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Interfield equality: Journals versus researchers

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ABSTRACT

The Scientific and Technological Research Council of Turkey (Tubitak) gives subsidies to researchers for their publications. Tubitak groups journals into subject categories, and gives equal subsidies to publications from journals with comparable standing. This formulation aims at interfield equality among journals. Unfortunately, interfield equality among journals does not necessarily lead to interfield equality among researchers because there are interfield productivity differences. We show that chemists in prestigious Turkish universities on average receive 4.30 times more subsidies than economists. We also apply the subsidy formula to the publications of the researchers from world's most prestigious universities. In this case, the inequality between chemists and economists is less pronounced.

1. Introduction

Research subsidies for publication performances are used in many countries. Hicks (2012) notes that formulae for the research subsidies differ among countries. Some countries evaluate individual researcher performance, others evaluate departmental performance and the rest evaluate university-wide performance. Bibliometrics and/or peer-review are used for publication evaluation.

There is an interfield compatibility issue when researchers are evaluated for their publication performances. Journals from different fields have very different impact factors. It is possible to tackle this problem and achieve interfield equality among journals to some degree. Web of Science ranks the journals by their impact factors within their subject categories so one can just use the percentiles to evaluate these journals. Accordingly, an economics journal and a chemistry journal which have equal percentile ranking within their subject categories will be treated equally.

The normalization of journals is not sufficient to make researchers' performances compatible because there are interfield productivity differences. The issue is widely known because the productivity differences are very apparent in some cases. Researchers in the social science and humanities fields publish books. Consequently, they publish much less articles than the science fields. The computer scientists emphasize conference proceedings. Hence, they publish much less articles than the other science fields. Medical science researchers are known to be very productive.

We try to address the reasons for the interfield productivity differences in Yuret (2014, 2015). We suggest that the productivity differences stem from capacity differences. The capacity in a field is defined as the annual number of articles published in all the journals of the field. For example, we show that the average journal in which economists publish have a capacity of just 193 articles whereas the average journal of a chemist have a capacity of 1310 articles (Yuret 2015). However,

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our explanation is subject to the chicken and egg problem. The capacities of the economics journals may be small because of the low productivity of the economists but not vice-versa.

We think that the field specific characteristics that cause the productivity differences have not been determined satisfactorily. Some characteristics such as slow refereeing process and high rejection rates are given as possible reasons for low productivity in some fields. However, there are no studies to our knowledge which systematically analyzes the field specific characteristics for slow editorial process. Another possible explanation is the objectivity of the fields. For example, the studies in the experimental fields can be judged more objectively because many facts in these studies are not open to interpretation. On the contrary, there are many subjective elements in the referee evaluations in most of the social sciences. However, the causality between the subjectivity of the refereeing process and the low productivity has not been shown.

The interfield productivity differences can be computed by analyzing the publication performances of researchers in different fields. Abramo et al. (2009) find the average publication performances of researchers in different fields, and use the field averages to normalize the publication performances of the researchers. The authors propose this bibliometric formulation to replace the expensive panel discussions at Triennial Research Evaluation (VTR) in Italy. Claro and Costa (2011) normalize the performances of researchers by the top researcher performance in their respective fields when the authors evaluate candidates for a research award at University of Porto.

In Yuret (2015), we use address information to assign the publications to individual departments in the United States. We collect the number of faculty members from the websites of the universities. We find the productivity of each department by dividing the publications with the number of faculty members. Then, we compare the productivities of the departments with comparable US News rankings. We find that the interfield productivity difference among departments of comparable standing is very large.

The magnitude of the productivity differences can also be computed by using bibliometric techniques. Schubert and Braun (1992) compute the total number of researchers in a field by estimating the number of researchers who have not been able to publish. Sandstrom and Sandstrom (2009) follow their technique and compute the number of field-adjusted publications by using the productivity differences among fields.

None of the normalizations of researcher performances has become the standard. Each institution devices its own formula. These formulae are open to criticism for unequal treatment of fields. Vanclay (2011) claims that some fields are favored over others at the bibliometric part of the Excellence in Research for Australia (ERA). Geuna and Martin (2003) state that United Kingdom's Research Assessment Exercise (RAE) field panels are criticized for treating applied and interdisciplinary fields unfavorably.

Shibayama (2011) and Wu (2015) show that research project funding is unequal among academic fields in Japan and China. However, the research project funds contain budget for machines and other supplies which are field-specific. Because of this, neither of the authors sees interfield differences in research project funds as a problem.

We have two main objectives in this paper. First, we show the productivity differences between chemists and economists by using the most popular bibliometric indicators. Second, we analyze the publication subsidies implemented by the Scientific and Technological Research Council of Turkey (Tubitak). We show that the Tubitak's formulation which aims at interfield equality among journals but lacks to account for productivity differences yield significant differences between economists and chemists. We do not confine ourselves to only Turkish universities. We repeat our analysis for the world's most prestigious universities in order to show that the problem is not endemic to Turkey.

