach suggests that in those phases of the lowest cycle, or of economic crisis, caused by insufficient private demand, it should be the public sector that compensates for this activity through an expansive fiscal policy. In turn, during phases of strong growth, due to the dynamism of private demand, the government must adopt a contractive fiscal policy, reducing spending and amortizing debt generated during periods of crisis.

A fundamental contribution of Keynes was to distinguish between the state's current expenditures and public investment, and specifically in investment in infrastructure. With regard to an expansive fiscal policy that uses the component of public investment in infrastructure, consisting of an increased investment financed with public debt, economic literature shows two possible effects on the private sector: a crowding-in effect, and alternatively, a crowding-out effect.

The crowding-in effect assumes that, in the short term, the demand for inputs necessary for the execution of infrastructure occurs on goods and services generally produced in the private sector, thereby increasing the sales expectations of those goods and services[3]. In terms of supply in the medium term, the provision of better public infrastructure allows for an improvement in productivity of the private capital stock, increasing its production potential.

In turn, the crowding-out effect, would be derived from the fact that the increase in public spending on investments could generate two collatreal effects. On one hand, the needs of public financing could be detrimental to the perceived country risk and therefore lead to a rise in interest rates and short-term inflation. On the other hand, this could derive an increase in companies' financial costs, making them less competitive internationally. As a final result, there would be reduced investment, production and employment. Table 1 shows the results obtained in various empirical works that have attempted to contrast the existence of such effects.

[3] The quantification of this effect would be derived from what is known in economic policy literature as the multiplier of public spending. (Fernández Díaz *et al,* 1995).

TABLE 1: Empirical evidence on the *Crowding in / Crowding out* effect

QUOTEs	SAMPLE ENVIRONMENT	CONCLUSIONS
Oshikoya (1994)	África	For most countries in this sample, public investment in infrastructure is complementary to private sector investment
de Oliveira Cruz and Teixeira (1999)	Brazil	Private investment is crowded out by public investment in the short term, but in the long term these two variables are complementary
Blejer and Khan (1984)	Developing Countries	Government investment in infrastructure is complementary to private investment, while other types of government investment are not
Balassa (1988)	Developing Countries	Crowding-out
Greene and Villanueva (1991)	Developing Countries	Crowding-in
Heng (1997)	Developing Countries	Shows that public capital can crowd-in private capital by raising the marginal productivity of labor and savings
Ghura and Goodwin (2000)	Developing Countries	Overall sample suggests crowding-in - Public investment crowds in private investment in SSAFR, but crowds out in Asia and LAC
Nazmi and Ramirez (1997)	Mexico	Crowding-out
Musalem (1989)	Mexico	Crowding-in
Ahmed and Millar (2000)	OECD and developing countries	Government expenditure crowds-out for both samples, plus pooled sample. For developing countries, government expenditure on transport and communication crowds-in
Argimon, Gonzalez-Paramo, Alegre (1997)	OECD	Crowding-in effect of private investment by public investment through the positive impact of infrastructure on private investment productivity
Monadjemi and Huh (1998)	OECD (Australia, UK, USA)	Empirics provide limited support for crowding-out effects of government investment on private investment
Source: Everhart and Sumlinsky (2001)		

One conclusion of this evidence is that the effect of public spending on infrastructure and consequently on growth can be ambiguous. The predominant result in each country will depend on the macroeconomic circumstances in which it is immersed and the effectiveness of the complementary policies carried out. For example, an expansive fiscal policy, combined with a contractive monetary policy, could limit the increase in prices and in interest rates. A policy on income that prevents the transfer of inflation to wages such that they would grow only with productivity, would prevent the crowding-out effect. Finally, to the extent that the GDP growth rate is way below its potential rate, and agents' expectations consider remaining in this scenario over a prolonged period of time, the increase in public expenditures would not supplant private investment, since there would not be short-term business opportunities.

The expansive effect of fiscal policy is greater when it is produced through an increase in investment, than when it is made through the increase of current expenses. This is due to the fact that, together with the multiplying effect of demand, we must consider the effect of infrastructure on supply, improving productivity of the private sector, as we pointed out previously.

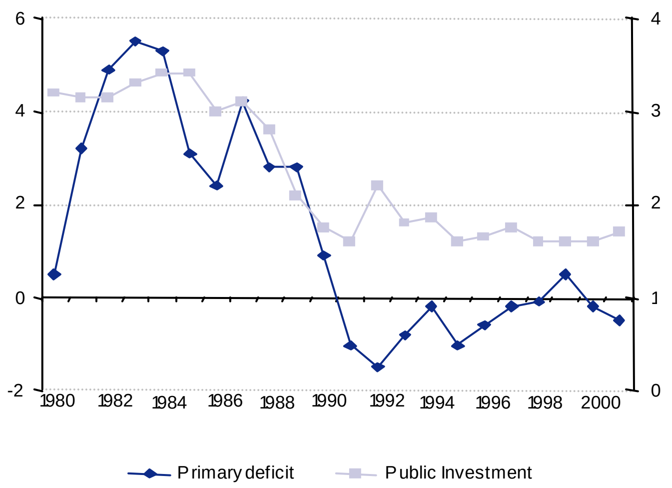
However, an expansive fiscal policy carried out through an increase in public investment has an important disadvantage. This is mainly derived from the delay that occurs from the moment in which the decision is made to build infrastructure to the moment its real effects on the economy occur. Kamps (2005) quantifies this delay in a study of 22 OECD countries between two and four years. This lapse is derived from the delay in the preparation and formal execution of public budgets and the time elapsed in the physical execution of the projects. This circumstance causes this tool to be an inflexible factor in its use as a counter-cyclical policy tool.

In the same manner that fiscal policy can be expansive, in a strong growth economic cycle, public expenditures could be used as a contractive policy, thereby adopting a counter-cyclical policy.

Considering the above, we might ask what the policy on investment in infrastructure has been in the environment of the Latin American economic cycle.

As can be seen in Graph 1, based on Calderón and Serven's 2004 document, we were able to observe that the fiscal consolidation of the Latin American area at the beginning of the nineties was produced thanks to a sharp decline of public investment in infrastructure from investment figures close to 5% of GDP at the beginning of the eighties to a mere 1.5% a decade later. The measure was very effective, leading to a budget surplus between 1991 and 1998. Since the countries were conscious of the fact that this measure reduced their capacity for long-term growth, many of them began ambitious privatization programs of public infrastructure projects, providing additional resources for fiscal consolidation and creating the bases for private companies, many of them of an international nature, to invest in a continuous manner in each country.

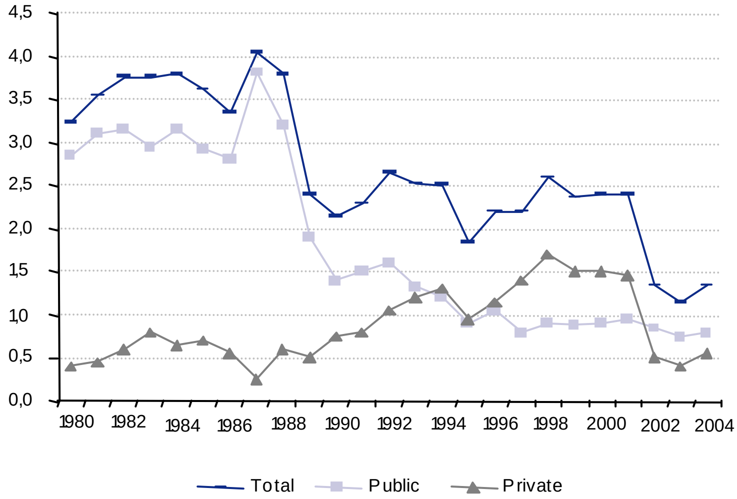
GRAPH 1: Primary deficit in public investment in infrastructure (as % of GDP)



Source: Calderón and Servén (2004)

The objective was only partly obtained. As seen in Graph 2, the strong reduction of public investment in infrastructure coincided with a rally in private investment derived from various privatization processes and the boom in foreign direct investment. Finally, the crisis at the beginning of the 2000 decade set investment back in comparison to other countries, notably reducing total investment. As derived from the Servén study of 2008, the private sector was unable to compensate for the decline in public investment since 1987.

GRAPH 2: Investment in infrastructure in six major countries in Latin America (as % of GDP)



Source: Servén (2008)

In the short term, this measure allowed balancing the public balance, but it has led to a decade lost in terms of establishing the means that would allow for long-term sustainable growth in the region, through a sustained increase of infrastructure projects.

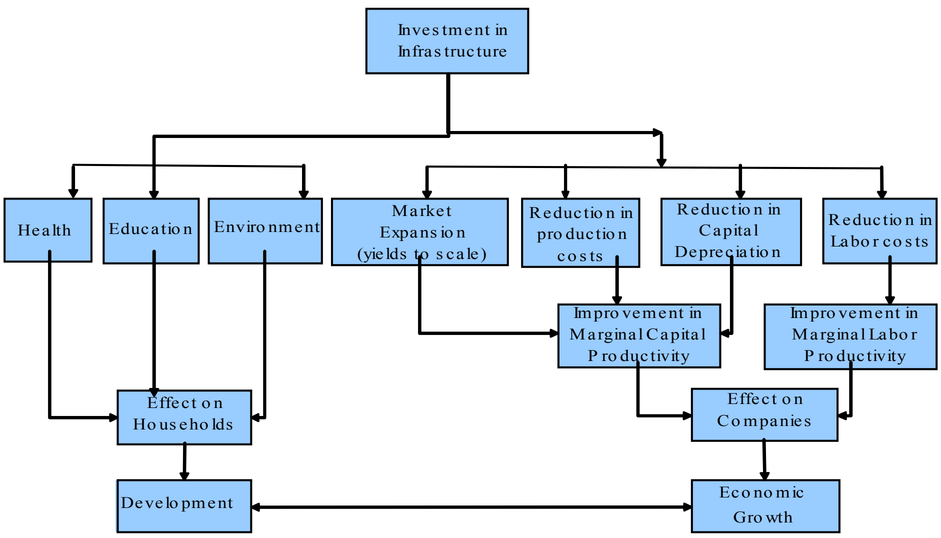
To sumarize, the last 20 years in Latin America have led to two important conclusions. The first is that it is not advisable to use investment in infrastructure in fiscal consolidation policies, since this implies restricting the possibility of achieving sustainable long-term growth. The second is that private investment can be a factor that helps the development of the country, but there must be a savings base and native investment that allows for the construction of the necessary infrastructure projects independently of international financial circumstances. Thus, the accumulation of domestic savings through private pension funds in Latin America, for example, could fulfill this role satisfactorily.

3. Infrastructure Projects, Growth and Development

The effect of infrastructure projects on the economy has multiple facets that are worth noting. The best known due to the vast number of studies it has given rise to is the effect that these projects have on economic growth. Based on the works of Solow, and all the theory of endogenous growth that began in the fifties, there has been an effort to explain how and why some countries grow and others do not. The law of diminishing returns to scale in the cumulative and constant factors (physical productive capital) for total factors, described a dynamic of transition toward a stationary state without growth. Solow's residual endogenization through various methods (externalities, scientific discoveries, learning by doing, etc.) and the incorporation of new productive factors that affect the efficiency of the factors (for example, human capital) allow them to escape from a stationary state, moving it over time. This trend of models introduced infrastructure projects as a factor for growth to be added to the representative production function. The seminal works of Ashauer (1989a, 1989b, 1989c) included infrastructure as an additional productive factor (See Graph 3).

Another more direct effect of infrastructure projects on the economy is how they affect families. The availability of certain facilities such as schools, hospitals, public sewage, access to drinking water, electric power, telecommunications, etc. are elements that have a special impact on the well-being of households. These infrastructure projects serve not only to produce, but have a very important social function that translates into economic development (See Graph 3).

GRAPH 3: Diagram of the effect of infrastructure projects on the economy



Source: ERD BBVA

3.1. Infrastructure projects and growth

The theories of economic growth promoted by Solow in the fifties, in which the main factors of production were capital, labor and a residual that included the remaining non-measurable factors (mainly technological innovation) have been enriched with new contributions that have improved the explanatory power of this model.

In fact, to illustrate this, let us define the Cobb-Douglas initial production function characterized by the expression:

$$Y_t = A_t (K_t)^{\alpha} (L_t)^{\beta} \quad (3.1)$$

where GDP for the year t (Y_t) is explained by the accumulation of capital (K_t) of the same period, the labor force (L_t) and the residual to which we referred above, (A_t). This function presents constant returns to scale for the group of factors $(\alpha + \beta = 1)$ and decreasing returns for each of these $(\alpha < 1, 1 - \beta < 1)$.

Later, the works of Ashauer (1989a, **1989b**, 1989c) included an additional element as a production factor: infrastructure projects. The intuition of this modification was derived from the empirical verification that the growth rate of productivity in the United States began to decline shortly after the decline of public investment in infrastructure. According to this study, the impact of this reduction was 57% of the decline in productivity. With this, the model assumed the following expression:

$$Y_t = A_t (K_t)^{\alpha} (L_t)^{\beta} (G_t)^{\chi} \quad (3.2)$$

Where G_t represents expenditure in infrastructure projects and χ is the elasticity of this factor that would be lower than one. Again, we observe constant returns to scale $(\alpha + \beta + \chi = 1)$.

The main argument regarding the contribution of infrastructure projects to economic growth is derived from their contributions to increases in the marginal productivity of labor and capital. In this sense, the development of infrastructure favors the securing of more productive privately financed projects, expanding markets and achieving greater returns to scale. Moreover, better infrastructure allows for a lower depreciation of productive capital (for example, tires) and lowers companies' expenditures, reducing production times and improving the distribution of merchandise. The facility of improved communications helps to attract a more qualified labor force to specific areas which were previously labor deficient (Ferreira, 1999; Agenor and Neanidis, 2006).

The empirical evidence that supports this perspective has had its share of problems. Gramlich (1994) shows the dificulties of finding empirical relationships between growth and infrastructure projects due to the difficulty of measuring the latter. Moreover, he emphasizes that many effects linked to development are not contemplated in the given GDP variable, with which the contribution of infrastructure projects could be limited by actual conditions.

