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Demand risk in the Portuguese SCUTS and the 2010 renegotiation

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Abstract

The aim of this thesis is to study the demand risk of those SCUTS highways that were renegotiated in 2010 and 2011, in which the demand risk was fully passed to the public sector. Is the State carrying now riskier highways, regarding the demand risk, comparing to the private benchmark – Brisa? The 2010 renegotiation is also analysed to study if the initial demand forecast errors of those 3 SCUTS renegotiated were corrected, adjusted to the historical data available and counted with the negative effect of the introduction of tolls.

This article, using the model proposed, compares the demand risk of the ex-SCUTS highways with the private benchmark highways chosen. The renegotiation of 2010 is analysed through the study of the previous forecast errors and the historical pattern of traffic. The study concludes that besides the ex-SCUTS, in a first analysis, do not show a significantly higher demand risk, the 2010 renegotiation with the introduction of tolls highlighted some questions about the usefulness of those highways, given the huge fall in the volume of traffic. It is also showed that the renegotiation ignored the historical pattern of traffic, the forecast errors already known and the negative effect of tolls, and projected future traffics very optimistically, completely misappropriated, leading to a great burden to the State.

The conclusions are limited by the short data and because of the comparison between highways without tolls (ex-SCUTS) with the benchmark highways (that always had tolls).

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1. Introduction

Public Private Partnership projects have been used all over the world, registering a substantial growth in Portugal. The PPPs appear as a recent procurement method in which it is agreed by the two contractors to share the risks of the project, bring its complementary skills and achieve higher efficiency. This type of arrangements between the public and the private sectors to build and operate capital-intensive projects begun in the United Kingdom and have proliferated through many countries. In Portugal, the first PPP contract is dated from the early 90's to build and operate the Vasco da Gama Bridge, which links the two riversides of Rio Tejo. After all this time, Portugal is now the country in the European Union with more Public Private Partnerships relative to the size of the economy.

The EC/ECB/IMF identified, in the Portuguese Memorandum of Understanding of 2011, the PPP as a major risk to the fiscal consolidation that Portugal has to follow. In fact, the number of PPP contracts in Portugal has grown significantly in these recent years, as well as the consequent burden to the public accounts. From 2008 to 2011 it was launched the construction of more nine PPP in the road sector. And in this period of time, the net charges to the state with PPP more than tripled, from EUR 475 millions to EUR 1822.6 millions, accounting for approximately 1% of the GDP in 2011 and representing a slippage cost of 18% in this year[1].

The biggest motivation to enter in an engagement such as a PPP contract is the seeking of Value for Money (VfM). VfM is the cost saving achieved by the fact that the project is conducted not only by the public sector but also by the private sector. It is attained sharing the risks of the project. The public and private sectors may share the risks based on which of them is best placed to manage it. Actually, this is also a motivation to increase the efficiency of the project. First of all, if the party that is best able to deal with some risk holds it, is expected to do it more efficiently than if the other party held it. The risks are being transferred from the public party to the private one, giving a financial premium for holding that risk and mitigate it more

[1] Direcção-Geral do Tesouro e Finanças (2011). Parcerias Público-Privadas e Concessões – Relatório de 2011.

efficiently. However, this gain of efficiency only happens until a certain level of risk transfer, where VfM is maximized. Then forward, the financial premium to be paid to the private sector is greater than the efficiency gain of transferring more risks.

One of the most important risks to take care about in a PPP project is the demand risk. Actually, some authors such as Li, Akintoye, Edwards, & Hardcastle (2005), Loosemore & Ng (2007), Lewis (2001), consider the demand risk a crucial aspect to analyse given the financial repercussions that the lack of demand for an infrastructure facility can cause.

Given this, our study focuses on the demand risks and its relation to the SCUTS (meaning "no costs for the user") road projects. The SCUTS were launched with the purpose of develop those regions where the infrastructure gap may constitute an obstacle to economic growth. In 2010 the demand risk of 3 of the 7 SCUT concessions became exclusively allocated in the public sector. Later, in December 2011, the remaining 4 SCUTS were renegotiated and followed the same path, allocating the demand risk to the public sector. We will study those SCUTS concessions regarding the demand risk of each, that are now solely supported by the public sector. The purpose of the analysis is to study whether these highways, whose demand risk was totally transferred to the public sector, show the same risk profiles as the benchmark set by private highways or whether the demand risk is higher and then transferring it to the public sector constituted a bad decision. This analysis will be made in comparison with the Brisa's highways, which will serve as benchmark.

In the 2010 renegotiation of the SCUT contracts, the demand forecasts proved themselves very optimistic, well above the real traffic later observed. To intensify this gap, the economic crisis exacerbated these numbers and time after time we have seen a progressive loss of traffic, characterizing a high level of uncertainty relative to the net future costs for the Government. In this thesis we will also analyse the 2010 renegotiation, regarding the traffic forecasts conducted and the real traffic later verified.

In what follows, our study is organized in the subsequent way: section 2 reviews the main literature regarding PPP and the risk sharing approach to reach Value for Money (VfM), as well as the main determinants of the traffic demand. Section 3 gives a brief contextualization of the Portuguese PPP and its demand risk sharing structures. Section 4 describes the methodology used to study the demand risk of each highway in comparison to Brisa. Section 5 presents the main results of the comparison of the predictability of traffic of the SCUTS highways and Brisa's highways. In this way, this topic attempts to address a comparison between demand risks of highways in which the demand risk are allocated in public sector and highways in which it is allocated in private sector. It is also discussed the 2010 renegotiation, where the traffic forecasts where updated with complete divergence with the historical traffic verified, not accounting for the negative impact of the introduction of tolls and the economic crisis that Portugal is passing through. Section 6 presents the main limitations of the study and section 7 retains the main conclusions.

2. Literature Review

The infrastructure facilities are a crucial issue in the potential growth of an economy. In these last decades, we have been faced in many countries with what is usually called an "infrastructure gap", that is the difference between what the government can afford and what people need (Hammami, Ruhashyankiko, & Yehoue, 2006). Loosemore (2007) argues that in most countries, the stock of public infrastructures constitutes a huge asset, which can play an important role in the social, cultural and economic stability, productivity, development and prosperity, if is successfully managed. This, coupled with the budgetary constraints to tackle the infrastructure gap, are one of the main fundamentals for the growing emergence of the Public Private Partnerships (PPP), intensified with the pressure to reduce public deficit and, at the same time, expand the economy.

PPP are seen as an arrangement "where the public sector bodies enter into a long-term contractual agreement with private sector entities for the construction or management of public sector infrastructure facilities by the private sector entity, or the provision of services by the private sector entity to the community on behalf of a public sector entity" (Grimsey & Lewis, 2002, p. 112). In a simplified way, it consists in the formation of a single entity, created by the private consortium, just for the purpose of the contract, known as a Special Purpose Vehicle (SPV). This new private entity uses contracts secondary to the concession, to build, operate, finance and maintain the infrastructure project during the concession period defined (Loosemore & Ng, 2007).

The main driver to enter in such agreements is to achieve Value for Money (VfM). It can be attained when, assuming the same level of quality and risk allocation, the total present value cost of the private sector supply is less than the base cost of the service if it was provided by the public sector (Grimsey & Lewis, 2005). It is the effective use of public funds on a capital project, which can arise from the efficient private sector skills, techniques, innovations and practices (Saravan, 2008).

Moreover, since the traditionally borrowing cost of the private sector is higher than the risk free bond of the public sector, stating that the private sector delivers VfM means that in all other stages/processes of the contract (construction, operation, maintenance, etc) there has to be more efficiency that compensates and overcomes the higher financial cost. As the private sector brings commercial discipline to public projects, the risks of costs overruns and delays can be effectively reduced (Akintoye, Beck, & Hardcastle, 2003). A more productively use of the resources can lead to substantial improvement of the quality of the public facilities and services provided (Edkins & Smyth, 2006). Besides that, a well-structured contract gives a clear path on accountability, and gives transparency in the outcomes.

