PUBLIC INVESTMENT OR PUBLIC-PRIVATE PARTNERSHIP?

A DECISION RULE BASED ON INDIFERENCE CURVE OF PUBLIC INEFICENCY AND PRIVATE RISK PREMIUM

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1. INTRODUCTION

Public-private partnerships (PPPs) are contracts that private sector offers infrastructure assets and services that is traditionally been provided by government. PPPs can be attractive for both government and private sector. For the government, private financing can provide expansion of the infrastructure without immediately pressure on tax burden or debt. Similarly, better management of the private sector, as its ability to innovate, can lead to increase efficiency, improving quality and costs of services.

PPPs appeared in the end of the 90s, period that privatizations were losing space compared on its previous time. The goal of PPP was getting private capital and expertise to manage investments in infrastructure where privatization had failed to act or had obstacles.

Currently, many countries of Organization for Economic Co-operation and Development (OECD) have a consolidated program of public-private partnerships. England is one of the most advanced countries related to PPP programs. PPP programs represent 14% of total public investment and have showed positive results[1]. However, according to IMF (2004), it is still early to establish conclusions of the benefits of this program, especially in emerging countries.

There is no consensus regarding the definition of PPP between countries, this program has two important characteristics: (i) provision of a service and investment by private partner and (ii) transference of risks from government to private sector.

According to Borges and Neves (2005), PPP idea must be compared to a leasing operation, where government rents (contracts) a service provided by private sector, even if the partner has to construct infra-structure[2] before operating. The private partner must be remunerated only if the service is given as satisfactory. Assets should be reversible to concessor power at the end of the contractual period. This model is called “built, operate and transfer” (BOT).

PPP accounting is an important aspect to be considered by the government. According to Sadka (2006), it is possible that the idea of the PPPs has been "invented" out of a desire to circumvent regular budgetary procedures. The accounting registration of a traditional public investment is made on the infrastructure construction time. Differently, PPPs expenditures is calculated and registered along

[1] Independent studies mentioned in IMF (2004).
[2] If necessary.

the time of the contract, as a "rent" of good or service. By this reason, government assumes payment obligations for future taxpayers.

It is necessary transparency on future commitments assumed by each part, either in relation to public sector future payments as on risks shared by private and public partner. Moreover, government should verify the fiscal impacts of these commitments on the sustainability of public accounts. Contracts of PPPs are potential contingent liabilities that can provoke fiscal and credibility instability to the government fiscal policy.

FMI (2004) mentions that PPP contracts involve a range of different risks. These can be usefully divided into five categories (somewhat overlapping): (i) construction risk, which is related to design problems, building cost overruns, and project delays; (ii) financial risk, which is related to variability in interest rates, exchange rates, and other factors affecting the financing costs; (iii) performance risk, which is related to the availability of an asset, continuity and quality of service provision; (iv) demand risk, which is related to the ongoing need of services; (v) residual risk, which is related to the future market price of an asset.

These risks are present on public, private and public-private investments. One of the objectives of the PPPs is to transfer part of these risks from government to private sector [Borges and Neves (2005)]. Even applying private capital and changing administrative responsibility of infrastructure cause benefits by themselves, risk transference is necessary for the full exploitation of these changes, and to develop a correct incentives structure to private partner. The private sector must consider risks taken to make decisions. Decision is expected to be more efficient if risks are considerated.

On the moment that government analyzes which method should be applied for financing investment (traditional public contracts or PPP), it should analyze the value for money (VFM) of the procurement. VFM is defined by Borges and Neves (2005) as the quantification of the difference between construction and management of an asset by State or private partner, considering risks, benefits and costs. In accordance to Department of Finance and Administration of the Australian Government (2007), value for money can be revealed as: (i) the delivery of a service or capability at a lower cost; (ii) greater certainty of the financial outcome due to less exposure to significant risks; (iii) increased benefits to the end-users of a service due to the public sector's focus on service delivery rather than asset procurement.

The government and private partner typically adopt different methods for pricing market risk. Government tends to use the risk free interest rate to discount future cash flows when appraising projects, while private bidders, for PPP projects, will include a risk premium in the discount rate to future project earnings. As a consequence, according to FMI (2004), the choice between public investment and PPP may be biased in favor of public investment.

However, the argument of the private sector higher efficiency (lower cost) for provision of goods and services (or construction and management of an asset) can be used to justify the option of PPP, even if this option is financial costly. This article has the objective to analyze the relation between private sector demanded risk premium and the "supposed" inefficiency degree of the public sector on infrastructure provision. It is calculated the indifference curve of private risk premium and public sector inefficiency. The objective of this curve is to develop a tool to be considered on the decision for infrastructure provision between public investment and PPP.

This work has six sections. In section two, it is presented legal and institutional aspects of the PPP in Brazil. Third section treats about the theory and references about the estimation of the public inefficiency and the trade-off between the public inefficiency and private risk premium. The financial model that calculates the indifference curve of private risk premium and public sector inefficiency are presented in section four. Section five simulates indifference curve considering different scenarios. Finally, the last section presents the main results and conclusions of this article.

2. PUBLIC-PRIVATE PARTNERSHIP REGULATION IN BRAZIL

In Brazil, the regulation for PPP contracts of Federal Government is established in Law 11,079/2004. This law is a complement of Law 8,987/95 that treats about contracts of common public concession (financially sustainable). Contracts of PPP must take at least 5 years and minimum value of R$ 20 millions (or US$ 11.8 millions). It can not have as a unique objective: (i) contract labor, (ii) equipment supply or installation, or (iii) just a construction of an infra-structure.