We use one social science field (economics) and one science field (chemistry) for our analysis. Economists give the utmost importance to journal articles. So they publish more in journals than most social science fields that usually rely on other publication types such as books as well. The chemists are more productive than most other science fields. Therefore, we compare a prolific social science field to a prolific science field in our analysis.

We collect the publication information about all the associate and full professors in 27 world universities and 9 Turkish universities. We search the publications from Web of Science and we also consult the professors' CVs to refrain from name confusions.

We see that the chemists publish 6.42 times more publications than economists in Turkey. When we consider fractional publications, the chemists publish 4.01 times more publications than economists. When we consider fractional publications in the journals that are in the top quarter in their subjects, we see that the chemists publish 7.55 times more than economists. The fact that the interfield productivity differences intensify when we consider the higher-ranked journals is consistent with our previous findings (Yuret 2014, 2015). There are also large productivity differences between chemists and economists in the non-Turkish universities but the difference is less pronounced. Turkish economists are more disadvantaged than non-Turkish economists possibly because the research in social sciences is more regionally engaged and most of the journals in Web of Science are in English and US based as stated in Hicks, Wouters, Waltman, de Rijcke, and Rafols, 2015.

Tubitak's research subsidy formulation is transparent and aims at interfield equality among journals. The journals are ranked within their subject categories and the publications from journals of equal standing are awarded the same subsidy. Moreover, Tubitak has additional rules that aim at curbing interfield differences.

We test whether or not Tubitak's research subsidy rules achieve interfield equality among researchers. We show that despite Tubitak's efforts to reconcile for interfield differences, there is a substantial difference between the subsidies that economists and chemists receive. We find that chemists on average get 4.30 times more subsidy than economists in prestigious Turkish universities. Because Tubitak adjusts for interfield differences in journal quality, the main source of the unequal distribution of subsidies is interfield productivity differences.

Table 1
List of Sample Universities.

University Name	#	Country	University Name	#	Country
Harvard University	A1	USA	University of Pittsburgh	D7	USA
Massachusetts Institute of Technology	A2	USA	The University of Hong Kong	E1	China
Stanford University	A3	USA	The University of Queensland	E2	Australia
University of California-Berkeley	A4	USA	University of Massachusetts Amherst	E3	USA
University of California, Los Angeles	B1	USA	University of Nottingham	E4	England
University of California, San Diego	B2	USA	University of Tennessee – Knoxville	E5	USA
University of Oxford	B3	England	Florida State University	F1	USA
Yale University	B4	USA	The University of Edinburgh	F2	Scotland
University of California, Irvine	C1	USA	University of South Florida	F3	USA
University of Illinois at Urbana-Champaign	C2	USA	Ankara University	T1	Turkey
University of North Carolina at Chapel Hill	C3	USA	Bilkent University	T2	Turkey
University of Southern California	C4	USA	Bogazici University	T3	Turkey
Aarhus University	D1	Denmark	Ege University	T4	Turkey
National University of Singapore	D2	Singapore	Gazi University	T5	Turkey
The Hebrew University of Jerusalem	D3	Israel	Hacettepe University	T6	Turkey
University of California, Davis	D4	USA	Istanbul University	T7	Turkey
University of Groningen	D5	Netherlands	Koc University	T8	Turkey
University of Notre Dame	D6	USA	Middle Eastern Technical University	T9	Turkey

We also do a hypothetical exercise to see how much the professors in the non-Turkish universities would earn if they were eligible for the subsidies. The aim is again to see whether the problem is endemic to Turkey. We perceive that the problem is less pronounced in the top universities in the world. There are even two universities that the economists would earn more than the chemists. As we walk down the ranking ladder, the disadvantage of the economists intensifies.

Tubitak's formulation fails to achieve interfield equality because it does not account for productivity differences. Tubitak gives the same amount of subsidy to the journal of comparable standing but the economists are not able to publish as many articles as chemists. Unfortunately, the bibliometric indicators that Tubitak use are not adjusted for productivity differences. Although there are no standard productivity normalization methods, possible techniques are known and applied in some research institutions. We will discuss possible normalization adjustments for Tubitak's formulation at the end of the paper.

2. Data

The popular Shangai Rankings list top 200 universities in five subject categories.[1] There are 29 universities which are ranked similarly in both economics and chemistry. We exclude Barcelona D'Autonoma because the information about their faculty members in their website is not sufficient. City University of Hong Kong is excluded because their chemistry faculty members are not listed separately from their biology faculty members.

Table 1 lists the remaining 27 universities. We partition universities into six ranking groups. The universities which are top ten in both economics and chemistry are in Group A. The other ranking intervals are 11–25 (Group B), 26–50 (Group C), 51–100 (Group D), 101–150 (Group E) and 151–200 (Group F). We sort the universities in alphabetic order within their ranking groups and assign subsequent numbers. We see that eighteen of the universities are from United States, three are from United Kingdom and the rest of the world has just six universities. This distribution reflects the high concentration of prestigious institutions in the world.