The fact that investment in infrastructure shows decreasing returns to scale assumes that those investment will be the most profitable in terms of generating growth and social development when the stock is low. At the same time, according to Canning and Pedroni (1999), there is a path of optimum infrastructure accumulation. Any allocation of resources that is under this curve will provide increases to GDP as investment increases, even though the total growth potential would not be fully taken advantage of. If the allocation is above the curve, resources could be used more productively, and thus we would not observe effects on economic growth due to crowding-out.

In general, these factors can also explain why in some countries positive effects on economic growth are observed while in others they are not. Thus we might find an empirical regularity, which would lead us to affirm that in developing countries there is a tendency to observe positive effects because they benefit from the law of decreasing returns to scale, while in developed countries, the rate of accumulation could be above the optimum and therefore an important contribution would not be perceived.

In a survey on infrastructure projects and growth, De la Fuente and Estache (2004) seem to find evidence of this (see Table 2). Among studies conducted in various countries and in the United States, the results seem to be mixed. However, in the developing countries there seems to be unanimity in the results of the conclusion that investment in infrastructure has beneficial effects on productivity and growth.

TABLE 2: Distribution of results of studies that show the effect of infrastructure investment on productivity or growth

Area studied	No. of studies	Percentage that shows positive effects	Percentage that does not show significant effects	Percentage that shows negative effects
Multiple countries	30	40	50	10
United States	41	41	54	5
Spain	19	74	26	0
Developing countries	12	100	0	0
TOTAL MEDIAN	102	53	42	5

Source: De la Fuente and Estache (2004)

3.2. Infrastructure and development

Graph 3 shows a diagram of the effects of infrastructure on the development of families. Concretely, we can say that improvement in the provision of infrastructure allows for the optimization of vital factors in the well-being (or on occasion on the survival) of individuals. At the same time, the improvement of living conditions immediately translates into more efficienct factors of production. Thus, infrastructure is an appropriate vehicle to link more closely the relationship between growth and development. The relationship is primarily established through three main avenues which are worthwhile to discuss in this chapter: health, education and the environment.

a. Health and nutrition

The construction of infrastructure projects which provide the population with access to sources of potable or drinking water and public sewage, could presumably substantially improve the health of the population, preventing numerous diseases. This especially affects children by significantly reducing their mortality rate (Leipziger *et al*, 2003).

On the other hand, access to energy sources (gas and electricity) substantially improves families' health by reducing the cost of boiling water and providing the possibility of refrigerating medicine and food.

At the same time, the improvement of transportation systems allows access to new foods from other reginons or countries, which makes it easier for the population to have a more varied diet that is less subject to local seasonal changes. This also reduces the dependence on the local availability of foods in light of adverse conditions, improving food supply in the region due to appropriate infrastructure (Wang y Taniguchi, 2003).

Finally, improved communication and transportation routes allows rapid access to healthcare for people that live in isolated regions, and also allows the population to have access to disease prevention programs.

In the end, all these elements lead to a healthier population that is more productive and therefore generates greater wealth.

b. Education

In numerous studies it has been observed that school registration rates (especially among women) increase considerably with the construction of adequate roads and transportation. The improvement of roads allows teachers from other cities to be hired (Khandker *et al*, 2004).

On the other hand, appropriate teaching facilities also lead to lower absences and withdrawals from school due to illness and to improved scholastic achievement.

The improvement of education allows the labor factor to be more efficient and capable, thereby further contributing to economic growth.

c. The environment

Regular access to more efficient energy sources, such as electricity and/or gas, allows the population to replace other sources of traditional energy. The possibility of heating the household with other energy sources reduces the need to use wood as an energy source, thereby preventing deforestation and preserving the local biodiversity (see WHO, 2005).

Moreover, the improvement of education and infrastructure for the recycling of trash improves the environment of the region, making the population healthier.

All these factors translate into improvements in the health and education of the population on the whole, thereby leading to the improvement of families' well-being. This well-being also presumes an improvement in labor conditions, which in turn leads to substantial improvements in growth. In this way, it is verified that growth and development are two sides of the same coin. Agenor and Moreno-Dodson (2006) emphasize this relationship and the positive impact of infrastructure on both.

4. The formulas of participation of the private sector in the financing of infrastructure

Throughout history, infrastructure financing has followed two main routes of development: public financing and private financing. In accordance with the tradition of each country, one or the other has prevailed. Currently, however, the model that is gaining ground is a mix of both formulas. This has allowed the government to liberate resources to finance other types of more social projects without neglecting a major factor in long-term economic growth. The various possible mechanisms for financing infrastructure are summarized in Table 3.

Despite the fact that the modes of public financing[4] are very interesting due to the various options available to governments, in this chapter we will make an in-depth analysis of the formulas of private and mixed financing, since these are the ones that offer greater possibilities for the participation of pension funds in different countries.

The administration model is also important. In most countries, the management of infrastructure has traditionally been done directly by the state, however, the financing

[4] For more information on these options, see Izquierdo and Vassallo (2004) pages 166 to 211.

formulas are increasingly reverting to a type of private management due to the advantages provided by the specialization of bidders of new investment projects.

TABLE 3: Different financing and management modes of infrastructure

MANAGEMENT	*FINANCING*				
		PUBLIC	**PUBLIC (with deferred payment)**	**PRIVATE**	**MIXED (Públic-private)**
	DIRECT	-Construction contract with certification deposits. -Public contributions to instrumental entities and institutions. -Public toll highways. - Non-budgetary (construction contract).	-Public debt. -Construction contract with total price payment. (German model).		
	INDIRECT	-Rental. -Conservation concessions	-Shadow Toll -Infrastructure management service agreement	-Traditional concession. *-Project Finance*.	-APP or PPP

Source::Izquierdo and Vassallo (2004)

The main advantages that private investment financing offers infrastructure projects are concentrated on the following points:

- Private investment in infrastructure projects allows for the fiscal consolidation of the public budget, freeing resources for other social expenditure items or to reduce tax pressures.
- It improves the allocation of resources, transferring the cost of infrastructure projects to the user or beneficiary, thus improving the efficiency and equality of its use.
- It realizes all the positive effects for the economies noted in Table 3 by the construction of said infrastructure. If the public budget were not able to execute the project alone, the difference would represent the opportunity cost.
- Some studies show that private infrastructure projects offer better quality at a lower cost than public infrastructure projects due to the different incentive structure.

In light of the hypothesis that not building a facility due to limitations in the public budget may represent certain opportunity costs in terms of growth and development, some countries (such as Germany and the United Kingdom) that had previously rejected private financing initiatives for infrastructure projects are now adapting the necessary laws and procedures to allow for this in their long-term planning (see Izquierdo and Vassallo, 2004).

As an example of the change in trends observed, Table 4 includes the number and value of private financing initiatives at the world level, by geographic area and by sector.

It can be easily verified that the highways and railroads sector account for most of the infrastructure projects financed by private enterprise. As to the number of projects, with the exception of the case of Africa, the rest of the geographic areas participate in generally similar amounts of initiatives. In this regard, the great number of projects financed in Latin America is particularly noteworthy, especially considering its relatively low economic weight.

TABLE 4: Private investments (financing) in transportation infrastructure projects at the world level between 1985 and 2003 (US$ billions)

	HIGHWAYS		RAILROADS		AIRPORTS		PORTS		TOTAL	
	Nº	$	Nº	$	Nº	$	Nº	$	Nº	$
NORTH AMERICA	107	32.8	16	11.7	18	5.3	1	0.3	142	50.1
LATIN AMERICA	79	20.2	22	7.2	7	0.8	12	0.9	120	29.1
EUROPE	82	55.7	35	72.2	14	4	12	0.6	143	132.5
AFRICA-MIDDLE EAST	7	3.2	1	0.2	1	0.2	3	0.2	12	3.8
ASIA FAR-EAST	56	41.7	31	51.8	24	37.9	13	4.6	124	136
TOTAL WORLDWIDE	331	153.6	105	143.1	64	48.2	41	6.6	541	351.5

Source: Table taken from Izquierdo and Vassallo (2004). Page 176.

In terms of the value of these investments, the cases of Europe and the Far East are outstanding, each with investments of around US$130 billion, in contrast to US$50 billion and US$29 billion in North and South America respectively. It could be assumed, therefore, that the average value of each project in the latter geographic area is lower than in Europe and the Far East. Total private financing of infrastructure projects at a world level, according to this data, is US$351 billion.

4.1. The concession system

The usual manner of participation by the private sector in the construction and operation of infrastructure projects in different countries begins with a concession process, by which the various government administrations may transfer the construction risk of infrastructure projects to concessionaires in exchange for the right to temporarily operate the projects and for which they receive remunerations. As we shall see, the risks associated with the process make it a necessary, although insufficient, condition to have a concession law for the successful participation of the private sector (see Izquierdo and Vassallo (2004).

The concession systems may adopt numerous forms which we will discuss further on, however, in order to be considered optimal, all of these forms must comply with two fundamental requirements:

- Given that the infrastructure projects respond to a model of natural monopoly, the concession must be the outcome of a competitive process in which the winning bidder represents the best project.
- The concession must ensure a controllable level of risk for the investment to be attractive for the bidder.

These conditions can be formalizad by means of diverse contract agreements differentiated by the property of the infrastructure, the financing and operation regime. The internationally accepted terminology is as follows:

- The BOT Model (*Build, Operate, Transfer*): The private sector builds the infrastructure and acquires the right to operate it for a determined period of time. When this period is over, the operation rights revert to the state. This is the type of model usually followed by project financing.
- The BOOT Model (*Build, Own, Operate, Transfer*): This is the same as the previous model except that during the operation period of the infrastructure, the concessionaire is the owner. Upon termination of the concession, both the ownership and the right of operation returns to the state. This mode allows the concessionaire greater financing guarantees, since it is the owner of the infrastructure project.
- The BOO Model (*Build, Own, Operate*): The same as the previous model, with one exception: at the end of the operation period, ownership of the property reverts to the state, since the useful period of the infrastructure coincides with that of its operation.

- The BLT Model (*Build, Lease, Transfer*): A corporation is established that is in charge of managing the leasing of a public project. The state administration makes payments previously agreed upon for this operation.
- The DBFO Model (*Design, Build, Finance, Operate*): The same as the BOT model with one exception; the design of the project corresponds to the concessionaire and its corresponding retribution is made by means of shadow toll payments[5].
- The DCMF Model (*Design, Construct, Manage, Finance*): The same as the DBFO, but in addition, management is transferred to the concessionaire (common for prisons, hospitals, etc.)

Regardless of whatever concession model used, it must comply with certain phases, the correct implementation of which will be vital for achieving a successful project.

4.2. Elements of the concession process

A good design of the concession process is a necessary condition, although not sufficient for the successful construction of infrastructure projects by the private sector.

In the preparatory phase, it must be decided whether an infrastructure project is necessary from a socio-economic standpoint, and if the participation of the private sector in the project represents an advantage. Then, the pre-qualification process of the candidates follows and the bidding process will be crucial in selecting the best project. A detailed study of all the possible risks and the availability of the tools for their mitigation will make it possible to carry out the project with guarantees. Finally, it is very important that there are public controls that guarantee the quality committed with regards to the infrastructure. All these phases will be itemized below and must comply with two general conditions: they must all be carried out with utmost transparency and in the shortest possible time.

a. Preparatory aspects of the bidding process

The various public administrations, through their planning departments, prepare long-term investment plans in which an in-depth analysis must be made with regards to the cost/benefit of each project and the best usable concession model.

There may be cases in which private enterprises detect infrastructure projects that it may be interested in participating in and proposes this intention to the Public

[5] A payment mode for the use of infrastructure with private financing in which the state pays a tariff agreed upon in terms of the public use of such infrastructure.

Administration. In case the government agrees that the project is viable and necessary from a socio-economic standpoint, it will open a bidding process to as many bidders as may be interested in participating, and if it considers it convenient, it may reimburse the expenses incurred by the company that presented the project (See Izquierdo and Vasallo, 2004; Yescombe, 2007).

The study process of the projects approved may follow two alternate routes:

- The Administration proposes a fully-developed project to the bidders so that they may present their bids, allowing them to propose marginal modifications.
- The Administration only proposes an infrastructure project with general details and it is the concessionaire companies that present alternate projects.

b. The process of pre-qualification and selection of candidates

The criteria for the selection of candidates for the bidding process to a concession may be subject to various parameters. In the first place, pre-qualification may be open (it can be open to any company), or closed, if a specific criterion is selected for participation.

If the choice is made to filter the participating bidders, the criteria to choose the candidates may correspond to objective parameters, such as the company's financial position, or they may be subjective, such as reputation and the technical capacity to carry out the infrastructure project. Another filter that incorporates some cost or the presentation of guarantees in order to be considered as pre-qualified may also be used.

Thus, the objective of limiting the number of bidders is that only those that have a true interest and have real options of winnning will participate in the process. In any case, the whole processes must be conducted with the maximum transparency to avoid inappropriate selections that respond to motives that are not strictly technical.

c. Bidding mechanisms

Multiple criteria can be established in the bidding process. In general, every concession must comply with an equilibrium between income flow and the costs of the concession, considering both of these plus a benefit.

$$\sum_{i=1}^{n} \frac{p_i q_i}{(1+\alpha)^i} = I + \sum_{i=1}^{n} \frac{C_i}{(1+\alpha)^i} \qquad (4.1)$$

Where p_i is the rate in the year i, q_i is the traffic of the year i, n is the number of years, C_i is the cost of the concession, I is the initial investment and α is the profitability of the project.

Traditionally it is said that a bidding process is “through the left”, when the main criteria is concerned with questions of income. Alternatively, it is said to be “through the right” when it is concerned with variables related to cost or expense. Thus, the most common methods are:

- Bidding that considers a minimum profitability rate: the concession is granted to the company that offers a lower rate of return on assets.
- Bidding due to a lower rate: In this case, the concession is granted to the consortium that offers the minimum toll, given the same project or equivalents.
- Bidding due to a minimum concession term: it is granted to the company that offers the lowest concession term, given a homogeneous rate or project among the participating bidders.
- Bidding for the minimum subsidy or the highest payment for the concession: in those projects that require a subsidy because the expected traffic is not enough for the project to be considered viable from a financial standpoint, it will be granted to the company that requests the lowest subsidy.
- Bidding by minimum value of income: this type of bidding awards the project to the company that offers a lower current value of the revenue generated by the concession. This mechanism is especially interesting because it eliminates the traffic risk. If it is lower than the bidding agreements, the concession term is extended until it is equal. If, on the contrary, the traffic is higher, and therefore the revenues are lower, the term of the concession is shortened until it is the same.
- Bidding based on quality: an infrastructure project is bid for, considering the quality of the service at a determined price.

d. Analysis of the concession risks

One of the most important elements in any concession is the detailed preparation of a map of risks associated with the project. Given the importance of this element, we will discuss this with greater detail in point 4.3.

e. Control of the execution of the project

Once the bidding has transpired and construction has begun, it is of vital importance that there be a follow-up by the public administrations to verify that quality standards and the terms agreed upon in the contract are being followed.

