ANALYSIS OF STATE INTERVENTIONS IN THE US AIRCRAFT MANUFACTURING

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Abstract. Aircraft manufacturing is an industry strongly related to the defense production also providing work places to a significant number of countries' citizens. Such importance determines high attention of governments to this area. Local authorities can take a big variety of measures to protect and encourage aircrafts' production, depending on their abilities and aims. Economic policies might be different, from laissez-fair to foundation of public corporations. Depending on one's point of view, attitudes towards state interventions can differ dramatically. Protectionists encourage subsidies as a way to create new jobs and increase production. The free market advocates regard state interventions as more harmful than useful for economy, since they require resources diversion. This article considers application of subsidies in the aircrafts manufacturing industry and their influence on market competition. Without denying the negative effects associated with the budgetary reallocation of resources between industries, the author examines the impact of government intervention on competition within one of the sectors of the US economy. This article is dedicated to the methods and results of state interventions in US aircraft manufacturing industry. The main goal of the article is to determine whether the subsidies have a selective nature of coverage and if they influence the market competition. In order to study if state interventions rely on company's size, the author applied the methods of mathematical statistics, including Poisson distribution, to check a hypothesis about the absence of any relation between distribution of subsidies and company's revenue. The research was based on subsidies and incomes data of the US enterprises received from open sources. As the result of this study, it was concluded that subsidization of aircraft manufacturing companies probably is not related to their size. This is explained by the fact the decision-making authorities have multiple levels and subjects due to the country's federal governance structure.

Keywords: aircraft manufacturing, Poisson distribution, state intervention, subsidies, tax incentives

АНАЛИЗ ГОСУДАРСТВЕННОГО ВМЕШАТЕЛЬСТВА В ДЕЯТЕЛЬНОСТЬ АВИАСТРОИТЕЛЬНЫХ ПРЕДПРИЯТИЙ США

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Аннотация. Авиастроение — отрасль, тесно связанная с оборонной промышленностью, которая также обеспечивает рабочие места для значительного числа граждан страны. Её важность определяет повышенное внимание к ней государственных органов. Власти страны могут принимать самые разные меры для сохранения и стимулирования производства воздушных судов, в зависимости от своих возможностей и целей. Экономическая политика может быть разной, от laissez-fair до создания государственных корпораций. В зависимости от точки зрения, отношение к государственному вмешательству может кардинально отличаться. Протекционисты поощряют субсидии как способ создания новых рабочих мест и увеличения производства. Сторонники свободного рынка считают вмешательство государства скорее вредным, нежели полезным для экономики, поскольку оно требует отвлечения ресурсов от других предприятий и отраслей. В статье рассматривается применение субсидий в авиастроении и их влияние на рыночную конкуренцию. Не отрицая негативных эффектов, связанных с бюджетным перераспределением ресурсов между отраслями, автор исследует вопрос влияния государственного вмешательства на конкуренцию внутри одной из отраслей экономики США. Эта статья посвящена методам и результатам государственного вмешательства в авиастроение США. Основная цель статьи — определить, имеет ли предоставление субсидий избирательный характер охвата и влияет ли оно на рыночную конкуренцию. Чтобы изучить, зависит ли вмешательство государства от размера компании, были применены методы математической статистики, включая моделирование распределения Пуассона для проверки гипотезы об отсутствии связи между распределением субсидий и выручкой компаний. Исследование проводилось на основе данных о субсидиях и доходах предприятий США, полученных из открытых источников. В результате исследования был сделан вывод, что субсидирование авиастроительных компаний, с достаточной вероятностью, не связано с размером этих компаний. Этот факт объясняется наличием множества уровней и субъектов в органах, принимающих решения, что является следствием федеративной структуры управления страной.

Ключевые слова: авиастроение, распределение Пуассона, государственное вмешательство, субсидии, налоговые льготы

Introduction

Russian government implemented nationalization of the whole aircraft construction industry and centralized management of these companies. The centralization was supposed to provide new supply chains and create stable demand for products. But the main reason for taking control over the whole industry was to ensure production for military purposes. Considering this case of huge economic intervention, it seems interesting to analyze government's policy regarding aerospace industry in a country that rather prefers the

laissez-fair approach. The most suitable example of such country is the United States, which have a large-scale aircraft manufacturing industry.

