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# Measuring the Extent of European State Aid Control: An Econometric Analysis of the European Commission Decisions[1]

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## Avrupa Devlet Yardımı Kontrolünün Kapsamını Ölçmek: Avrupa Komisyonu Kararlarının Ekonometrik Bir Analizi[2]

### Abstract

This paper provides an analysis of the European Commission (EC) decisions on state aid control using data on 550 state aid cases approved by the EC between 1998 and 2009. We measure the determinants of the duration of state aid, total budget of state aid and daily budget of state aid. By using these imperfect proxies, we try to identify the extent of European state aid control. Our results suggest that aid with multiple objectives to achieve has both longer durations and higher amounts of budget. We also find that for some aid objectives or industries, the EC approves cases of aid with both longer durations and higher levels of budget. On the other hand, for some class of aid objectives and industries, there is a trade-off between duration and the level of budget to counter-balance the undesired effects. The interpretation of the results implies that the European state aid control, which once was originally intended to address concerns about export subsidies and strategic trade, recently puts more emphasis on market failures mostly associated with externalities and public goods.

**Keywords** : State Aid Control, Europe, Duration Analysis, Quantile Regression.

**JEL Classification Codes** : K21, L40, L50, H25.

### Öz

Bu makale, Avrupa Komisyonu (AK) tarafından 1998 ve 2009 yılları arasında onaylanan 550 farklı devlet yardımı vakasının verisini kullanarak AK kararlarının bir analizini sunmaktadır. Devlet yardımlarının süresinin, devlet yardımlarının toplam bütçesinin ve devlet yardımlarının günlük

[1] *This article is the revised and extended version of the paper presented in "First International Annual Meeting of Sosyoekonomi Society" which was held by Sosyoekonomi Society and CMEE - Center for Market Economics and Entrepreneurship of Hacettepe University, in Munich/Germany, on October 29-30, 2015.*

[2] *Bu makale Sosyoekonomi Derneği ile Hacettepe Üniversitesi Piyasa Ekonomisini ve Girişimciliği Geliştirme Merkezi tarafından Almanya'nın Münih şehrinde, 29-30 Ekim 2015 tarihlerinde düzenlenen "Birinci Uluslararası Sosyoekonomi Derneği Yıllık Buluşması"nda sunulan çalışmanın gözden geçirilmiş ve genişletilmiş halidir.*

bütçesinin belirleyicileri ölçülmektedir. Bu üç vekil değişken kullanılarak, Avrupa devlet yardımı kontrolünün içeriğinin belirlenmesine çalışılmaktadır. Sonuçlar, birden fazla amacı olan devlet yardımlarının hem daha uzun sürdüğünü hem de daha yüksek bütçeli olduğunu göstermektedir. Belli amaçlar doğrultusunda verilen veya bazı endüstrilere verilen devlet yardımlarının ise hem daha yüksek bütçeli hem de daha uzun süreli olduğu görülmektedir. Öte yandan, arzu edilmeyen etkileri dengelemek adına, başka devlet yardımları için ise süre ve tutar arasında bir ödünleme olduğu bulunmuştur. Bulunan sonuçlar, bir zamanlar stratejik ticarete ve ihracat desteklere odaklanan Avrupa devlet yardımı kontrolünün, son zamanlarda dışsallıklar ve kamu mallarıyla alakalı olarak piyasa başarısızlıklarına daha çok vurguda bulunduğunu göstermektedir.

**Anahtar Sözcükler** : Devlet Yardımı Kontrolü, Avrupa, Süre Analizi, Kuantil Regresyon.

## 1. Introduction

Governments tend to give financial support to companies in numerous ways owing to their incentives to shift a larger share of rents to be earned in the market to their sides. Generally, this form of financial aid has the impact of distorting competition in the internal market. The purpose of European state aid control is to enable European member states to grant state aid to address real market failures while avoiding the distortions of competition that this type of state intervention might give rise to.

The objective of this paper is to provide an analysis of the European Commission (EC) decisions on state aid control. In doing so, we adopt a positive approach rather than a normative approach, explaining *what the state of affairs is* instead of *what the state of affairs ought to be*. We characterize the last decade of European state aid control policy in summary statistics and, detailed quantile regression and duration analysis on 550 state aid cases in total.

This paper is not the first attempt to analyze the EC's decisions on antitrust issues. Previously, Carree et al. (2010) have provided a statistical analysis of all 538 formal Commission decisions under Articles 81, 82, and 86 of the European Community Treaty (cases of state aid excluded). Elsewhere, Buts et al. (2011) investigate the determinants of state aid decisions given by the European Commission using data for 2007.

In our paper, we consider three imperfect proxies to measure the impact of state aid: duration of state aid, total budget of state aid and daily budget of state aid. By using these imperfect proxies, we try to identify the extent of European state aid control. Our results suggest that aid with multiple objectives to achieve has both longer durations and higher amounts of budget. Our findings also reveal that for some aid objectives or industries, the EC approves aid with both a long duration and a high budget. Among these objectives, there are environmental protection aid, which is thought to be in the sphere of negative externalities, and aid given for services of general economic interest (SGEI), which occupy a specific position in the economies of the member states of EU. As to the industries, real estate activities sector draws special attention, as it is an example to the industries that can be characterized as being industries where public goods are not provided by the market up to an efficient level because it is not lucrative to do so. On the other hand, for some class of aid objectives and industries, there is a trade-off between duration and the level of budget so

as to counter-balance the undesired effects. Aid given as a remedy for serious disturbance in the economy or aid given to the industries of public administration and defense; compulsory social security can be given as examples.

According to Heidhues and Nitsche (2006) it is obvious that EU state aid control has evolved over time. What once was originally intended to address concerns about export subsidies and strategic trade has now become Article 107, which is the legal basis for state aid control in Europe. In the light of the findings above, the emphasis of state aid control is more on market failures mostly associated with externalities and public goods.

The remainder of this paper is organized as follows: The following section presents an extensive review of the literature examining the incentives of governments to provide state aid together with the review of the literature on distortionary impact of state aid. In Section III, we explain the legal framework about state aid control in Europe and describe the data used in this study. In Section IV, we present the estimation strategy and introduce various specifications. In Section V, we report the estimation results. Finally, we discuss the findings and conclude in Section VI.

## 2. A Pure Economic Approach to European State Aid: An Overview

Even though limited interest was shown in the economic analysis of state aid by scholars, recently there has been vivacity in this "virgin" field of antitrust economics, which can be seen from the fact that one chapter has been devoted to European State Aid Control in the Handbook of Antitrust Economics. Yet, most of the analysis about the practice of European state aid control is model- and econometric analysis-free and could not go beyond suggesting some principles based on vague and immeasurable definitions. As witnessed by Martin and Valbonesi (2006), formal treatments are scanty. According to Spector (2006) this is partly due to the lack of interest for this field in the United States, where there is no control for state aid. More fundamentally, an evaluation of state aid control from an economic perspective does not include well-defined research questions, but instead an immense array of various fields of economics.

As pointed out by Friederiszick et al. (2006), the economics of state aid is connected to various areas of economics: first, to public economics, as state aid is an interventionist activity by the governments and is financed by taxes; second, to the economics of competition, since state aid provides assistance to some companies and, therefore, has the potential impact to distort competition; and third, to international trade theory, as state aid may alter trading conditions. Indeed, most of the previous literature on the potential impact of state aid has centered more on competition between member countries to grant state aid instead of considering the competitive effects of state aid within an integrated market. Beginning with Collie (2000), this strand of the literature asked the question of whether the prohibition of state aid increases overall welfare.

Ignoring non-economic or political expositions for state aid such as the inclination of governments to assist non-competitive and inefficient domestic firms and to support

employment in specific sectors for political interests, Collie (2000) presents a partial equilibrium analysis of the welfare effects of production subsidies -which are proxies for state aid- in a homogenous good Cournot oligopolistic industry located within a single integrated market. His model can be seen as a two-stage game where at the first stage the national governments set production subsidies to maximize their national welfare and firms compete in a Cournot oligopoly at the second stage. Collie's models main finding is that the multilateral prohibition of subsidies would raise welfare of all countries hence providing a rationale for a general ban of state aid. However, two possible sources of deficiencies emerge in his model. Firstly, considering product differentiation instead of homogenous goods case, one might conjecture that product differentiation would reduce the impact that one jurisdiction's subsidy will have on the firms located in other jurisdictions. In other words, when products are adequately differentiated, the rationale for the multilateral ban or control on subsidies may be tapered. Secondly, switching from Cournot oligopoly to Bertrand oligopoly might change the results considerably. Taking these issues into consideration, Collie (2002) presents a symmetric model with identical firms where they produce differentiated products and market structure is either Cournot or Bertrand oligopoly. A production subsidy was used as a proxy for state aid as in Collie (2000). His main results indicate that under both Cournot and Bertrand oligopoly, if the products are adequately close substitutes then there is a range of values where the Nash equilibrium subsidy is positive and where the multilateral prohibition of subsidies will raise the welfare of all countries. On the other hand, if the products are differentiated enough then there is a range of values where the Nash equilibrium subsidy is positive and where the multilateral prohibition of subsidies will reduce the welfare of all countries under both Cournot and Bertrand oligopoly. Assuming Bertrand oligopoly instead of Cournot oligopoly does not change the results in a considerable way.