4.3 Risk management in an infrastructure project with private participation

To conduct a good evaluation of the risks involved in an infrastructure project, it is necessary to know these risks and evaluate every dimension. The different nature of these requires conducting a specific analysis of each of them (see point 4.3.1). At the same time, the specific treatment that these must receive has different dimensions (see point 4.3.2), that range from the proper preparation of the project itself, ranging from the selection of the most appropriate insurance institution, to the use of the most appropriate product for each type of risk.

4.3.1 Types of risks in an infrastructure project

The risks observed in private investment of infrastructure projects may appear at any time throughout the various phases of the project. From the very conception of the project itself, to the moment of termination of operations, there are various events that could imply difficulties that affect the project's financial viability. Some of these are common to any economic activity (corporate risks), while others are specific to this type of investment, given its technical complexity, as well as due to its nature as a capital asset with long-term amortization (risks inherent to the project). Finally, public infrastructure projects that are financed by the private sector generally respond to conditions regulated by the public sector. This characteristic adds risks associated with changes in the original status quo of the infrastructure with regards to operating conditions and the contractual relationship with the state, which are commonly referred to as sovereign risks.

The risk-mitigating measures taken in the private financing of infrastructure projects should use cost/benefit and other associated risk studies to determine the demand and feasibility of of carrying out investment projects. The concession law and its correct execution will allow selecting the best project and the best promoter, providing greater confidence both to financiers as well as to risk insurers. During the process it is possible to face the following types of risk (see Matsukawa and Habeck, 2007 and Davis, 2008):

-Corporate risks

- Risk of fraud or non-payment: As is true of any company, infrastructure concessionaires may be subject to fraud or non-payment of the rates established for the services they provide; for example, illegal connections to electric power supply lines or water sewage networks.
- Risk of devaluation: the perception of revenue in a local currency by international investors could depreciate both the value of the assets invested as well as the loss of income when there is a change in the exchange rate.

-Risks inherent to the project

- Risks due to delays in expropriations, permits and licenses: Prior to the beginning of construction of any infrastructure project, there is a series of protocols that it is necessary to comply with in order to begin construction. These depend on very diverse spheres of the public administration that are often not coordinated. For example, the expropriation of land for the construction of infrastructure projects and the resolution of the possible judicial resources derived from this, the reports on environmental impact and their consequent authorizations, diverse permits and construction licenses that are obtained at different administrative levels (local, regional, national) which may not have the same political priority, etc. and many of which may be conditional factors that may not have been sufficiently coordinated. The consequence is that exogenous administrative delays emerge for the promoter, which makes it difficult to advance with the project due to increased costs and problems in the appropriate planning of the project.
- Construction risks: many engineering projects present unforeseen events that affect construction costs when there are modifications to the project due, for example, to unexpected geological structures or significant variations in the prices of building materials.
- Traffic or demand risks: the decision regarding the construction of a specific infrastructure project must respond to an in-depth analysis of the cost/benefit ratio. In this analysis, it is therefore very important to calculate the potential demand of the project, given the price structure

agreed to by the contract. If real demand does not adjust to that estimated in the construction of the project, there is the risk of non-profitability, which therefore affects long-term financing.

Sovereign risks

- Risk of variation in prices: In some circumstances, and for fundamentally political reasons, governments could be tempted to reduce the rates applied to certain public services that have been financed by the private sector. This leads to an increased risk in the of loss of profitability. Also the drop in international prices of some raw materials (energy, mining) could make the necessary infrastructure projects not profitable.
- Political and unexpected risks: a case of extreme sovereign risk is the case of expropriation of the infrastructure, generally with strong losses for the concessionaire companies. Other unexpected risks are for example, the possibility of local or international conflicts derived from a deterioration of the infrastructure itself or a decline in demand. At the same time, natural catastrophes or epidemics could generate the same effect.

Another issue is that in terms of investment in infrastructure, the same maxims could be established that apply to any type of investment: the greater the diversification of risk, the better, and the risk must be assumed by whomever is best prepared to assume it and manage it. Another element to be considered is that uncertainty (and therefore risk), is directly proportional to the lack of information and transparency in the process. The risk mitigation mechanisms in infrastructure investment that are being adopted in different parts of the world are directed, to the extent possible, to follow these fundamental points.

4.3.2 Risk mitigation tools

a) Well-designed projects and their execution

The success of an investment project in infrastructure depends on the conception of its design or purpose from the very beginning. Many risks of subsequent phases would be mitigated if the appropriate studies were undertaken from the beginning. The cost/benefit analysis of the project will provide information to the public authorities on the advisability of undertaking it. The difficulty of this exercise often flows from the lack of statistical information on the relevant aspects of the project, especially those that are derived from factors that are difficult to quantify such as positive and negative externalities.

The credibility of the team that conducted the study is a decisive factor in the assignment of the project's credit rating and, therefore, of the decrease/increase in its financial cost. Such teams should be multidisciplinary and specialized in each of the facets that comprise the project. Typically they should have finance experts, legal experts for preparing contracts and negotiations, technical and engineering experts, as well as insurance and cost control experts.

Some countries have created agencies specialized in the conception, development, and execution of public/private participation or they have a team specialized in the field. Many times these teams do not directly carry out the work but subcontract it to consultancy firms that have the necessary know-how. Some important cases in this regard are those of Australia[6] and Chile[7], where well formulated analysis models are being applied and have provided satisfactory results[8].

Once it has been decided to carry out an infrastructure project through private financing, the different countries' concession laws are key to ensuring that the best project with the best promoter will be used.

Government control over compliance with the agreed upon terms of the project's execution (both in terms of aspects that correspond to the public administration as well as those that depend on the promoter), as well as supervision of its costs and quality, are key for ensuring greater credibility for possible investors or insurers of the project.

b) Risk insurance institutions

An important element in the design of the concession process is the search for institutions and/or mechanisms that will allow for greater guarantees to be provided in undertaking the infrastructure project, which are known as risk insurance institutions. In this regard, we can mention governments, bilateral financing, and substitute guarantee mechanisms.

- The governments

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[6] http://www.partnerships.vic.gov.au/domino/web_notes/PartVic/PVWeb.nsf
[7] http://www.concesiones.cl/
[8]The public-private comparative model used by the Australian authorities is currently an example of good practices.

Public Private Participation (PPP) is characterized by the participation of the state in some type of risk associated with the construction/operation of an infrastructure project with private financing. In this sense, there are different ways in which the state can participate. Governments can play a positive role in insuring *Risks Inherent to the Project* through different mechanisms. For *Construction Risks* and *Risks due to Delay in Expropriations, Permits and Licenses* there are different possibilities that have been applied on certain occasions:

- Assumption of a percentage of the cost of construction of the infrastructure.
- Non-reimbursable subsidies.
- Contribution of old facilities or their sale to contribute to the new project.
- Granting a credit or offer of a guarantee to third party lenders for the period of construction under advantageous conditions. These conditions would allow for the principal and interest to be returned only after the infrastructure project has concluded and is generating revenue.

With regard to traffic or demand risks, the governments can use different compensatory mechanisms:

- Subsidies on rate prices. If it is necessary to decrease the price so that a more intensive use can be made of the facility, the government can subsidize this reduction. It should be scalable to the extent that the increase in demand will allow for an improvement in the project's profitability.
- Guarantee of minimum revenue. In some cases, uncertainty concerning the demand for the service forces the governments to insure a minimum amount of revenue from its operation. This insurance can be total or partial, in the sense that it can be limited in time.
- Debt operation guarantee. The governments can offer guarantees on credit lines associated with the operation of the infrastructure.
- Increase the concession period. There are some infrastructure projects that although they do not involve losses, do not achieve the degree of profitability promised by the government. Given such circumstances, governments can extend the concession period to reach the accepted revenue levels.

In the same way that governments can assume part of the losses generated by the operation of an infrastructure project, they can also establish mechanisms to share in the profits of projects when they are greater than expected. For example, they can sign clauses that allow the profit to be shared in the event that it surpasses a certain level, or for a downward revision of the price applied in the service, or for a reduction/elimination of guarantees offered by the government. At the same time, the government can establish fines and penalties in case the necessary quality standards are not met or delays occur in relation to the date on which the infrastructure project is to begin operating.

In the *Private Finance Initiative* models (PFI)[9] based on availability, that is, those in which the state pays based on a capacity offered to the public independently of the use that is made of them (e.g., a school offers a number of admissions in accordance with its capacity), or the *shadow toll*, in which the state pays based on the number and characteristics of the user of the facility (e.g., users of a freeway whether they are motorcycles, tourism busses, or heavy vehicles), the PFI model provides insurance to the concessionaire based on the financial solvency of the country in question. It is usually the state that articulates a series of conditions for the entire collection of the agreed upon rate based on meeting some quality and service standards, determining, if applicable, the corresponding penalties in case they are not met.

The mitigation of risks by the state is subordinate to the government's credit quality (see Table 5).

TABLE 5: Long term public debt ratings (SEPT. 09)

Country	Rating
Argentina	B-
Brazil	BBB-
Chile	A+
Colombia	BBB-
Mexico	BBB+
Peru	BBB-
Venezuela	BB-

Source: Bloomberg

Chile is relatively well placed, but Brazil, Colombia and Peru are at the lowest levels in the investment scale. Venezuela and Argentina are in the speculative investment rating category.

At the same time, the governments are not the most appropriate institutions for covering sovereign risks, since in many cases they could be both judge and jury.

Therefore, to be effective, government guarantees should be complemented with those of other sources, which is known as multilateral financing. In this regard, the development banks and insurance companies have played an important role.

9 Those PPP projects in which the state pays the agreed upon rate, and not the user.

- Multilateral financing

The goal of the international financial institutions (IFIs) that are associated with infrastructure financing or insurance is to promote countries' economic development. In this regard, we could mention the Inter-American Development Bank (IDB), the Asian Development Bank, or for the case of Europe, the European Bank for Reconstruction and Development and the European Investment Bank. The World Bank group has specialized institutions such as the International Bank for Reconstruction and Development (IBRD), the International Development Agency, the International Finance Corporation (IFC), and the Multilateral Investment Guarantee Agency (MIGA).

These banks or agencies can directly lend/insure governments or private companies. However, the formula that they have increasingly adopted is the multilateral mode of financing/insuring infrastructure projects in which several of these institutions, the government, insurance companies, and the project promoter itself jointly participate. Thus, the risk is diversified and allows new projects to be adopted.

There are also some local institutions that promote investment within their respective countries. In general they are institutions very specialized in development projects that allow the government to act as investor or guarantor of infrastructure projects, without affecting the public sector balance sheets, since they are considered independent. Some cases that can be pointed to in this regard are the Korean Development Bank (KDB), the National Economic Development Bank (NDB) of Brazil or the State Infrastructure Bank (SIB) in the United States.

In recent decades, monoline insurance companies have been very active in risk insurance. However, the financial crisis has had a major effect on them, with their S&P credit rating having been downgraded from "AAA" in 2007 to ratings even lower than those they insure[10].

All these institutions can interact, insuring specific risks, especially sovereign type risks, given their international nature and scope.

c) Risk mitigation instruments.

In this case we are referring to the different guarantee plans mainly aimed at covering credit risk and political risks.

[10] Current rating of the main monoline insurance companies: Financial Guaranty Insurance "CC"; Ambac Assurance Corp. "BBB", MBIA Insurance Corp. "BB" (Bloomberg).

- *Credit guarantees*
  - Partial Credit Guarantees (PCG) cover the risk of default on the debt service of a credit or bond independently of the reason behind the nonpayment. The purpose of this instrument is to improve the conditions for accessing government financial or investment projects that could initially have a bad credit rating. This instrument can also cover the return of the principle on investments without recourse. Most international and national financial institutions have this risk mitigation tool.
  - Full Credit Guarantees (FCG) or Wrap Guarantees cover the total amount of the debt service in case of default. This product is usually used by bond issuers to achieve higher credit ratings. Monoline insurance companies have been very active using this product, providing their triple A credit rating as the main guarantee. Due to the financial crisis and the downgrading of these companies' credit rating, some projects have also had their credit rating downgraded. This is also a product provided by international financial institutions.
- *Political risk guarantees*

To cover sovereign risks such as currency inconvertibility, expropriations, war or local disturbances, or modifications in contractual provisions, there are two similar mechanisms for risk mitigation.

- The multilateral development banks and some local institutions can provide Political Risk Guarantees (PRG). These cover 100% of the contracted debt and only cover the political risks specified in the contract. These instruments have been used in insuring concessioned infrastructure investments and Project Finance for default risks on commitments acquired by the government.
- Private insurers have a product similar to the previous instrument known as Political Risk Insurance (PRI). This, however, usually does not cover 100% of the investment and is also limited to the specific contingencies established in the contract.

The latest trend in risk mitigation is undertaking specific financial innovations, designing a specific mechanism for each project. In general, they combine several risk mitigation products, with several participants that share a percentage of the risk (see Tables 6 and 7).

In the case of the "Rutas del Pacífico" concession in Chile, the IDB offered a partial credit guarantee (GCP) together with another presented by a monoline insurance company to comprise a full credit guarantee (FCG). This allowed the infrastructure project to achieve the maximum rating, with access to the best financial conditions.

In the case of the IIRSA Northern Amazon Hub in Peru, the IDB guaranteed the state’s commitments in the payment of services to the concession through a partial credit guarantee and political risk insurance with one condition. In the event that the Peruvian Government could not meet the obligations incurred and the IDB had to compensate the company holding the concession, this compensation would become a loan from the IDB to the Peruvian Government.

USAID backed 50% of the principal on some bonds issued by a pool of municipal governments belonging to the Tamil Nadu's Municipal Urban Fund. This grouping facilitated the application of the risk mitigation instrument.