Our strategy of grouping departments as we describe above has two advantages. First, each group has similarly ranked chemistry and economics departments so that the productivity differences do not stem from the quality differences of the departments. Second, the chemistry and economics departments are from the same universities in each group. This means we are controlling for the university-specific characteristics. For example, consider the comparison of the economics department from University X that has a similar ranking with the chemistry department from University Y. University Y might prefer established scholars whereas University X might prefer young scholars who are at the peak of their productivity cycle. Then some of the productivity differences between the economics and chemistry departments will be because of the characteristics of Universities X and Y.

Unfortunately, none of the Turkish Universities are ranked in the top 200. Therefore, we use the University Ranking by Academic Performance (URAP) rankings developed by the Turkish Middle Eastern Technical University. The rankings do not differentiate between subject matters. We take the top ten public universities and the top three private universities. Three technical public universities either do not have an economics department or the economics department has less than five associate and full professors. One private university does not have a chemistry department. We label the Turkish universities group with T and list the seven public and two private (Bilkent and Koc) universities alphabetically.

[1] Data sources are listed before the references.

We use a five-year time period (2010–2014) to avoid yearly fluctuations in publication performances. We only include associate professors and full professors in our analysis because assistant professors may not have a five-year research time. There are 887 economics and 1076 chemistry associate and full professors in the 36 universities.

We use both Web of Science and CVs of the faculty members in order to get an accurate listing of articles published. We search the names of the faculty members from Web of Science for the time period. We also check the publications in the CVs of the faculty members in order to avoid name confusions. Unfortunately, the full list of publications is not available for some faculty members. Therefore, we also check the address information of the publications in Web of Science and match them to the academic positions information in the CVs.

Tubitak's formulation for research subsidies is transparent and available from their website.

We download all the articles in economics and chemistry for the years 2010–2014 from Web of Science in order to compute the interfield productivity differences in various countries by adopting the bibliometric methodology used in Schubert and Braun (1992).

3. Interfield productivity differences

As a first step, we find the unadjusted number of publications for each professor. We only consider articles but exclude other types of publications such as conference proceedings and commentaries. We use the same methodology for both Turkish and non-Turkish universities. We find the number of articles from Web of Science and we refrain from name confusions by consulting the CVs of the professors. We do not adjust for the number of authors. So the number of articles that we find is not fractional.

Second, we rank the researchers by the number of articles that we find in first step. Then, we find the productivities of the researchers by quartiles within their departments. In order to do this, we divide the number of articles that are published by the professors for the five-year period (2010–2014) in each quartile to the number of the professors in each quartile. Therefore, we do not compute the annual productivity but we compute the total productivity for the five years that we consider.

The results are given in Table 2. We see that chemistry and economics faculty productivities are vastly different. The top quartile of economists are less productive than the third quartile of chemists in all but three Turkish universities. The top quartile of economists are less productive than the last quartile of chemists in seven universities. When we compare the top quartile of chemists to the top quartile of economists, we see that the productivity differences are stark. For instance, the top quartile of chemists on average publish 85 articles whereas the top quartile of economists on average publish 18.7 articles at Harvard University (A1) in the five-year period.

There are also large productivity differences among researchers within the same department. For example, the top quartile of chemists on average publish 82.4 articles whereas the last quartile of chemists publish on average just 21.9 articles at MIT (A2) in the five-year period. We do not believe that this productivity difference reflects the quality difference among researchers in such a prestigious institution.

Another interesting fact is the abundance of zero publications across the Turkish economists given that we span a five-year period. We understand that many economists in prestigious Turkish universities do not receive any research subsidies for such a long time.

In the above analysis, we do not control for the number of authors in the articles. That is, an article with N authors increases the number of publications by one article for each of the N authors. Chemistry articles typically have more authors than economics articles. Therefore, the number of authors is one of the causes that creates the differences in productivities between economics and chemistry. In order to account for this, we compute the fractional publications. That is, we attribute 1/n publications to each author in an n author paper. Then we compute the number of fractional publications to the number of professor in each group in order to find the fractional productivities. We compare the unadjusted and fractional productivities in Table 3. Both the fractional and the unadjusted productivities are total productivities for the five-year period; they are not annual productivities. We see that the fractional productivities are more equal than the unadjusted productivities. For example, Group A chemists on average publish 4.54 times more articles than Group A economists but this ratio decreases to 2.33 for the fractional publications.

It is well known that impact factors are very different across academic disciplines. Therefore, Web of Science partitions journals into subject categories and ranks them by their impact factors within these subject categories. Many journals belong to more than one subject category. In this case, we take the average of the percentile rankings from all the subject categories to which the journal belongs. In the fourth and seventh columns of Table 3, we compute the fractional publications for the articles in the top quartile journals. We see that the discrepancy between fields increases when we only consider the top quartile journals.[2]

[2] In two preceding papers, we also conclude that adjusting for the quality of the journals may increase the inequality among academic fields. The data processing is different in this paper because we match the publications to the individual faculty members rather than to the academic fields (Yuret 2014) or to the departments (Yuret 2015).