According to that Law, PPP contracts are classified in two categories: "sponsored concessions" and "administrative concessions". Sponsored concessions are contracts which private partner can charge users for utilization of goods or services. Government participates on the contract sponsoring financially the project

to make it economically viable (Example: roads). Administrative concessions are those cases when the State is direct or indirect user of the concession and is responsible exclusively for the flow of payments to the private partner (Example: penitentiaries).

PPP agreements require private partner to create Special Purpose Vehicle (SPV) [3]. SPV is responsible for the service established on the contract. Government cannot participate of that society. SPV must follow corporative governance standards and adopt standardized and transparency accounting principals. One of the advantages of SPV creation requirement is the idea of funding diversify. In accordance to Borges and Neves (2005), there are similar characteristics of "project finance" and PPP financial design which involves agents able to develop sophisticated financial structures for attainment of established goals. Common elements of these structures are: (i) securitization of future receipts flow on market negotiated bonds; (ii) focus in infrastructure concession rules and; (iii) techniques of risk dilution and mitigation.

Federal Decree 5,385/2005 regulates the PPP Management Committee (CGP)[4]. The Committee is responsible for: (i) definition of priorities services to be managed by PPP regime; (ii) discipline procedures and issues of PPP contracts; (iii) authorization of procurement process and approve its results and; (IV) appreciation of balances and reports of PPP contracts under execution. The CGP is formed by a member of the Ministry of Planning, Budget and Management (MPOG), Ministry of Finance and Presidential Staff Office. MPOG is responsible to evaluate the merit of the project. Treasury Department has the duty to analyze government expenses on PPP contracts and its limit of 1% of Net Current Revenues[5] (RCL)[6].

In 2005, it was created Government Public-Private Partnership Trust Fund[7] (FGP). The objective is to guarantee the private sector of public financial commitments. If government becomes default on its payments, private partner can request PPP Trust Fund its financial receipts rights. Initially, Federal Government funded R$ 6 billions composed by Vale do Rio Doce, Eletrobras and Banco do Brasil bonds on stock market. The Fund is managed by Banco do Brasil, an independent

[3] In Portuguese, Sociedade de Propósito Específico (SPE).
[4] In Portuguese, Comitê Gestor das PPPs (CGP).
[5] In portuguese, Receita Corrente Líquida (RCL) which is the total receipts less transferences to States and Municpals Governments.
[6] Art. 22 of 11.079/2004 Law.

state owned firm. It is expected that FGP reduces the financial risk of government default of its payment obligations and, as a consequence, the financial cost to the project[8].

Law 11.079/ 2004 establishes limits for Federal Government to contract PPP project. Federal Government is only allowed to contract PPP if the sum of the annual government financial obligations of contracts (payments) is inferior to 1% of the Net Current Revenues (RCL) for the next projected ten years. The objective of this restriction is to guarantee fiscal responsibility of public accounts. PPP contracts can compromise future resources and be transformed into contingent liabilities.

Art. 28 of PPP Law expand this limit to States and Municipals. In this case, Federal Government suspend grant of guarantees for debt assumption or voluntary financial transferences for those government levels if the expenditure limit is not respected. It is important to notice that PPP Law doesn't prohibit States and Municipals to exceed the limit; the Law just penalizes (financially) them. States and Municipals must inform previously Senate and National Treasury the allowance of the Law before contract PPP project.

The transparency of obligations and risks assumed by government[9] had been regulated by Act n. 614/2006 of the National Treasury. Art. 7 establishes that public bodies must register on its sheets the estimated values of assumed risks guaranteed to private partner. Accounting registration methodology must reflect present value of all the obligations of public partner contained on contract. Moreover, the risks assumed by public partner must be registered as a debt for fiscal issues.

Generally, PPP Brazilian legislation is in accordance with international principles on the subject. On fiscal responsibility matter, Brazil has gone forward, establishing limits to contract (assume expenditures of) PPPs. PPPs are a way to expand the public expenditures on the time, it is important the establish limits for public expenditures commitments to guarantee fiscal sustainability on long run.

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[7] Fundo Garantidor das Parcerias Público-Privadas (FGP).
[8] CAPM method would price the reduction of the financial risk involved on PPP Project.
[9] Mentioned by Sadka (2006) and FMI (2004)

3. INDIFERENCE CURVE OF PUBLIC INEFICENCY AND PRIVATE RISK PREMIUM

Most part of the studies that treats about public expenditures efficiency uses non-parametric methods, where a set of inputs (costs or goods and services) is compared to outputs (performance indices). In accordance to Alfonso (2007), the economic efficiency can be divided in: technical efficiency and alocative efficiency.

Technical efficiency is defined when a unit of decision (country, governmental agency, company, etc) is able to get a maximum output for a fixed set of inputs, or it will be able to minimize production inputs, for a fixed level of output. The most common methodology for this purpose is the DEA Model (Data Envelopment Analysis). Allocative efficiency reflects the capacity of a unit of decision to use several inputs in the best proportionality to produce determined output.

Customarily, works that apply the DEA methodology to measure efficiency formulate a comparative analysis of decision units. Alfonso, Schucknecht and Tanzi (2006) calculate the efficiency of 24 developing countries. The input variable is governmental expenditures on: current expenses, transferences, payment of interests, investment and education and health expenses. As an output to represent public sector efficiency, it was defined the following variables: (i) administrative (corruption, bureaucracy, informality of the economy and efficiency of the judiciary), (ii) educational (quality of the mathematics and sciences), (iii) health (infantile mortality and life expectancy), (IV) distributive (Gini coefficient), (v) economic stability (inflation and stability of the economic growth) e (vi) economic performance (unemployment and growth of the GDP).