A crucial issue in this type of contracts is the perception of the risks involved. Grimsey & Lewis (2002) identify the sharing risk approach as a crucial advantage of the PPP/PFIs projects arrangements. In fact, the main literature considers the risk allocation the crucial driver to deliver VfM. It allows to transfer risks from the public to the private sector, under some conditions, if the private sector is best placed to manage and mitigate those risks and, in this way, save a plenty of resources and reach higher levels of efficiency. There are several risks that can influence the success of the investment, as well as the usefulness of the infrastructure: construction cost, changing economic conditions, tax and expenditures limitations, public bureaucracy, governments' budgetary constraints, sectorial reforms, changes in priorities, technological development and globalization of financial markets (Saravan, 2008). However, Kwak, YingYi and Ibbs (2009) argue that there is not a fixed list of risks that can be blindly applicable to all PPP. There is not a universally risk classification to apply in all the projects. Thus, some authors identify in their works some lists of risks that can be found in some projects. Tinsley (2001) identifies a list of risk categories as well as Hardcastle (2003), who defines each risk. Chinyio (2003) recognize some techniques to identify risks and prioritize them. Based on Panel (1995), Gallimore (1997), Birnie (1999) and Salzmann (1999), Akintoye (2001) identify a range of risks presented in those papers. Centred on infrastructure projects, also Grimsey and Lewis (2004) classify some risks faced in this type of engagements.

The accomplishment of the partnership highly depends on the proper risk identification of the project, which with a precise documentation should be shared between the public and the private sector. Shen et al (2006) argue that large scale public works, as those used in the PPP' contracts, tend to be more risky than other business activities due to the complexity of the coordination of a wide range of different skills and activities. Thus, the question of risk appears as a central concern when discussing the implementation of a PPP contract because it may imply unexpected consequences in the future. In fact, to ensure the success of PPP infrastructures projects and reach VfM, risks should be shared.

The allocation of risk constitutes an important incentive to increase efficiency. If the private party shows better performance in mitigating some risk than the public one, it should hold it. Becker and Patterson point that there is a strong correlation between risks and rewards. Since the private sector can mitigate it more efficiently, the public sector should transfer risks to the private party, leading to a higher level of efficiency, and rewarding it for the assumption of more risks. The risks should be transferred until the point were the efficiency gain of transfer more risks is less than the financial premium that have to be paid to the private party. In that point the optimal allocation of risks is achieved and VfM is maximized. Thus, if the risks are well recognized and balanced VfM can be maximized. However, this optimal balance of risks is not usually observed (Grimsey & Lewis, 2002).

Based on the work of Zou, Wang, & Fang (2008), we can conclude that among all of those risks, the demand risk is one of the most significant risks that may have higher repercussions on the returns and successfulness of the investment. In fact, when we are referring to PPP contracts in roads, the demand and the traffic forecast become a critical aspect to take into account. The possibility of insufficient traffic volume and the alternative roads to do the same route might affect the revenues and consequent income of the project. At the feasibility stage, there must be a simulation to assess if there is sufficient traffic volume, as well as the optimal toll price for the road (Zou, Wang, & Fang, 2008). Despite table 1, which shows the main conclusions of the mentioned authors regarding the allocation of demand risk, we found that there is not complete consensus concerning whether the demand risk should be allocated to the public or the private sector.

Table 1: **Demand risk allocation in the main literature**

The author column identifies the authors of the papers mentioned. Columns Country and PPP identify the country and the sector of the analysed PPP. Allocation pretends to identify to which part (public, private or shared) were the risk demand allocated. Conclusions give the main conclusions of the referred case studies.

Author	Country	PPP	Allocation	Conclusions
Li, Akintoye, Edwards, & Hardcastle (2005)	UK	Generic	Private	• Government should adopt economic policies to maintain favourable economic conditions. • Private sector should bore the demand risk.
Loosemore & Ng (2007)	Australia	Railway	Private	• The SPV took the risk of operating trains, selling tickets and meeting agreed service standards. • The SPV went bankruptcy and began to be heavily compensated for the differences in the real and forecasted demand.
Wang, Tiong, Ting, & Ashley (2000)	China	Power Plants	Private	• Demand risk is borne by the private sector and the tariffs are subject to annual review in accordance with the formulas previously agreed.
Lewis (2001)	Generic	Generic	Private	• The project company/investors should bear the risk of decreased demand.
Arndt (1998)	Australia	Road	Shared	• The traffic models are maintained updated throughout the life of the project to revise the situation in comparison to the base case. • The State adopts traffic management measures in the surrounding road network and compensates the private if the measures are not initiated in certain date. The private pays to the State 50% of the additional benefits of that measures.

Source: Made by the authors, based on the literature.

Li et al (2005) argue that in theory, allocating a specific risk to the party best able to manage it will reduce the individual risk premium and so it should be able to do it at a lowest price. Consequently demand risk should be allocated to the private consortium while the governments should adopt policies to guarantee the macro-economic stability, maintaining a growing economic environment and supporting a reasonable certainty and confidence in the market.

However, Loosemore (2007) argues that recent research indicated that even in the largest PPP projects the risk management practices are highly variable, intuitive unsophisticated and subjective. Many times those demand risks are not well assessed and even with high uncertainty related to the expected traffic volume and to the real need of that investment, the contracts are signed. Zou et al (2008) identifies that usually the public sector is more concerned in achieving a social goal, highly correlated with their political standing and influence, than ensuring a good investment and a reasonable share of risks, to obtain the desired return for the country. Chan, Lam, Chan, & Cheung (2008) stresses the case study of the Sydney Cross City Tunnel, an infrastructure designed to ease the traffic congestion in the central business district of Sydney and to improve the east to west traffic flows. It was decided to allocate all the demand risk to the private sector, based on the forecasts made by the government. It was designed based on very optimistic demand forecast. The expected traffic revealed well disappropriated and the lack of toll revenues was the main cause for the collapse of the project company. This example gives an insight for the importance of having a clear and precise demand forecast as well as a realistic analysis of the need of the investment when it is in the study phase of the project. In fact, the objective of the projects is to efficiently satisfy the demand that those infrastructures will have. The revenue and the State payments (in the case of the SCUTS) will depend and be projected through that demand. So, it is of extreme importance to have, as possible, an accurate forecast of what will be the demand and a study of how is its behaviour given variations over its fundamentals.

In what concerns to the study of the evolution of the road traffic demand, Graham & Glaister (2004) define the fuel price and the income/economic activity as the main determinants of the variation of the road traffic. Actually, they state that the road traffic is highly elastic with respect to generalized cost of driving, where the fuel price plays a crucial role. The immediate response of an increase in fuel prices is the change of some decisions like modifying the number of trips. In the long run, it leads to a change in behaviour: people make adaptations, changing distances travelled, destinations chosen; there are a relocation of population and retail and services activities (De Jong & Gunn, 2001). Brain (2009) identifies the recent macroeconomic downturn in Portugal as a major cause of the progressive loss of traffic verified. The author highlights that recessions or economic downturns was referred in a number of cases, emphasizing the positive relation between economic growth and traffic growth. Moreover, the introduction of tolls and the consumer's willingness to pay them is also an important variable that influences the road traffic demand.

3. A brief consideration of the Portuguese context

The first Portuguese PPP contract is dated from 1993 with the Vasco da Gama Bridge, in Lisbon. Since then more 35[2] significant PPP arrangements have been launched making Portugal the European country with the highest investment per capita in PPP. These investments represent an expected NPV of net costs of EUR 10 703 millions[2] from 2011 to 2040. The structure of these partnerships is divided through the road sector (79%), rail sector (18%), health sector (2%) and security (1%)[2].

The allocation of the demand risk in the Portuguese Public Private Partnerships differs depending on the partnership. Table 2 identifies the model of demand risk sharing in the most significant PPP. As we can observe the allocation of the demand risk is more frequently allocated only to one part than a risk shared structure.

[2] According to Direcção-Geral do Tesouro e Finanças (2011). Parcerias Público-Privadas e Concessões – Relatório de 2011.

Table 2: **Actual demand risk allocation in the most significant Portuguese PPP**

This table identifies the most significant Portuguese PPP, as well as its sector and the allocation of its demand risk.

	PPP	Sector	Public	Shared	Private
SCUTS	Concession SCUT Algarve (Via do Infante)	Road	X		
	Concession SCUT Beira Interior	Road	X		
	Concession SCUT Costa de Prata	Road	X		
	Concession SCUT Grande Porto	Road	X		
	Concession SCUT Norte Litoral	Road	X		
	Concession SCUT Beiras Litoral e Alta	Road	X		
	Concession SCUT Interior Norte	Road	X		
Partnerships	Concession Lusoponte	Road			X
	Concession Norte	Road	X		
	Concession Oeste	Road			X
	Concession Brisa	Road			X
	Concession Litoral Centro	Road			X
	Concession Grande Lisboa	Road	X		
	Concession Douro Litoral	Road			X
	Sub-concession AE Transmontana	Road			X
	Sub-concession Douro Interior	Road			X
	Concession Tunel do Marão	Road	X		
	Sub-concession Baixo Alentejo	Road			X
	Sub-concession Baixo Tejo	Road			X
	Sub-concession Litoral Oeste	Road			X
	Sub-concession Algarve Litoral	Road			X
	Sub-concession Pinhal Interior	Road			X
	Metro Sul Tejo	Rail	X		
	Transp. Ferroviário eixo-norte/sul	Rail			X
	Gestão H. Braga - Ent. Gest. do Estabelecimento	Health		X	
	Gestão H. Cascais - Ent. Gest. Estabelecimento	Health		X	
	Gestão H. Loures - Ent. Gest. Estabelecimento	Health		X	
	Gestão H. V. Franca - Ent. Gest. Estabelecim.	Health		X	
	SIRESP	Security	X		

Source: Direcção-Geral do Tesouro e Finanças (2011). Parcerias Público-Privadas e Concessões – Relatório de 2011.