Table 2
The productivity for each quartile within the department for five-year period (2010 to 2014).

	Chemistry				Economics			
#	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
A1	85.0	39.3	27.7	16.6	18.7	10.1	7.0	2.7
A2	82.4	41.7	29.9	11.7	21.9	11.9	7.2	3.2
A3	86.0	61.6	42.0	18.8	15.9	10.2	6.2	2.9
A4	81.2	50.9	30.5	10.5	19.1	7.8	5.4	2.3
B1	66.3	31.0	17.3	4.7	9.1	5.5	3.0	1.4
B2	71.9	31.0	16.6	5.7	13.7	7.0	4.0	2.4
B3	80.1	34.6	22.9	13.8	12.2	6.0	3.4	1.1
B4	58.0	35.3	21.8	8.3	16.5	7.6	4.4	1.8
C1	56.3	27.8	20.7	8.5	14.4	7.6	4.8	1.2
C2	85.6	43.8	33.5	20.3	10.8	5.3	4.0	1.5
C3	51.9	28.6	16.3	7.3	10.5	5.4	2.5	0.6
C4	66.6	36.8	17.4	5.5	15.8	8.0	3.8	0.0
D1	86.1	35.3	26.6	14.9	10.2	4.5	2.4	0.6
D2	83.0	44.2	24.9	9.1	11.3	7.0	3.9	1.2
D3	64.7	31.5	15.7	8.2	8.6	4.3	3.0	1.3
D4	76.8	36.0	20.6	7.5	12.0	6.2	4.0	1.8
D5	83.0	31.5	23.4	14.5	13.5	7.3	2.7	0.4
D6	48.3	22.9	15.1	6.9	8.2	5.8	3.5	1.0
D7	58.6	27.5	13.1	2.7	5.5	3.0	1.7	0.0
E1	102.8	34.8	26.7	13.7	12.8	5.5	3.0	1.1
E2	71.5	41.0	25.7	13.8	15.6	8.0	5.2	1.6
E3	44.0	19.3	11.3	3.2	7.5	4.3	2.7	0.4
E4	73.9	35.3	20.7	10.1	13.5	7.8	4.8	2.8
E5	80.8	24.2	10.0	2.8	9.0	5.7	3.3	1.0
F1	56.6	23.8	16.9	6.1	10.2	5.3	2.7	0.3
F2	51.4	27.8	20.2	6.6	8.0	4.3	1.8	0.0
F3	34.0	14.4	8.6	1.7	3.3	2.0	1.0	0.0
T1	19.5	7.9	5.2	2.0	4.5	1.0	0.0	0.0
T2	28.5	18.0	9.5	3.0	11.3	6.0	2.3	1.0
T3	24.3	8.8	4.5	1.3	13.0	4.2	2.0	0.5
T4	18.8	10.8	6.2	3.2	4.0	1.0	0.0	0.0
T5	21.4	9.9	5.7	2.6	6.7	0.0	0.0	0.0
T6	31.2	8.0	4.6	1.6	4.4	2.4	1.0	0.0
T7	28.9	8.3	4.0	1.7	2.0	0.0	0.0	0.0
T8	19.0	17.5	16.0	15.0	6.5	4.0	1.5	0.0
T9	47.1	13.3	6.3	0.5	2.0	N.A[a]	1.0	0.0

[a] There are many faculty members who have 2 and 1 publications in Middle Eastern Technical University (T9) economics department. Because the faculty members who have the same publications ranked the same, there are percentile gaps. Consequently, there are no faculty members who have percentiles between (25%,50%].

Table 3
The productivity at group level for five-year period (2010–2014).

Group	Economics			Chemistry (Economics = 1)		
	Unadjusted	Fractional	Top Q Only	Unadjusted	Fractional	Top Q Only
A	9.70	4.61	3.08	4.54	2.33	2.97
B	6.40	3.27	2.10	5.22	2.29	2.68
C	5.99	2.98	1.53	5.47	2.67	4.19
D	5.05	2.42	1.17	6.62	3.18	4.98
E	6.47	3.05	1.17	5.15	2.39	4.50
F	3.67	1.94	0.74	6.27	2.57	4.95
T	1.77	0.80	0.20	6.42	4.01	7.55

4. Formulation for Tubitak's research subsidies

Tubitak's research subsidy formulation is transparent and available from their website. We use the 2015 subsidy formulation for all five years of publications. This is because we cannot attain the subsidy formulation prior to 2014. The advantage of using the current formulation is that we are able to evaluate the interfield differences under the current rules.

The formulation has five steps.