Even though these two articles give a flavor as to why member states tend to give state aid and why the European Commission (EC) would prohibit them, they have been subject to criticism based on the fact that production subsidies –which are proxies for state aid in these articles- are not allowed under EC state aid control policy, and that state aid for investment and research and development (R&D) are more germane to the prevailing policy. Based on these critiques, Collie (2005) augmented the analysis in Collie (2000, 2002) by including the investment or R&D decisions of firms, and adding subsidies to investment or R&D given by the member states. In order to model R&D, he considered a non-strategic case in which firms set output and R&D simultaneously, whereas he thought of a strategic case so as to model investment where firms set investment given subsidies, and then firms set output given investment decisions. Under this set up, he showed that when there are no spillovers, the prohibition of state aid to investment will raise welfare. In a similar vein, welfare will increase if state aid to R&D is prohibited when spillovers are low. On the other hand, when the spillovers to R&D are at a moderate level, whether the ban on state aid to R&D will raise or reduce welfare hinges on the opportunity cost of government revenue. Finally, the prohibition of state aid will always decrease welfare when the spillovers from R&D are large enough.

As opposed to this general literature on subsidies, which are built upon models that are akin to models in the strategic trade, tax competition and rent-seeking literature, Martin and Valbonesi (2006, 2008) focus on the idea that the incentive to provide state aid is endogenously determined by the process of market integration. That is, they consider the idea that the process of market integration itself creates pressure for granting state aid, since market integration may result in exit by firms absent state aid. Apart from political arguments, they come up with the explanation that market integration activates an exit process by firms and consequently generates incentives for governments to subsidize their inefficient domestic firms at the expense of common market welfare.

One should bear in mind that the models considered so far examine incentives of governments to grant state aid and these models except Martin and Valbonesi (2006, 2008) are models of symmetric oligopoly. Different from these models that try to come up with pure economic explanations to the incentives of governments to give state aid, Møllgaard (2005) focuses on how state aid distorts competition by conferring competitive advantages to firms receiving them. A priori, the resulting equilibrium is asymmetric as long as state aid is existent. Another distinct feature of Møllgaard's model is that he models state aid as reducing the cost of capital to the firm rather than assuming that state aid decreases the recipient's marginal costs. In turn, state aid in the form of reduction in the cost of capital enables the recipient firm to invest more and the competitors to invest less in quality. Consequently, the recipient's price adjusted for the quality will be lower than the case that would materialize under a level playing field. In the extreme case where the aid is colossal, the demand-boosting investments in quality are of significant importance, and/or investments in cost reducing process innovation are substantial, then the non-recipient firm might be required to exit the market, which means that state aid may be predatory.

A more thorough analysis of the distortions of competition induced by state aid was performed by Garcia and Neven (2005). They consider three variants of state aid (state aid affecting marginal cost, subsidies affecting entry and subsidies affecting the degree of vertical product differentiation) and analyze whether specific market characteristics are robust indicators of the intensity of the distortions under these three different scenarios. The authors find that in all three scenarios, an increase in market concentration is conducive to an increase in price distortions that are borne by both domestic and foreign firms supporting the premise that state aid is more probable to abet distortions in concentrated markets. Furthermore, intense domestic rivalry proxied by low product differentiation or low margins is not a robust indicator of the intensity of distortions, since its impact hinges on the type of state aid, which suggests that the degree of rivalry should be evaluated carefully when measuring the magnitude of the distortion. Lastly, a greater degree of market segmentation in all three cases will protect the foreign firm from state intervention and raise the distortion experienced by domestic firms.

In addition to forms of state aid mentioned in the models above, other types of state aid relevant to the economics of competition are rescue and restructuring subsidies that are subject to strict regulation in the European Union. These rescue and restructuring subsidies known as bailouts are granted not only on political grounds but also on economic grounds.

For instance, if a firm in failing conditions is a monopolist in supplying nationwide services required for economic activities such as railways, then a bailout might be imminent to prevent a huge negative externality on the whole economy. Besides, if the bankruptcy of a firm in jeopardy leads to enormous job losses in a region with high rates of unemployment, a bailout may also be justified. A general formal treatment for rescue and restructuring subsidies is proposed by Glowicka (2008). She considers an asymmetric duopoly model (asymmetric in the sense that firms have asymmetric production costs) with two firms located in a different jurisdiction and selling in a common market. These firms restructure so as to decrease their unit production costs and then compete in a Cournot setting. Her results suggest that if cost asymmetry is not too large and the restructuring aid granting country is small enough, the subsidy saves the inefficient firm (which she calls successful rescue), increases the welfare of the intervening country by raising the profits of the aid recipient and reduces the surplus of all consumers in the integrated market. On the other hand, if the cost differential between firms is excessive, the subsidy is granted, yet it does not avert the subsidized firm from leaving the market (which she calls failed rescue).

In practice, the effectiveness of bailouts in Europe has been of a great concern, as only between 1992 and 2003, 79 firms going through difficulties were shored up with firm-specific aid of which total corresponds to billions of Euros (Glowicka, 2008: 21). In an attempt to measure the effectiveness of rescue and restructuring aid in Europe, Chindooroy et al. (2007) study the survival of companies having been granted rescue or restructuring aid in the EU between 1995 and 2003. Employing a one-period discrete choice model, they find that a high fraction of firms receiving rescue aid corresponding to about 50% were not able to survive. Besides, failure among restructuring aid recipients is less prevalent (about 20%). A more comprehensive analysis regarding the effectiveness of rescue and restructuring aid was performed by Glowicka (2008). She analyzes rescue and restructuring aid conferred to 79 firms from 10 European countries between 1992 and 2003. Her results indicate that in the first four years after the state aid, firms leave the market at an increasing rate, which suggests that the firms went bankrupt with a delay. 29% of the recipients exit anyway. She ascribes such high bankruptcy rates to possible deficiencies in the European Commission's decision-making process, as bailouts of firms with low probabilities for survival should have been acceded.

Friederiszick et al. (2003) examine the effectiveness of state aid in boosting the efficiency of railways in the 15 EU countries by estimating a stochastic frontier production function for the incumbent monopolists during the period 1988-2000. Their results reveal a positive link between aid level and efficiency. Moreover, they also show that in member states with lower aid intensity, aid brings about more investment in comparison to countries with higher aid intensity.

In a more recent study, Stöllinger and Holzner (2016) use data on state aid given to the manufacturing industries by 27 EU Member States over the period 1995-2011, and find that state aid has an insignificant effect on manufacturing value added exports. Van Cayseele (2014) examine all European state aid cases that were conferred in manufacturing during the

period 2003-2011, and conclude that state aid boosts productivity growth especially when firms are financially constrained.

To sum up, competition scrutiny of state aid is of crucial importance in order to distinguish good state aid from bad state aid. Nonetheless, the relevant economics literature has not grown up yet to provide economic principles to evaluate the potential impact of state aid on competition.

## 3. Institutions and Data

### 3.1. The Legal and Procedural Framework for State Aid Control in the EU

State aid control is crucial to assure a level playing field for European firms and to prevent European governments from involving in lavish subsidy races for which the taxpayers would have to bear the expenses. Article 107 (ex Article 87 of TEC) of the Treaty on the functioning of the European Union (TFEU) regulates the main principles concerning state aid. More specifically, Article 107(1) puts that state aid is, in essence, incompatible with the common market. However, this incompatibility principle does not mean an absolute prohibition of state aid as such. Articles 107(2) TFEU and 107(3) TFEU of the Treaty stipulate several cases where state aid can be deemed permissible. Particularly, for the majority of approved state aid cases, the most pertinent clauses are 107(3)(a) and 107(3)(c) of the Treaty. The European Commission is given the authority to control these cases under Article 108 of the Treaty. State aid rules are only applicable to measures fulfilling the criteria outlined in Article 107(1) TFEU, which are transfer of state resources, economic advantage, selectivity, and impact on competition and trade.

Several competent bodies are responsible for the application of state aid rules for various sectors. For instance, for the aid granted in the sectors related to the production and marketing of agricultural and fisheries products, the state aid units of the DG Agriculture and Rural Development and the DG Maritime Affairs and Fisheries are responsible. For state aid to transport sectors, the state aid unit of DG Energy and Transport is the competent body. Likewise, DG Energy and Transport is also competent for the application of state aid rules to the coal sector. Finally, aside from the DG Agriculture and Rural Development, DG Maritime Affairs and Fisheries and DG Energy and Transport, DG Competition is competent for aid measures in all remaining sectors.