Meanwhile, there are private capital providers (venture capital, etc) that can assume the risks associated with the development of the project and its construction, but that do not wish to assume any type of sovereign risk. In a natural gas infrastructure project in South Africa and Mozambique, a company assumed all the commercial risks but refused to accept Mozambique’s political risks, over which it had no control. These risks were insured through World Bank political risk guarantees (PRG) and political risk insurance (PRI) with the MIGA, where they, in turn, were reinsured with private insurers.

TABLE 6: Risk Mitigation in Different Projects Around the World

Project	Country	Sector	Project Cost	Type of RMI	RMI Provider	RMI Beneficiary	Amount of RMI	Closing Date
Privatization of Banat and Dobrogea Power Distribution Companies	Romania	Energy (distribution)	Private US$142.6 million	Political risk guarantees (PRG)	IBRD	L/G bank (bill given as security)	US$76.7 million	2005
Joint Kenya-Uganda Railway Concession	Kenya, Uganda	Transportation (rail)	US$400 million	Political risk guarantees (PRG)	IDA	Rift Valley Railways Consortium (concessionaire)	US$45 million for Kenya US$10 million for Uganda	2006
Phu My 2.2 BOT Power Project	Vietnam	Energy (generation)	US$480 million (financing requirements including contingencies)	Political risk guarantees (PRG)	IDA, ADB (private insurance companies)	Lender	US$ 100 million	2002
West African Gas Pipeline Project (WAGP)	Benin, Ghana, Nigeria, Togo	Energy (gas pipelines)	US$590 million	Political risk guarantees (PRG), Political risk insurance (PRI)	IDA, MIGA, Zurich/OPIC	WAPCo (equity investments; shareholder debt)	US$250 million	2005
Southern Africa Regional Gas Project	Mozambique and South Africa	Energy (Natural gas pipelines and development)	US$572 million (debt)	Political risk guarantees (PRG), Political risk insurance (PRI)	IBRD (enclave), MIGA (SACE/EFIC), ECIC	Lender	US$ 0.23 bn (local currency)	2004

Source: Matsukawa y Habeck (2007)

TABLE 7: Risk Mitigation in Different Projects around the World

Project	Country	Sector	RMI Type	RMI Provider	RMI Beneficiary	RMI Coverage	Lender	Debt	Maturity	Capital Repayment	Interest Payments	Rating	Closing Date
Philippines Power Sector Assets and Liabilities Management Corporation (PSALM)	Philippines	Energy	Partial credit guarantee (PCG)	Asian Development Bank (ADB)	Debt (bond investments)	Capital at the end of the maturity date	PSALM	JPY 61.75 bn (class A: JPY 24.75bn; class B JPY 37 bn)	Class A: 18 years maturity. 2010 Class B: 20 years maturity 2022	Without Recourse (Bullet)	Clase A: 3.20% semi-annual Clase B: 3.55% semi-annual	Baa1 (Moody's)	2002
Philippine Power Trust I (Napocor – Nacional Power Corporation)	Philippines	Energy	Political risk guarantee (PRG)	Overseas Private Investment Corporation (OPIC)	Debt (bond investments)	Complete capital and interests	PP Trust I (core lender is Napocor)	US$250 million	15 years maturity in 2018	Average life of 10 years (4.5-year interest only period)	5.4%	AAA (S&P)	2003
Tlalnepantla Municipal Water Conservation Project	Mexico	Water	Partial credit guarantee (PCG)	Internacional Finance Corporation (IFC), Dexia Crédito Local	Debt (bond investments)	90% of the capital and interest pending; up to US$8.2bn	Trustee (return of revenue to the Municipality of Tlanepantla/Cía de Agua	US$9.1 million	10 years extendible for one year	Equal semi-annual payments beginning the first year	UDIS+5.5%; semi-annual	AAA (local) S&P, Moody's	2003
City of Johannesburg	South Africa	Multi-Inf.	Partial credit guarantee (PCG) (local currency)	IFC, Development Bank of Southern Africa (DBSA)	Debt (bond investments)	40% of the capital and capital interest pending	City of Johannesburg	US$153 million	12 years	6 equal semi-annual payments for the next 3 years	11.9% semi-annual	AA (zaf) Fitch (local)	2004
AES Tietê	Brazil	Energy (gtion.)	Political risk guarantee (PRG) and FX liquidity	OPIC	AES Tietê	Up to US$85 million for PRI and US$30 million for liquidity facilities	AES Tietê Certificates Grandor Trust	US$ 300 million	15 years; average life of 10.11 years	N/A	11.5% annual	Baa3 (Moody's); BBB (Fitch IBCA)	2001
Tamil Nadu Pooled Financing for Water and Sanitation	India	Water and health services	Partial credit guarantee (PCG) (local currency)	Tamil Nadu government, USAID	Debt (bond investments)	50% of the principal and interest pending; up to US$3.2 million	Water and financial group of health – 13 small and medium size municipalities	US$64 million	15 years	Equal annual payments beginning year one	9.2% annual	AA (local) Fitch	2002

Source: Matsukawa y Habeck (2007)

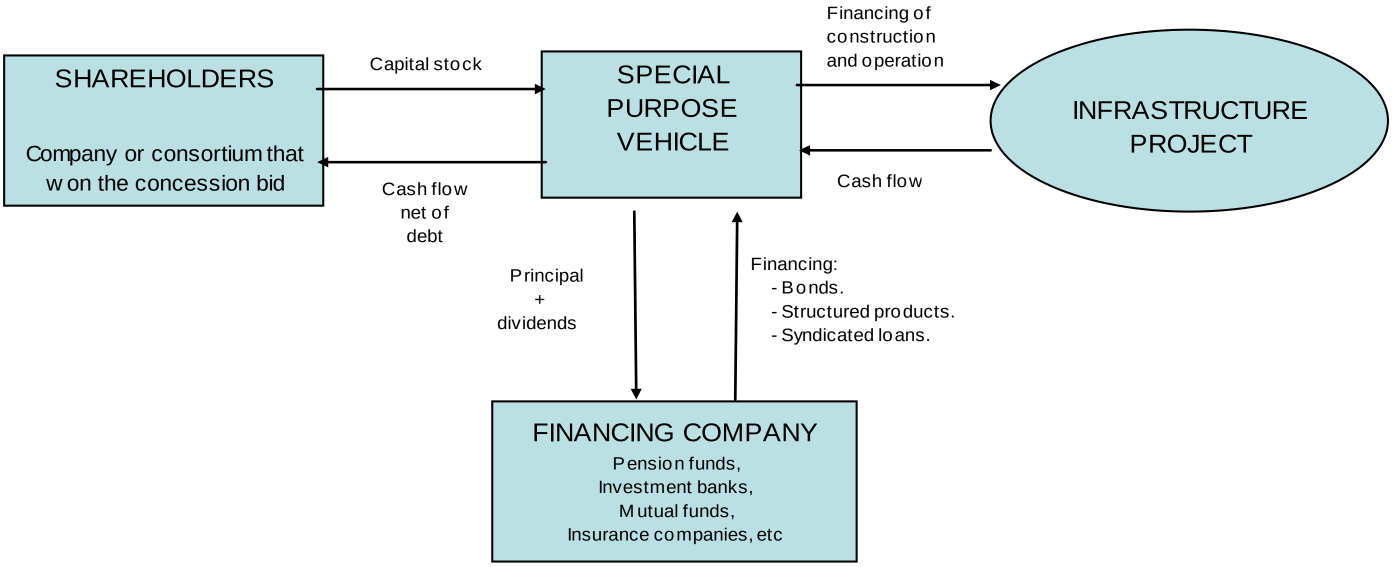
4.4. Project Finance operation

A common characteristic of infrastructure projects is the need for strong financial resources that should be available in the short term in order to cover construction costs. At the same time, returns should be perceived as accruing in the medium-long term. This temporary lag in time between spending and revenue leads companies holding concessions to look to the capital markets to obtain these resources, assuming with it important risks and high leverage.

As an alternative formula a relatively short time ago the Project Finance model emerged. It consists of an investor, or group of investors, contributing the necessary funds for infrastructure construction with the only guarantee being the corresponding cash flow generated by the project.

In Graph 4 we can see how a Project Finance plan functions.

GRAPH 4: Project Finance plan Functioning



Source: ERD BBVA

The company awarded a concession for the construction and operation of a project constitutes a special purpose vehicle (SPV) (of which it will be the main shareholder) for purposes of operating the infrastructure. This SPV has its own legal status, usually as an incorporated entity, and its capital stock is paid by the company awarded the bid. If the concession model used is Build-Operate-Transfer (BOT), which is the most common, the SPV is owner of the rights to operate the infrastructure associated with the concession. The SPV builds and exploits the infrastructure project with its own resources provided by the shareholders, but above all, with the resources furnished by the financial backers of the project. The latter are usually constituted of pension funds, insurance companies, investment banks and funds.

A basic characteristic of these plans is that the financing of the SPV by a third party does not have guarantees from the shareholders promoting the project. Only in some cases where the risk is very high, creditors can demand additional guarantees, although these are usually limited.

Based on the asset selected for the financing and contractual agreements that determine the amortization of the principle and the return, the financial backers will receive their payments from the cash flow generated by the operation of the infrastructure. The shareholders of the SPV will receive their dividend once the principle and the pending debt service have been discounted.

From the promoter's (shareholder) point of view, this formula presents advantages and disadvantages:

Among the advantages are:

- The capacity to safeguard the assets of the company, since they are not the guarantee for financing the project.
- Redistribution of the risks to other financial entities.
- Allowance for a greater borrowing capacity or greater availability of resources by limiting the contributions that they can make to the project.

Among the disadvantages that can be mentioned are:

- It complicates structuring the project by requiring additional studies and a complicated contractual structure with the infrastructure's financial backers.
- The financing cost are higher because the contracts contain "limited liability" clauses.

For the financial backers, the key variable of the entire model is the project's cash flow, since it usually does not have another guarantee. This is precisely what presents greater uncertainty in terms of its estimate. This is why investors should have a group of specialists such as engineers, legal, environmental, and financial advisors to evaluate the project as a whole.

The uncertainty in estimating demand for the use of the infrastructure projects can lead the financial backers to perceive an excessive risk in Project Finance investments. It can also be the case that they agree to finance the project, but that given the high perceived risk, demand very high interest to the extent that this formula is no longer interesting for the infrastructure promoter.

To alleviate these problems there are two formulas that lessen risk. Either the state guarantees a minimum cash flow, given the possible public interest in the construction of such infrastructure, or an insurance policy is contracted with a monoline insurance company that guarantees a final cost for the work project and/or a certain level of cash flow. In both cases, the rating agencies would minimally assign the same risk level that the government and the insurance company have respectively. If this rating is high and the cash flow is insured, the investors will agree to contribute their resources at a much more competitive price.

4.5. The public-private partnership (PPP) model

It is difficult to define what the public-private partnership (PPP) model is due to the immense variety of possible types and degrees of cooperation between the two sectors at the present time. The OECD (2008) offers five different definitions from five different institutions. In the spirit of bringing together most of the characteristics of these descriptions, we could say that public-private partnerships are agreements between the public sector and a private promoter for the construction of a specific infrastructure project, where its development is agreed to upon the part of the promoter in exchange for a return and for assuming a certain risk in the investment.

There are several reasons that can lead governments to promote PPP projects:

- There are a series of infrastructure projects that can have a very positive socio-economic effect for each country. However, these are projects that are known with a high degree of certainty to be financially unprofitable. These projects will never be bid upon by the private sector alone.
- At the same time, there exists the possibility that the public sector might not have the necessary resources to undertake new infrastructure projects, and/or might not have experience in operating them, and the government may therefore decide to transfer this expense and part of the risk to a private promoter. There is no international consensus on how the financial commitments agreed upon with the private promoter should be assessed. Taking advantage of this situation, different countries exclude these commitments from the public accounts to improve their balance sheets.

- One of the arguments in defense of the PPPs is that there is the assumption that private management of the projects will improve their efficiency and reduce the costs of the infrastructure projects. According to the IMF (2004), this assumption might not be completely true in all cases. It seems that for this relation to exist it is necessary for risk to be transferred from the public to the private sector, so that the latter has incentives to optimize its operation. In these circumstances, the public sector can have an interest in undertaking a PPP project with a private promoter. At the same time, according to the established profitability/risk conditions of the previously mentioned projects, this type of infrastructure project can be an interesting business for private investors.

In a global macroeconomic scenario involving the quest for budgetary stability in the short and long term, at the beginning of the 1990s the PPP formula began to have great success on an international level. Following the pioneer projects undertaken in Australia and the United Kingdom, numerous countries (developed and developing) have begun to promote projects of this type throughout the length and breadth of the globe. The cases of France, Germany, South Korea, Ireland, Italy, etc. should be pointed to, but also those of other countries such as Mexico and Chile in Latin America (OECD, 2008 p. 12). According to AECOM (2005), between 1984 and 2004 worldwide some 2,096 PPP projects were undertaken with a value of US$884,000 million, with the transportation sector having sparked the greatest interest among investors (37% of the total value).

The definition of PPPs has many similarities with the projects concessioned in bidding processes and does not allow a clear line of demarcation to be placed between them, as can be deduced from the previous point. In the OECD (2008) broad arguments have been offered in favor of PPP projects and traditional acquisitions of public goods and services on the one hand, and the system of concessions on the other. In this sense, it could be concluded that the main difference between a PPP project and a concession is the degree of risk that is transferred from the public to the private sector, which is greater in the case of the concessions than with the PPP. Table 8 illustrates the possible formulas that have been used in different countries to carry out PPP projects and their characteristics.

TABLE 8: Types of Possible PPP Projects

	The private promoter designs, constructs, and manages the new infrastructure projects	The private promoter buys or rents, improves already undertaken infrastructure projects	The private sector is owner of the infrastructure	The private sector transfers the infrastructure at the end of the concession period
Build-own-operate (BOO)	YES	NO	YES	NO
Build-develop-operate (BDO)	YES	NO	YES	NO
Design-construct-manage-finance (DCMF)	YES	NO	YES	NO
Buy-build-operate (BBO)	NO	YES	YES	NO
Lease-develop-operate (LDO)	NO	YES	NO	NO
WRAP-around addition (WAA)	NO	YES	YES	NO
Build-operate-transfer (BOT)	YES	NO	NO	NO
Build-own-operate-transfer (BOOT)	YES	NO	YES	YES
Build-rent-own-transfer (BROT)	YES	NO	NO	YES
Build-lease-operate-transfer (BLOT)	YES	NO	NO	YES
Build-transfer- operate (BTO)	YES	NO	NO	NO

Source: IMF (2004) and ERD BBVA

As can be seen in the comparison, many of these models have common characteristics with concession bidding, making it difficult to distinguish between the two. Again, it will be the risk assumed by the promoter that defines whether it is a PPP or a concession. These types of risks are comparable to those that a concession would assume, and have been explained in point 4.2.