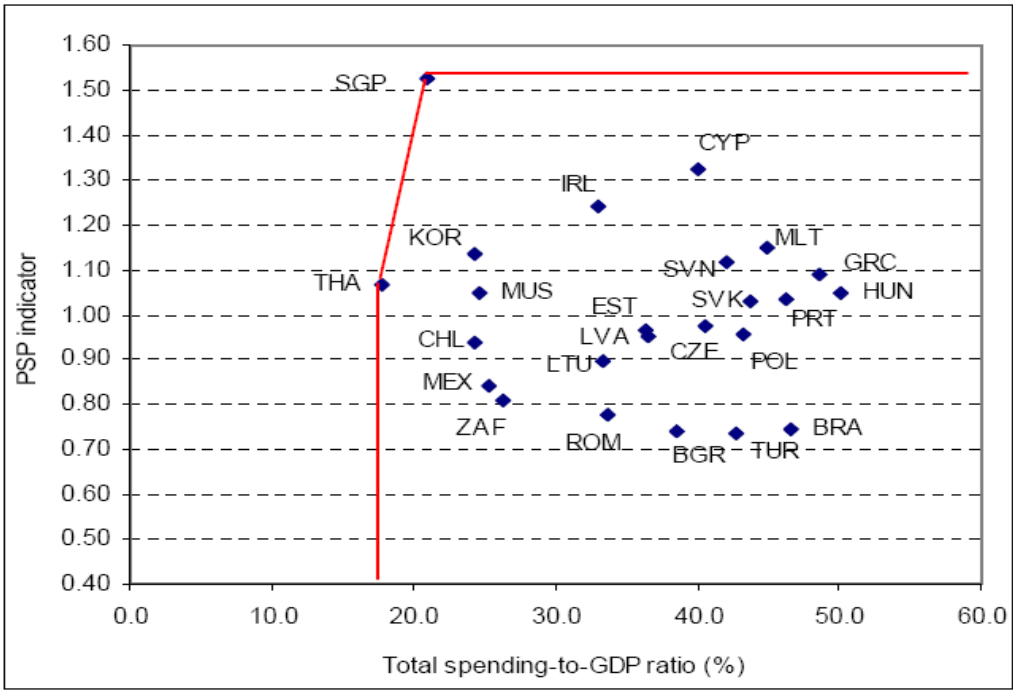
Considering limitations of DEA methodology and the choice of those specific variables as an output, the article suggests that Brazil is one of the most inefficient countries in the sample. In Figure 1, the vertical distance between Brazil (0,75) and the border of efficiency (1,53) shows how the public sector efficiency indicator could be improved for a fixed expenditure quantity (efficiency in terms of output). The efficiency in terms of input is determined by horizontal distance between total level of expenditure of Brazil (46.6% the GDP) and the border (17,8%). These results indicate that, if Brazil were the most efficient country of the sample, it could spend

17.8% of GDP and achieve the same output indicator of public sector. So, Brazil has an inefficiency "indirect cost" of 162% for public expenditures.

Figure 1 presents the results of this work. The table with notes and the ranking of the most (in) efficient countries is on Appendices 1.

Figure 1

Production Possibility Frontier (2001 – 2003)



Source: Afonso, Schucknecht e Tanzi (2006)

Boueri (2007) analyses Brazilian cities efficiency for the provision of the public services: school registrations (education), hospitals procedures (health) and garbage collection (urbanization). The constant returns of scale DEA model indicates a wastefulness of 70.4% of the public expenditures. Considering non-constant returns of scale model, the inefficient result is 47.4% of financial resources.

Ribeiro and Rodrigueses Júnior (2007) make an extension of the Alfonso, Schucknecht and Tanzi (2006) model and apply to 21 countries of Latin America. The results were similar. Brazil is the second worst country in efficiency ranking of public expense (0,613), losing only to Colombia (0,505). The results indicate that Brazil could save 40% of its resources without modifying the results of its indicators.

In relation to public versus private inefficiency comparative analysis, Fourie and Burger (2000) mention that differences between government and private sector

efficiency are difficult to analyze empirically (econometrics). In some cases, "products" of the government are not quantified. Moreover, the objectives of the public sector can be not only the "product" (efficiency), but also social and politics (equity) matters.

Despite this fact, most part of authors identifies private sector as more efficient than the public sector for the resources management. FMI (2004) suggests, as general rule, that the private property is preferable to public when the prices of competitive market can be achieved. In such circumstances, private sector is guided by the market competition to sell products on the price that consumers desire to pay and by the stock market disciplines the profits amount.

There are some markets failures as public goods that justify the government property. However, it is important to mention that if government level of inefficiency is significant high, market imperfection can be simply substitute by failures of government [FMI (2004)]. These arguments can justify the use of PPPs as a combination of government force with the private provision. The PPP does not solve market failures, but it minimizes the government failure risk.

Fourie and Burger (2000) explain that the main argument for the government inefficiency for goods and services provision is the structure of incentives of the "bureaucrat". The motivations of the government officers are not only their obligations of the work, but their political objective as status or power maximization. The behavior of "bureaucrat" leads to a wrong allocation of the resources. There is a tendency to supply public goods above their necessary quantity [Brown and Jackson (1990)].

Corry (1997) describes the benefits of private sector management for public investments, as in case of PPPs. First, the private sector has gains of efficiency due its greater flexibility, better administration and an incentives oriented behavior. Moreover, there is a better quality supply of services at the same price. Thus, focus in productivity and results; private sector has discretionary to identify excellent allocations, reducing costs of services for users.

However, in relation to costs of financing investments, private sector has disadvantage compared to public sector. According to Sadka (2006), private sector typically acquires loans with higher interests than government. By this reason, the private sector applies a higher discounting rate of cashes flows, causing a negative impact for the attractiveness of the investment project. A project can present a

positive net effect to government and negative to private sector. This fact will probably cause the rejection for private provision of public goods and services.