The regulation of state aid rests on a system of *ex ante* authorization. According to this system, member countries have to notify the Commission of any plan to grant state aid and this aid is not put into effect before it has been approved by the Commission, which has the authority under Article 108 of the Treaty. Save the proposed aid falls under the scope of

the General Block Exemption Regulation[3] (GBER) or the *de minimis* Regulation[4], states cannot grant any aid unless they have notified and have been allowed by the Commission. Any state aid, which is conferred absent the Commission consent, is accordingly put down as "unlawful aid".

Recently, in order to overcome the challenges brought about by the enlargement in 2004 and the increasing complexity, and to utilise state aid rules to induce member states to contribute to the Lisbon Strategy, the EC implemented its State Aid Action Plan[5] (SAAP) during the period 2005–2009. The aim of the SAAP was to present a reform package emphasizing (i) less and better targeted state aid, (ii) a more refined economic approach, (iii) more effective and transparent procedures, and, (iv) improved cooperation between the EC and member states. In addition, the SAAP delineated eight key priorities: (a) targeting innovation and R&D to strengthen the knowledge society, (b) creating a better business climate and stimulating entrepreneurship, (c) investing in human capital, (d) high quality services of general economic interest, (e) better prioritization through simplification and consolidation, (f) a focused regional aid policy, (g) encouraging an environmentally sustainable future, and (h) setting up modern transport, energy and information and communication technology infrastructures.

Having described the legal and institutional framework, we explain the data used in our study and present the estimation strategy in the next section.

### 3.2. Data Sources and Description of Variables

The relevant data for this study has been extracted from the competition cases database of the EC. Besides, for further details for each case, we have looked at the Official Journal of the European Communities. The sample of state aid cases considered in this study includes regional and sectoral aid together with the following horizontal aid schemes: training, innovation, employment, energy saving, rescuing firms in difficulty, research and development, SMEs (small- and medium size enterprises), restructuring firms in difficulty, environmental protection, services of general economic interest, remedy for a serious disturbance in the economy, and other aid. These state aid cases were approved by the EC over the period 1998-2009. Note that for these cases DG Competition was the competent body for the application of state aid rules. Therefore, state aid cases for which DG Agriculture and Rural Development, DG Maritime Affairs and Fisheries and DG Energy and Transport were the competent bodies have been excluded from our analysis. In total, we have 550 observations.

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[3] *Commission Regulation (EC) No 800/2008 of 6 August 2008, Official Journal of European Union, L 214: 3-47.*

[4] *Commission Regulation (EC) No 1998/2006 of 15 December 2006, Official Journal of the European Union, L 379: 5-10.*

[5] *<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0107:FIN:EN:PDF>, 28.02.2015.*

For each state aid case we collected information on the following:

*Dependent Variable 1: Duration of state aid cases*

We have collected the beginning and end dates for each state aid case. None of these dates are censored. There are several reasons to focus on state aid duration. Firstly, duration is one of the most important ingredients of the so-called proportionality test, which ensures that the duration, intensity and scope of the aid must be proportional to the importance of the desired outcome. For instance, in cases where market failures -which are among the most noteworthy justifications for state aid approval-, are long-lasting, a longer duration of aid is required. Alternatively, some forms of state aid are considered to have a (more) distortive impact if aid is conferred over a longer period of time. Consequently, measuring duration of state aid will tell a lot about the extent of state aid control in Europe.

*Dependent Variable 2: Total budget of state aid cases*

The amount of total budget allocated for each state aid case has also been collected. These are in Euros and adjusted for inflation. The budget is also one of the most important ingredients of the so-called proportionality test mentioned above. For instance, in cases where market failures -which are among the most noteworthy justifications for state aid approval-, are chronicle, a higher amount of budget is required.

*Dependent Variable 3: Daily budget of state aid cases*

Finally, we have generated a variable by dividing the total budget by the duration of state aid cases. These are also in Euros and adjusted for inflation. This will tell us how "intense" an aid is.

*Independent Variables:*

*Country dummies*: These dummy variables indicate in which member state, aid was granted. These variables are included to control for country-specific inclinations to give state aid to industries. In total, there are 27 country dummies, covering all EU-27 member states.

*Primary objective of cases*: These are dummy variables indicating the primary objectives of state aid cases. The coefficients on these variables indicate if the European Commission's attitude towards aid cases with different objectives are divergent. These primary objectives refer to regional and sectoral aid together with the horizontal aid schemes mentioned above.

*Average real GDP change during state aid case:* This variable is the average real GDP change during state aid case. The inclusion of this variable is due to the fact that state aid duration and budget is affected by macroeconomic conditions.

*Industry dummies*: These dummy variables show to which industry aid is conferred or in which industry aid recipient operates. These variables are included to check whether

certain industries are favored in terms of state aid duration and budget. This classification is made according to NACE Rev 2 level.

*Year dummies:* These are the dummy variables showing in which year the state aid case was approved by the EC to control for approval year fixed effects. These are similar to notification year dummies in Buts et al. (2011).

However, one should bear in mind that it might also be the case that an aid has multiple objectives (for instance, an aid might have both the objectives of energy saving and environmental protection) and/or that aid is given to several industries (for instance, an aid might be given to all industries in an underdeveloped region). In order to control for these, several dummy variables have been created. The definitions of these variables can be found in the summary statistics further demonstrate that manufacturing industries receive state aid for many times. The highest daily budget belongs to those cases of aid given to the industries of financial and insurance activities. As discussed by Van Cayseele et al. (2014), as a result of 2008 financial crisis, there has been a tremendous increase in state aid given to these industries. Furthermore, aid given to the industries of accommodation and food service activities, of real estate activities, and of public administration and defense; compulsory social security has the longest mean duration, while aid given to the industry of financial and insurance activities has the shortest mean duration. On the other hand, the highest amount of both daily and total budget belongs to the aid conferred to the industry of financial and insurance activities. The sample statistics on the mean daily budgets and durations for each state aid objective show that remedy for serious disturbance aid has both the shortest mean duration and the highest mean total and daily budget. Finally, according to the summary statistics on the mean duration, daily and total budget of state aid cases by selected characteristics, for those cases of aid given to a single industry, duration is longer and, total and daily budget is higher for aid with multiple objectives.

### 3.3. Sample Statistics

According to the summary statistics[6], the average duration of state aid in our sample is approximately 859 days, with a standard deviation of 654 days. Most of state aid cases in our sample consist of aid given in large economies. German state aid cases dominate the sample with 90 observations, followed by 72 Italian and 67 British cases of state aid. Apart from Malta (with 1 observation), Lithuania, France, and Luxembourg are the top 3 countries in terms of state aid duration. Furthermore; Luxembourg, Netherlands and Denmark are the countries where state aid has the highest level of total budget. As to daily state aid budget, the Netherlands and the U.K. rank top together with Luxembourg. On the other hand, when

[6] *For a more detailed overview of the sample statistics and further analyses, the reader can refer to the online appendix, which can be found in the following link: <https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxmY296YnVnZGF5fGd4OmE0NTYxYjY5YzNjMmI0NQ>, 28.02.2015.*

crisis measures are excluded, the top 3 member states for state aid duration do not change, while France, Ireland and Romania rank top for both daily and total state aid budget.

The summary statistics further demonstrate that manufacturing industries receive state aid for many times. The highest daily budget belongs to those cases of aid given to the industries of financial and insurance activities. As discussed by Van Cayseele et al. (2014), as a result of 2008 financial crisis, there has been a tremendous increase in state aid given to these industries. Furthermore, aid given to the industries of accommodation and food service activities, of real estate activities, and of public administration and defense; compulsory social security has the longest mean duration, while aid given to the industry of financial and insurance activities has the shortest mean duration. On the other hand, the highest amount of both daily and total budget belongs to the aid conferred to the industry of financial and insurance activities. The sample statistics on the mean daily budgets and durations for each state aid objective show that remedy for serious disturbance aid has both the shortest mean duration and the highest mean total and daily budget. Finally, according to the summary statistics on the mean duration, daily and total budget of state aid cases by selected characteristics, for those cases of aid given to a single industry, duration is longer and, total and daily budget is higher for aid with multiple objectives.