5. Participation of pension funds in infrastructure project financing

Pension funds, as with other private investors, could feel that investing in infrastructure projects is a good option to maximize the value of their asset portfolio. However, this option should be considered as one investment possibility among many others. Only if the ideal conditions exist, with which pension fund investment in infrastructure would be mutually beneficial, both for the state as well as for the fund, would pension fund managers as well as governments accept this type of collaboration agreement. If these conditions do not exist and the pension funds were to be invested in infrastructure projects without the necessary and sufficient risk and profitability conditions, the resources of thousands of future pensioners could be put in jeopardy.

At the same time, defining what an investment in infrastructure is can be a complex task due to the numerous elements that enter into play. From our point of view, it is important to adopt criteria to address the way in which the investment is undertaken. Concretely, we would differentiate between what an indirect investment is as opposed to a direct investment:

- Indirect investment: in the financial market, pension funds acquire fixed income or equity assets of companies tied to the construction or management of infrastructure projects. In this case, there is no guarantee that this financing will directly translate into the promotion of new projects. However, in numerous publications, investment in infrastructure projects is considered since the main activity of these companies is the construction and management of already existing facilities. Indirect investments provide the asset portfolio with some particular characteristics of volatility and profitability that are specific to this sector.

Meanwhile, the acquired assets can belong to listed or unlisted companies.

With regard to the listed companies, the successive economic and market crises at the beginning of the 1990s had an important effect on pension funds, reducing their value and, therefore, also the benefits received by those who retired at that moment. Since then, pension funds, especially in Latin America, have sought new assets that would provide alternative sources of revenue and which would help diversify their asset portfolio in order to control financial market volatility risk. In this sense, they began to focus on the possibility of directly investing in infrastructure projects.

With regard to unlisted companies, the valuation of their assets is much more complicated and thus the participation of the rating agencies is necessary.

- Direct investment: The financial agents participate in financing specific projects that have been concessioned to promoter companies. Through a Project Finance or a Public-Private Partnership model, the pension funds acquire assets linked to the return provided by a specific infrastructure, which can more or less be insured by the state, a monoline insurance company or international financial institutions.

In turn, direct investment can adopt two different modalities. According to Inderst (2009) the phase of the project in which pension funds begin to participate is crucial in determining the risks and profitability that can be expected by the funds. If the pension fund associates with the concessionaire in the planning and bidding stage, the risk perceived by the pension fund will be higher (basically, construction and subsequently demand risk) and therefore the expected profitability will necessarily be greater. In this case, we would consider a primary direct investment and the law of concessions and the prior project study would be shown to be a key factor in determining the profitability and even viability of the project. Meanwhile, pension funds are considered participating in secondary direct investment projects when they incorporate the financing of the project in which the infrastructure is already built and so they mainly face demand risk.

5.1 The advantages of pension fund participation in the financing of infrastructure projects

If the conditions that are necessary and sufficient for pension funds to invest in infrastructure projects exist, numerous positive effects could result for the revaluation and security of the managed funds. This model has been successful in numerous countries around the world.

- Given the long term nature of the investment projects, and through (public or private) mechanisms for insuring appropriate revenue levels, the assets invested in infrastructure projects allow for good long-term portfolio planning (Inderst, 2009).
- It is expected that the participation of pension funds in infrastructure investment projects reduces political and regulatory risk. Greater discipline should be expected on the part of the governments with regard to the contracts and the rules of the game if resources are involved that will finance the pensions of local workers (Vives, 2000).
- The financing of a long term, correctly designed investment project normally provides a good risk/benefit ratio.
- The participation of pension funds in local investment projects eliminates some financial risks such as the fluctuation of the exchange rate. Also, many contracts include review clauses for increases in inflation.
- At the same time, public opinion can be more favorable to the participation of private pension funds if they sees that the investments in infrastructure projects generate improvements to society’s quality of life here and now (e.g. investment in

electric power facilities, management of drinking and waste water and water for irrigation, transportation networks, etc.), at the same time that it improves the portfolio's risk and profitability profile.

5.2. The advantages for the state from the PFMs' contribution in investment projects

The participation of pension funds in financing infrastructure projects generates the same advantages for the state that funding from any other private party would.

- It helps the fiscal consolidation of the public budget, facilitating resources for other social expenditure items or by reducing the fiscal pressures of the respective country.
- It improves the allocation of resources, transferring the cost from the infrastructure projects to the user or beneficiary.
- If the national budget were not able to execute the project due to cyclical problems, private sector participation could offset the opportunity cost.
- Greater probability of improvements in quality at a lower cost than with public resource allocations, given the greater transparency of the incentives for the interested parties.

Additionally, the social nature of pension funds offers an added advantage. The potential benefits of private management of infrastructure projects, with the financial support of pension funds, translate into improvements in the well-being of the population itself by increasing the living standards of retirees.

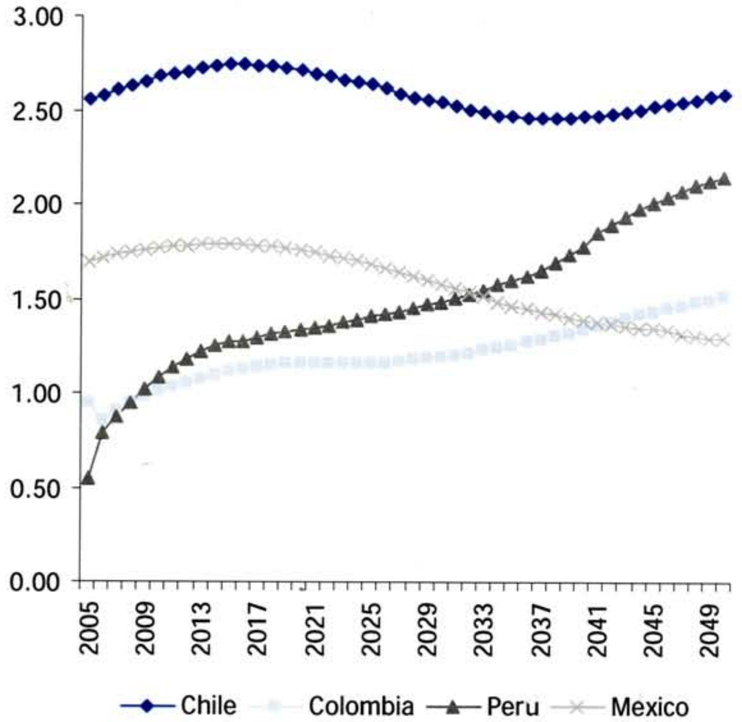
6. An estimate of pension fund contributions to economic growth through investment in infrastructure

According to what we have reviewed thus far, it appears that there are arguments that well designed PPPs provide mutual benefits to both the public and private sectors.

The recent reform of the pension systems in several Latin American countries, specifically those undertaken in Chile, Colombia, Mexico, and Peru, which establish either a single capitalization pillar or one shared with another based on distribution, will increase the stream of savings significantly, to the point that they will reach very significant levels. In the case of Chile, which was a pioneer in these reforms decades previously, this phenomenon is already more than clear.

This stream of domestic financial savings should be invested in assets that meet some conditions of profitability/risk that are appropriate to the purposes for which they were created. In this sense, direct investment in infrastructure projects by private pension companies can be a very valid option if the necessary and sufficient conditions are present. With this in mind, factors such as regulations, risk coverage, assets, and adequate financial markets are elements that need to be optimized so that these conditions are met. At the same time, each of these countries would benefit from these investments that would improve their level of development.

GRAPH 5: Annual fee payments to pension funds (as % of GDP)



Source: Favre et al (2006), Muñoz et al (2009), Albo et al (2007), Bernal et al ((2008)

In this sense, Graph 5 illustrates the projections on the fees paid into the private pension systems of Chile, Colombia, Mexico and Peru as a percentage of GDP. These fee payments have been calculated in very detailed actuarial models for each of the countries[11]. Of particular importance are the current figures for Peru and Chile, which will reach 2.15% and 2.56% respectively within approximately forty years. Meanwhile, the percentages of fee payments made in Colombia will grow until 2050, finally reaching 1.52% thanks to the maturation of the system, demographic trends and the evolution of the labor market. In the case of Mexico, the indicator will be around 1.5% on average. The investment of a higher percentage of these resources in new infrastructure assets, instead of being undertaken in other assets with different characteristics, could lead to higher living standards in the country thanks to the positive effects that infrastructure has on growth and development. Therefore, in this chapter we will seek to measure to what extent the Latin American countries can improve their living standards in case the necessary and sufficient conditions were to occur for pension funds to increase their investments in infrastructure projects.

Concretely, we will conduct an experiment in which we will calculate the difference in the evolution of the per capita GDP of Chile, Colombia, Mexico and Peru, based on the assumption that they will earmark the same percentage of pension fund fee payments to invest in infrastructure as is currently the case, compared to the alternative hypothesis that presupposes an increase in this percentage until reaching an adequate and feasible level in accordance with the current legislation.

We will measure this effect based on an augmented neoclassical growth model, in which GDP depends on the accumulation of the traditional factors plus the introduction of the infrastructure capital stock, which partially depends on pension fund contributions.

In order for there to be consistency between the fees paid into the pension systems and the projection model, all the macroeconomic assumptions specified in the projection models of the pension systems whose methodologies appear in the studies conducted by BBVA between 2006 and 2009[12] have been adopted.[8] These have been calibrated to the same date in order to recover the same results in terms of potential GDP growth rate calculated for these countries in the medium term by a recent study of the BBVA Economic Studies Department (2009).

However, a limitation exists that the currently available model cannot resolve. It is not possible to measure the effect on the fees of those affiliated with the PFMs of a situation in which part of their funds might be invested in infrastructure projects, and therefore, could

[12] For the projections of the pension systems of Chile, Colombia, Mexico, and Peru see Favre et al (2006), Muñoz et al (2009), Albo et al (2007), Bernal et al (2008), respectively.

improve labor productivity and boost wages. Consequently, additional increases in pension fund fees should occur. This virtuous circle would add greater benefits to the economy of the countries than the model used in this research can process.

Table 9 shows the percentages of fee payments to pension funds for each country with earmarks for infrastructure investment in the inertial and higher scenario.

Table 9: Scenarios of PFM investment in infrastructure (% of the fund portfolio)

	Hypothesis: Inertial scenario	Hypothesis: Higher scenario
Colombia	0%	20%
Chile	1.8%	18.8%
Mexico	1%	10,7%
Peru	3%	20%

Source: Economic Research Department (ERD) own data and SSE (2009)

In the case of Colombia, in Alonso *et al* (2009) it is indicated that at the present time there are no direct investments in infrastructure projects. For the higher hypothesis we consider as a working assumption the possibility that such pension fund investments could reach a level that is in the range allowed by current regulations given Colombia's great investment potential and we feel that 20% could be a possible and desirable percentage.

In the Chilean case, the inertial scenario shows the current situation of direct investment in infrastructure projects by the PFMs. The higher scenario (18.8%) results from its own estimate based on the investment possibilities in the country.

For Mexico, in the inertial scenario we use the zero value, since to date there is no direct investment on the part of the Pension Fund Managers (Afores). The superior scenario assumes that in the future an investment level equivalent to the maximum allowed by the law will be reached (see Alonso *et al*, 2009).

The hypothesis of the Peruvian inertial scenario (3%) involves its own estimates based on information from the Superintendence of Banking and Insurance regulatory agency on current direct investment in infrastructure. The higher hypothesis assumes a reasonable percentage and one that is within the maximum limit of investment in this type of asset.

It should be emphasized that the experiment that we conducted involves a partial investment reallocation using fees already paid into pension funds to finance new infrastructure projects, and does not use additional resources. Therefore, any gain in living standards achieved is not the result of more funds being earmarked for investment in general, but the optimization of already existing resources.

6.1. Growth accounting in Colombia, Chile, Mexico and Peru

As was commented in point 3, there are several factors in the economy that have been identified as contributing to long-term GDP growth. Growth accounting seeks to identify the extent to which each factor contributes to the increase in a country's output. Jan Tinbergen's seminal work (1942), and the later writings of Fabricant (1954) and Abramovitz (1956) emphasized the importance of total factor productivity (TFP) as the key element that contribute to growth in total labor productivity. It was Solow (1957), however, who clarified this understanding of growth accounting using the current nomenclature with the Cobb-Douglas function based on equation 3.1.

The GDP of year t (Y_t) can be explained by the capital accumulation $(K_t)$of the same period, the labor force (L_t) and the so-called Solow residual (A_t), also known as total factor productivity (TFP). This function presents constant returns to scale for the accumulable factors as a whole $(\alpha + \beta = 1)$ and the diminishing factors for each of them$(\alpha < 1, 1 - \beta < 1)$.

This model provides a long-term outlook that is certainly disturbing. The law of diminishing returns of the accumulable factors poses a future without growth. Therefore, the only way to grow in the long term depends on an increase in the Solow residual[13] (A). This factor is known as this because it encompasses all the non-measurable elements that positively affect growth, the most important of them being technological change.

To the extent that less developed countries are farther from the stationary state, the contributions to growth from the capital and labor factors will be more positive. In this sense, papers such as Barro (1999), Easterly (2001), Easterly and Levine (2001) among others, quantified the contributions to increases in GDP for different countries and periods

[13] Or what is the same, of the TFP.

with growth accounting models. In the case of Latin America, the work of Santella (1998), Faal (2005), and Corbo and Schmidt-Hebbel (2003) should be highlighted.

As has already been commented, Ashahuer (1989a, 1098b, 1989c) broke down the accumulation of the fixed capital stock into two different categories: the infrastructure project stock G_t, and its corresponding elasticity χ, and the rest of the accumulated physical capital (K_t). Again, constant returns to scale were posted for the series of factors $(\alpha + \beta + \chi = 1)$ in accordance with equation 3.2.