A way to solve this problem is the government assumes that private partner adopts different method of pricing risk on the moment of projects evaluation. Government tends to use the risk free interests rate to discount future cash flows of the project. Private partner will use a risk premium on its discount rate. Thus, on PPP contracts that government assumes public payments for financial viability of the project, the cost of the private partner risk premium impacts positively public financial obligations (cost) or user's price of services.

By this reason, there is a trade-off between: (i) public sector inefficiency[10] for directly implementation of investment projects, defined as an "overpayment" of infrastructure and; (ii) In case of PPP project, financial costs of project by risk premium requested by private partner that will be financed by the government obligations or by user's price of services.

The proposed model has objective to quantify the inefficiency assumed for the public sector for a given risk premium demanded by private partner (financial cost) or, in other words, calculate the indifference curve between risk premium and public inefficiency. The objective of this curve is to subsidy government with an instrument that is able to indicate the best structure of funding: traditional public investment or PPP, considering a given inefficiency and risk premium.

4. FINANCIAL MODEL

Assume that implementation of a public infrastructure demands two phases: (a) construction and (b) maintenance (or management). Moreover, there are three forms of infrastructure implementation: (i) Simple Concession, (ii) Direct Public Administration or (iii) Public-Private Partnerships.

(i) Simple Concession: contracts which public sector authorizes private initiative to manage the infrastructure, charging users for the offered service. An important characteristic of concessions is the financial viability of the project. The simple concession is a financial auto-sustainable project. Its future financial flow of user's tariff receipts pays investments and operational costs of the infrastructure deducted by a discount rate.

[10] Or private sector eficiency.

(ii) Direct Public Investment: financial structure in which government is responsible to finance the necessary investments of the project and manage the maintenance of the infrastructure. Usually, government doesn't tariff users for the offered services at infrastructure.

(iii) Public-Private Partnership: it is a "sponsored concession" where private initiative is responsible for investments and maintenance of the infrastructure. Users are charged for the offered services. However, the project is not financially auto-sustainable. It is necessary public transfers to assure the financial viability of the project.

For a determined investment project, it is assumed that[11]: (i) government decided to charge users for the infrastructure service, (ii) project is not financial auto-sustainable and (iii) government requests private sector to become responsible for maintenance of infrastructure. Consequently, there are two possibilities for the government:

Option I: Contract PPP including construction (private sector) and maintenance (management) of the infrastructure (private sector).

Option II: Divide implementation of infrastructure in two stages: (i) construction by direct public investment (public sector) and maintenance by simple concession contract (private sector).

Moreover, assume for implementation of the project that:

(i) The construction of the infrastructure takes only a year (year zero).

(ii) Services receipts (user's tariff) and operational expenditures are equal and will happen after year zero ($T \geq 1$). As consequence, in case of PPP contract, the financial amount of public transfers must be equal to the budget of construction infrastructure to assure the financial viability of the project, net present value = 0 (NPV) .

(iii) There is no construction risk.

(iv) If Option I, government will make its transfers by linear yearly payments during the contract, based on the service of infrastructure maintenance ($T \geq 1$). The transferred value will be enough to assure project's NPV equal zero. Private sector will demand a "risk premium" for the government.

[11] The reason for these assumptions is to find an indifference situation between two options of project implementation.

(v) If Option II, by the fact the government is inefficient, there will be an "overpayment" (cost) for infrastructure construction.

Option I has advantage of better efficiency of private sector for infrastructure construction. However, private initiative will demand a higher discount rate on NPV calculus to price risk premium (π). The risk premium will be financed by public transfers (government higher financial cost).

Option II has advantage of a lower financial cost for the government. In that case, the government opportunity cost of public resources is the risk free interest rate of the economy. However, it is assumed that construction of infrastructure directly by government will be inefficient, generating an overpayment (costs) for the government.

4.1 OPTION I: CONSTRUTION AND MAINTENANCE BY PPP

Considering assumptions (i) and (ii), the financial analysis of option I without public transfers is:

$$NPV_{T=0} = -I$$

$$NPV_{T\geq 1} = 0$$

Thus,

$$NPV_{Total} = -I$$

Private Initiative must require for government the financial viability of the project, NPV=0. Thus, government has to make its annual linear payment to private sector to assure viability. According to assumption (iv), government will transfer in t periods after the construction of the infrastructure ($T \geq 1$). Each government payment must be equal to:

$$I = \sum_{T=1}^{n} \frac{P_G}{(1+i+\pi)^T}$$

$$\therefore P_G = I\left[\sum_{t=1}^{n} \frac{1}{(1+i+\pi)^T}\right]^{-1} \quad (1)$$

Where: *I* = Total investment.

P_G = Government annual payment (transfer).

i = Free risk interest rate

π = Risk premium required by private sector.