**Table: 1**
**Variables and Definitions**

| **Core Characteristics** | |
|---|---|
| multiple_objectives | 1 = aid has more than one objective to achieve |
| multiple_industries | 1 = aid is given to several industries |
| ln_budget | Log of total budget of state aid |
| daily_budget_m | Daily budget of aid in million Euros (inflation adjusted) |
| **Primary Objective Dummies** | |
| training | 1 = Training |
| regional | 1 = Regional aid |
| sectoral | 1 = Sectoral aid |
| rd_innovation | 1 = Research and development or innovation |
| employment | 1 = Employment |
| energy | 1 = Energy saving |
| rescue | 1 = Rescuing firms in difficulty |
| sme | 1 = SMEs (small- and medium size enterprises) |
| restructuring | 1 = Restructuring firms in difficulty |
| environmental | 1 = Environmental protection |
| general interest | 1 = Services of general economic interest |
| remedy | 1 = Remedy for a serious disturbance in the economy |
| other | 1= Other |

| **Industry Dummies** | |
|---|---|
| agriculture | 1 = Aid is given to the industry of agriculture, forestry and fishing |
| mining | 1 = Aid is given to the industry of mining and quarrying |
| manufacturing | 1 = Aid is given to the industry of manufacturing |
| electricity & gas | 1 = Aid is given to the industry of electricity, gas, steam and air conditioning supply |
| water & waste | 1 = Aid is given to the industry of water supply; sewerage; waste management and remediation activities |
| construction | 1 = Aid is given to the industry of construction |
| motor | 1 = Aid is given to the industry of wholesale and retail trade; repair of motor vehicles and motorcycles |
| transporting & storage | 1 = Aid is given to the industry of transporting and storage |
| accommodation | 1 = Aid is given to the industry of accommodation and food service activities |
| information & communication | 1 = Aid is given to the industry of information and communication |
| financial & insurance | 1 = Aid is given to the industry of financial and insurance activities |
| real estate | 1 = Aid is given to the industry of real estate activities |
| professional & scientific | 1 = Aid is given to the industry of professional, scientific and technical activities |
| public administration & defense | 1 = Aid is given to the industry of public administration and defense; compulsory social security |
| arts | 1 = Aid is given to the industry of arts, entertainment and recreation |
| other services | 1 = Aid is given to the industry of other services activities |
| **Macro Variables** | |
| gdp_avg | Average change in real GDP during the course of state aid in that country |

## 4. Econometric Methodology

### 4.1. Determinants of State Aid Duration

The utilization of duration analysis in the field of antitrust economics is not a new phenomenon. For instance, there are studies[7] that perform duration analysis by employing cartel duration as an imperfect proxy to gauge cartel performance. The idea behind these studies is that the longer the cartel lives, the greater damage it gives to the markets and society. Likewise, our conjecture is that the longer period's state aid is given, the more distortive effects it will have.

In what follows, we perform a duration analysis of state aid using two different estimation methods: non-parametric estimation and parametric estimation. In non-parametric estimation, no assumption is made regarding the baseline hazard distribution. It imposes the leanest structure and it is mostly descriptive. On the other hand, parametric estimation imposes a structure which also allows incorporation of covariates.

#### 4.1.1. Non-parametric Estimation

To help understand state aid duration, we first calculate Kaplan-Meier (1958) estimates of the survivor function $S(t)$, which is the probability of survival after time $t$. In Figure I we plot the Kaplan-Meier estimate for the overall observations in our dataset. The estimated probability of survival decreases sharply in the first 1,095 days of a state aid's life.

[7] *Marquez (1994), Suslow (2005), Jacquemin et al. (1981), and Levenstein and Suslow (2006).*

**Figure: 1**
**Graphical Illustration of Kaplan-Meier Survival Estimate**

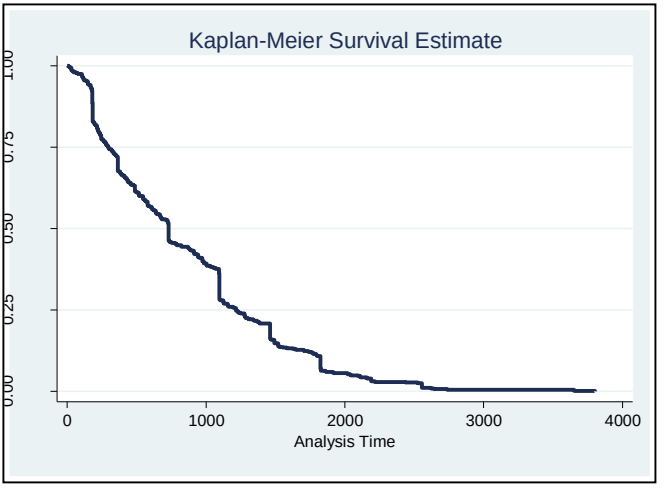


**Table: 2**
**The Results from the Kaplan-Meier Estimator**

| | | Survival Probability | | Survival Probability | |
|---|---|---|---|---|---|
| | | Single Objective | Multiple Objectives | Single Industry | Multiple Industries |
| Time | 7 | 0.9979 | 1 | 0.9980 | 1.0000 |
| | 481 | 0.6125 | 0.7714 | 0.6298 | 0.6604 |
| | 955 | 0.3833 | 0.6000 | 0.4266 | 0.2642 |
| | 1429 | 0.1854 | 0.3714 | 0.2113 | 0.1887 |
| | 1903 | 0.0563 | 0.0857 | 0.0604 | 0.0566 |
| | 2377 | 0.0208 | 0.0857 | 0.0282 | 0.0377 |
| | 2851 | 0.0021 | 0.0286 | 0.0060 | - |
| | 3325 | 0.0021 | 0.0286 | 0.0060 | - |
| | 3799 | - | 0.0143 | 0.0020 | - |
| | 4273 | - | - | - | - |

In Table 2 we compare the estimated survivor functions of state aid based on various characteristics. The table indicates that state aid with multiple objectives has a better survival experience than state aid with single objective. To be more precise, as can be seen from Table 2, the probability of surviving after 955 days is 38% for state aid with single objective, while it is 60% for state aid with multiple objectives. On the other hand, the probability of surviving after 955 days is 42% for state aid given to a single industry, while it is 26% for state aid given to multiple industries. However, interpreting the differences in estimates of the survivor functions might be misleading, because this method does not control for the remaining state aid characteristics. To disentangle the effects of those characteristics, we analyze state aid duration using multivariate parametric techniques in the next section.

### 4.1.2. Parametric Estimation

The determinants of state aid duration are estimated using parametric accelerated failure-time models, which follows the parameterization $\ln(t_j) = x_j\beta_x + \ln(\tau_j)$, where the distribution of $\tau_j$ is specified. In what follows, we will econometrically investigate the following two different specifications:

$$\ln(t_j) = multiple\_objectives_j\beta_1 + multiple\_industries_j\beta_2 + gdp\_avg_j\beta_3 + \text{country dummies} + \text{year dummies} + \ln(\tau_j) \quad (1)$$

$$\ln(t_j) = gdp\_avg_j\gamma_1 + \text{objective dummies} + \text{industry dummies} + \text{country dummies} + \text{year dummies} + \ln(\tau_j) \quad (2)$$

For each specification, we will consider exponential, Weibull, log-normal, log-logistic and Gamma regressions. The differences in these regressions originate from how we specify the distribution of $\tau_j$. For instance, in exponential regression we assume that $\tau_j$ is distributed as exponential with mean $exp(\beta_0)$. This yields $\ln(t_j) = x_j\beta_x + \ln(\tau_j) = x_j\beta_x + \beta_0 + u_j$ where $u_j$ follows the extreme value distribution.

Having run all these regressions for each specification, we choose the model which fits the data best according to Akaike Information Criterion and interpret the results.

### 4.2. Determinants of State Aid Budget

The amount of aid appears to be one of the most indubitable measures to gauge the likely effects on competition. Even though the conventional intuition envisages that more aid is associated with more distortion, there are reasons to be skeptical about this statement. For instance, huge amounts of aid might be required to correct market failures in an effective way in industries such as banking. Correcting those market failures with huge sums of money will not harm but enhance competition. Thus, a massive sum of aid might well be pro-competitive. On the other hand, small amounts of aid might also have considerable impact within a small relevant market. For instance, aid given to SMEs in a small geographic area might result in distortion of competition in that market. Overall, the final impact of the budget of state aid depends on specific industry conditions such as market shares of the recipients, the level of product differentiation etc. Yet, even though the amount of aid cannot tell the likely effects of aid on competition per se, it might tell us about the extent of European state aid control. Overall, the amount or budget is considered to be an important component of public subsidies, and it has been analyzed in former studies for empirical assessments of aid.[8]

[8] *For an extensive summary of those studies, the reader can refer to Zuniga-Vicente et al. (2014).*

In what follows, we will examine the determinants of state aid budget. We have two different dependent variables. The first one is the natural logarithm of the total budget of state aid (*ln_budget*) and the second one is the daily budget of aid in million Euros (*daily_budget_m*). To be more precise, the specifications of the models to be estimated are:

$$ln\_budget_j = multiple\_objectives_j\beta_1 + multiple\_industries_j\beta_2 + gdp\_avg_j\beta_3 + \text{country dummies} + \text{year dummies} + \varepsilon_j \quad (3)$$

$$ln\_budget_j = gdp\_avg_j\gamma_1 + \text{objective dummies} + \text{industry dummies} + \text{country dummies} + \text{year dummies} + \varepsilon_j \quad (4)$$

$$daily\_budget\_m_j = multiple\_objectives_j\beta_1 + multiple\_industries_j\beta_2 + gdp\_avg_j\beta_3 + \text{country dummies} + \text{year dummies} + \varepsilon_j \quad (5)$$

$$daily\_budget\_m_j = gdp\_avg_j\gamma_1 + \text{objective dummies} + \text{industry dummies} + \text{country dummies} + \text{year dummies} + \varepsilon_j \quad (6)$$

However, estimating this model with the standard linear regression may not be appropriate in this set up. Since the budget data is highly skewed and characterized by influential observations, we will focus on quantile regression (QR) rather than standard linear regression. In other words, the QR analysis is more appropriate in our setup, as it is not as sensitive as the OLS regression to the presence of outliers.