Establishing the dynamics of accumulation of A_t, K_t, L_t y G_t, and estimating the participation values of each of the factors in GDP $(\alpha + \beta + \chi = 1)$, it is possible to project the future production of each country, and therefore their economic growth.

Table 10 illustrates the participation of each of the factors in GDP. As we commented in previous paragraphs, the data for the assumptions adopted are taken from the macroeconomic scenarios of the projection models for the pension systems of Chile, Colombia, Mexico and Peru. In the hypotheses contained in these models on the participation of physical capital in GDP, the part corresponding to the elasticity of infrastructure project capital has been subtracted, always fulfilling the hypothesis of constant returns to scale for the accumulable factors as a whole $(\alpha + \beta + \chi = 1)$ (see Table 10).

Table 10: Percentage share of each productive factor in GDP (1961-2002)

	Elasticity of the capital accumulation (α)	Elasticity of the labor factor (β)	Elasticity of infrastructure projects (χ) (e)	TOTAL 100%
Chile (a)	31.55%	55%	13.45%	100%
Colombia (b)	28.55%	58%	13.45%	100%
Mexico (c)	26.55%	60%	13.45%	100%
Peru (d)	37.55%	49%	13.45%	100%

Source:

(a) Favre et al (2006) and ERD.

(b) Muñoz et al (2009) and ERD.

(c) Albo et al (2007) and ERD.

(d) Bernal et al (2008) and ERD.

(e) see appendix B.

The elasticity of the infrastructure projects has been calculated in appendix B by means of a meta-analysis exercise. This component is vital for our experiment given that it is the parameter that allows for linking investment in infrastructure projects (and therefore the different contributions that the PFM can make) to the growth of GDP. In total we have consulted 70 studies that relate infrastructure projects with growth. Of these, we have selected 13 that have sufficient model information. The selected studies offer 130 alternative models, those of which we have used in the goal-analysis exercise (see appendix B).

In addition, for our purposes, we will establish a slight variant of the Ashahuer model. As was commented, according to the neoclassical growth theory, the Solow residual or TFP is intimately associated with technological progress. Therefore, the theory of endogenous growth has based an important part of its foundation on trying to explain how and why TFP has or has not grown. Different factors such as R&D, the improvement in efficiency through learning by doing, the externalities of investment, etc. possibly explain the technical progress. However, the empirical evidence that underpins endogenous growth is limited due to the restrictions on the availability of sufficient and quality data. In the different growth accounting exercises this leads the cumulative dynamic of the Solow residual (A_t) to grow exogenously at a rate that is rationally justified for each economy. In our case, we have tried to uncover the effect that investment in infrastructure would have on the improvement in total factor productivity (TFP), a relation already commented on by Ashahuer in his studies.

Thus, investment in infrastructure projects would have an effect on growth through two main mechanisms:

- The accumulation of one more productive input: (G_t).
- Through an improvement in the efficiency of all the existing productive factors: $A_t=f(c,G_t)$

The following points will offer an estimation of the dynamics of accumulation of the productive factors of the growth accounting model (equation 3.2), estimating the different parameters and necessary indicators and the progression of TFP.

6.2. Measurement and projection of infrastructure projects in Latin America

a. Projection of the capital stock (K_t)

To undertake the projection of the capital stock of infrastructure projects, we will use the permanent inventory methodology, which is standard for this type of exercise:

$$K_t = sY_{t-1} + (1-\partial)K_{t-1} \qquad (6.1)$$

In which K_t is the physical capital stock of year t, where (s) is the percentage of GDP earmarked for public and private investment in infrastructure projects, Y_{t-1} is the GDP of year t-1. Therefore, the year's gross investment of physical capital would be determined by (sY_{t-1}). By the same token, (∂) is the annual depreciation rate of the capital stock and K_{t-1} is the capital stock of the previous year (see Kamps, 2006).

The assumptions on the value of the parameters that the equation (6.4) uses can be seen in table 11. The capital depreciation rate is taken from the macroeconomic scenarios of the pension system projection models of each country. The savings rate for investment in physical capital (without infrastructure) is taken from the ECLAC (2007), from which the part corresponding to the savings rate in infrastructure investment has been deducted as we will see in the following point. Finally, the physical capital stock of the initial year has been calculated in appendix A and has been subtracted from the capital stock in infrastructure projects calculated further on.

Table 11: Hypothesis on capital accumulation			
	Depreciation (∂)	Savings Rate (s)	K_{2005} (in billions of 2005 dollars)
Chile (a)	5.3%	19.9%	306 (f)
Colombia (b)	5%	12.3%	309
Mexico (c)	10%	19.2%	2300
Peru (d)	4%	18.1%	115
Source: (a) Favre et al (2006) and ERD. (b) Own Estimate. (c) Albo et al (2007) and ERD. (d) Bernal et al (2008) and ERD. (e) ECLAC (2007) (f) Banco de Chile and ERD			

b. Projection of the capital stock of infrastructure projects

The dynamics of capital stock accumulation in infrastructure also adopts the permanent inventory model.

$$G_t = sY_{t-1} + AP_t + (1-\partial)G_{t-1} \qquad (6.2)$$

In which G_t is the capital stock in infrastructure of year t, (s) is the percentage of GDP earmarked for public and private investment (without pension funds) in infrastructure, Y_{t-1} is the GDP of year t-1 and AP_t is the contributions from pension funds slated for new infrastructure projects. Therefore, gross capital investment in infrastructure projects would correspond to current gross public and private investment plus PFM funds earmarked for investment in infrastructure (AP_t). This latter parameter is key in our experiment since the possible values that they can adopt (according to the inertial and higher hypotheses shown in Table 9), will determine growth in GDP due to greater investment in infrastructure projects on the part of the PFMs. In addition, (∂) is the annual rate of depreciation of the capital stock and G_{t-1} is the capital stock of the previous year.

Table 12: Hypothesis on capital accumulation in infrastructure projects			
	Depreciation (∂) (b)	Public and private savings rate (without pensions) (s) (a)	G2005 (in billions of 2005 dollars) (b)
Chile	3%	2.5%	70
Colombia	3%	2.5%	73.1
Mexico	3%	3.3%	310
Peru	3%	1.8%	16.4
Source: (a) ECLAC (2007) and ERD. (c) ERD own estimate.			

Table 12 illustrates the values associated with different parameters comprising the function of the accumulated infrastructure projects stock.

The corresponding depreciation has been established at 3% in all the countries under the assumption of a lineal 30-year amortization. The savings rate corresponding to investment in each country fluctuates between 1.8% in Peru and 3.3% in Mexico.

The value of the infrastructure projects stock in the 2005 base year has been calculated in appendix A.

c. Projection of the labor force

The labor force considered in the projections is the same as the one used in the pension system projection models for Chile, Colombia, Mexico and Peru. Each model adopts a series of differentiated hypothesis, in accordance with the countries' inherent reality and the data available.

For Chile's case in Favre *et al* (2006), the corrected labor force (FTC_t) is calculated as follows:

$$FTC_t = FT_t * (1-Un_t) * H_t * E_t \qquad (6.3)$$

Where FT_t is the labor force (in thousands of persons), Un_t is the natural unemployment rate, H_t is an index of the average hours worked and E_t is an index of the educational level of the labor force, structured based on the information on the average number of school years of the labor force..

In Colombia's case, following Muñoz *et al* (2009) based on the CELADE population projections, the distribution of the economically active population (EAP) has been done by age range provided by the CELADE and has been projected to reach an average growth rate of 2%, which is the result of various hypotheses regarding the processes of urbanization and the incorporation of women in the labour market. Unemployment is made to converge from 7.42% to 5.5% in the medium term. Employment results as the difference between the EAP and the unemployment level.

Following Albo *et al* (2007), Mexico's demographic projection, used as the basis for calculating the number of employed persons is based on estimates made by the National Population Council (CONAPO for its Spanish acronym). For projecting the economically-active population (EAP) through 2050, data from the CONAPO projection to date was used, and the data of the intermediate years were linearly inserted. The open unemployment rate (OUR) will go from 3.64% in 2005 to 3.7% in 2050, although this is based on a broader rise in the number of formal workers. The number of employed workers is calculated as the difference between the EAP and the number of unemployed persons.

For the Peruvian case and following Bernal *et al* (2008), the demographic projections through 2050 have been taken from the National Institute of Statistics and Information Technology (INEI for its Spanish acronym), together with the CELADE. The assumptions adopted for the labor market assumed a drop in informal employment from the current 60% to 45% in 2035. The unemployment rate will decrease from 6.2% to 5% in the long term.

d. The projection of total factor productivity

As we set forth in the previous chapters, total factor productivity (TFP) shows the technological/efficiency level of a country. The endogenous growth theory has attempted to explain its growth through diverse factors such as the I+D, the positive externalities of investment, among others. Ashahuer (1989a, 1098b, 1989c) proposed infrastructure as a type of capital investment that improved the efficiency of all the productive factors.

In the case of Latin-American countries (as with many others), there is not sufficient information to contrast the relevant factors in the explanation of the growth of TFP. In the epigraph, by structuring an index of its own infrastructure (see

APPENDIX A), it is possible to estimate the contribution of infrastructure to TFP growth.

In our model, the dependent variable is the growth rate of the Total Factor Productivity (TFP), which we calculated using data from the BBVA Research Department.

The explanatory variables are the following:

- Growth rate of the infrastructure stock. The infrastructure stock is estimated in Appendix A.
- Growth in middle school attendance as a proxy of the human capital stock. Source: World Bank.
- The per capita GDP logarithm as a proxy of the level of development. Source: World Bank.
- The TFP growth rate lagged one period.
- A dummy variable for each period to account for time-fixed effects.

For the estimattion we used a dynamic panel, following the Arellano and Bond (1991) methodology, given the strong correlation between the growth rate of the TFP and its lagged value. This methodology allows us to correct the endogeneity problems that the latter correlation generates, by using the lagged values of the endogenous variables as instruments.

For all the variables, the statistical information of 12 countries is available, which contains observations from 1980 up to 2001. In Table 13, we can observe the estimation results:

Table 13: Regression results of the TFP explanatory model

Dynamic Panel Data Estimation, Arellano-Bond			
Number of obs = 145			
Number of Groups = 12			
Wald chi2(29) = 9883.86			
	Coefficient	Robust Error Est.	P>z
TFP(-1)	0.8269***	0.0245	0.000
INFRASTRUCTURE GROWTH	0.0139***	0.0047	0.003
MIDDLE SCHOOL GROWTH	0.0003	0.0023	0.882
LN(PCGDP)	-0.0297***	0.0045	0.000
INTERCEPT	0.0003***	0.0000	0.000

***, ** and * denote significance at a 1% , 5% and 10% levels respectively-

According to our results[14] the TFP growth rate depends positively on the infrastructure stock growth rate. The estimated coefficient means that if the infrastructure stock increases by 1%, the TFP growth rate rises 0.014%. Considering that we are saying that 1% is a relatively small percentage increase for infrastructure stock, the results found on total factor productivity are not irrelevant.

Based on the traditional specification in growth accounting in which TFP grows at an exogenous growth rate (tcptf), we describe the following equation:

$$PTF_t = PTF_{t-1}(1+tcptf) \qquad (6.4)$$

According to the model estimates, we will make the *tcptf* variable from an exogenous growth rate *(tce)* from the non-explained part of the model plus the explanatory component of the rise in the infrastructure stoc*k*. (*tcGt)*:

$$tcptf = tce + (0{,}014\% \times tcG_t) \qquad (6.5)$$

Substituting (6.5) in (6.4), we have the TFP accumulation rule in our model.

$$PTF_t = PTF_{t-1}(1 + tce + (0.014\% * tcG_t)) \qquad (6.6)$$

Where the TFP depends on the TFP of the previous period, t-1 multiplied by the growth rate that is exogenous (*tce*) and calibrated for each country according to long-term assumptions of the model, and the growth rate by the infrastructure growth rate $(0{,}014\% * tcG_t)$, the parameter being (0.014%), the elasticity of TFP growth compared to the growth rate of the infrastructure stock calculated per equation 6.2.

In Table 14, the values of the parameters adopted in (6.6) can be observed. The TFP exogenous growth rate (tce) has been calibrated to recover under all the previous assumptions of the model and using the GDP growth rate estimated by SEE (2009). These growth rates appear in the last column of Table 14.

14 These results should be taken with a certain caution since available information only allows a regression for 12 countries, which is not a very broad sample from the standpoint of the asymptotic properties of the model.

Table 14: Hypothesis on the accumulation of Infrastructure capital				
	Tce *(2005-2020)* (b)	*tcG* (annual average 2005-2050) (b)		Growth rate of annual average GDP. (2005-2020) (inertial version) (a)
		Inertial version	Superior version	
Chile	1.9%	2.51%	2.9%	4.42%
Colombia	2.1%	2.9%	3.2%	4.2%
Mexico	0%	3.45%	3.57%	2.78%
Peru	1.8%	4.8%	5.2%	5.45%

Source:
(a) ERD (2009).
(b) Our estimate.

Of note is the value observed by Mexico where the *tce (exogenous growth rate)* does not grow in this period, which is the same performance as in recent decades. This would prove the urgent need to realize important reforms in order to reach superior growth rates in the long term and not lose the course of development. It is foreseeable that they will follow the rest of the Latin American countries.

In the case of Chile, Colombia and Peru up to 2020, the *tce* will decrease by 0.01 percentage points annually until it converges to a *tce* of 0%, remaining stationary in said value through 2050.

On the other hand, in reference to the growth rate of infrastructure stock, the additional contribution of the pension funds to said stock per the superior version would add between 0.2 and 0.4 annual percentage points to the growth of infrastructure stock.