In the road sector stands out the SCUT ("sem custos para o utilizador", which means "no costs for the user") highway projects, in which we will focus our study. The SCUT Public Private Partnerships were primarily composed by:

- Concession SCUT do Algarve;
- Concession SCUT da Beira Interior;
- Concession SCUT Costa de Prata;
- Concession SCUT Grande Porto;
- Concession SCUT Norte Litoral;
- Concession SCUT Beiras Litoral e Alta;

- Concession SCUT Interior Norte;

These SCUT projects correspond to 930 km of highways with a shadow toll payment, in which the state budget pays the private consortium for the utilization of the roads. This type of contracts was made for the purpose that it would develop those repressed regions that were somehow isolated and in this way fight the lack of infrastructure that may constitute an obstacle to development and investment attraction. However, the 2003 audit to the SCUT PPP, made by the Tribunal de Contas (Court of Audit of Portugal) indicated that the main driver of the launch of this SCUT program was the advantage to transfer the financial effort to the private sector rather than the possible value added that the investment would bring to the public purse. This, coupled with the lack of experience and a not so clear legal framework, until 2003, regarding the Public Private Partnerships, led to some questionable decisions in this area.

Until 2010, the state budget paid annually for the use of the highways, rather than charging the users. The payment was made through three bands, the inferior band, the reference band and the superior band.

1. Inferior band: it was paid x per vehicle per kilometer for the first vehicles of the day (filling in the first band).
2. Reference band: it was paid y (with $y < x$) per vehicle per kilometer for the next vehicles (filling in the second band).
3. Superior band: for all vehicles per kilometer higher, it had no payment.

This inverse relation had the objective of marking out the risks taken by each part. In the superior band the State budget pays “zero” for what exceeds the upper bound of the band and in the inferior band there is a minimum revenue/traffic guaranteed paid to the private sector. So, the private sector is, in this type of payments, also exposed to the demand risk. However, the assumption of risk by the private party only takes place if the alternative roads to the highway are only those present on the PRN 2000 (national road plan, from the year 2000).

Table 3: **Demand risk allocation in SCUTS before and after renegotiation**

This table identifies the initial 7 SCUTS concessions and its risk sharing model before and after its renegotiations in 2010 and 2011.

SCUT	Initial project	After renegotiation	
		Year	
Concession SCUT Algarve	Shared	2011	Public
Concession SCUT Beira Interior	Shared	2011	Public
Concession SCUT Costa de Prata	Shared	2010	Public
Concession SCUT Grande Porto	Shared	2010	Public
Concession SCUT Norte Litoral	Shared	2010	Public
Concession SCUT Beiras Litoral e Alta	Shared	2011	Public
Concession SCUT Interior Norte	Shared	2011	Public

Source: Direcção-Geral do Tesouro e Finanças (2011). Parcerias Público-Privadas e Concessões – Relatório de 2011.

In 2010, the Portuguese government renegotiated 3 SCUT contracts. In this renegotiation the payment method of the concession of Costa de Prata, Norte Litoral and Grande Porto changed from payment by bands of traffic to payments for availability. Real tolls were installed, whose the revenue accrue to *Estradas de Portugal* (Portuguese state owned entity, responsible for the management of the national road grid). As counterpart, the consortium is paid for the availability of the road networks and the service of toll collection, and this payment is based on the traffic forecasts present in the Base Case of each concession, which in fact have proved to be very optimistic (analysis that will be addressed more carefully in section 5.3). The demand risk became, in this way, entirely under the public sector responsibility, in the sense that deviations of traffic volume will only affect the revenue to the state budget.

December of 2011 marked the extinction of the SCUT projects as highways with no costs for the users, in Portugal. The Government decided to implement the same scheme in the remaining SCUTS, leaving the payment by bands and introducing the payment by availability, with the toll revenues reverting to *Estradas de Portugal*.

These renegotiations and the consequent change in the methodology of payment led to significant controversial questions regarding whether the public interests were preserved and put in the first place. Actually, the demand risk changed from a shared scheme to a public allocation. In the method of payments by bands both public and private sectors should bore the risk of demand (although, in practice, the State budget supported the risk of having lower demand – inferior band – and the private supported the risk of having extremely high demand – which did not happened). This new approach of payment by availability led the public sector to bear all the demand risk. Since the private sector will always receive the revenue corresponding in the Base Case, that were calculated considering the forecasts, the risk of having lower traffic volumes is all carried by the public purse. Moreover, since the highways adopted tolls, as it was expected, the traffic volume fell. This can lead us to question whether the change from payment by bands to payment for availability was favourable to the public purse since it changed from a method were, in principle, the two parties shared the possible lack of traffic to a model were the public sector borne the risk which is significantly higher given the introduction of tolls, while the private sector receives the revenues corresponding to the traffic volume forecasted in the Base Case.

4. Methodology

4.1. Analysis of the demand risk and the 2010 renegotiation

4.1.1. Variables

Given the literature considered in this area, we will study the development of the traffic demand in the Portuguese SCUTS regarding the evolution of the economic activity and the fuel prices. Since the traffic for data is given in a monthly basis by the average daily monthly Traffic (ADMT) and given that the data for the gdp growth are only available in a quarter basis, we decide to use the leading indicator of Banco de Portugal "*indicador coincidente de actividade* económica"[3], that is published every month, as proxy of the gdp year on year monthly growth.

It seems reasonable that the effect of gdp growth on the traffic demand will be different from highway to highway due to different characteristics of the areas that those highways serve. For instance, it appears to be relevant to consider that in

[3] The "indicador coincidente da actividade económica" is a leading indicator developed by Banco de Portugal, which is used to evaluate the evolution of the economic activity of Portugal and have proved to be a precise indicator to analyse the monthly variation of the GDP.

areas with a lower population density, where in principle there are not so much economic activity, the effect of gdp growth on traffic will not be so substantial as it is in areas with high concentration of population and services. So, we constructed a variable to interact with the growth of gdp, that we call *coefficient of urbanism*. This variable weights each highway by the population density of each part of its route. The weighted variable takes values of 1 for counties with less than 20000 habitants, 2 for counties with population between 20000 and 100000 and 3 for counties with more than 100000 people. For each highway we computed a weighted variable that weights each section and subsection of the highway by its population density ending up in a specific weight per highway.

Portugal is a country that benefits from a good climate. In 2010 the "consumption" of tourism accounted for 9.2% of the gdp[4]. According to Proença & Soukiazis (2005), Spain, Germany, France and U.K. are responsible for almost 90% of the total inflows of tourists in Portugal. In addition to the foreign tourists, also the Portuguese emigrants have an important role in the tourism of Portugal, returning back in the holiday months. Given the importance of tourism in Portugal and that it presents a seasonality rate of 40%[5], it seems logical to consider introducing in the analysis the dummy variable summer, that will take value 1 for July, August and September and 0 otherwise. It will explain some variability of the volume of traffic in the summer months that are highly significant given the influx of tourists, emigrants and the natural predisposition of people to travel in this season.

A dummy for toll is also considered to capture the effect of this method of payment on traffic. The dummy will take value 1 for time periods after October 2010 for the concessions Costa de Prata, Norte Litoral and Grande Porto, and in January 2011 for Algarve, Beiras Litoral e Alta, Interior Norte and Beira Interior.

[4] According to Turismo de Portugal, Report of Sustainability (2010).
[5] According to Turismo de Portugal, Report of Sustainability (2010).

4.1.2. Determinants of traffic

We will perform a panel data regression, using the fixed effects model[6], to show that the variables pointed by the literature are significant and apply to Portugal.

In this way, the model considered is the following:

$$traffic_{i,t} = \propto_i + \beta_1 gdp_t * weight_i + \beta_2 fuel_t + \theta_1 toll_{i,t} + \theta_2 summer_t + \varepsilon_{i,t}.$$

4.1.3. The measure of demand risk on each concession

It is important to clarify our definition of traffic and demand risk. By traffic we intend to refer to the average number of cars that crosses some highway in a determined month. The traffic data available is in average daily monthly basis (ADMT), which is calculated by averaging the daily number of cars that crosses a highway in a month. ADAT (average daily annual traffic), which will use in the last section to analyse the renegotiation of 2010, refers to the average of the ADMTs in a year.