## 5. Estimation Results and Interpretation

### 5.1. Determinants of State Aid Duration

Table 3 displays the results from various accelerated failure-time models for the first specification. Since cases of state aid given in a particular jurisdiction might be correlated and may not be independent, because they are conferred by the same governmental body, we have clustered individual state aid cases on member states in order to get robust standard errors obtained via the Huber/White/sandwich estimator of the variance. After the estimation of the specification, in order to choose the best model from this class of nonnested parametric models, Akaike Information Criterion (AIC) can be used (Cleves et al. 2008, 273). To be more specific, the preferred model is the one with the lowest value of the AIC. For parametric duration analysis models, the AIC is defined as $\text{AIC} = -2\ln L + 2(k + c)$ where $L$ is the log-likelihood, $k$ is the number of variables and $c$ is the number of model-specific distributional parameters.

**Table: 3**
**Determinants of the Duration of State Aid Cases for the First Specification**

| *Duration in days* | **Weibull Regression** | |
|---|---|---|
| Constant | 6.6987 | *** |
| | (0.1889) | |
| multiple_objectives | 0.3701 | *** |
| | (0.0821) | |
| multiple_industries | -0.0928 | |
| | (0.0944) | |
| gdp_avg | -0.0402 | |
| | (0.0291) | |
| **Country Dummies** | YES | |
| **Year Dummies** | YES | |
| **Statistics** | | |
| Observations | 550 | |
| Log-likelihood | -604.46 | |
| Akaike | 1244.92 | |

[*] *Significant at 10% level,* [**] *significant at 5% level,* [***] *significant at 1% level*

For the first specification the minimum AIC value is obtained after Weibull regression. Therefore, we will restrict our attention to Weibull regression when interpreting the estimation results. Note that negative parameter estimates imply that duration decreases with the variable of interest, while positive parameter estimates refer to increased duration associated with the variable. Firstly, state aid with multiple objectives has better prospects to endure, ceteris paribus. Exponentiating the *multiple_objectives* coefficient we see that state aid with multiple objectives last 45% longer than state aid with the same characteristics but single objective, as 1 – exp (0.3701) = -0.4479. Also, we can say that time passes 31% slower for state aid with multiple objectives than for those with a single objective, everything else being equal. This is because exp (-0.3701) = 0.6907. This finding might be resulting from the fact that the multiple purposes that some state aid schemes serve might be complementary, and in order to have the desired effects, the EC is convinced that aid should have a longer duration. On the other hand, we report statistically insignificant results for aid given to multiple industries (*multiple_industries*).

As to member state dummies and approval year dummies, they are jointly statistically significant. Not surprisingly, average change in real GDP seems to be negatively associated with duration of state aid cases, as *gdp_avg* has a negative but statistically insignificant coefficient.

In Table 4 we report the results from accelerated failure-time Weibull model for the second specification, as the minimum AIC value is obtained after Weibull regression. In doing so, we split our sample and restrict our attention to the cases of state aid with single objective and given to a single industry. In this specification, aid given to SMEs is left out as the base group in order to make comparisons among aid objectives. Similarly, aid given to manufacturing industries is left out as the base group for industries. Moreover, since cases of state aid given in a particular jurisdiction and in a particular industry might be correlated and may not be independent, because they are conferred by the same governmental body, and affected from common shocks, we have clustered individual state aid cases on industries in member states in order to get robust standard errors obtained via the Huber/White/sandwich estimator of the variance.

**Table: 4**
**Determinants of the Duration of State Aid Cases for the Second Specification**

| *Duration in days* | **Weibull Regression** | | *Duration in days* | **Weibull Regression** | |
|---|---|---|---|---|---|
| Constant | 6.5422 | *** | **Industries** | | |
| | (0.2621) | | agriculture | -0.2655 | * |
| gdp_avg | -0.0509 | ** | | (0.1413) | |
| | (0.0236) | | mining | 0.0051 | |
| **Objectives** | | | | (0.0968) | |
| training | -0.0450 | | electricity & gas | -0.1629 | |
| | (0.1839) | | | (0.3184) | |
| sectoral | -0.1161 | | water & waste | -0.4371 | *** |
| | (0.3444) | | | (0.1051) | |
| regional | 0.2540 | * | construction | -0.1085 | |
| | (0.1478) | | | (0.1645) | |
| rd_innovation | 0.4025 | ** | motor | -0.1293 | |
| | (0.1992) | | | (0.1434) | |
| employment | -0.4613 | | transporting & storage | -0.1933 | |
| | (0.3129) | | | (0.2292) | |
| energy | -0.8045 | | accommodation | 0.0781 | |
| | (0.5166) | | | (0.1569) | |
| rescue | -0.7983 | *** | information & communication | -0.2518 | ** |
| | (0.3089) | | | (0.1186) | |
| restructuring | -0.0198 | | financial & insurance | -0.3863 | ** |
| | (0.2245) | | | (0.1583) | |
| environmental | 0.3229 | | real estate | 0.4174 | *** |
| | (0.2712) | | | (0.1234) | |
| general interest | 0.4421 | | professional & scientific | -0.5209 | *** |
| | (0.3966) | | | (0.1751) | |
| remedy | -0.9915 | *** | public administration & defense | 0.9227 | *** |
| | (0.2972) | | | (0.1899) | |
| | | | arts | -0.4371 | *** |
| | | | | (0.1051) | |
| | | | other services | -0.2099 | |
| | | | | (0.2039) | |
| **Country Dummies** | | | YES | | |
| **Year Dummies** | | | YES | | |
| **Statistics** | | | | | |
| Observations | | | 438 | | |
| Log-likelihood | | | -420.96 | | |
| Akaike | | | 943.91 | | |

** Significant at 10% level, ** significant at 5% level, *** significant at 1% level*

The results indicate that average change in real GDP (*gdp_avg*) is negatively and statistically significantly (at 5% level) linked to state aid duration. This finding suggests that governments are inclined to give state aid in longer durations when macroeconomic conditions are relatively worse. As to the comparison of state aid duration based on the objectives, we find that aid given for purposes of R&D or innovation (*rd_innovation*) and regional aid (*regional*) seem to last statistically significantly (at 5% and 10% significance levels, respectively) longer than aid given to SMEs. To be more precise, aid given for purposes of R&D or innovation and regional aid survive 50% and 29% longer, respectively, than SME aid, ceteris paribus. On the other hand, aid for rescuing firms in difficulty (*rescue*) and remedy for a serious disturbance in the economy (*remedy*) last statistically significantly (at 1% significance level) shorter than aid given to SMEs. Stated more explicitly, rescue aid and remedy aid last 55% and 63% shorter, respectively than SME aid everything else being equal. It is not surprising to find that rescue aid lasts shorter, as it reduces effective competition by supporting inefficient production, and accordingly, the EC will be stricter about its duration length. This can also be seen from the fact that rescue aid can only be granted for a maximum of six months by law.

As to the comparison of state aid duration based on the sectors, on one hand, we find that aid in industries of real estate activities (*real estate*); and public administration and defense, compulsory social security (*public administration & defense*) appears to last statistically significantly longer (52% and 152% longer, respectively) compared to aid given to manufacturing industries, everything else being equal. These industries can be characterized as being industries where public goods are not provided by the market up to an efficient level because it is not lucrative to do so. For instance, affordable housing for low-income households might be undersupplied in real estate industry just because it is not profitable. Moreover, public administration and defense can also be held as an example to public goods, for which it is impossible to exclude anyone from using them.