1 Tubitak aggregates Web of Science subject categories to have a statistical meaningful set to perform their computations. They do not disclose the aggregation procedure. This is the only non-transparent part of their formulation. One cannot reproduce the subsidy amounts from the bibliometric indicators because the link between the bibliometric indicators and the subsidy amount for each journal is broken in this step. This non-transparency is not important for this analysis because

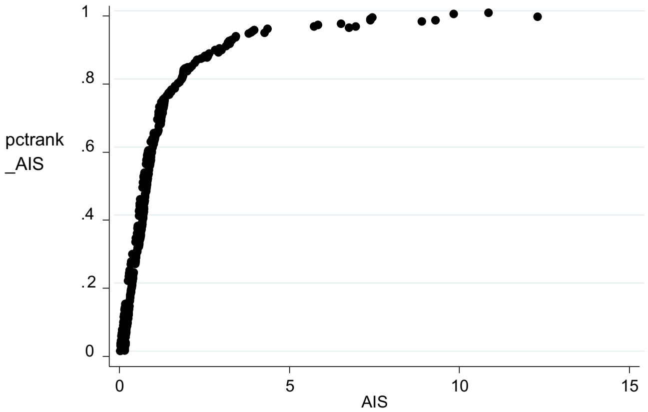

Fig. 1. Distribution of AIS in Economics.

we only use the subsidy amount for each journal to compute the subsidies that the authors receive which is available. However, a researcher who wonders why publications in some journals receive lower subsidies and others receive higher subsidies would be enlightened if she is able to compute the subsidy amount from the bibliometric indicators.

2 Tubitak uses Article Influence Score (AIS) to rank the journals within their subject categories. The statistics and definition of AIS are available from the Journal Citation Reports (JCR) provided by Web of Science. JCR states that AIS is different from Impact Factor because Impact Factor treats each citation the same but AIS gives more weight to the citations if the source journal itself receives more citations.

Naturally, the AIS and the Impact Factor are highly correlated. We find that the journal ranking within each subject category when we use AIS has a correlation of 0.89 with the journal rankings when we use the Impact Factor. Therefore, the interfield productivity differences in the high impact factor journals in Table 3 are indicative for the interfield productivity differences in the high AIS journals.

3 Tubitak defines "Effect Score" (ES) as follows. First, the mean and standard deviation AIS of each subject category are computed. Then, the journals which have AIS greater than mean plus two standard deviations receive 100 ES and the journals which have AIS lower than the mean minus two standard deviations receive 0 ES. All other journals are assigned ES linearly on [0,100] according to their standing.

Tubitak limits the ES between 0 and 100 in order to moderate the subsidy amounts for the outliers. The ES of each journal is provided by Tubitak. We see that 6.18 percent of the journals receive 100 ES and 4.05 percent of the journals receive 0 ES.

Fig. 1 gives the distributions of the AIS of the journals in the economics subject category. Because the aggregated subject categories that Tubitak uses is not available, we use the economics subject category from Web of Science to illustrate our point. The x axis is the actual AIS and y axis is the percentile rank of the journals in the economics subject. The mean AIS is 1.24 and the standard deviation is 1.79 for the journals in the economics subject category. Since the minimum AIS is bounded by zero, no journals are below the mean minus two standard deviations. However, there are 13 journals which have AIS greater than 4.82 which is the mean plus two standard deviations. The maximum AIS that an economics journal has is equal to 12.3 which is 6.17 standard deviations above the mean. Because the maximum ES is restrained to be 100, this journal gets the same ES as the journal which is just above 2 standard deviations above the mean.

Fig. 2 gives the distribution of the AIS of the journals in economics which have AIS smaller than the mean plus two standard deviations. Step 3 of the formula states that the ES is assigned linearly from 0 to 100, therefore the percentile ranks in this figure also correspond to the ES scores divided by 100. We clearly see that the shape is concave. Therefore, linearization harms the outliers. For example, the median journal has 0.68 AIS and receives 50 ES according to the formula.[3] The top journal in this restricted sample has 4.26 AIS which is 6.26 times more than the median AIS but only receives 100 ES according to the formula.

4 The subsidy amount for each journal is computed by the following formula:

$$\text{Subsidy} = 500 + 7000 * (\text{ES}/100)^{2.5}$$

[3] Please note that the ES of the journals that we give in this example are driven from the formula for the Economics Subject category. They do not correspond to the actual ES of the journals because we are unable to use the aggregated subject categories that Tubitak uses.

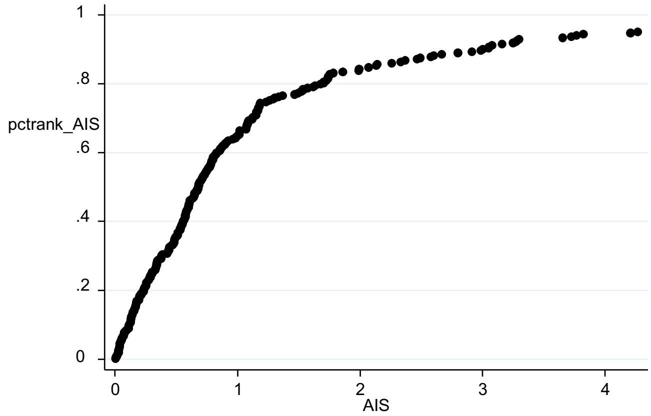

Fig. 2. Distribution of AIS in Economics (AIS<4.82).