Unlike countries relying on centralized state control over production, the USA prefer to develop the aerospace field providing subsidies and tax incentives to the enterprises. Grants, subsidies and tax incentives are provided here on three levels of authorities: cities' local authorities, states and federal government. The federal government provides subsidies for the following reasons:

1) encouraging export of national products
2) programs regarding federal defense;
3) scientific researches ordered by federal agencies including NASA, Energy department, etc.

Local and state authorities have others reasons of providing such benefits. Usually, when giving grants and tax incentives, they estimate expansion of production and new jobs creation for locals. In several cases local authorities provide tax exemptions lest company moves to other city or state. Forms of benefits rely on level of authorities: states provide grants, tax credits and tax exemptions whereas cities mostly diminish taxes.

Economists of Austrian school made a great contribution to the study of state interventions in economy. In general terms, Austrian economists are skeptical regarding this theme. Friedrich von Hayek concluded in his book "The constitution of liberty" [1, p. 264] that subsidies are suitable not as means for economic redistribution, but only as a way to make the market provide services that cannot be paid for by individual customers. Dr. Hayek considered financing developments that are necessary for national defense field as an example of such situation.

Ludwig von Mises thought that subsidizing to help any project can be harmful for the whole economy, and he described it in his work "Human action" [2, p. 654]. From his point of view, the profitability of a project is a measure of its utility for society. So, subsidizing any less profitable enterprise diverts resources from production of something necessary for customers. Ludwig von Mises noted that sources of subsidies are always found at the expense of tax-payers: due to money emission and increasing inflation or public funds.

His student, Murray Rothbard, paid attention to the difference between the kinds of state interventions [3, p. 1411]. He considered tax exemptions as a kind of state interventions that is fairer than subsidies. In case of a subsidy, a company receives cash from other enterprises as taxes. Tax exemption is less harmful for economy since it doesn't influence taxation of other companies, although it still provides unequal conditions for enterprises.

The scientists listed above created a theory to understand the influence of subsidization on economy. A significant share of current empirical researches regarding business subsidies is dedicated to their efficiency in terms of new jobs and production excess creation. Their estimations regarding efficiency vary from positive rates to small negative effect depending on country and volume of subsidies program. L. Simone, R. Lester and A. Raghunandan [4] studied the US data for 2004−2018 years and found that subsidies increase employment and salaries but this effect occurs more than one year after the payment. J. Lester [5] examined this problem in Canada during 2014−2015 years and concluded that nearly 60% of subsidies did not improve economic performance. J. Bundrick and Th. Snyder [6] have proven a small negative economic effect after testing data of Arkansas governor's economic incentives program in 2009−2015.

This problem is correlated with subsidies' influence on survival of start-up enterprises. Duhautois R., Redor D. and Desiage L. [7] studied the data of French companies and made a conclusion that subsidization increases the chances of start-ups to survive in comparison to other similar companies. Bergerab M. and Hottenrott H. [8] found that subsidizing increases private investing to company's capital it receives later.

Z. Naglova [9] studied the working efficiency in subsidized enterprises. She analyzed Czech meat industry of 2007−2013. Although the funding created a number of jobs and enhanced the size of companies' assets, it did not increase working efficiency and competitiveness of products.

Another branch of studies focuses on the subsidies targeted to research and development. C. Jiang, Y. Zhang, M. Bu, W. Liu [10] studied the new energy vehicles industry. They found that subsidizing has positive influence on research and development intensity, but the profit of these companies does not depend on this process. D. Ravshelj and A. Aristovnik [11] studied Slovenian companies performance in 2012−2016 and concluded that subsidies do not lead to the increase of investing to research and development since they displace companies' own expenses.

The efficiency of subsidies for research and development purposes is a deeply researched problem. In addition to the studies listed above, it was studied by L. Mewes and T. Broekel [12], Huili Zhanga, Ran Ana and Qinlin Zhongb [13], Th. H.W. Ziesemer [14], Sang-Ho Lee, Timur K. Muminov and Yoshihiro Tomaru [15], S. M. Galaasen and A. Irarrazabal [16], S. Afcha and A. Lucena [17], Jingtao Yi, Michael Murphree, Shuang Meng and Sali Li [18].