On the other hand, aid conferred to the industries of agriculture, forestry and fishing (*agriculture*); water supply, sewerage, waste management and remediation activities (*water & waste*); information and communication (*information and communication*); financial and insurance activities (*financial & insurance*); professional, scientific and technical activities (*professional & scientific*); and, arts, entertainment and recreation (*arts*) is statistically significantly less likely to end up earlier (23%, 35%, 22%, 32%, 41 and 35% shorter, respectively) than aid given to manufacturing industries. Among these industries with a history of relatively shorter state aid duration, financial sectors are the most noteworthy ones. As previously mentioned, these financial industries such as banking are important input markets with a high potential to affect trade flows. Alternatively, the EC might have employed high levels of budget intensities instead of longer duration in state aid given in these industries (see the next subsection). Finally, as in the first specification, country and year dummies are jointly significant.

### 5.2. Determinants of State Aid Budget

Table 5 presents the results for the determinants of the state aid budget for the third specification. The second, third and fourth column displays the estimation results for $25^{th}$, $50^{th}$, and $75^{th}$ quantiles, respectively. The fifth and sixth columns include the results of hypothesis tests of equality of the regression coefficients at different conditional quantiles. Finally, the last column shows OLS estimates in order to compare to quantile regression estimation results.

First of all, one should note that the coefficients vary across quantiles. Most evidently, the highly statistically significant explanatory variable *multiple_objectives* (aid with more than one objective to achieve) has a bigger effect at the lower conditional quantiles of state aid budget ($25^{th}$ and $50^{th}$) while *gdp_avg* (average change in real GDP during the course of state aid in that country) has a greater impact at the highest conditional quantile ($75^{th}$). The standard errors slightly vary at different conditional quantiles. Moreover, OLS coefficients differ significantly from the quantile regression coefficients. The null hypothesis of coefficient equality is rejected at a level of 0.05 for *multiple_objectives* while we cannot reject it for variables *multiple_industries* and *gdp_avg*. Finally, country and year dummies are jointly significant for each quantile and OLS regression.

**Table: 5**
**Determinants of the Budget of State Aid Cases for the Third Specification**

| | Quantile Regression | | | Test of Equality for Coefficients | | OLS |
|---|---|---|---|---|---|---|
| *ln_budget* | q25 | q50 | q75 | F-Statistic | p-value | |
| constant | 12.3793 *** | 13.7923 *** | 17.5595 | 11.50 | 0.000 | 14.9794 |
| | (0.7015) | (1.0396) | (0.9636) | | | (0.4148) |
| multiple_objectives | 1.6106 *** | 1.5915 *** | 0.5468 | 4.95 | 0.007 | 1.0576 ** |
| | (0.4436) | (0.4937) | (0.4847) | | | (0.4124) |
| multiple_industries | 0.2281 | 0.3049 | 0.2128 | 0.02 | 0.979 | 0.0322 |
| | (0.7833) | (0.4298) | (0.4448) | | | (0.6882) |
| gdp_avg | -0.2327 * | -0.2844 *** | -0.3417 *** | 0.37 | 0.694 | -0.3186 ** |
| | (0.1209) | (0.0976) | (0.1050) | | | (0.1180) |
| **Country Dummies** | | | YES | | | |
| **Year Dummies** | | | YES | | | |
| **Statistics** | | | | | | |
| Observations | 550 | 550 | 550 | | | 550 |
| Pseudo R-Squared | 0.22 | 0.28 | 0.35 | | | |
| R-Squared | | | | | | 0.43 |

** Significant at 10% level, ** significant at 5% level, *** significant at 1% level*

Focusing on the results of median regression (50th quantile), we can see that average change in real GDP (*gdp_avg*) is negatively and statistically significantly (at 1% level) linked to total state aid budget. This finding suggests that governments tend to give and the EC is more likely to approve state aid in greater amounts when macroeconomic conditions are relatively worse. Elsewhere, *multiple_objectives* has a positive and statistically significant (at 1% level) coefficient implying that total state aid budget is greater in amount for those cases of state aid with multiple objectives compared to state aid a single objective, everything else being equal. Excluding aid given as a remedy for serious disturbance in an economy (since its budget is enormously high), aid with multiple objectives has an excess total budget of about €38 million compared to state aid having a single objective, everything else being equal.[9] On the other hand, we report statistically insignificant results for aid given to multiple industries (*multiple_industries*).

[9] *This value is obtained by the multiplication of the coefficient of* multiple_objectives *by the multiplier that converts quantile regression coefficients in logs to average marginal effect in levels. For detailed information see Cameron and Trivedi (2009).*

## Table: 6
## Determinants of the Budget of State Aid Cases for the Fourth Specification

| | Quantile Regression | | | Test of Equality for Coefficients | | OLS |
|---|---|---|---|---|---|---|
| *ln_budget* | q25 | q50 | q75 | F-Statistic | p-value | |
| Constant | 10.2700 *** | 13.7599 *** | 15.3534 *** | 8.75 | 0.000 | 13.2606 *** |
| | (1.3093) | (0.9035) | (0.8189) | | | (0.7620) |
| gdp_avg | -0.0100 | -0.0690 | -0.0000 | 0.98 | 0.377 | -0.0557 |
| | (0.0885) | (0.0574) | (0.0537) | | | (0.0740) |
| **Objectives** | | | | | | |
| training | -0.3912 | -1.4736 ** | -0.1849 | 2.16 | 0.117 | -0.6594 |
| | (0.9353) | (0.6139) | (0.5174) | | | (0.6142) |
| sectoral | 5.6633 ** | 3.5618 * | 3.2872 * | 2.08 | 0.127 | 3.9454 *** |
| | (2.8431) | (2.0722) | (1.6855) | | | (0.6580) |
| regional | 3.5800 *** | 2.0551 *** | 2.5418 *** | 2.13 | 0.121 | 2.7803 *** |
| | (0.7705) | (0.3640) | (0.5521) | | | (0.6089) |
| rd_innovation | 2.7932 *** | 1.5766 ** | 2.2909 *** | 1.50 | 0.224 | 1.9718 *** |
| | (1.0315) | (0.7095) | (0.5502) | | | (0.6181) |
| employment | 0.9165 | -0.5377 | 2.8012 * | 2.18 | 0.114 | 0.7176 |
| | (1.2789) | (1.8729) | (1.5367) | | | (1.1469) |
| energy | 0.4343 | -3.2167 | -3.5061 | 2.28 | 0.104 | -2.6213 |
| | (2.9489) | (2.6103) | (2.6197) | | | (1.9287) |
| rescue | 0.4225 | 1.0817 | 2.2445 ** | 0.44 | 0.645 | 1.6281 * |
| | (1.9715) | (1.1066) | (0.9392) | | | (0.8929) |
| restructuring | 3.6040 | 1.4462 | 3.8205 * | 6.24 | 0.002 | 3.6212 *** |
| | (2.1889) | (1.6783) | (2.0473) | | | (1.1057) |
| environmental | 3.4405 *** | 2.5818 ** | 2.3774 * | 0.69 | 0.501 | 2.8830 *** |
| | (1.0833) | (1.1067) | (1.2675) | | | (0.8318) |
| general interest | 4.4446 | 2.2533 | 5.9046 * | 0.74 | 0.479 | 5.1772 ** |
| | (3.7120) | (3.4658) | (3.0778) | | | (2.0609) |
| remedy | 7.7074 ** | 7.7566 *** | 9.2070 *** | 0.24 | 0.788 | 8.0356 *** |
| | (3.3715) | (1.6070) | (1.3763) | | | (1.2197) |
| **Industries** | | | | | | |
| agriculture | -0.8036 | -1.1174 | -0.9810 | 0.09 | 0.911 | -1.0886 |
| | (0.9533) | (0.7797) | (0.6343) | | | (0.7929) |
| mining | 0.0807 | -0.0607 | -0.5443 | 0.32 | 0.725 | -0.1257 |
| | (0.4717) | (0.3440) | (0.7612) | | | (0.3319) |
| electricity & gas | 0.8024 | -0.1460 | 0.3653 | 0.56 | 0.572 | 0.2148 |
| | (0.8856) | (0.9147) | (1.3535) | | | (0.5814) |
| water & waste | -0.0007 | -0.2335 | -0.6103 | 0.95 | 0.389 | -0.3807 |
| | (0.2074) | (0.2123) | (0.4111) | | | (0.3210) |
| construction | -0.8215 | -0.6027 | -1.0298 | 0.11 | 0.896 | -0.9214 |
| | (1.8832) | (1.1243) | (0.9776) | | | (1.0059) |
| motor | 0.0731 | -0.0683 | -0.5426 | 0.28 | 0.758 | 0.0309 |
| | (0.1961) | (0.3159) | (0.3341) | | | (0.4679) |
| transporting & storage | -1.1739 * | -1.9809 ** | -0.8719 | 1.76 | 0.174 | -1.3728 ** |
| | (0.6677) | (0.8015) | (0.7269) | | | (0.5451) |
| accommodation | 1.0621 | 0.6543 | 1.7095 | 1.03 | 0.359 | 1.0629 * |
| | (0.8022) | (0.6888) | (1.2373) | | | (0.5649) |
| information & communication | -0.8588 | -0.7078 | -0.5635 | 0.03 | 0.974 | -1.1787 * |
| | (1.2462) | (0.5650) | (0.5350) | | | (0.6205) |
| financial & insurance | 0.1255 | -0.0158 | 1.3711 | 0.35 | 0.705 | 0.5817 |
| | (2.9484) | (1.6706) | (1.3776) | | | (0.9138) |
| real estate | 3.2492 * | 2.4036 * | 1.2072 | 1.09 | 0.336 | 2.5359 ** |
| | (1.9672) | (1.4338) | (1.0180) | | | (1.0810) |
| professional & scientific | -0.3106 | -2.0398 ** | -2.9491 *** | 2.41 | 0.092 | -1.5626 ** |
| | (1.1299) | (0.8875) | (0.8908) | | | (0.6401) |
| public administration & defense | 0.2599 | -2.4197 | -4.0956 * | 2.79 | 0.063 | -1.9548 ** |
| | (1.1809) | (1.5170) | (2.1024) | | | (0.8575) |
| arts | -0.3037 | -0.5365 ** | -0.9132 ** | 0.65 | 0.522 | -0.6836 ** |
| | (0.2453) | (0.2632) | (0.4192) | | | (0.3210) |
| other services | -0.9500 | -1.1713 | -1.5389 * | 0.31 | 0.735 | -1.2763 * |
| | (0.9239) | (0.7314) | (0.8774) | | | (0.6640) |
| **Year Dummies** | | | YES | | | |
| **Country Dummies** | | | YES | | | |
| **Statistics** | | | | | | |
| Observations | 438 | 438 | 438 | | | 438 |
| Pseudo R-Squared | 0.50 | 0.55 | 0.62 | | | |
| R-Squared | | | | | | 0.78 |