Equation (1) presents a geometric progression with finite terms. The result of its sum is:

$$P_G = I \cdot \left\{ \frac{\frac{1}{(1+i+\pi)} \cdot \left[\left(\frac{1}{(1+i+\pi)} \right)^n - 1 \right]}{\frac{1}{(1+i+\pi)} - 1} \right\}^{-1}$$

After some algebra operations, each government annual payment is expressed as:

$$P_G = I \cdot \left(\frac{(1+i+\pi)^n \cdot (i+\pi)}{(1+i+\pi)^n - 1} \right) \tag{2}$$

The NPV total cost of government at the project is calculated by adding all transfers considering government risk free interest rate as a discount rate:

$$G_{PPP} = -\sum_{T=1}^{n} \frac{P_G}{(1+i)^T} \tag{3}$$

Equation (3) presents also geometric progression with finite terms. The result of its sum is:

$$G_{PPP} = -P_G \cdot \left\{ \frac{\frac{1}{(1+i)} \left[\left(\frac{1}{(1+i)} \right)^n - 1 \right]}{\frac{1}{(1+i)} - 1} \right\}$$

After algebra operations, the result is:

$$G_{PPP} = -P_G \cdot \left(\frac{(1+i)^n - 1}{(1+i)^n \cdot i} \right) \tag{4}$$

Substituting (2) in (4), we find the total expenditure of the government in net present value with PPP option:

$$G_{PPP} = -I \cdot \left(\frac{(1+i+\pi)^n \cdot (i+\pi)}{(1+i+\pi)^n - 1} \right) \cdot \left(\frac{(1+i)^n - 1}{(1+i)^n \cdot i} \right) \tag{5}$$

4.2 OPTION II: CONSTRUTION BY PUBLIC DIRECT INVESTIMENT AND MAINTENANCE BY SIMPLE CONCESSION

In Option II, the government finances the necessary investments for construction of infrastructure and, after that, bids the infrastructure management for the private sector as a simple concession. As operational receipts and costs are equal in $T \geq 1$[12] [assumption (ii)], government will not have any cost on the simple concession contract for maintenance. However, government is responsible for infrastructure construction. It is assumed that the government is inefficient [assumption (v)]. Thus, project will have an extra expenditure (overpayment) of $\phi\%$ for its execution.

The financial analysis of Option II is given by:

$$NPV_{T=0} = -(1+\phi)\cdot I$$

$$NPV_{T\geq 1} = 0$$

Thus,

$$NPV_{Total} = -(1+\phi)\cdot I$$

Where: *I* = Total investment.

ϕ = Government ineficiency, extra cost (%).

Thus, the total governmental expenditure in case of option II in NPV is:

$$G_{InvPub} = -(1+\phi)\cdot I \qquad (6)$$

4.3 INDIFERENCE CURVE

The indifference curve of private risk premium and public inefficiency is calculated considering a situation where the government is indifferent between financing the project by PPP (option I) or joint public investment and simple concession (Option II). Thus, it is necessary to make equal the government costs of both options (5) and (6):

$$G_{PPP} = G_{InvPub}$$

[12] NPV=0

$$-I \cdot \left(\frac{(1+i+\pi)^n \cdot (i+\pi)}{(1+i+\pi)^n - 1} \right) \cdot \left(\frac{(1+i)^n - 1}{(1+i)^n \cdot i} \right) = -(1+\phi) \cdot I$$

Isolating ϕ term on equation, we can find the following function:

$$\phi(i,\pi,n) = \left(\frac{(1+i+\pi)^n \cdot (i+\pi)}{(1+i+\pi)^n - 1} \right) \cdot \left(\frac{(1+i)^n - 1}{(1+i)^n \cdot i} \right) - 1 \qquad (7)$$

This is the function of public inefficiency in relation to the private premium risk π, interests rate *i* and period of contract *n*.

This relation is a pricing method of the implicit public inefficiency on PPP contracts when it is determined the premium risk rate of project by private partner, usually calculated by CAPM model. If government estimates its inefficiency on the management of infrastructure projects[13], it can establish its optimal decision between PPP (Option I) or joint tradicional public investment and concession (Option II), considering the demanded risk premium.

5. SIMULATIONS

This section presents simulations of the indifference curve of private risk premium and public inefficiency ("overcost" of government direct investment).

The public inefficiency (ϕ) is a function of risk premium demanded by private sector (π), risk free interest rate of the economy (*i*) and the period of contract (*n*).

5.1- 10 YEARS CONTRACTS

Graph 1 presents the indifference curve of private risk premium and public inefficiency for different values of the economy risk free interest rates in a period of 10 years.

It is observed that indifference curves are convex in relation to the premium risk rate[14]. Moreover, the inefficiency is negative related to the risk free interest rates of the economy (*i*). The reason for this behavior is the formation rule of parameter ϕ

[13] Using Methodologies like DEA

[14] $\frac{\partial^2 \phi}{\partial \pi} > 0$

that equals the costs of government in Options I and II in net present value. As discount rate of NPV is fixed as *i*, there is a negative relation between interests rate and project cost and, as consequence, on public inefficiency.