The demand risk will be given by the (1-R^2) of each regression of each highway. The reasoning is the following: given that the main determinants of the traffic demand are the economic activity and the fuel prices, and that summer and the introduction of tolls are recognized as important factors to take into consideration, 1-R^2 will give us a measure of that unexplained variation of demand. So, this unexplained variation of traffic caused by unobserved circumstances will constitute the demand risk.

4.1.4. Analysis of demand risk/variability

To assess the demand risk of each highway we will perform OLS regressions of traffic over the already referred variables to assess the (1-R^2) and distinguish the ones with more demand risk. Those results will be compared to the results of the same regressions but using the traffic data of Brisa's highways, a private enterprise that owns and manages the most important (with more traffic) highways in Portugal, which will constitute our benchmark for demand risk. This comparison has to be

[6] Tests over random effects and pooled OLS showed the fixed effects to be the preferable model.

done considering only data from January 2008 to September 2010, since in October 2010 the decision of introducing tolls in some SCUTS were taken and that event (controlled by the dummy variable toll) will be highly significant in explaining the variation of traffic, exponentially increasing the R^2 and thus compromising the basis for comparison between highways.

It is important to refer also that Brisa have built some highways where the decision of investment can be questionable, since its traffic variability appears to be also substantial.

4.1.5. The analysis of the renegotiation of 2010

In this section we will analyse the recent developments of the traffic volume of the concessions that have been renegotiated in 2010. To do so we will analyse the pattern of traffic size until 2010 and after 2010 and compare them with the initial contract forecast and with the reviewed forecasts made in 2010 for the year of 2011. We will assess the growth pattern that the SCUTS exhibited until 2010 and the not so realistic growth forecasts made to 2011, after the renegotiation and the introduction of tolls.

5. Results

5.1. Results from panel regression

The results from the panel regression (appendix A1) confirm the use of the variables suggested since all are significant and have an expected logical coefficient. The traffic demand varies positively with the economic growth and summer, while the increase in fuel prices and the introduction of tolls have a negative impact in the road traffic demand, given the negative elasticity of demand.

5.2. Measurement of risk of each concession/highway

Here we will measure the demand risk of each highway given the ($1-R^2$) of each regression. To make the comparison with Brisa's highways, we restrict the sample from January 2008 and September 2010, because our R^2 would get influenced by the introduction of tolls in Costa de Prata, Grande Porto and Norte Litoral.

The results of each regression can be seen in the Appendix A2. For our analysis we'll focus on the ($1-R^2$) of each regression, as well as in the standard deviation of each distribution to justify some incoherent results that may appear with the analysis. The comparison has to be done through highways that have similar characteristics, for which we will use the calculated coefficient of urbanism. The tables A3.1 and A3.2 of the Appendix A3, summarizes the results regarding our risk indicator and some descriptive statistics.

5.2.1. Algarve A22 and Costa de Prata A17

The highway from Algarve, the A22, constitutes a very important route linking all the coast of this region. The only alternative to this highway is the EN125, considered one of the most dangerous roads in Portugal, with high levels of accident rates. However, the summer season, characterized by a huge influx of tourists, highly influences the standard deviation of the distribution. And this may be conditioning the result by explaining a lot the variation verified. The A17 from Costa de Prata is also a coast highway that crosses some locations, like Mira and Figueira da Fóz, which is also heavily influenced by the summer season with a great influx of tourists.

The demand risk of these two highways should be compared to A14 from Brisa. This highway links Coimbra to Figueira da Fóz, and exhibits also seasonality variation in the summer with a significant increase in the traffic volume. Regarding the results, we can conclude that using this indicator as a measure of risk, the SCUT A22 from Algarve and A17 from Costa de Prata exhibit less demand risk than the A14 from Brisa (A22: 0.3322; A17: 0.5680; A14: 0.6063). This result is somehow expected in Algarve since, as we referred, this is a road with few alternatives.

5.2.2. Beira Interior A23, Costa de Prata A25 and Beiras Litoral e Alta A25

The A23 from Beira Interior, A25 from Costa de Prata and the sequence of A25 from Beiras Litoral e Alta, can be compared to the Brisa's A6. A25 from Beiras Litoral e Alta has its continuation through the concession of Costa de Prata, so it seems reasonable to compare them jointly. This part of A25 and A23 from Beira Interior are located in the interior of the country and have similar types of population density over its routes. The results show that the SCUTS Costa de Prata A23 exhibits much the same demand risk as the Brisa's A6, while A25 from Costa de Prata and Beiras Litoral e Alta have less risk than A6 (A23: 0.4483; A25 CP: 0.4282; A25 BLA: 0.3971; A6: 0.4549).

5.2.3. Costa de Prata A29, Grande Porto A4, A41 and A42

Costa de Prata A29, Grande Porto A4, A41 and A42, are all in the area of the city of Oporto, the second most important and populated city of Portugal. These roads are used to connect the neighbouring towns to Oporto. They can be compared to A5 and A12 from Brisa's. Even if the former are located in the North and the latter in the South, A5 and A12 are also in the metropolitan area of Lisbon and are used by the population as a connection between Lisbon and the nearest areas. Comparing these highways, and based on our indicator, we can say that the traffic in the SCUTS roads is less predictable than in the Brisa's highways, since the explanation power of our model is lower in these highways. The SCUTS exhibit higher risk indicators (A29: 0.7374; A4: 0.8721; A41: 0.5975; A42: 0.6335) than the ones managed by Brisa (A5: 0.5287; A12: 0.6289).

5.2.4. Interior Norte A24, Norte Litoral A28 and A27

The A24 from Interior Norte, links Viseu to Vila Real and ends in Spain. A6 from Brisa in the one that better fits the comparison, since it starts in a more coaster area and crosses the interior of the country through Spain. The risk indicator shows a very similar risk pattern (Interior Norte A24: 0.4393; Brisa A6: 0.4549).

The SCUT A28 and A27, from the Norte Litoral concession are located in the North Coast of Portugal. The A3 (Brisa), also located in the north and is relatively closer to the other two. By comparing these three highways, we found evidence of similar patterns of predictability, based on the variables considered, on A28 and A3 and a more risky profile of A27 comparing to the benchmark highway (A27: 0.3838; A28: 0.3619; A3: 0.3570). Table 4 presents the results of the comparisons between the SCUT's and Brisa's highways.

Table 4: **Comparison of demand risk between SCUT's and Brisa's highways**

This table identifies the different SCUTS highways and its correspondent compared highway in Brisa, as well as which of them exhibits higher demand risk, based on the proposed indicator.

SCUT	Brisa	Higher demand risk
Algarve A22 Costa de Prata A17	A14	Brisa Brisa
Beira Interior A23 Costa de Prata A25 Beiras Litoral e Alta A25	A6	Similar pattern Brisa Brisa
Costa de Prata A29 Grande Porto A4 Grande Porto A41 Grande Porto A42	A5 and A12	SCUT SCUT SCUT SCUT
Interior Norte A24	A6	Similar pattern
Norte Litoral A28 Norte Litoral A27	A3	Similar pattern SCUT

Source: Made by the authors.

After doing all of this analysis, we must notice that since the highways are not substitutes and do not have all the same conditions to make a straight forward match between them, the comparisons of their predictability of traffic must be taken carefully.

5.3. An analysis of the 2010 renegotiation regarding demand traffic

In October 2010 the government changed the model sharing demand risk of 3 concessions: Norte Litoral, Costa de Prata and Grande Porto, with the purpose of reducing the public deficit. These SCUTS passed from the method of payment by bands to the method of payment by availability, where the revenues are guaranteed to the private concession, as long as the roads are available to travel, and the revenue from tolls became allocated to Estradas de Portugal (State owned company). In this type of contracts, the demand risk is all carried by the public sector, which does the payments to the private consortium based on the forecasted demand of the contract.