Ningzhong Li, Youchao Tan and Cheng Zeng [19] made a study that is closer to a problem of subsidies and market competition. They examined Chinese private companies that received subsidies in 2007−2016 and were connected with state officials. As it was found, these companies tend to avoid disclosing subsidies information. Also, these scientists have proved that firms connected to state officials get less subsidies if they disclosed subsidies information in past reports.

The majority of the viewed researches is connected with subsidies efficiency, and the problem of creating non-market condition with subsidizing does not receive sufficient attention. Due to unavoidable shortcomings and failures in public subsidies distribution system, this problem can suppress market competition of an industry. There is still lack of methods for analyzing whether the process of funding companies is selective.

The influence of state interventions on market competition in the context of federal governance system is explored in this article. The US aircraft and spare parts manufacturing companies are the object of this research. The application of state interventions to these companies is the subject of research.

Purpose

To describe whether state interventions suppress market competition in the US aircraft construction industry is the purpose of this study. This purpose is achieved by performing the following tasks:

− Characterizing the levels of authorities providing subsidies and tax incentives for aircraft manufacturers.

− Analysis of subsidies and tax incentives provided to check whether this process is selective. To assess it, the distribution of subsidized companies along the amounts of their revenue was studied.

Methods

According to open data, during 2011−2017, the majority of subsidies, tax incentives and tax credits were received by the US aerospace companies from local and states authorities (Table 1). Since 2017, federal benefits began growing, which is explained both by the increase in the federal benefits and the reduction of states and local authorities subsidies. This trend may cause selective application of subsidies and tax exemptions in the future thus leading to concentration of production in several huge companies.

To evaluate the influence of state interventions from given points of view, we should check whether interventions are made in a discriminative way.

Table 1 demonstrates that most of the time between 2011 and 2020, local and state benefits given to aircraft manufacturers make up the majority. Considering author's point of view and reviewed materials, there are two possible results of state interventions: either application of them is selective and relies on companies' size or application is random and has no dependence on the size of enterprises. To check whether interventions are selective, the author formulates two hypotheses:

H_0: application of subsidies, grants, tax credits and tax exemptions to the US aircrafts and spare parts producers doesn't rely on the size of the company's revenue.

Table 1. Subsidies and tax incentives received[1]

Year	Benefits from federal government, USD thousands	Benefits from local and state authorities, USD thousands	Share of local and state authorities, %
2011	163 713	446 619	73%
2012	143 396	127 749	47%
2013	170 611	8 886 605	98%
2014	170 095	2 276 392	93%
2015	191 492	660 029	78%
2016	150 951	440 016	74%
2017	233 392	308 402	57%
2018	800 959	299 832	27%
2019	805 096	268 474	25%
2020	286 812	62 139	18%

H_1: application of listed in H0 benefits is selective and relies on company's revenue.

To confirm or disprove the hypothesis H0, we have to check whether distribution of benefits by companies is random. In other words, the problem of testing the hypothesis is reduced to the classical statistical task. The task is quite similar to the one solved by R.D. Clarke, which he described in his article [20]. In his case, he checked if objects fell on the ground in clusters due to aiming or their distribution was random. In contrast, our task is to test whether the companies that received subsidies and tax incentives fall into groups along their annual revenue value selectively or this process is random. The author applied the same methods to test the hypotheses above with these steps:

1) grouping of companies received benefits by their revenue;
2) simulation of the Poisson distribution for calculated number of revenue ranges and companies count;
3) comparison of actual and simulated distribution with Chi-square test.

Results

The actions listed above were implemented. Their detailed description is also divided into three stages.

1. The annual number of companies that received subsidies, tax incentives and tax credits was grouped by their revenue's value. All these companies produced aircrafts or aircraft's spare parts during the period of 2011−2020. The author used the data regarding 18 publicly traded companies.

Fig. 1 presents the distribution of companies whose subsidies were higher than or equal to 0.1% of annual revenue. The events are grouped with a step of 2 mln. USD of annual revenue and each point represents the combination of company and year. As it is shown in the Figure, some ranges include several companies and this highlights that providing subsidies probably depends on company's size.