Table 4
Number of Journals and Articles in Subsidy Intervals.

	Journals					
	Number		Percentage		Number of Articles	
Subsidy (TL)	Econ	ChemMu	Econ	ChemMu	Econ	ChemMu
7500	36	9	0.11	0.06	1933	3410
5000–7499	9	3	0.03	0.02	379	1290
3500–4999	18	4	0.06	0.03	942	5620
2500–3499	16	5	0.05	0.03	1100	1845
1500–2499	22	5	0.07	0.03	1067	1870
1000–1499	23	8	0.07	0.05	1409	5059
500–999	202	112	0.62	0.77	9278	30879
Total	326	146			16108	49973

Because ES/100 is between 0 and 1, raising it to the power 2.5 decreases the distance between high-quality journals and low-quality journals. As a result, most journals are closer to the minimum subsidy (500 Turkish Lira [TL]) than to the maximum subsidy (7500 TL).

Table 4 lists the statistics for two Web of Science categories that researchers in our sample most publish. The economists publish 83 percent of their publications in "economics" subject category whereas the chemists publish 29 percent of their publications in "chemistry, multidisciplinary" subject category.

We see that the economics subject category has more journals that have the maximum subsidy. The economics subject category is also advantageous for having proportionally more journals that have the maximum subsidy. A possible explanation for the advantage is that the economics subject category may be merged into a subject category which has journals with lower AIS in step 1.

When we look at the number of articles in the journals that receive the maximum subsidy, we see that the direction of the advantage is reversed. Becuase the journals which have the maximum subsidy in the "chemistry, multidisciplinary" subject category have more articles, there are more articles in this subject category that can be awarded with the maximum subsidy than the economics subject category.

5 Tubitak has additional rules for distribution of the subsidies. We will see in a later section that all these three rules decrease the discrepancy between economists and chemists.
  a. Fraction rule: The authors receive subsidy inversely proportional to the number of authors. In other words, the authors receive 1/n of the subsidy assigned to the journal in an n author paper.
  b. 250 TL rule: The researchers do not receive any subsidy if the reward per author falls below 250 TL.
  c. 10 paper rule: The researchers cannot submit more than ten articles in a given year for reward. There are no additional regulations as to which articles to be submitted if the researcher publishes more than ten articles. We assume that the researchers submit the ten articles which have the highest subsidy amounts when they have more than ten articles. This is possible because the submission process is independent for each researcher. Suppose that Researcher X and Y write a joint paper. It can be the case that Researcher X submits the article for reward and at the same time Researcher Y can refrain from submitting the article for reward. Therefore, each researcher can independently maximize their publication subsidies. Of course, there can be violations of this assumption. For example, a researcher who publishes in January may

Table 5
Average Research Subsidy.

#	Econ	Chem	Ratio	#	Econ	Chem	Ratio
A1	24288	30124	1.24	D7	4738	13210	2.79
A2	28819	25460	0.88	E1	5239	12793	2.44
A3	20061	33089	1.65	E2	7502	13029	1.74
A4	19969	26176	1.31	E3	3422	9877	2.89
B1	13078	15865	1.21	E4	5882	12373	2.10
B2	15874	14297	0.90	E5	4139	9494	2.29
B3	12182	14425	1.18	F1	4291	11669	2.72
B4	17538	18175	1.04	F2	5891	8238	1.40
C1	12687	15695	1.24	F3	1138	4987	4.38
C2	9282	25281	2.72	T1	297	1600	5.38
C3	7142	15451	2.16	T2	3309	10093	3.05
C4	8625	16820	1.95	T3	1808	3181	1.76
D1	3798	12991	3.42	T4	250	2531	10.13
D2	6468	16705	2.58	T5	211	2819	13.37
D3	9296	13891	1.49	T6	696	3646	5.24
D4	8839	15448	1.75	T7	23	3470	151.74
D5	5899	16948	2.87	T8	2635	5516	2.09
D6	10130	14405	1.42	T9	844	5153	6.10

prefer to submit the paper for reward immediately. If she publishes ten more articles which have more subsidy than that paper during the rest of the year, then our assumption is violated.

5. Interfield differences in Tubitak's research subsidies

Tubitak's research subsidies are given to publications which have Turkey addresses. Nevertheless, we compute the subsidies for 27 non-Turkish universities to see whether or not the interfield difference is specific to Turkish universities. We do not have any additional information for Turkish professors. We use the same methodology for Turkish and non-Turkish professors. We find their publication information from Web of Science and correct for the name confusions by consulting the professors' CVs. We use the journal subsidy amounts which are available from Tubitak's web site[4] and the restrictions stated in step 5 of the formulation to compute the subsidy amount that the researchers deserve. Although the publications span a five-year period (2010–2014), we find the subsidies under the current rules (2015) because of data availability and our desire to evaluate the current rules.