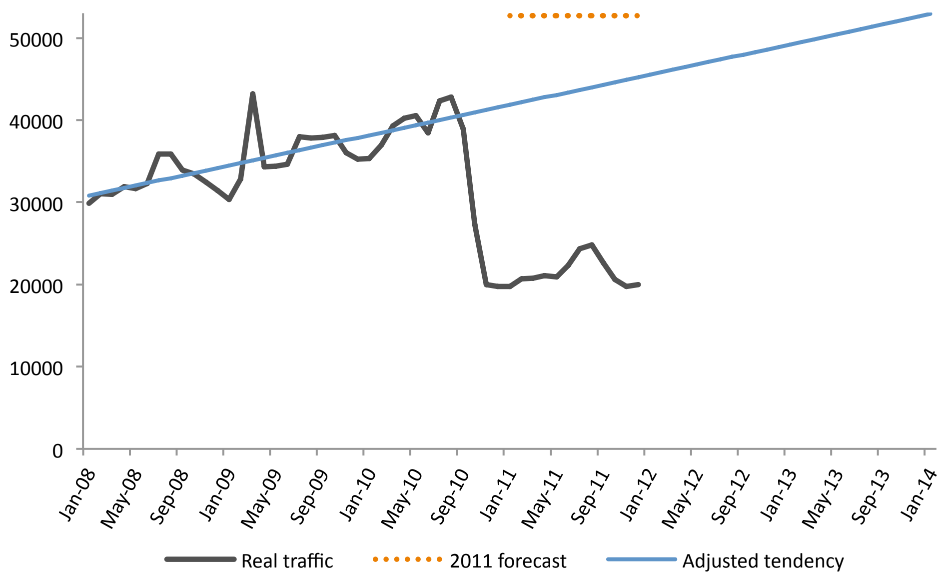
5.3.1. Renegotiation of Costa de Prata

The 2010 renegotiation, at the same time modified the methods of payment, and was expected to update the values for the traffic forecast. Our calculations based on the historical monthly data available, indicates an average daily annual traffic (ADAT) of 32 558 vehicles in 2008, 36 066 vehicles in 2009 and a daily average of 39 428 vehicles from January to September 2010. Even with the historical pattern of traffic (grew 10.8% in 2009 and 9.3% in 2010, until September) and with an expected decrease caused by the introduction of tolls (INIR states that international experiences indicates an average decrease of 15%), the forecasted traffic for 2011 was of 52 700 vehicles. This forecast represents a growth rate of 34% relatively to the average traffic of the first 9 months of 2010. The forecasted traffic of 52 700 should be compared to the real traffic verified of 21 477 vehicles in 2011.

Table A4.1, in the Appendix A4 shows the results of applying the model we have used in the previous section but here for the concession and not for the highways individually. Assuming that for having an average daily annual (ADAT) increase of 13 272 vehicles the impact on average daily monthly traffic (ADMT) have to be of 13 272 vehicles in the first month, and not considering for a decrease caused by the introduction of tolls, the results suggest that, ceteris paribus, it would be needed a monthly growth rate y-on-y of 51%. Or, in other way, to have an impact on the average daily traffic of 13 272 vehicles, the fuel price, ceteris paribus, would have to fall €0.83. This analysis might be not realistic, since that it is impossible to have only the gdp or fuel varying and because our model only justifies 35% of the variation of traffic demand. Moreover, it is assumed that all ADMT grow to the same traffic volume and we have seen that, for instance, in the summer months the volume of traffic is above the remaining months. But this constitutes a number to reflect how much unrealistic was the projection, intensified by the fact that in 2010 Portugal was already in a crisis scenario.

The Figure A4.1, in the appendix A4, illustrates the evolution of the real traffic in Costa de Prata compared with the forecasts. Unfortunately, we do not have information about the forecasted demand of the period 2008 – 2010. Although, the historical data of 2011 show that the ADAT was 21 477 in this year, which represents a decrease of 46% relatively to the period from January to September of 2010 and only 40.7% of what was forecasted for 2011. So, the forecast error was about 60% of the traffic volume in 2011. The extrapolation presented in Figure 1, is based on the historical data of Costa de Prata until October 2010.

Figure 1. Costa de Prata Real traffic vs 2011 ADAT forecast vs Adjusted tendency.



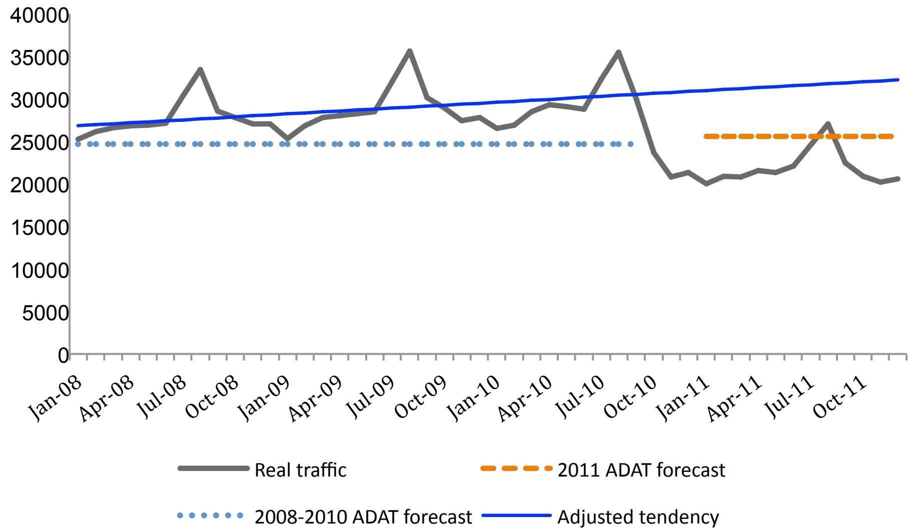
Source: Made by the authors, based on the traffic data available.

Estimating the tendency, not counting for the introduction of tolls and assuming that the traffic would continue to have the same pattern of growth, the average of 52 700 vehicles forecasted for 2011, would only be achieved on January 2014. However, for 2014 the forecasted traffic will be well above the 52 700. This analysis leads us to conclude that in addition to not rely on the introduction of tolls, the forecasts were inexplicable above of what could be projected for the future, based on the historical data. With the information available in 2010 and even if we do not count for the negative impact of the introduction of tolls, the forecasts based on the historical traffic should be around a ADAT of 43 529 for 2011, well below the 52 700 vehicles forecasted (which have counted for the introduction of tolls).

5.3.2. Renegotiation of Norte Litoral

From 2008 to 2010, the concession Norte Litoral registered ADAT of 27 774 vehicles in 2008, 28 910 in 2009 and an average traffic of 29 666 from January to September 2010. This represented a growth rate of 4.1% in 2009 and 2.6% in 2010. The average ADAT forecasted in the Base Case for the period 2008 – 2010 were 24 700 vehicles, which should be compared to the average 28 783 of real traffic verified, establishing a forecast error of 17%. For this period the real traffic verified revealed to be higher than what was projected primarily. The initial concession contract forecasted for 2011 an ADAT of 25 600 vehicles. The 2010 renegotiation decided to keep the values forecasted for 2011. Table A5.1, in the appendix A5, shows the results of applying the model we have used but for the concession and not for the highways individually. The figure 2 illustrates the differences between the real and forecasted traffic over the period 2008-2011.

Figure 2. Norte Litoral real traffic vs traffic forecasts.



Source: Made by the authors, based on traffic data available.

From 2010 to 2011, the average traffic decreased 26% to 21 893 vehicles which compares to the 25 600 predicted. The real traffic was 86% of the forecast, constituting a forecast error of 15%. This result evidences again a bad forecast of the negative effect that is expected from the introduction of tolls (given the negative elasticity of demand) that was also heightened by the economic crisis that was already installed.

5.3.3. Renegotiation of Grande Porto

The historical data of traffic in the Grande Porto concession show an ADAT of 37 218 vehicles in 2008, 39 508 vehicles in 2009 and an average of 39 415 vehicles from January to September 2010. This represents a positive variation of 6.2% in 2009 and a relatively constant (-0.2%) volume of traffic from 2009 to 2010. The historical data of this concession evidences an average daily annual traffic of 38 714 vehicles for the period of 2008-2010, when the predictions of the initial Base Case where 58 300 vehicles, constituting a forecast error of 34% (the real traffic was only 66% of what was projected).