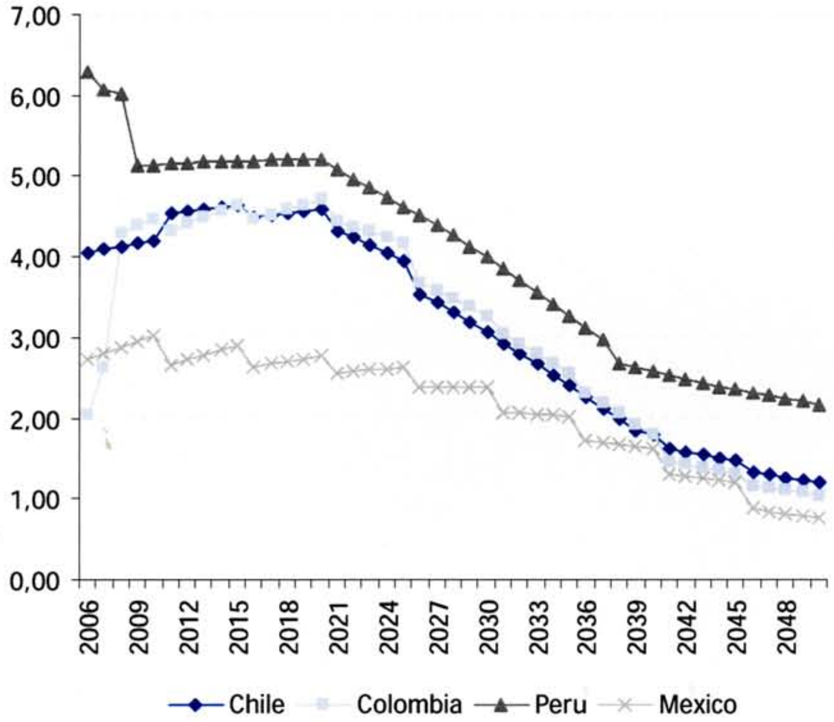
The resulting GDP growth rates of the macroeconomic assumptions, brought together in the inertial model, show the dynamics of the transition to the stationary state for Chile, Colombia, Mexico and Peru (see Graph 6).

The assumptions adopted regarding the growth rate of the total factor productivity reduce the growth possibilities for Mexico in the long term. The dynamics of transition depend exclusively on the factors of labor accumulation and savings, with which this country will advance more quickly to the stationary state.

The growth rate in Mexico could reach values in the region of 2.5% by early 2030, only to later drop to a rate near 1% by 2050.

On the other hand, the lower relative per capita GDP of Chile, Colombia and Peru and the assumptions of the rise in TFP will allow growth rates to remain relatively high in the medium and long terms, surpassing 4% by the end of 2020. The growth hypothesis of TFP and the Law of Diminishing Return will give rise to a transition toward a slower stationary state than in Mexico's case, likely obtaining a growth rate between 1% and 2% in 2050.

GRAPH 6: Per capita GDP growth rate
Inertial version (as %)



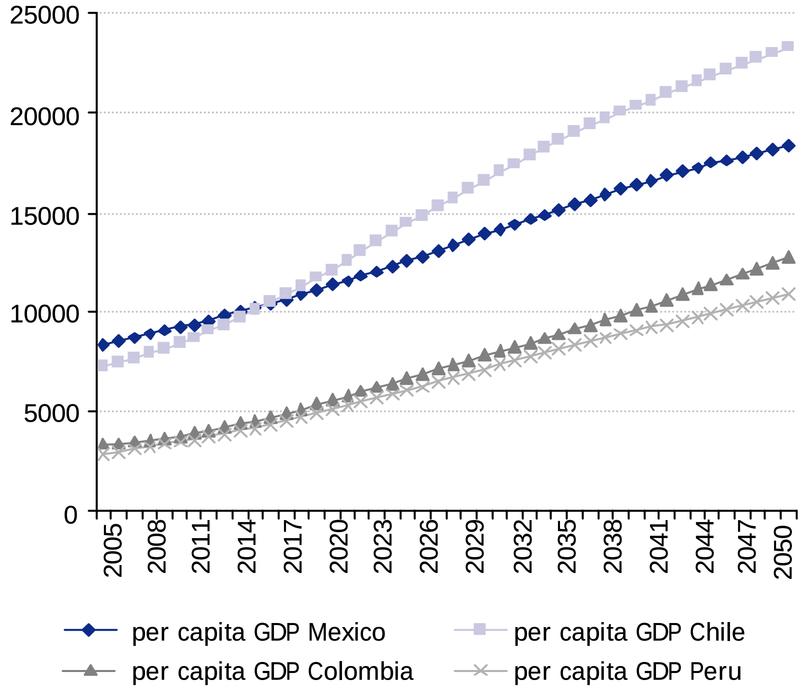
Source: ERD BBVA.

The growth rates shown in Graph 6 demonstrate the evolution of the per capita GDP of each country in Graph 6.2.

From the per capita US$8,370 that Mexico currently has, it could reach US$18,343 in 2050 in real terms.

In the Chilean case, said ratio would rise from its current US$7,245 to US$23,289 in 2050, surpassing Mexico in 2016 and reaching values similar to the current OECD average. These values show the strong dynamism in the Chilean economy and its continued "catch up" process to the more developed economies of the world.

GRAPH 6.2: The Chile per capita GDP Inertial version (in US$)



Source: ERD BBVA.

Finally, Colombia and Peru would go from US$3,378 and US$2,846 per capita GDP in 2006 to US$12,809 and US$10,897 in 2050, respectively. This scenario considers the convergence hypothesis of these less developed countries with Mexico, reaching similar levels to countries that today would be considered of medium income.

6.3. Contribution of pension funds to GDP growth.

Based on the assumptions of a possible macroeconomic evolution in Chile, Colombia, Mexico and Peru as set forth in points 6.1 and 6.2 and the result shown in the projections of Graphs 6 and 6.2, we will simulate what could happen in the economic growth of these countries if private pension funds recognize the advantages of direct infrastructure investment for their affiliates. This is the "superior" hypothesis whereby the pension industry would invest a greater percentage of its funds (as per Table 9). A higher supplementary investment in infrastructure projects by pension funds would increase the capital stock and improve Total Factor Productivity.

TABLE 15: Per capita GDP in the inertial and superior projections in constant $ and the difference in % of the two versions

	2020	2030	2040	2050
Inertial Version				
PC GDP Mexico	11344	13878	16406	18343
PC GDP Chile	12166	16606	20364	23289
PC GDPColombia	5574	7827	10119	12809
PC GDP Peru	5076	7134	9059	10897
Superior Version				
PC GDP Mexico	11430	14015	16582	18543
PC GDP Chile	12381	17053	21020	24119
PC GDPColombia	5624	7936	10302	13085
PC GDP Peru	5154	7300	9327	11290
Difference in % compared to the inertial version				
Diff in % México	0.76%	0.99%	1.07%	1.09%
Diff in % Chile	1.77%	2.69%	3.22%	3.57%
Diffin %Colombia	0.89%	1.40%	1.80%	2.16%
Diff in % Peru	1.55%	2.33%	2.96%	3.60%
Source: ERD BBVA				

In Table 15, we can observe the differences in the projection of the inertial version compared to the superior one. In 2050, per capita GDP in Mexico, according to the superior version, would be per capita GDP US$18,543 compared to the US$18,343 of the inertial version. In this case the difference is lower. If we compare Chile, the difference would increase by almost a thousand dollars per capita (US$24,119 compared with US$23,289 in the superior and inertial version). The Peruvian case is also quite notable. Compared to the per capita GDP US$10,897 that a citizen would receive in 2050 according to the inertial version, in the superior he could receive US$11,290. Finally, in Colombia the per capita GDP reaches in the middle of the century would be US$12,809 in the inertial version compared to US$13,085 in the superior version.

In percentage terms, the superior version in 2050 is 1.09%, 3.57%, 2.16% and 3.60% higher than the inertial version in Mexico, Chile, Colombia and Perú respectively. These are the differences that would be observed in only a year. If we were to try to measure the opportunity cost if pension funds did not invest all of their potentially available resources in infrastructure, we would measure all of the current income that would not be received in present value that has been discounted[15].

TABLE 16: Net value discounted from additional income of the superior version as a % of the 2005 GDP	
Chile	89.3%
Colombia	49.1%
Mexico	24.1%
Peru	103.3%
Source: ERD	

In Table 16, the cases of Peru and Chile which are in first and second place respectively are noteworthy. The opportunity cost of not investing in infrastructure could represent 103.3% of the 2005 GDP of Peru, although we should consider that the country currently has the lowest GDP and therefore could obtain the highest growth rates. The Chilean case is also important and reaches high opportunity costs due to the fact that the resources it could invest on infrastructure are significant due to the advanced state of its private pension system.

In the case of Colombia, the GDP that would not be produced could reach 49.1%, which is also a significant amount.

Finally, Mexico would observe a lower opportunity cost of 24.1%, although equally important. In this case, the effect is limited due to restrictions by law on investing a higher percentage of pension funds in infrastructure.

We should also point out that the improvements in wellbeing of these countries would only be obtained by improving the framework by which the pension funds could invest in infrastructure assets, without which it might be necessary to withdraw or substitute other types of investments or social expenditures.

15 As a discount factor, we will use a real interest rate of 4.2% corresponding to that observed as an average of the last 30 years in the U.S. 30-year bond..

7. Conclusions

The analysis of infrastructure in Latin America presents wide gaps compared to an objective situation. Various studies indicate that the situation worsened as a result of the continuous shocks to which the economies of the region were exposed, forcing different governments to make important adjustments in public investment on infrastructure. Although, in the nineties, with the privatization processes, a new model was implemented for attracting private capital to improve infrastructure, which is fundamentally external and shows enormous sensitivity in the face of crisis without fully compensating for the decreased participation of the state. The need to channel private domestic capital motivated the search for new investment plans, thereby generating a new involvement of the state from a more strategic outlook, which would allow the establishment of an association with the only objective of using private domestic capital where new concession plans are conveniently linked.

In the search for adequate capital, some Latin American countries followed the lead of some more developed economies by allowing the long-term savings concentrated in the insurance and pension companies to be invested in infrastructure. In this sense, the presence of private pension systems in Latin America was perceived by some as an opportunity to mediate enormous resources in favor of optimizing the investment portfolios of workers who save in their pension funds and, at the same time, allowing the economy as a whole to take advantage of the funds' destination so as to provide greater potential growth in the countries.

The main argument in favor of the contribution of infrastructure to economic growth is derived from the impact of a greater capital stock accumulation. Infrastructure also raises the total factor productivity by attracting more profitable private investments, expanding the markets, allowing higher returns to scale, improving merchandise production and distribution times, and facilitating conditions for a more qualified labor force to work in determined areas where they previously did not have the capacity to. In addition, there are other impacts related to the improvement in the quality of life and the distribution of income that can be obtained as a result of expanding investment in infrastructure. In brief, these benefits can be seen in the improvement of conditions in health, education and the environment that raise the levels of development.

The conditions for private pension funds to decide to invest in infrastructure shoud be based on pure market incentives that might be consolidated by decisions that would improve the efficiency of the affiliated portfolios, which implies an appropriate equilibrium between profitability and risk. This implies objectifying all the possible risks through transparent processes that would ultimately safeguard the interests of the pension fund owners, who are the workers. In this sense, the numerous studies cited in this research paper show the success of pension funds investing in infrastructure, finding evidence that it supports the optimum planning of long-term portfolios; the reduction of political and regulatory risk; the need for greater discipline by the governments regarding contracts and the rules of the game if the resources involved in financing the projects are the local workers' pensions; the elimination of some financial risks such as the exchange rate fluctuations; while at the same time finding that public opinion may be more favorable towards using private pensions if they observe that, at the present time, investment improves the quality of life of society.

Taking all of this into consideration, we have also come to the conclusion that an important element in the development of transparent and attractive plans for pension funds to invest in infrastructure is a well designed concession process. Thus, in the preparatory phase of the project, it should be decided whether the infrastructure is socio-economically necessary and whether there is a clear advantage for private sector investment. Immediately thereafter, the prequalification of the candidates and the bidding processes are crucial to the selection of the best project. The itemized study of all the possible risks is crucial, as is checking the availability of tools for mitigating risks so that the project can be undertaken with guarantees. Finally, the existence of public controls that insure a high quality of infrastructure is also necessary.

Based on the evidence obtained from other studies regarding the attractiveness for pension funds to invest in infrastructure, this study is ultimately concerned with designing a methodology that would permit the estimation of its impact on the growth of countries. To this end, an experiment is conducted by which the difference in the evolution of the per capita GDP of Chile, Colombia, Mexico and Peru are estimated under the assumptions that the governments invest in new infrastructure at the same percentage that pension funds are currently contributing, instead of the superior hypothesis that assumes the rise in said percentage up to an adequate and feasible level as per the current legislation. To this end, we used an expanded neo-classical growth model, where GDP depends on the accumulation of the traditional factors plus the introduction of infrastructure capital stock, which depends, in part, on the contributions from pension funds.

A key element in the calculation process is to determine the dependent variable which is the growth rate of Total Factor Productivity (TFP), making the explanatory variables the growth rate of infrastructure stock, which is estimated with our own index; the growth in the secondary school registration rate as a proxy for the human capital stock; the per capita GDP logarithm as proxy for the development level; the TFP growth rate lagging one period; and a fictitious variable for each period to bring together the fixed effects of time. Through the dynamic panel used, we obtain that the TFP growth rate positively depends on the growth rate of the infrastructure stock. The interpretation shows that if the infrastructure stock increases by 1%, the TFP growth rate rises 0.014%. Considering that 1% is a relatively small percentage increase for infrastructure stock, the effects found on the total factor productivity are not negligible by any means.

This variable is then incorporated in the aforementioned neo-classical model to find the impacts on growth, both in the inertial scenario (current pension funds participation conditions) and the superior scenario (with a maximum increase in which they could invest the pension funds, given the institutional frameworks of each country). The incorporation of these scenarios finds that, in 2050, Mexico's per capita GDP would be US$18,543, 1.09% higher than the inertial version, while that of Chile would be of US$ 24,119 (3.57% higher). In the case of Colombia and Peru, their respective per capita GDP would reach US$13,085 and US$11,290, respectively, which represent 2.16% and 3.6% increases from their GDPs in the inertial version.

It would seem that an annual spread of the magnitude mentioned is also not important. However, we believe that this spread would be produced every year, by which the opportunity cost of not carrying out the reforms pertinent to the investment of pension funds in infrastructure could result in a significant loss of production for the period under consideration. The results show that the opportunity cost of not investing in infrastructure could represent 103% of the 2005 GDP of Peru. The Chilean case is important as it represents notably high opportunity costs, given the funds that it could invest on infrastructure are significant due to the advanced state of its private pension system (89.3%). Colombia would observe a lower opportunity cost because of the lower volume of resources managed by the private pension funds in that country (49.1%). Finally, in the case of Mexico, the opportunity cost is lower although equally relevant. In this case, the effect is limited due to legal restrictions on pension fund investment in infrastructure which is capped at 24%.