Table 5 gives the average research subsidy at the department level. We see that the chemistry faculty members on average get more research subsidy than economists in all Turkish universities. The ratio of the average earnings of chemists over economist's range from 1.76 to 152. If the Turkish universities were publishing as much as the world's top universities, the economists could even earn more than chemists. The economists at MIT (A2) and University of California at San Diego (B2) on average receive more subsidy than chemists. But as we walk down the ranking ladder the chemists start to earn considerably more research subsidy than economists.

6. The marginal effect of Tubitak's rules

We analyze the effect of Tubitak's rules on the interfield inequality among the researchers. To do this, we change the rules one by one. We cannot claim that we see the pure effect of the rule because the rules are interrelated. For example, when we relax the 250 TL rule, then the 10 papers rule becomes more restrictive. Nevertheless, we think that it is instructive to look at the marginal rule changes.

Table 6 gives the ratio of average subsidy received by chemists over economists. Under the current rules, the average chemist receives 4.30 times more subsidy than the average economist. We see that all three rules decrease the interfield differences. The fraction rule affects the chemists more because the chemistry papers have more authors. The 250 TL rule also harms chemists more because it is more likely that the subsidy falls below 250 TL when the subsidy is divided among more authors. The 10 paper rule is also disadvantageous for chemists because economists rarely publish more than 10 papers in a given year. Of all these three rules, the fraction rule is the most influential in curbing the differences between economists and chemists.

[4] We mentioned previously that since the first step of the formula is not transparent we cannot compute the result of the first four steps from the bibliometric indicators. However, Tubitak provides the list of the subsidy amount for each journal that we use when we compute the subsidies that the researchers deserve.

Table 6
Marginal Effects of Tubitak's Rules on the Ratio of Subsidies Received by the Average Chemist over Average Economist.

Group	Current Rules	Eliminate Fraction	Eliminate 250 TL	Eliminate 10 paper
A	1.20	2.40	1.24	1.32
B	1.06	2.70	1.14	1.12
C	1.91	4.03	2.00	2.00
D	2.47	5.32	2.63	2.58
E	2.05	4.49	2.23	2.15
F	2.00	5.25	2.22	2.03
T	4.30	7.29	4.62	4.32

Table 7
The Productivities in Chemistry and Economics subjects.

Country	Chemistry			Economics			Ratio of Articles Per Author (Chem/Econ)	Ratio of Articles per Potential Authors (Chem/Econ)
	# of Authors	Articles per Author	Articles per Potential Authors	# of Authors	Articles per Author	Articles per Potential Authors		
Argentina	1547	2.28	0.63	101	1.36	0.21	1.68	2.97
Czech R.	2144	2.72	0.50	547	1.53	0.20	1.78	2.50
Greece	1213	2.60	0.78	287	1.87	0.31	1.39	2.49
Hungary	946	2.88	0.81	137	1.38	0.13	2.09	6.02
Lithuania	322	2.32	0.54	259	1.64	0.03	1.41	16.38
Mexico	2187	2.02	0.25	247	1.25	0.14	1.62	1.82
Pakistan	1017	3.25	1.12	116	1.84	0.18	1.76	6.36
Poland	5153	2.71	1.04	385	1.54	0.14	1.77	7.18
Romania	2011	2.41	0.84	460	1.52	0.32	1.59	2.60
Russia	9158	2.49	0.61	153	1.43	0.03	1.74	20.81
Slovakia	759	2.09	0.60	201	1.38	0.16	1.51	3.67
Turkey	3603	2.47	0.78	659	1.59	0.05	1.55	16.43

7. Productivity differences between chemistry and economics subject areas

The economists publish 83 percent of their papers in the economics subject area and the chemists publish 64 percent of their papers in chemistry subject area. Therefore, the main source of the productivity differences between chemists and economists is the productivity differences in their respective subject areas.

We follow Schubert and Braun (1992) to compute the productivity differences. We find the number of reprint authors and the total number of articles for each country in both chemistry and economics for the years 2010 to 2014. There are many researchers who have not been able to publish during these years. In order to account for that, Schubert and Braun (1992) use the Waring distribution that leads to the following formula to compute the total number of potential authors.[5]

$$T = N(1\text{-}f)/(1\text{-}2f + f/x)$$

where T is the number of potential authors, N is the number of reprint authors, f is the number of reprint authors who have exactly one article and x is the average number of papers by the reprint authors.