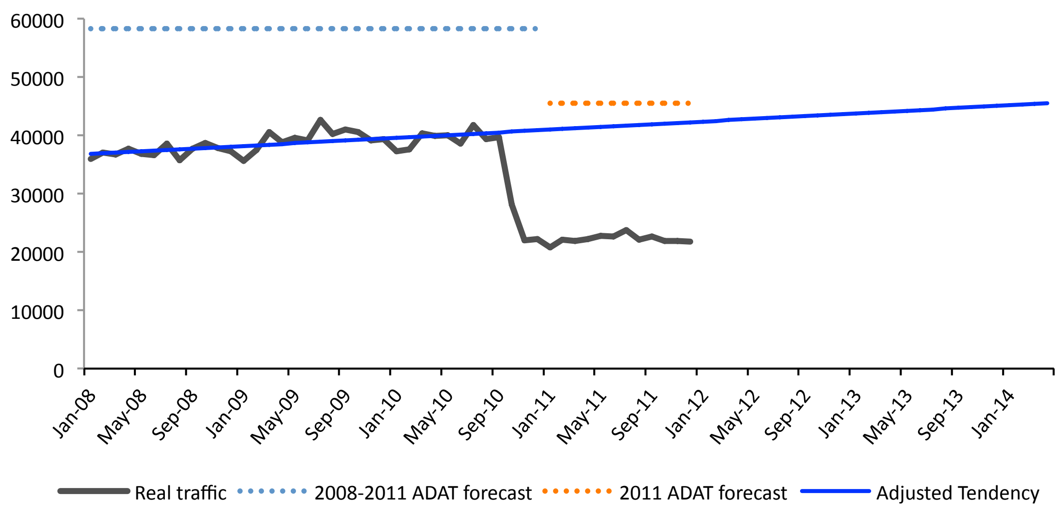
The renegotiation of 2010 reviewed the forecasted demand of 62 400 vehicles for 2011 to 45 500 vehicles. This represents a very optimistic forecast traffic variation of 15.4% relatively to 2010. Portugal was passing through a very difficult economic situation, with expectations of zero economic growth (or even recession) and the introduction of tolls would make us expect a decrease of the traffic volume.

Table A6.1, in the appendix A6 shows the results of the estimation of the traffic of the concession over the considered variables, for the period of January 2008 to September 2010.

The impact of gdp is not significant in the concession Grande Porto. However, applying the same reasoning as we did in the analysis of concession Costa de Prata, in order to have an average daily monthly increase (ADMT) of 6 085 vehicles in the first month (assuming that all the a ADMTs would increase 6085 vehicles to have an ADAT increase of 6085 vehicles for the overall year), the fuel prices, ceteris paribus, would have to fall approximately €0.73. These numbers are again unrealistic because it is an assumption that everything else remains constant, which do not apply in real economies. Moreover, it is assumed that the behaviour of the ADMT is equal in all months and, besides that, our model only explains 29.3% of the variation of the traffic demand, based on the considered variables. So, 70% of the variation is not explained. Even so, the forecast made in the 2010 renegotiation seems to us very optimistic given the historical data and the fact that we have to consider also the expected negative impact from the introduction of tolls.

Figure A6.1, of the Appendix A6 shows the evolution of the real traffic of the concession Grande Porto with comparison to the forecasted values. The forecasted traffic accounted for an increase of 15.4% but, as we can see, the real traffic in 2011 was well below the forecasted value. Actually, the traffic volume decreased by 43.7% compared with the period of January to September 2010 and corresponds to only about 48.8% of what was projected. The real traffic verified was less than a half of what was forecasted, constituting a forecast error of 51%. Figure 3 shows the results of the extrapolation of future traffic based on the data available until October 2010.

Figure 3. Grande Porto Real traffic vs 2011 ADAT forecast vs Adjusted tendency.



Source: Made by the authors, based on traffic data available.

If we extrapolate the future traffic based on the historical data available until October 2010 on Grande Porto, by estimating the tendency, we find that the daily average of 45 500 vehicles would only be achieved on April 2014, where the forecasted traffic is well above the 45 500 forecasted for 2011. This leads us again to conclude that the projections made for 2011, in addition to do not count for the negative impact of the introduction of tolls, where very optimistic and in complete discordance to what where the traffic profile until October 2010. Based on the historical records, and even if we do not count for the negative impact of the introduction of tolls (which was one of the main reasons for the renegotiation), the traffic forecasts, based on our projections, should be a ADAT of 41 618 vehicles. This is again well below the 45 500 vehicles forecasted, even not considering for the introduction of tolls (which must have been considered by the authorities in the renegotiation).

Table 5 and table 6 summarize the results obtained in the analysis of the forecasted traffic demand in comparison with the real traffic verified.

Table 5: **Real vs forecasted traffic for the period 2008 - 2010**

Before renegotiation - Period 2008 - 2010			
	Real traffic	**Forecasted Traffic**	**Forecasted error**
Costa de Prata	36017	not available	not available
Norte Litoral	28783	24700	-17%
Grande Porto	38714	58300	34%

Source: Made by the authors, based on INIR data and own calculations.

Table 6: **Real vs forecasted traffic for the period 2011**

After renegotiation - 2011			
	Real traffic	**Forecasted traffic**	**Forecasted error**
Costa de Prata	21477	52700	59%
Norte Litoral	21893	25600	14%
Grande Porto	22198	45500	51%

Source: Made by the authors, based on INIR data and own calculations.

Table 7: **Comparison between historical growth rate and forecasted growth rate of traffic for 2011**

This table identifies the traffic growth rates in 2009 and 2010, based on the available historical data. The column "renegotiation forecast" identifies the expected traffic growth for 2011, based on the real traffic of 2010, of the October 2010 renegotiation. "INIR forecast" identifies the expected decrease of traffic of INIR and "Real traffic" recognizes the effective variation of real traffic from 2010 to 2011.

	Historical data on growth rates		**Renegotiation forecast**	**INIR forecast**	**Real traffic**
	Year 2009	**Year 2010**	**Year 2011**	**Year 2011**	**Year 2011**
Costa de Prata	11.8%	9.3%	33.6%	-15%	-45.5%
Norte Litoral	4.1%	2.6&	-11.0%	-15%	-26.2%
Grande Porto	6.2%	-0.2%	15.4%	-15%	-43.7%

Source: Made by the authors, based on INIR data and own calculations.

The initial forecasted values revealed misappropriated to the real traffic verified. The renegotiation of 2010, that should update those forecasted values to reasonable values and account for a decrease resulting from the introduction of tolls (which INIR indicates as 15% on average, based on international experiences), revealed inadequate again. The forecasts were very optimistic and did not take into account the historical evidence of the pattern of traffic, as well as the negative effect of tolls. Grande Porto and Costa de Prata counted 51% and 59% of forecast errors, respectively.

6. Limitations of the study

This study presents some limitations, which have to be considered. The model proposed to estimate the demand risk of each highway presents some restrictions to estimate the demand risk per se. The value of R^2 of each highway is not a good indicator per se, since it can be conditioned by the highly significance of a variable. Therefore, the risk measures have to be made on a basis of comparison between SCUTS highways and Brisa's highways, which have to present characteristics as similar as possible, in order to compare its risk indicators ($1-R^2$). The comparison had to be done using only the data for the period before the introduction of tolls, since the insertion of the dummy variable "toll" would be highly significant in explaining the variation of traffic, causing a huge increase in the R^2 and, in this way, compromising the comparison with Brisa. The sample reduced to 33 observations, from January 2008 to September 2010. It would be interesting to perform this analysis for the period after the introduction of tolls, to compare the ex-SCUTS highways, which have now tolls, with the ones from Brisa. However, we would only have 13 observations to do so.

Regarding the analysis of the 2010 renegotiation, it does not present an extensive data on the traffic of the various highways, leading to an analysis centred on the period 2008-2011. Additionally, the unavailability of the base cases concerning the traffic forecasts and the information of models used by the authorities, limited the analysis to the data available in INIR, which for instance does not provide the forecasted demand for Costa de Prata for the period of 2008-2010.

7. Conclusions

The last decade in Portugal coincided with a period of low economic growth. The needed real convergence disappointed and the entry in the European single currency helped to show the divergence that already persists in relation to the major European economies. The gap of education, productivity, judicial efficiency and the lack of infrastructures have been used to justify the Portuguese growth delay relatively to the core countries of the European Union.

Given the fiscal constraints and the debt limits imposed by the entry in the monetary union, Portugal followed the path of public-private partnerships to try to modernize the country constructing new infrastructures, giving more opportunities to growth and generating employment, at least in the industry sector.

The 7 SCUTS PPP projects were launched with the intent of develop the more repressed areas of Portugal. However, their effective location were not so into this criteria as we could expect (as it is the example of concession Grande Porto). The comparative risk analysis based on the variables considered found the A22 in Algarve, A17 in Costa de Prata, A25 in Beiras Litoral e Alta and in Costa de Prata as having less demand risk than its correspondent highways in Brisa. Moreover, A23 from Beira Interior, A24 from Interior Norte and A28 from Norte Litoral exhibit the same pattern of risk as its compared highways, where the demand risk was carried by the private sector. The highways from Grande Porto A4, A41 and A42, A29 from

Costa de Prata and A27 from Norte Litoral revealed less predictability, and so, higher demand risk than the highways from Brisa.

These comparisons between the SCUTS highways and Brisa's highways must be done carefully. Since the Brisa's highways already had (and always had) tolls, it may let us considering that its R^2 can be less than if they do not had tolls. This might occur because in paid highways people will only use them if they really have to use and in these cases the explanatory power of the model may come conditioned.