The only thing remaining is to point out that these production earnings would be obtained without dedicating additional resources to invest in infrastructure. They would be obtained through the allocation of resources that would have been invested in other financial assets that perhaps would not exert as positive an effect on the economy. The increase in production would therefor be obtained by optimizing the pension fund portfolios, in situations where it is a viable option based on the necessary present regulations and risk control conditions, in such a way that it would be convenient and in the best interest of the affiliated workers.

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APPENDIX A

a) The measurement of the synthetic index of infrastructure stock

Based on the data provided in Canning (1998), we structured synthetic indicators of infrastructure stock summarize the information contained in various indicators. To construct these indexes, the Principal Components Analysis (PCA) is used by taking the first principal component of the analysis of the variables as an aggregate index of the infrastructure stock. Thus, the information contained in others can be consolidated as a sole indicator different sizeunits.

The first aggregate index (InfrastA) summarizes the absolute infrastructure stock and is structured based on annual data from the telecommunications sector (number of main telephone lines, from the energy sector (capacity for generating electricity in MW), from the land transportation sector (the length of the highway network in kms.), from the air transportation sector (number of passengers transported), and from the railway transportation sector (length of the railway network in kms.).

The first principal component of the PCA analysis (the absolute aggregate index) summarizes 80% of the information contained in the original variables. As is to be expected, the index is highly correlated with each one of the indicators. Succinctly, the correlation between the absolute aggregate index and air transportation is 0.953, with a capacity to generate energy of 0.989, with the length of the railway lines is 0.869, with the length of the highway network is 0.961, and with the number of telephone lines is 0.931.

The absolute synthetic index depends on the standardized variables according to the following specification:

InfrastA = 0.213 x *AirTransp* + 0.221 *x EnergyGen* + 0.200 *x Railways* + 0.215 *x Highway* + 0.208 *x Telef*

The second aggregate index (InfrastB) summarizes the information of the infrastructure stock relative to population levels or the geographic area. It is structured based on the data of the number of main telephone lines per inhabitant (Telef2), the capacity for generating electric energy in MW per inhabitant (EnergyGen2), the length of the highway network in kms. per square kilometer of area (Highway2), the number of passengers transported per inhabitant (AirTransp2) and the length of the highway network in kms. per square kilometer of railway (Railways2).

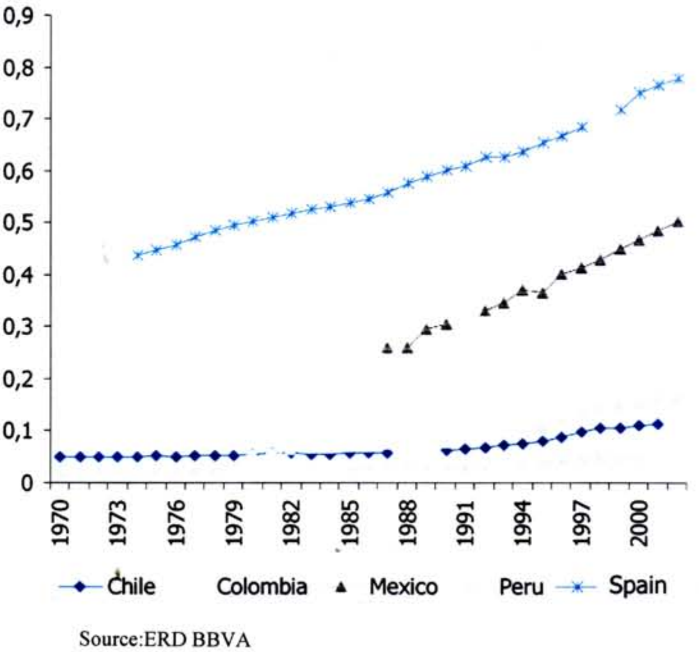
The first principal component of the PCA (the absolute aggregate index InfrastB) summarizes 60% of the total changes among the five original indicators. The correlation between the InfrastB index and that of air transportation is 0.834; with the capacity to generate energy is 0.843; with the length of railway lines is 0.606; with the length of the highway network is 0.720 and with the number of telephone lines is 0.833.

The relative synthetic index depends on the standardized variables according to the following specification:

InfrastB = 0.279 x *AirTransp* + 0.282 x *EnergyGen* + 0.203 x *Railways* + 0.241 x *Highway* + 0.279 x *TelefB*

In Graph A1, the evolution of the estimated indicators is shown for Chile, Colombia, Mexico, Peru and Spain.

GRAPH A1: Infrastructure Index in absolute values



Source:ERD BBVA

Based on this evolution and considering the relative differences of the indicators of each Latin American country compared to Spain, we can estimate both the monetary value of the past infrastructure stock and make projections going forward, given that the data for Spain is known (Mas and Cucarella, 2009).

APPENDIX B

b) Contribution of infrastructure to growth. A meta-analysis exercise

Even though there is an extense empirical literature on the existing relationship between economic growth and investment in infrastructure, the heterogeneity of the various existing studies, both at a methodological level and in terms of results, makes it difficult to choose just one study that reports a trustworthy estimate of the elasticity of the infrastructure stock in its contribution to GDP growth.

The meta-analysis is a collection of statistical methods that are used to review different results of empirical research. If there is information from different independent studies regarding one topic in particular, the meta-analysis combines the different results, using the data bases and other methods together to obtain a clearer view with greater explanatory power than the mere enumeration of individual results.

More specifically, meta-regression is a form of meta-analysis specially designed to examine empirical research in economics (Stanley and Jarrell, 1989; Jarrell and Stanley, 1990). In a meta-regression, the dependent variable is a statistic which, in turn, is an empirical result of each individual study, while the independent variables can include characteristics of the methodology, sample design and the data used in each study.

Thus, meta-regression can help to identify what particular characteristics of each study have an effect on the reported results. It can also help to find out why there is contradictory empirical or inconsistent evidence and to reconciliate the results of said evidence. In like manner, it can help to identify which common factors are shared by all the studies.

The objective of the study in our case is to identify the magnitude of the marginal effect of infrastructure on economic growth that is shared or constant through all the empirical studies that have researched the determinant factors of economic growth.

In Table B1, we can observe the main descriptive statistics of the elasticity found in the different studies. In total, we have consulted 70 works that relate infrastructure with growth. Of those works, we have selected 13 that have sufficient available information in their models. The selected works have 130 alternative models which we have used in the meta-analysis.

The simple average of infrastructure elasticity is equal to 0.1004 and the median is 0.0515. However, the standard deviation is quite large, which is to be expected, given the heterogeneity of the estimated models. We can also see that we found values from -0.62 up to 0.53. We can also see that if we weigh the number of observations in terms of each estimate, the average value increases to 0.1129.

Table B1. Descriptive Statistics of the Elasticity

Variable	Observations	Average	Median	Typical Dev.	Minimum	Maximum
Elasticity	130	0.1004	0.0515	0.1449682	-0.62	0.53
Weighted Average		0.1129				

Table B2 shows us the main characteristics of the studies that have been considered. We can observe that most of these use data from the panel and the study period. The studies included average around 30 years.

Table B2. Summary of Characteristics of the Studies

Number of study	Authors	Date of the study	Time Period	Number of observations	Number of observations	Type of data
1	Cesar Calderon and Luis Serven	September 2004	1960-2000	399	All of the countries	Panel data
2	Norman Loayza, Pablo Fajnzylber & Cesar Calderon	June 2004	1966-1999	350	Geographic area	Panel data
3	Gustavo Nombela	June 2005	1976-2002	27	Regional Study	Time Series
4	Angel de la Fuent Moreno	October 1996	1970-1986	600	Geographic area	Panel data
5	Cesar Calderon and Luis Serven	October 2002	1960-1997	101	Several countries Not-OCDE	Cross-section
6	Balazs Égert*, Tomasz Kozluk & Douglas Sutherland	March 2009	1960-2005	849	Several countries OCDE	Time Series
7	David Alan Aschauer	January 2000	1970-1990	920	Several countries Not-OCDE	Time Series
8	Lars-Hendrik Roller and Leonard Waverman	September 2001	1971-1990	396	Several countries OCDE	Panel Data

Number of study	Authors	Date of the study	Time Period	Number of observations	Number of observations	Type of data
9	Paul Evans and Georgia Karras	February 1994	1970-1986	768	Regional Study	Panel Data
10	Teresa Garcia-Mila, Therese J. McGuire and Robert H. Porter	March 1995	1970-1983	672	Regional Study	Panel Data
11	David Canning	November 1999	1960-1990	1348	Several countries Non-OECD	Panel Data
12	Cesar Calderon and Luis Serven	September 2008	1960-2005	582	Geographic area	Panel Data
13	David Alan Aschauer	September 1988	1949-1985	37	Justote country OECD	Time Series

Source: ERD BBVA

Specification and Methodology

In most meta-analysis and meta regression studies, the most important objective is to identify the effect of the different methodologies, specifications and design on the results of the statistic of interest (for example, elasticity). Our study's objective is not so much to identify these effects, but to estimate elasticity common to all the estimations found, controlling for the characteristics of each estimate that can make the estimated value differ from the elasticity between GDP and the expense on infrastructure.

It is particularly important to consider the different mathematical transformations, the definitions of the variables and the different econometric methodologies that are used in every different estimation.

Ideally, we should only use studies where the mathematical transformations of the dependent variable and the explanatory variables are the same, and in which the same explanatory (Proxy) variables were used to measure infrastructure stock. However, for the purposes of our research topic (and for almost any other topic in economics), it is almost impossible to create a sufficiently large sample of estimations that share those said characteristics. For this reason, our empirical strategy consists of controlling for the differences in the estimation of elasticity through the inclusion of dummy variables for those estimations where mathematical transformations or definitions of the Infrastructure Proxy variable differ from a defined base model.

Said base model would include the models in which the log of GDP (or its growth rate) is used as a dependent variable, and the log of the Infrastructure Stock (or its growth rate) as an explanatory variable.

More concretely, in the first analysis, the following control variables are included: The first dummy variable takes a value of one when, in the estimate, the dependent variable and the Infrastructure Proxy are defined in Ratios (Ratios {1.0}). The second dummy variable takes a value of one when the dependent variables of infrastructure have been transformed in some way or another (combination of logarithm and levels, logarithm of a ratio, etc.) (Another transformation {1.0}).

Given that, ideally, the infrastructure variable should be defined as the value of infrastructure stock, we have also included a dummy variable for models that use any other different definition (No Stock {1.0}).

Because we are interested in knowing the differences in elasticity between developed and developing countries, we have included a dummy variable for those estimates that use OECD countries or studies of individual developed countries (OECD or individual country {1.0}).

In addition, we included dummy variables for the different types (groups) of methodologies used in the different studies.

In each analysis, the value that interests us is the constant or intercept of the Meta-Regression, since we can associate this value with a "constant" or common value to all the empirical estimations, once the effect of the different methodologies or samples have been discounted.

The methodology used is Weighted Least Squares, with the weighting factor being the number of observations used in each estimate. As proof of robustness, we also used Ordinary Least Squares with Robust Standard Errors.

In the third and fourth analyses, we estimate elasticity without considering the geographic factors, that is, not including the OECD variable or the individual country dummy.

Table B3. Meta-Regression Results

	Number of Obs. = 130	Number of Obs. = 130	Number of Obs. = 130	Number of Obs. = 130
	F(11, 118) = 31.96	F(11, 118) = 32.47	F(10, 119) = 31.59	F(10, 119) = 32.3
	Prob > F = 0	Prob > F = 0	Prob > F = 0	Prob > F = 0
	R-square = 0.3989	R-square = 0.4734	R-square = 0.3803	R-square = 0.4581
	Root MSE = 0.10331	Root MSE = 0.11	Root MSE = 0.10446	Root MSE = 0.1111
Dependent Variable: Elasticity				
	Weighted (1)	Robust (1)	Weighted (2)	Robust (2)
CONSTANT	0.1092**	0.0723*	0.1345***	0.0963***
	(0.024)	(0.068)	(0.002)	(0.006)
Ratios {1,0}	-0.0456	-0.0185	-0.0221	-0.0138
	(0.245)	(0.713)	(0.592)	(0.785)
Other Transformation {1,0}	-0.1063***	-0.0976***	-0.0791***	-0.0715***
	(0.001)	(0.001)	(0.002)	(0.000)
No Stock {1,0}	-0.0017	0.0106	-0.0242	-0.0009
	(0.969)	(0.735)	(0.531)	(0.977)
Time Series {1,0}	0.2318***	0.2299***	0.2043***	0.2092***
	(0.000)	(0.000)	(0.000)	(0.000)
Cross-Section {1,0}	0.0019	0.0184	-0.0146	-0.0104
	(0.980)	(0.753)	(0.838)	(0.854)
OECD or Individual Country {1,0}	0.0491	0.0470		
	(0.161)	(0.133)		
Methodology 1 {1,0}	-0.0575	-0.0500*	-0.0382	-0.0267
	(0.271)	(0.097)	(0.405)	(0.294)
Methodology 2 {1,0}	-0.1226***	-0.0930**	-0.0763**	-0.0596**
	(0.008)	(0.015)	(0.023)	(0.042)
Methodology 4 {1,0}	-0.0181	-0.0017	-0.0227	-0.0113
	(0.571)	(0.967)	(0.433)	(0.762)
Methodology 5 {1,0}	-0.0310	-0.0130	-0.0119	-0.0046
	(0.270)	(0.201)	(0.585)	(0.564)
Methodology 6 {1,0}	-0.0432	-0.0252**	-0.0241	-0.0168**
	(0.125)	(0.015)	(0.269)	(0.039)

Results of the Meta-Regression.

In the three analyses, the intercept or constant of the Meta-Regression, which is the elasticity value we wish to estimate, is positive, significant and varies between 0.0723 and 0.1345.

It is important to note that the estimated elasticity (the constant or intercept) is higher in the cases in which we used a weighted MC. In theory, when we use this methodology, more weight is given to studies with better information (higher quality) which is why these estimates would be the most trustworthy.

It can also be observed that if we omit the geographic factor, the elasticity found is greater in both cases (Weighted MCO and Robust MCO). Given that the geographic variable is insignificant, our preferred estimate would be the Weighted Least Squres (2) (Third column).

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