We lay out the results in Table 7 for some selected countries. The first column for each subject is the number of reprint authors (N). The second column for each subject gives the number of publications per author (x). We see the productivity differences between subject areas clearly. The productivity in chemistry ranges from 2.02 to 3.25 whereas the range is from 1.25 to 1.87 for economics. The penultimate column of Table 7 gives the ratio of productivity of chemists to economists. We see that the range is from 1.39 to 2.09.

The third column for each subject category gives the number of publications per potential authors. The productivity differences are even starker. The productivity in chemistry ranges from 0.25 to 1.12 whereas the range is from 0.03 to 0.32 in economics. The last column of Table 7 gives the ratio of the productivity of chemists to economists in terms of potential authors. We see that the ratio ranges from 1.82 to 20.81.

[5] The only change we make to the formula is that we use the number of reprint authors whereas Schubert and Braun (1992) use the number of first authors.

8. Conclusion

Tubitak has distributed 11.5 million Turkish Lira (₺)[6] publication subsidies to 12,500 researchers for 11,530 articles in 2014 (Tubitak Report 2014). The total amount of the subsidy is small in respect to the total Tubitak budget which is 2.5 billion ₺. However, the publication subsidy amount can be substantial for some researchers. The researchers can get up to 7500 ₺ from a single article in some journals which is about two times the monthly wage of an associate professor in a public university.

Hicks et al. (2015) announce the Leiden Manifesto which states ten principles to be adopted when bibliometric method is used. The fourth principle is about the transparency and simplicity of the evaluations. Tubitak's formulation is transparent except for the first step in which Tubitak aggregates Web of Science subject groups. The step is crucial because it breaks the link between the bibliometric indicators and the result of the formula. The researchers are unable to verify whether the formula stated is used in a correct way.

Tubitak's formulation is simple because it uses the basic bibliometric indicators and easy statistical formulas. However, the simplicity interferes with the sixth principle which states that interfield differences should be taken into account. Tubitak has made some effort to achieve interfield equality but they do this only at the journal level. We show that this is not sufficient because the formula lacks to account for interfield productivity differences. There is no standard way to account for interfield productivity differences but some research institutions do successful normalizations for interfield productivity differences.

The first way to account for interfield productivity differences is to consider the third principle in the Leiden Manifesto which is about protecting the locally relevant research. Hicks et al. (2015) state that most of the journals in Web of Science are US based and in English and this is especially problematic for social sciences and humanities. There are no economics journals that are based in Turkey or publish articles in Turkish. Dogan and Yuret (2013) find that more than half of the economics departments do not have any faculty members who publish any SCI or SSCI papers in their lifetimes in Turkey. Any bibliometric formulation that is confined to Web of Science would leave most faculty members out of the system. Tubitak should try to be more inclusive when the social sciences and humanities are considered.

A possible solution to the interfield productivity differences is to assign researchers to the fields and evaluate researchers within the field. We allocate researchers according to the departments that they work. This field allocation serves our purpose as we are able to show interfield productivity differences and unequal subsidy allocation. Unfortunately, this technique cannot be generalized to be used for the whole research system because some fields are not organized as departments. However, Tubitak can assign researchers to fields and evaluate researchers within the fields as it is done for the Italian research system which is described in Abramo and D'Angelo (2011).

Researchers from prolific academic fields may feel that they are treated unfairly when the researchers are evaluated within their academic fields. This is because the interfield equality requires them to earn a much lower per article subsidy than the researchers from other academic fields. This problem can be addressed by analyzing non-Turkish data as we do in this analysis. We choose the best universities in the world to show that the interfield productivity difference exists even in the best universities. However because of language and other factors, the interfield productivity differences in Turkish universities are more severe than the interfield productivity differences in the world's best universities. If similar interfield productivity differences exist in non-Turkish universities that are comparable to Turkish universities in terms of quality and other factors, then the possible concerns of researchers from prolific academic fields would be addressed.

Tubitak can adopt the bibliometric methodology used in Schubert and Braun (1992). The problem with this methodology is that it relies on an estimation of productivity but not the productivity itself. However, the methodology has three main advantages. First, the bibliometric methodology is simple and replicable. Second, the methodology can be applied to all subject categories. Lastly, it is easy to convince the researchers from prolific fields that similar productivity differences exist in other countries as well.

Data sources

Shangai Rankings (Academic Ranking of World Universities), 2014, available at <www.shanghairanking.com>

Tubitak web site is accessed to get the research subsidy formulation available at <http://ulakbim.tubitak.gov.tr/tr/hizmetlerimiz/ubyt-yayin-tesvik-programi>

University Ranking by Academic Performance (URAP), 2014, available at <tr.urapcenter.org/2014/>

Web of Science Core Collection is used to collect publication information available at <www.isiknowledge.com>

Web of Science Journal Citation Reports is used to find the list of first quartile journals. We also extract the annual number of articles in the journals of "economics" and "chemistry, multidisciplinary" subject categories from this source.

Web Sites of 72 departments in 36 universities are used to collect information about academic positions held and publications of 1963 faculty members.

[6] 1 € is about 3 ₺ in 2014.

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