The decision of introduction tolls in some SCUTS in 2010 raised two questions: 1) will the forecasted errors be corrected and adjusted to the historical data? And 2) are those highways really useful and the introduction of tolls cause, as it is mentioned by INIR, a fall of 15% on the average traffic based on international experiences? The analysis showed that the first did not apply and the second appear as a big doubt. As we can observe in the figures A7.1 and A7.2 of the Appendix A7, the traffic forecasts of the initial SCUTS contracts revealed very optimistic for the concession Grande Porto and Costa de Prata and below the real traffic in concession Norte Litoral. The projection period 2008-2010 for Costa de Prata is not available. However, in Grande Porto the forecast error for the period 2008-2010 was about 34% relatively to the real traffic verified and in Norte Litoral the real traffic was more 17% than the volume verified.

The 2010 renegotiation should have updated the previous forecasts, counting for the negative impact of the introduction of tolls and for the fact that Portugal was in a severe economic crisis. Nonetheless, it proved again to be even more optimistic and misappropriated. In Grande Porto and Costa de Prata the forecasted traffic for 2011 was exponentially greater than the historical data from 2008-2010. In 2011 the forecasted errors assumed unexplained values. The traffic in Grande Porto and Costa de Prata represented only 49% and 41%, of the respective forecasts, constituting forecast errors of 51% and 59%, which seems to be very huge even considering the economic crisis developments in 2011. Even if the forecasts did not count for the negative impact of the introduction of tolls, extrapolating the traffic demand based on the historical data available, the forecasts of Costa de Prata and Grande Porto will only start to be achieved in January 2014 and April 2014, respectively. This indicates that the projections were not made through the historical records and that were inexplicable optimistic. In other hand, the forecast traffic for Norte Litoral, which had revealed lower than the real traffic verified in 2008-2010, proved to be above the real traffic for the forecast for 2011. Here, the forecast error changed from -17% to 14% beyond the effective traffic, underestimating again the negative impact of the introduction of tolls. These results suggest that with the renegotiation, in addition to do not correct the traffic forecasts to the historical pattern of traffic, the new projections worsened the errors, given this scenario of introduction of tolls.

These results are in accordance with our findings regarding the demand risk analysis. Given that Grande Porto and Costa de Prata are composed by highways in which the predictability of traffic is lower, its forecast error revealed superior. Even though, we are very concerned about the magnitude of these numbers. The renegotiation led to very strange forecasts, inconsistent with the past and in the cases of Costa de Prata and Grande Porto well above the traffic patterns until then. This could let us consider that probably the public purse could have been better protected and their interests better negotiated. Moreover, the fact that international experiments show an average drop of 15% with the introduction of tolls and that in the Portuguese case that was far greater, leads us to question whether those highways were really needed. A so high initial forecast error and a so abnormal fall with the introduction of tolls let us to consider, at least, that those investments were not so useful and that they were carried out because of the possibility of put them in an off sheet balance, to promote employment and economic growth in those years of construction, rather than to mitigate an absolute necessity. A so higher error in the traffic demand has been counting for a great pressure in the State budget given that the predictions of revenues with the introducing tolls were made through traffic forecasts that, as we have seen, were completely inadequate.

8. Appendices

Appendix A1 – Panel regression

Traffic	Coef.	Robust std. errors	t	P>|t|
gdp	123.1338	34.70439	3.55	0.005
fuel	-4133.173	1203.903	-3.43	0.006
toll	-10742.87	2252.075	-4.77	0.001
summer	3410.52	717.0575	4.76	0.001
const	30609.27	1874.686	16.33	0.000

Pooled OLS vs FE: F(11;560)=871.903, p-value=0; Validates the alternative hypothesis of FE.

Pooled OLS vs RE (Breusch-Pagan): LM=10505.1; $p = prob(\chi^2(1) > 10505.1) = 0$; Does not accept the Pooled OLS as adequate model.

FE vs RE (Hausman): H=32.2061; $p = prob(\chi^2(4) > 32.2061) = 1.73624e^{-0.6}$; Does not accept the null hypothesis of consistent RE estimates. Validates the alternative hypothesis of FE.

Appendix A2 – Individual regressions

Algarve

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	-265.1406	222.7527	-1.19	0.244
fuel_price	9815.682	6163.919	1.59	0.122
summer	8237.683	1275.747	6.46	0.000
const	3396.329	3396.329	0.43	0.674
				R^2=0.6677

Beira Interior

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	-19.71538	87.66577	-0.22	0.824
fuel_price	676.2631	2077.885	0.33	0.747
summer	2361.089	430.0601	5.49	0.000
const	9018.38	2692.531	3.35	0.002
				R^2=0.5517

Beiras Litoral e Alta

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	50.29005	109.8669	0.46	0.651
fuel_price	-48.20645	2449.7	-0.02	0.984
summer	3153.673	507.0148	6.22	0.000
const	12823.14	3174.331	4.04	0.000
				R^2=0.6029

Costa de Prata A17

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	432.147	202.4115	2.13	0.041
fuel_price	-15548.17	5322.884	-2.92	0.007
summer	4878.138	1101.678	4.43	0.000
const	36661.03	6897.415	5.32	0.000
				R^2=0.4324

Costa de Prata A25

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	133.1973	171.0697	0.78	0.443
fuel_price	-5436.919	5088.158	-1.07	0.294
summer	6449.612	1053.097	6.12	0.000
const	38005.23	6593.257	5.76	0.000
				R^2=0.5719

Costa de Prata A29

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	355.6551	149.9589	2.37	0.025
fuel_price	-7730.357	4895.404	-1.58	0.125
summer	2608.849	1013.203	2.57	0.015
const	55842.63	6343.485	8.80	0.000
				R^2=0.2627

Grande Porto A4

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	-3497829	104.9664	-0.33	0.741
fuel_price	-6700.332	4682.159	-1.43	0.163
summer	796.1759	969.0673	0.82	0.418
const	65057.6	6067.161	10.72	0.000
				R^2=0.1280

Grande Porto A41

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	287.5	94.29849	3.05	0.005
fuel_price	-13432.96	4207.107	-3.19	0.003
summer	3161.469	870.7456	3.63	0.001
const	59493.27	5451.586	10.91	0.000
				R^2=0.4029

Grande Porto A42

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	176.911	72.10998	2.45	0.020
fuel_price	-6732.845	2144.781	-3.14	0.004
summer	1531.031	443.9056	3.45	0.002
const	32613.25	2779.216	11.73	0.000
				R^2=0.3667

Interior Norte

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	215.3477	73.32866	2.94	0.006
fuel_price	-2469.436	1735.989	-1.42	0.166
summer	1973.39	359.298	5.49	0.000
const	9120.619	2249.502	4.05	0.000
				R^2=0.3667

Norte Litoral A27

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	42.8771	61.20857	0.70	0.489
fuel_price	-731.2585	1820.538	-0.40	0.691
summer	2455.254	376.7971	6.52	0.000
const	10832.57	2359.061	4.59	0.000
				R^2=0.6163

Norte Litoral A28

Traffic	Coef.	Std. errors	t	P>|t|
gdpweight	78.30328	119.4976	0.66	0.517
fuel_price	-3298.807	3730.748	-0.88	0.384
summer	5380.047	772.1536	6.97	0.000
const	36651.04	4834.319	7.58	0.000
				R^2=0.3667

Appendix A3

Table A3.1. Demand risks, average traffic and std. dev. of each highway - SCUTS

SCUTS	Avg.	Max	Min	Std. Dev.	Std. Dev/avg	Coefficient of urbanism	(1-R^2)
Algarve A22	18570	31764	13365	5062.3	0.273	1.861	0.3322
Beira Interior A23	10552	14529	8669	1469.2	0.139	1.594	0.4483
Beiras Litoral e Alta A25	13578	18899	11349	1840.6	0.136	1.499	0.3971
Costa de Prata A17	17524	24829	11043	3345	0.191	1.768	0.5680
Costa de Prata A25	32608	41524	27534	3682	0.113	2.000	0.4282
Costa de Prata A29	46151	52018	40896	2699.2	0.058	2.195	0.7374
Grande Porto A4	57701	61976	51029	2373.9	0.041	3.000	0.8721
Grande Porto A41	42558	47912	38482	2577.6	0.061	3.000	0.5975
Grande Porto A42	24155	26507	21866	1276	0.053	2.000	0.6335
Interior Norte A24	6282.6	10626	4640	1240.1	0.197	1.592	0.4393
Norte Litoral A27	10511	14937	8984	1391.4	0.132	2.000	0.3838
Norte Litoral A28	33775	41405	29563	2936.3	0.087	2.099	0.3619