* *Significant at 10% level,* ** *significant at 5% level,* *** *significant at 1% level*

Table 6 provides estimation results for the fourth specification. In doing so, we split our sample and restrict our attention to the cases of state aid with single objective and given to a single industry. Firstly, the coefficients and standard errors differ considerably across quantiles. Secondly, in general, the standard errors are smaller for the lower and upper quantiles (25$^{th}$ and 75$^{th}$) than median regression (50$^{th}$), demonstrating more precision at the tails of the distribution. In this specification, average change in real GDP appears to be negatively linked to the total budget of state aid cases, as *gdp_avg* has a negative but statistically insignificant coefficient in all quantile regressions and OLS. Focusing on median regression (50$^{th}$ quantile) results, we see that sectoral aid (*sectoral*), regional aid (*regional*), aid given for purposes of R&D or innovation (*rd_innovation*), environmental aid (*environmental*) and aid as a remedy for a serious disturbance in the economy (*remedy*) have statistically significantly higher amounts of total budget relative to SME aid, ceteris paribus. On the other hand, the total budget is statistically significantly less for training aid (*training*) compared to SME aid, everything else being equal.

As to the comparison of total state aid budget based on the sectors, we report that the total budget of aid given in industries of real estate activities (*real estate*) seems to be statistically significantly higher than that of aid given in manufacturing industries, while cases of aid given in industries of transporting and storage (*transporting & storage*); professional, scientific and technical activities (*professional & scientific*); and arts, entertainment and recreation (*arts*) have statistically significantly higher amounts of total budget relative to state aid conferred in manufacturing industries, ceteris paribus. Finally, country and year dummies are jointly significant.

**Table: 7**
**Determinants of the Daily Budget of State Aid Cases for the Fifth Specification**

| | Quantile Regression | | | Test of Equality for Coefficients | | OLS |
|---|---|---|---|---|---|---|
| *daily_budget_m* | q25 | q50 | q75 | F-Statistic | p-value | |
| constant | 0.0019 | 0.0067 | 0.0646 | 0.05 | 0.955 | 63.0875 |
| | (0.0026) | (0.0162) | (3.4909) | | | (45.3412) |
| multiple_objectives | 0.0048 | 0.0124 * | 0.0098 | 0.49 | 0.613 | 10.6750 |
| | (0.0039) | (0.0066) | (0.0201) | | | (38.5244) |
| multiple_industries | 0.0002 | 0.0053 | 0.0159 | 0.32 | 0.728 | -24.8566 |
| | (0.0073) | (0.0066) | (0.0189) | | | (23.8813) |
| gdp_avg | -0.0008 | -0.0026 | -0.0124 | 0.40 | 0.673 | -12.4145 |
| | (0.0011) | (0.0052) | (0.0181) | | | (11.4436) |
| **Country Dummies** | | | | YES | | |
| **Year Dummies** | | | | YES | | |
| **Statistics** | | | | | | |
| Observations | 550 | 550 | 550 | | | 550 |
| Pseudo R-Squared | 0.01 | 0.02 | 0.12 | | | |
| R-Squared | | | | | | 0.16 |

* *Significant at 10% level,* ** *significant at 5% level,* *** *significant at 1% level*

The estimation results for the fifth specification are displayed in Table 7. The results suggest that the coefficients and the standard errors vary slightly across different quantiles. Focusing on median regression (50$^{th}$ quantile) we see that aid with more than one objective to achieve (*multiple_objectives*) has a statistically significantly (at 10% level) greater daily budget than state aid with the same characteristics but single objective. However, we report statistically insignificant results for aid given to multiple industries (*multiple_industries*) and

average change in real GDP (*gdp_avg*). As in the previous estimations, country and year dummies are jointly significant.

**Table: 8**
**Determinants of the Daily Budget of State Aid Cases for the Sixth Specification**

| | Quantile Regression | | | Test of Equality for Coefficients | | OLS |
|---|---|---|---|---|---|---|
| *daily_budget_m* | q25 | q50 | q75 | F-Statistic | p-value | |
| Constant | -0.0021 | -0.0029 | 0.0370 | 0.67 | 0.514 | 75.3090 |
| | (0.0067) | (0.0170) | (117.9931) | | | (60.9718) |
| gdp_avg | 0.0001 | 0.0016 | 0.0067 | 0.49 | 0.611 | -13.5771 |
| | (0.0012) | (0.0026) | (0.0061) | | | (17.1127) |
| **Objectives** | | | | | | |
| training | -0.0014 | -0.0020 | -0.0064 | 0.18 | 0.839 | -17.8285 |
| | (0.0026) | (0.0042) | (0.0088) | | | (19.6369) |
| sectoral | 0.1033 ** | 0.1071 ** | 0.0978 ** | 0.55 | 0.578 | -22.9978 |
| | (0.0510) | (0.0514) | (0.0451) | | | (20.1752) |
| regional | 0.0112 * | 0.0341 *** | 0.0643 *** | 3.36 | 0.036 | 20.1307 |
| | (0.0060) | (0.0100) | (0.0204) | | | (19.2411) |
| rd_innovation | 0.0024 | 0.0034 | 0.0139 | 0.26 | 0.770 | -9.5463 |
| | (0.0050) | (0.0103) | (0.0228) | | | (23.5679) |
| employment | -0.0013 | 0.0005 | -0.0106 | 0.00 | 1.000 | -50.9269 |
| | (1.9561) | (0.0061) | (0.8584) | | | (34.0082) |
| energy | -0.0123 | -0.2988 | -0.3726 | 1.17 | 0.310 | -240.0000 |
| | (0.1678) | (0.2434) | (0.2438) | | | (296.6408) |
| rescue | -0.0088 | 0.0947 | 1.4395 * | 1.08 | 0.339 | -37.4642 |
| | (0.4338) | (0.4761) | (0.7807) | | | (43.0360) |
| restructuring | 0.0060 | 0.0292 | 0.0855 | 0.01 | 0.986 | 54.6827 |
| | (0.3748) | (0.5045) | (0.7619) | | | (48.0825) |
| environmental | 0.0085 | 0.0266 | 0.0645 | 0.05 | 0.950 | 44.0188 |
| | (0.0116) | (0.1571) | (0.1950) | | | (35.4635) |
| general interest | 0.0546 | 0.0538 | 0.9360 * | 3.45 | 0.033 | 65.8150 |
| | (11.9689) | (0.4539) | (0.5019) | | | (70.6964) |
| remedy | 20.7273 | 96.7577 * | 283.8675 | 1.36 | 0.257 | 248.6386 ** |
| | (15.3207) | (55.2293) | (179.8355) | | | (96.2204) |
| **Industries** | | | | | | |
| agriculture | -0.0020 | -0.0015 | -0.0029 | 0.04 | 0.964 | 2.3151 |
| | (0.0029) | (0.0034) | (0.0067) | | | (28.2907) |
| mining | -0.0001 | -0.0013 | -0.0068 | 0.53 | 0.587 | 0.4582 |
| | (0.0025) | (0.0032) | (0.0092) | | | (19.6841) |
| electricity & gas | 0.0124 | 0.3209 | 0.4796 ** | 1.76 | 0.173 | 19.2312 |
| | (0.1795) | (0.2385) | (0.2258) | | | (44.9508) |
| water & waste | 0.0004 | 0.0019 | 0.0040 | 0.13 | 0.876 | -16.7157 |
| | (0.0013) | (0.0036) | (0.0085) | | | (18.9462) |
| construction | -0.0035 | -0.0023 | -0.0111 | 0.01 | 0.987 | -3.7529 |
| | (0.0045) | (0.0052) | (0.3593) | | | (29.7700) |
| motor | -0.0001 | -0.0009 | -0.0067 | 0.62 | 0.540 | 10.2352 |
| | (0.0011) | (0.0009) | (0.1465) | | | (27.8997) |
| transporting & storage | -0.0021 | -0.0013 | -0.0047 * | 0.32 | 0.729 | -4.9139 |
| | (0.0015) | (0.0026) | (0.0025) | | | (22.8737) |
| accommodation | 0.0026 | 0.0036 | 0.0468 | 0.01 | 0.987 | 42.7570 |
| | (0.0021) | (0.0091) | (0.0371) | | | (41.4179) |
| information & communication | -0.0032 | -0.0133 | -0.0053 | 0.00 | 0.999 | -48.8622 |
| | (1.2771) | (0.3884) | (0.0727) | | | (46.8248) |
| financial & insurance | -0.0001 | -0.0009 | 0.0124 | 0.00 | 1.000 | -4.4196 |
| | (0.3860) | (0.1175) | (0.3876) | | | (44.0951) |
| real estate | 0.1341 | 0.1162 * | 0.0625 | 0.18 | 0.835 | 87.5090 |
| | (8.7944) | (0.0647) | (0.0518) | | | (92.5429) |
| professional & scientific | -0.0015 | -0.0011 | 0.0086 | 0.12 | 0.888 | 64.3004 |
| | (7.0152) | (18.7867) | (112.3704) | | | (62.3098) |
| public administration & defense | -0.0004 | -0.0038 | -0.0674 | 1.90 | 0.151 | -67.4875 |
| | (0.0012) | (0.0132) | (118.0078) | | | (53.8658) |
| arts | 0.0001 | 0.0016 | 0.0037 | 0.18 | 0.837 | -16.7160 |
| | (0.0012) | (0.0033) | (0.0090) | | | (18.9462) |
| other services | -0.0030 | -0.0009 | 0.0016 | 0.22 | 0.802 | 18.3710 |
| | (0.0026) | (0.0022) | (0.0042) | | | (29.6554) |
| **Country Dummies** | | | | YES | | |
| **Year Dummies** | | | | YES | | |
| **Statistics** | | | | | | |
| Observations | 438 | 438 | 438 | | | 438 |
| Pseudo R-Squared | 0.10 | 0.15 | 0.28 | | | |
| R-Squared | | | | | | 0.27 |