Graph 1

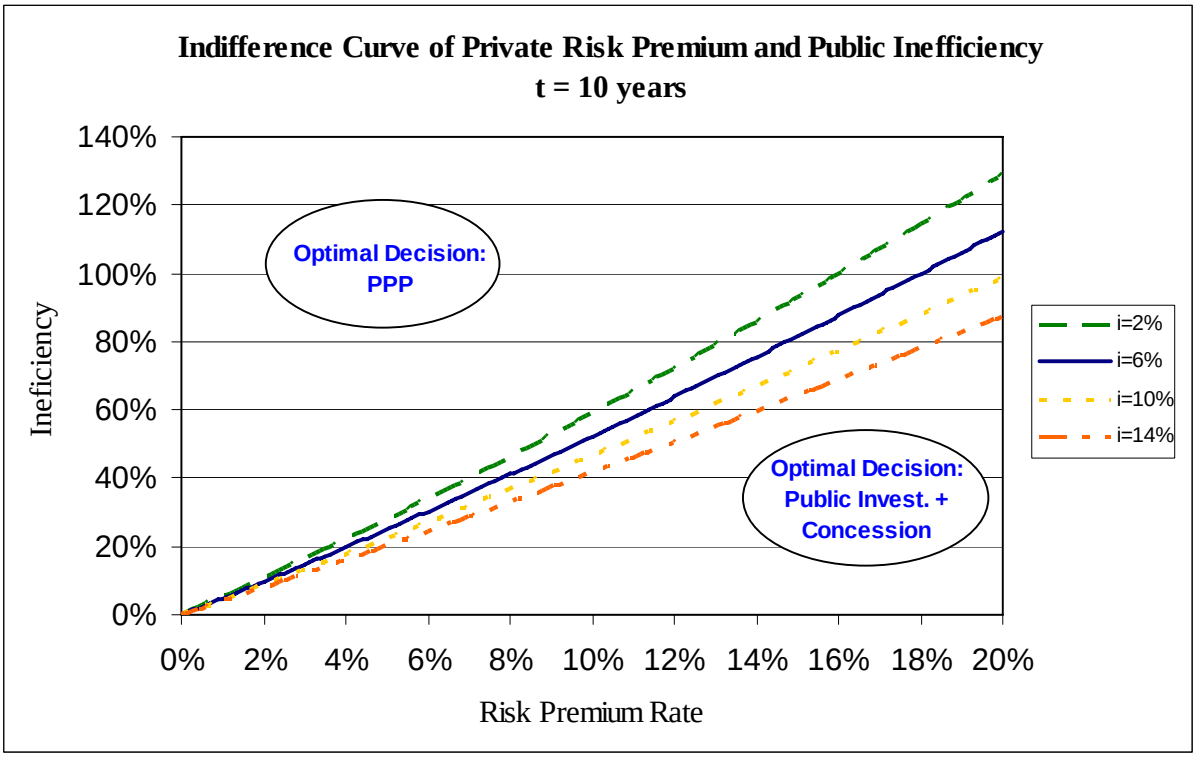


Table 1 presents some referring values of assumed inefficiency and premium risk rate for *i* = 6% a.a.

Table 1

Premium x Ineficiency Relation (*i* = 6% a.a.)				
Risk Premium	5%	10%	15%	20%
Public Ineficiency	25%	52%	82%	112%

Indifference curves in Graph 1 indicate the optimal decision rule of financing investment projects. Based on estimations of public inefficiency[15] and the calculated risk premium demanded by private sector, government can determine if the project should be financed by PPP or joint direct public investment (construction) and simple concession (maintenance).

[15] One way is to use DEA methold..

The left superior area of the indifference curve indicates that assumed inefficiency is relatively higher than risk premium of private sector. Thus, the optimal decision is to implement infrastructure project by PPP. The risk premium required by private sector is relatively higher than inefficiency of public sector in inferior right area. In those cases, PPP is costly. The best decision is government direct investment plus simple concession.

5.2- 15 YEARS CONTRACTS

Graph 2 presents the indifference curve for a 15 years contract. The period increase of public payments (contract government transfers), influencing positively the risk premium-inefficiency relation. The reason of this behavior is the higher financial costs of PPP contract occurred by longer duration of government annual transfers.

Graph 2

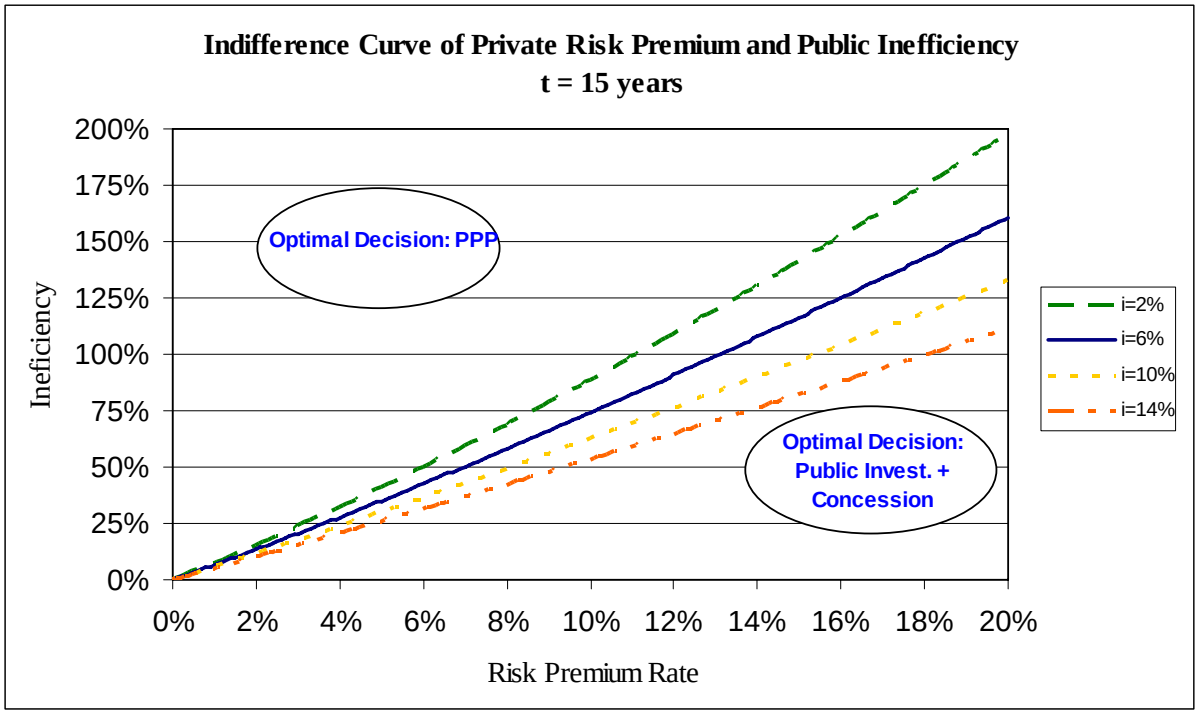


Table 2 presents some points of indifference curve for *i* = 6%a.a to be compared with 10 years contract values. For a premium risk of 5%, it is observed that there is an increase from 25% (10 years) to 35% (15 years) of inefficiency required, or 40%, for the contractual indifference.