Table A3.2. Demand risks, average traffic and std. dev. of each highway – Brisa

BRISA	Avg.	Max	Min	Std. Dev.	Std. Dev/avg	Coefficient of urbanism	(1-R^2)
A1	33691	44125	26944	3962.8	0.118	2.284	0.4431
A2	17758	32716	11970	5403.2	0.304	1.416	0.3874
A3	18476	24238	14872	2490.8	0.135	2.296	0.3570
A4	24554	29263	20096	1927.9	0.079	2.058	0.4230
A5	80916	102052	63940	10849	0.134	3.000	0.5287
A6	5215.2	6655	4073	629.73	0.121	1.438	0.4549
A9	26016	29316	13331	2982.6	0.115	3.000	0.9299
A10	6715.7	8204	5348	606.86	0.090	1.986	0.4809
A12	22273	26194	19079	1873.3	0.084	1.756	0.6289
A13	5241.8	11800	3358	2216	0.423	1.714	0.5917
A14	6517.7	14889	4317	2432.3	0.373	2.083	0.6063

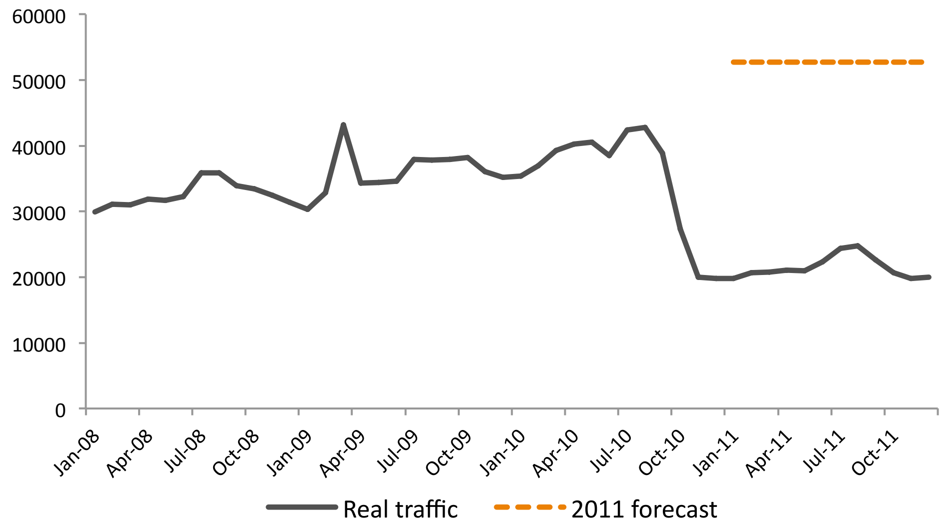
Appendix A4

Table A4.1. Costa de Prata regression

(Notice that here the coefficient of urbanism, that is multiplied by the gdp, is 2.0466)

Traffic	Coef.	Robust std. errors	t	P>|t|
gdp	528.725	208.899	2.63	0.014
fuel_price	-16020.08	6358.093	-2.52	0.018
summer	4515.295	1315.936	3.43	0.002
const	55754.69	8238.844	6.77	0.000
				R^2=0.3527

Figure A4.1. Costa de Prata Real traffic vs 2011 ADAT forecast



Appendix A5

Table A5.1. Norte Litoral Regression

(Notice that here the coefficient of urbanism, which is multiplied by the gdp, is 2.0777)

Traffic	Coef.	Robust std. errors	t	P>|t|
gdp	70.8558	105.0668	0.505	0.505
fuel_price	-2739.046	3246.43	-0.84	0.406
summer	4742.547	671.9142	7.06	0.000
const	31022.45	4206.737	7.37	0.000
				R^2=0.6450

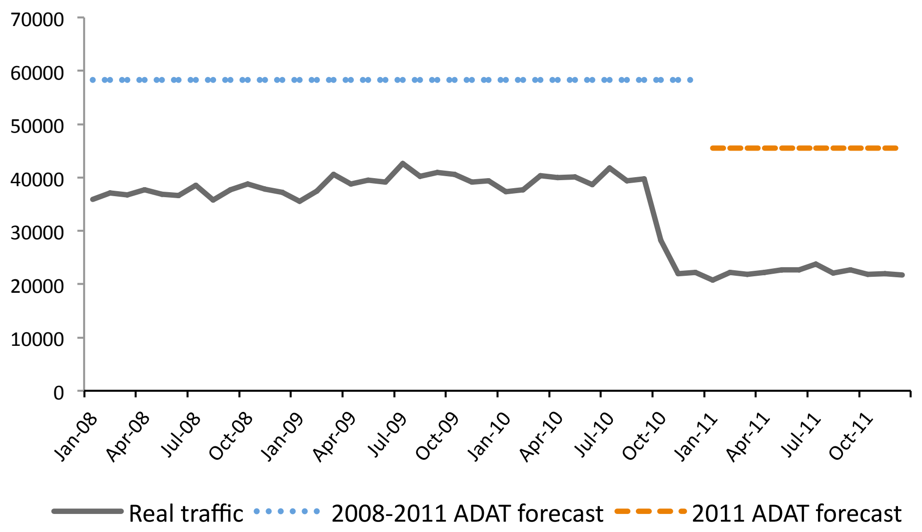
Appendix A6

Table A6.1. Grande Porto regression

(Notice that here the coefficient of urbanism, which is multiplied by the gdp, is 2.4575)

Traffic	Coef.	Robust std. errors	t	P>|t|
gdp	115.3955	85.2926	1.35	0.187
fuel_price	-8300.179	3117.182	-2.66	0.013
summer	1924.159	645.1638	2.98	0.006
const	48981.75	4039.258	12.13	0.000
				R^2=0.2928

Figure A6.1. Grande Porto real traffic vs traffic forecasts



Appendix A7

Figure A7.1. Absolute forecast errors

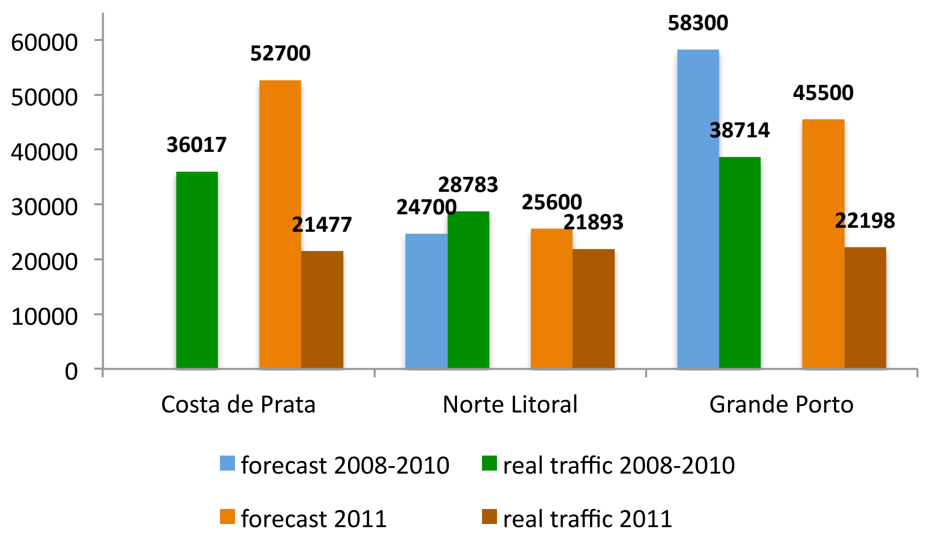
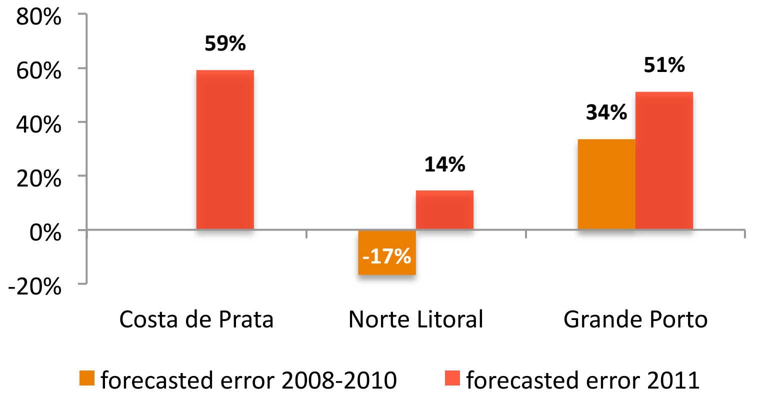


Figure A7.2. Relative forecast errors



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