* *Significant at 10% level,* ** *significant at 5% level,* *** *significant at 1% level*

Finally, Table 8 presents the estimation results for the sixth specification. In this specification we split our sample and focus on the cases of state aid with single objective and given to a single industry. Most of the explanatory variables have a bigger effect at the upper conditional quantiles of daily state aid budget ($75^{th}$) while the standard errors are smaller for the lower quantile ($25^{th}$) than median regression and upper quantiles ($50^{th}$ and $75^{th}$), implying more precision at the lower tail of the distribution. To be consistent with previous interpretations, we restrict our attention to median regression results. We report that, sectoral aid (*sectoral*), regional aid (*regional*) and aid as a remedy for a serious disturbance in the economy (*remedy*) have statistically significantly greater amounts of daily budget relative to that of SME aid. If we were to examine daily state aid budget based on the industries, we only report that the daily budget of aid given in industries of real estate activities (*real estate*) seems to be statistically significantly higher (at 10% level) than that of aid given in manufacturing industries, everything else being equal.

## 6. Discussion and Conclusion

Having estimated the determinants of state aid duration and budget, we have ranked the objectives for which and the industries to which aid is conferred based on duration and the amount of total and daily budget. When other variables are controlled for, the top three state aid objectives with longest duration are aid given for services of general economic interest, R&D or innovation aid, and environmental aid. On the other hand, remedy for serious disturbance aid, energy saving aid, and rescue aid have the shortest durations, everything else being equal. As to the total budget ranking, remedy for serious disturbance aid, sectoral aid, and environmental protection aid have the highest amount of total budgets while training aid, energy saving aid and employment aid have the least amount of total aid budget.

These rankings suggest that the EC is keen on eliminating negative externalities, since environmental protection aid, which is thought to be in the sphere of negative externalities, has both a very long duration and a very high amount of total budget. This long duration and high amount of budget incentivize companies, which are constrained by additional costs, to deliver environmental gains. Furthermore, aid given for services of general economic interest draws a special attention in this context, as it has both a long duration and high amount of total budget, too. As stated by Nicolaides (2003), services of general economic interest (SGEI) occupy a specific position in the economies of the member states of EU. These services are not necessarily public goods that are under-supplied or not supplied by the market. Instead, SGEI are services for supplies of which member states impose specific terms and prices. Thus, at the heart of the problem lies the inadequacy of suppliers to cover their costs due to the conditions imposed on them by member states. According to the rankings based on our estimations, the EC approves cases of aid given for services of general economic interest with a longer duration and a higher amount of budget so as to prevent those inadequacies. Finally, the length of R&D or innovation aid might be associated with keeping companies incentivized for a long time so as to counter-weigh inefficiencies in R&D activities due to market failures. However, the budget of R&D or innovation aid is at a modest level, since subsidies for R&D may also distort competition.

For instance, a successful process innovation may have a distortionary impact on pricing and entry/exit decisions by decreasing the firm's fixed or variable costs of production.

Elsewhere, remedy for serious disturbance aid has the shortest duration and the highest level of both daily and total budget. In order to overcome serious disturbances in the economy in an effective way, huge amounts of aid might be required. This was especially necessary when the 2008 financial crisis hit European economies. But the gigantic amount spent on correcting those crises might also have undesired impact on effective competition in a market. In order to keep that undesired effect to a minimum, the duration of this type of aid is set to be very short. Following remedy for a serious disturbance aid, sectoral aid has the second highest level of total budget. Sectoral aid consists of aid to facilitate the development of certain economic activities in certain sectors of the economy. These sectors include shipbuilding, transport, broadcasting, coal, steel etc. Facilitating the development of overall economic activities in these industries necessitates huge sums of money, which explains why sectoral aid has a very high level of total budget. But sectoral aid has also a short duration, as in the case of remedy for serious disturbance aid, to keep the undesired effects to minimum.

On the other hand, it is not surprising to find that rescue aid both lasts shorter and has relatively low levels of budget, as it reduces effective competition by supporting inefficient production, and accordingly, the EC will be stricter about its duration length and aid budget. This can also be seen from the fact that rescue aid can only be granted for a maximum of six months by law.

Elsewhere training and employment aids have both relatively shorter durations and less amounts of budget. Even though these types of aid are seen as benevolent, one might also take into account that the EC has issued a warning that employment aid might result in adverse effects that might offset the immediate effects of job creation; they could even lead to distortions in competition in the long run. Consequently, as put by Bree (2003), there is a tension between employment assistance and competitiveness.

As to the rankings of industries to which aid is given based on duration and budget, when other variables are controlled for, the top three industries with longest duration are industries of public administration and defense; compulsory social security; real estate activities; and accommodation and food service activities. On the other hand, the industries of real estate activities; of accommodation and food service activities; and of manufacturing rank top in terms of total budget. The longevity and the enormity of aid in industries of real estate activities reveal that aid with longer duration and with a high level of budget is given to industries that can be characterized as being industries where public goods are not provided by the market up to an efficient level because it is not lucrative to do so. For instance, affordable housing for low-income households might be undersupplied in real estate industry just because it is not profitable. In contrast, even though aid given to industries of public administration and defense; compulsory social security has the longest duration, it has the least amount of budget. More interestingly, aid given to the industries of

accommodation and food service activities has both relatively longer durations and higher levels of budget.

This paper has provided an analysis of the European Commission (EC) decisions on state aid control. In doing so, we have adopted a positive approach rather than a normative approach, explaining *what the state of affairs is* instead of *what the state of affairs ought to be*. We have characterized the last decade of European state aid control policy in summary statistics and, detailed quantile regression and duration analysis on 550 state aid cases in total.

According to Heidhues and Nitsche (2006) it is obvious that EU state aid control has evolved over time. What once was originally intended to address concerns about export subsidies and strategic trade has now become Article 107, which is the legal basis for state aid control in Europe. In the light of the findings above, the emphasis of state aid control is more on market failures mostly associated with externalities and public goods.

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