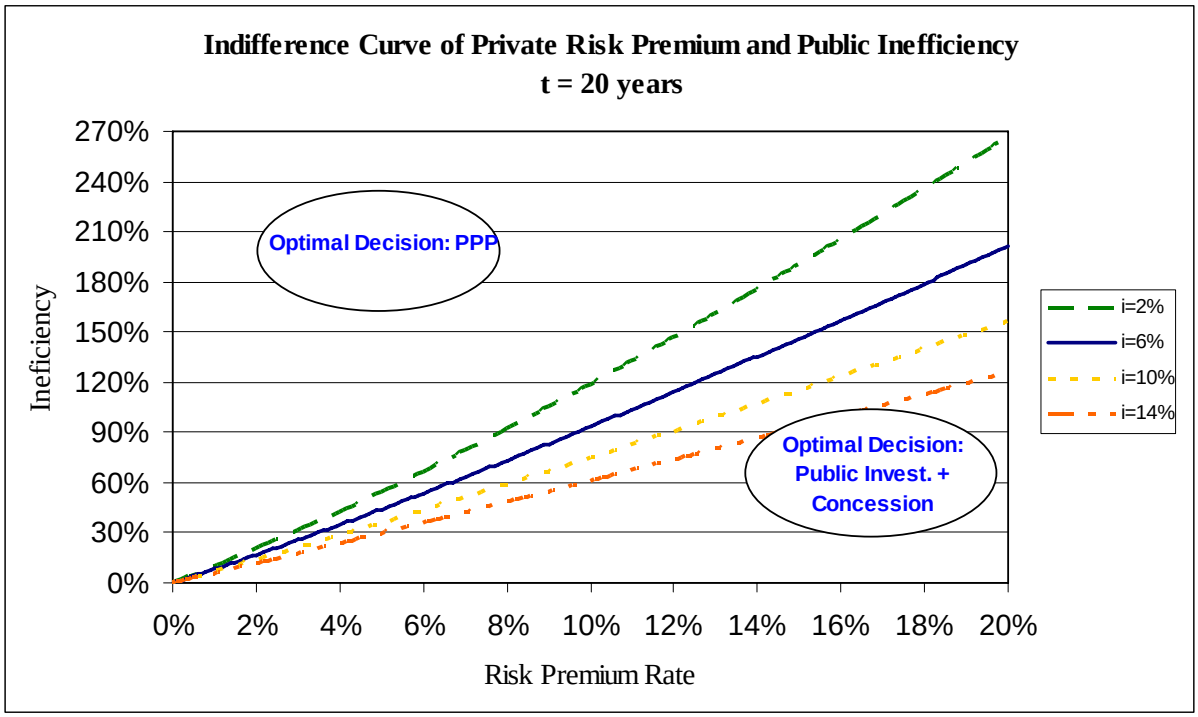
Table 2

Premium x Ineficiency Relation (i = 6% a.a.)				
Risk Premium	5%	10%	15%	20%
Public Ineficiency	35%	74%	116%	161%
Differen.% (Contract 10ys)	40%	42%	43%	43%

5.3- 20 YEARS CONTRACTS

Graph 3 presents the indifference curves between risk premium and public inefficiency for contracts of 20 years. The financial cost of public-private partnership contracts rises in relation to shorter period contracts. This fact can be visualized by the indifference curves inclination (required inefficiency).

Graph 3



It is verified, in Table 3, the relations between inefficiency and risk premium for values of 5%, 10%, 15% and 20%. There is an increase of assumed inefficiency in relation to the previous simulations. It is observed that the average increase of the inefficiency is 79% in relation to 10 years contract for a given premium risk.