In order to make the data of different years comparable, the normalization was implemented. Annual revenues of each company were divided by total value of yearly US aerospace manufacturing. As the result, normalized revenues of enterprises exist in the range of (0, 0.25]. Table 2 shows an example of such data for 2018 and 2019.

The first five rows of data grouped by revenue's segments are shown in Table 3 (original data include 25 ranges). Each row represents the count of companies that received subsidies and have normalized revenue in the range specified. Since there are many cases when annual subsidies or tax exemptions were low relative to company's turnover, the author considered only the companies that received yearly benefits from authorities in amount of more than 0.1 % of their annual revenue. The author names every combination of company / year as an event.

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[1] Good jobs first. Subsidy Tracker. URL: https://subsidytracker.goodjobsfirst.org/prog.php (accessed September 14 2021)
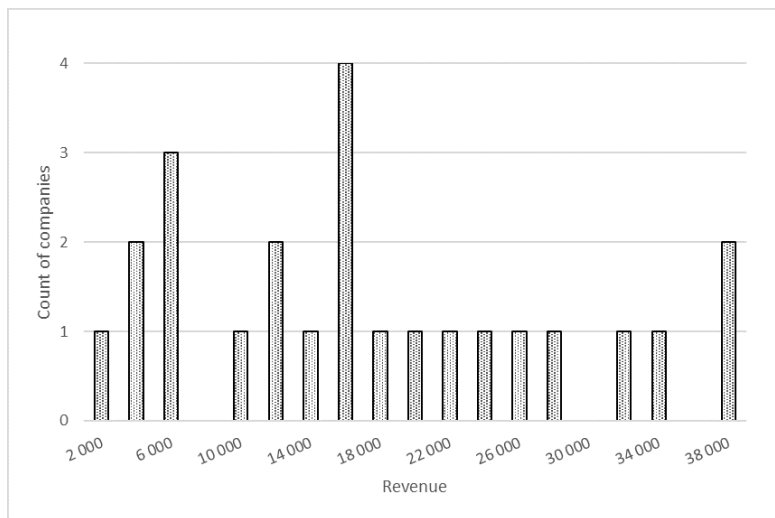
Fig. 1. Distribution of number of company and year combinations along revenue

Table 2. Calculation of normalized revenue on 2018—2019

Company	Year	Company revenue, mln. USD	Market revenue, mln. USD	Revenue normalized
Rockwell Collins	2018	16 634	272 454	0.06
General Dynamics	2018	36 193	272 454	0.13
Lockheed Martin	2018	53 762	272 454	0.20
Rockwell Collins	2019	26 028	266 144	0.10
Lockheed Martin	2019	59 812	266 144	0.22

Table 3. Distribution of enterprises' quantities' count (first 5 ranges)

No. of range	Revenue normalized, from	Revenue normalized, to	Quantity of events
1	0.00	0.01	2
2	0.01	0.02	1
3	0.02	0.03	3
4	0.03	0.04	1
5	0.04	0.05	—

Since our approach is to check how unevenly events are distributed along revenue value, at the next step this table will be pivoted to one comparing quantity of events and quantity of ranges.

2. Considering total amount of events and ranges quantity, we can simulate a Poisson distribution for this case. The Poisson distribution shows how revenue ranges would be grouped by events quantity if the process is random. Comparing actual and simulated counts, we can check whether there is random spreading of events. The Poisson distribution is simulated with this formula:

$$\frac{\lambda^{k} * e^{-\lambda}}{k!}.$$

In the formula, k means the number of concurrencies and λ is the average count of events. In our case, k equals the current count of events and λ is calculated as the number of events divided by the number of
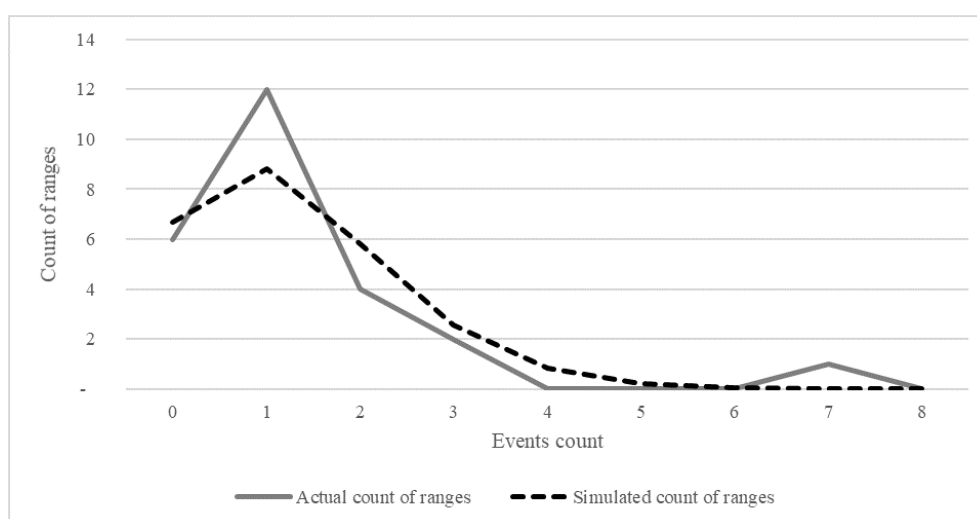
Fig. 2. Count of ranges simulated

ranges: 33 / 25 ≈ 1.3. When distribution is calculated, its values represent probability. Because of this, we multiply the calculated values by the number of ranges to get an estimation. Fig. 2 shows the result of this calculation.

3. The chi-square test is implemented to compare actual and simulated figures. As it is shown in Fig. 2, there is an outlier on Fig. 7. This is a range that lacks data between it and the last filled one, so its existence is arbitrary with no pattern. Therefore, when applying the chi-square test the author grouped figures over 4 events to one row. Table 4 contains the results of the test.

Table 4. The chi-square test

Number of events	Actual count of ranges	Simulated count of ranges	Chi-square
0	6	6.68	0.07
1	12	8.82	1.15
2	4	5.82	0.57
3	2	2.56	0.12
≥ 4	1	1.13	0.01
Total	**25**	**25.00**	**1.92**

Because the value of λ parameter of distribution was calculated, we have $(5 - 1) - 1 = 3$ degrees of freedom. The probability that we will get result of chi-square equal to 1.92 or higher is 0.59. Thus, we proved hypothesis H_0 correct, with the probability of 0.59.

Conclusions

In this research, the following results related to the established purpose were obtained:

− The features of funding authorities' levels were identified. While federal authorities prefer to make subsidies in different forms of direct payments, states' governments usually combine these payments with tax exemptions. Local authorities prefer only tax exemptions forms. Considering the research of D. Ravshelj and A. Aristovnik [11], direct payments are the least efficient form of subsidies, at least in case of research and development targets. Since 2017, the share of federal subsidies has been increasing, which means a loss in overall subsidizing efficiency.

– The distribution of subsidies between aerospace companies was analyzed. To check whether the funding is selective and depends on companies' turnover, the model of its distribution was done. When modelling the distribution, the author assumed the funding was random. After it was compared with real distribution with chi-square test, results proved non-selective kind of subsidizing the US aerospace companies. The novelty of this result is a methodology which allows checking whether a subsidizing program gives preferences to one group of similar enterprises or not.

The results obtained show that application of grants, subsidies and tax exemptions does not rely on companies' size in the case of the US aircraft manufacturing. Non-selective kind of interventions can be explained with the federative structure of United States. State and local authorities collect a large part of total taxes and are able to to provide subsidies or reduce taxes for chosen companies. Such conditions ensure competition between different regions of the US. Every state or city can encourage any company to operate on their territory by providing taxation benefits or prevent them from relocating from it by means of grants, subsidies or tax exemptions. Our research confirms that the federal structure of country's governance allows it to retain market competition even in case of state interventions.

However, the described situation will not last long. Since 2017, the share of local authorities in the provided interventions has been diminishing. If federal authorities continue providing the majority of subsidies and tax exemptions, it can lead to unfair aerospace market conditions due to concentration of decision-making processes at the federal level.

Directions for further research

This study was performed on a limited number of aircrafts constructing companies that provided data regarding revenues. There are numerous enterprises which do not reveal their accounting information thus being unavailable for study by the given method. Further researches can be related to any other ways to check conditions of state interventions in the considered industry, covering the majority of enterprises. In addition, random processes modelling described in this article can be applied in any study aimed at determination of discriminatory conditions in economy.

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