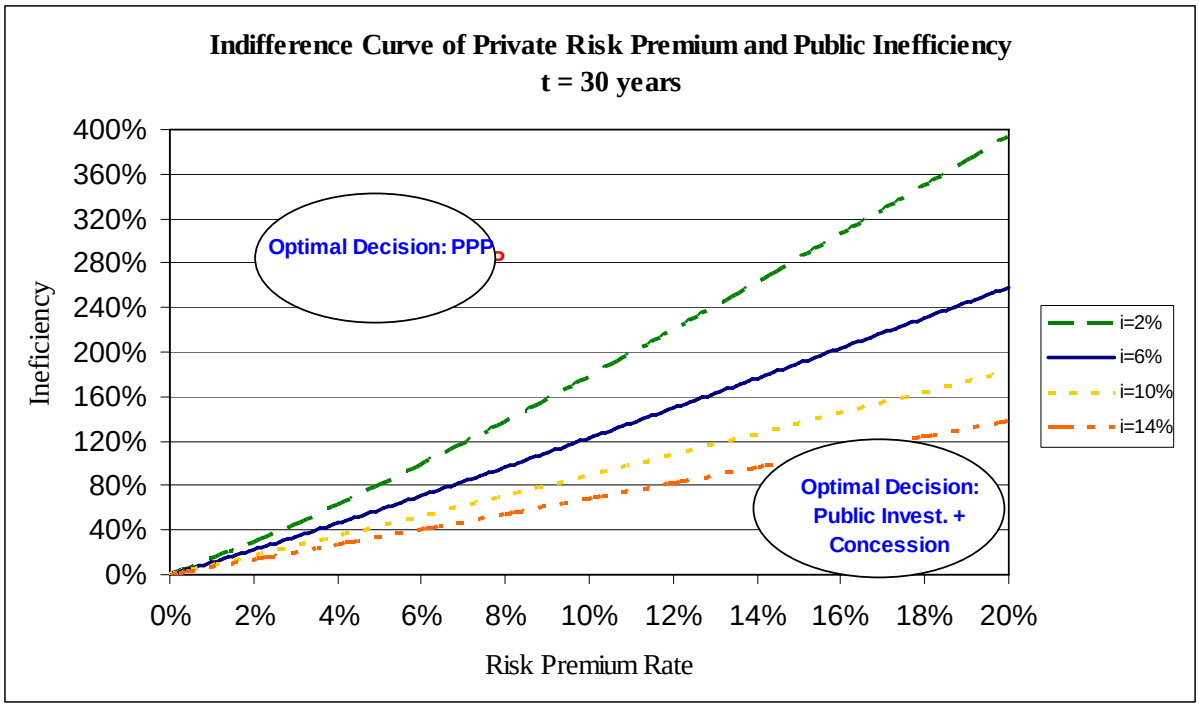
Table 3

Premium x Ineficiency Relation (i = 6% a.a.)				
Risk Premium	5%	10%	15%	20%
Public Ineficiency	44%	93%	146%	201%
Differen.% (Contract 10ys)	76%	79%	79%	79%

5.4- 30 YEARS CONTRACTS

In 30-years contracts, it is observed that the assumed public inefficiency has a significant increase in relation to the previous simulations. This fact makes the choice in favor of public investment plus simple concession (Option II) to finance infrastructure.

Graph 4



It is important to mention that the assumed inefficiency sensibility for the risk free rate of the economy (*i*) increases for lengthen contracts.

Table 4

Premium x Ineficiency Relation (*i* = 6% a.a.)				
Risk Premium	5%	10%	15%	20%
Public Ineficiency	58%	123%	190%	258%
Differen.% (Contract 10ys)	134%	135%	133%	130%

Table 4 shows the value of the assumed public inefficiency that generates indifference between two contract options: PPP or public investment plus concession. It has a non linear positive relation with the period of contracts (n). The increase of public ineficency required, in relation to 10 years contract, is around 133%.

6. RESULTS AND CONCLUSIONS

This article has the objective to analyze the relation between premium risk rate demanded by the private partner and the degree of inefficiency assumed to infrastructure provision by public sector. The indifference curve of private risk premium and public sector inefficiency is an indicator to subsidy government decision of public infrastructure projects implementation: public investment or PPP.

The proposed financial model is determined by calculating the relationship between public sector inefficiency and private risk premium, assuming two equivalent options of infrastructure projects funding. This relationship determines public inefficiency as a function of the risk premium (π), risk free interest rate of the economy (*i*) and period of the contract (*n*).

Simulations indicates that public sector inefficiency has: (i) positive relation with risk premium demanded by private partner, (ii) negative relation with risk free interest rate of the economy and (iii) positive relation with the period of the contract. This work quantifies the sensibility of the model for these variables and indicates the optimal decision for government to the financing infrastructure configuration.

The increase in the period of public transfers (payments) of PPP contracts (*n*) and the risk premium demanded by private partner (π) influence positively the decision in favor of public investment (option II). The reason for this behavior is the increase of financial costs of PPP contracts by allonging public payments or the value of disconting rate (risk premium) of financial flow.

The negative relation between public inefficiency and economy free risk interest rate (*i*) is determined by the formation rule of parameter ϕ. This parameter equals the government cost on the two proposed options in terms of net present value (NPV). As the discounting rate of NPV was established as *i*, it impacts negatively the financial cost of the project and, consequently, public inefficiency.

This work aims to develop a model able to measure the implicit public inefficiency assumed in PPP contracts on the moment that private risk premium is determined. If government estimates its inefficiency on the management of infrastructure projects[16], it can establish its optimal decision between PPP or tradicional public investment, considering the demanded risk premium.

[16] Using Methodologies like DEA

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APENDICES 1

Public Sector Efficiency Indicator (2001 – 2003)

Country	DEA Analyis				Public Sector Efficiency (PSE)	
	Input oriented		Output oriented			
	Score	Rank	Score	Rank	Score	Rank
Brazil	0.381	22	0.488	22	0.69	23
Bulgaria	0.461	14	0.483	23	0.77	22
Chile	0.73	4	0.615	17	1.38	5
Cyprus	0.489	11	0.867	3	1.08	8
Czech Republic	0.439	15	0.637	13	0.85	17
Estonia	0.489	12	0.632	14	0.91	12
Greece	0.369	23	0.713	8	0.96	9
Hungary	0.355	24	0.687	9	0.85	17
Ireland	0.576	8	0.813	4	1.37	6
Korea	0.749	3	0.743	6	1.65	3
Latvia	0.486	13	0.624	16	0.91	12
Lithuania	0.535	9	0.588	18	0.86	15
Malta	0.408	19	0.753	5	0.78	21
Mauritius	0.721	5	0.686	10	1.56	4
Mexico	0.703	6	0.551	19	1.31	7
Poland	0.412	18	0.627	15	0.83	19
Portugal	0.385	21	0.678	11	0.82	20
Romania	0.528	10	0.509	21	0.86	15
Singapore	1	1	1	1	2.39	1
Slovak Republic	0.406	20	0.674	12	0.92	11
Slovenia	0.431	16	0.731	7	0.88	14
South Africa	0.676	7	0.529	20	0.95	10
Thailand	1	1	1	1	1.83	2
Turkey	0.416	17	0.482	24	0.63	24
Correlation	Score	Rank	Score	Rank		
DEA input-PSE	0.91	0.77	-	-		
DEA output-PSE	-	-	0.71	0.56		

Source: Afonso, Schucknecht e Tanzi (2006)