Does Monetary Support Increase the Number of Scientific Papers? An Interrupted Time Series Analysis

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Outline

- Performance-based research funding systems (PRFSs)
- TÜBİTAK's Support Program of International Scholarly Publications
- Data Sources
- Method
- Findings
- Limitations of the Study
- Conclusions

Performance-based Research Funding Systems (PRFSs)

- Give more to higher performers so that low performers work harder to get support (Herbst, 2007, p. 90)
- Not clear though if PRFSs increase productivity and impact
- "Side effects" (e.g., "Homogenizing" research outputs; discouraging experiments using new approaches; rewarding "safe players" whose work may have no or little societal impact)
- PRFSs:
  - Peer review or informed peer review (e.g., Research Excellence Framework)
  - Bibliometric measures (i.e., journal impact factors JIFs, article influence scores -AISs)
- Examples and consequences of using PRFSs based on bibliometric measures only

TÜBİTAK's Support Program of International Scholarly Publications

- Turkey has 185 universities w/ 151K faculty & 5M students

- 400K papers in WoS-indexed journals (1976-2015)

- Impact is below world, EU and OECD averages

- Support Program (1993-   )
  - Used JCR's JIF2 (1993-2012), JIF5 and cited-half-life (2013), and AISs (2014-2015) to determine the amount of support
  - 157K publications got supported (1997-2015)
  - About 35M USD paid to 285K authors
  - # of papers supported, # of pubs & amount of support increased four-, 10- and 13-fold, respectively
 - Yet, its impact has not been not evaluated in 25 years

Data Sources

- 390K pubs with Turkish affiliations (1976-2015) (Source: Web of Science)

- 157K pubs with payment data (1997-2015) (Source: TÜBİTAK)

- 146K papers (93% of all pubs and 97% of total amount of payments

of publications with Turkish affiliations (1976-2015)

Year	Papers		Other		Total	Year	Papers		Other		Total
	N	%	N	%	N		N	%	N	%	N
1976	216	80	53	20	269	1996	3359	84	623	16	3982
1977	229	72	91	28	320	1997	3844	83	796	17	4640
1978	272	72	108	28	380	1998	4460	82	1001	18	5461
1979	256	71	106	29	362	1999	5201	83	1078	17	6279
1980	343	74	123	26	466	2000	5462	84	1059	16	6521
1981	299	73	110	27	409	2001	6684	84	1271	16	7955
1982	315	70	132	30	447	2002	8985	86	1434	14	10419
1983	354	72	141	28	495	2003	10662	84	1978	16	12640
1984	420	77	129	23	549	2004	13199	84	2488	16	15687
1985	447	76	145	24	592	2005	14194	83	2877	17	17071
1986	506	77	151	23	657	2006	15070	79	4099	21	19169
1987	588	77	174	23	762	2007	17853	80	4414	20	22267
1988	672	75	227	25	899	2008	19327	82	4379	18	23706
1989	829	80	209	20	1038	2009	21655	82	4627	18	26282
1990	912	78	261	22	1173	2010	22833	83	4760	17	27593
1991	1134	80	290	20	1424	2011	23588	82	5325	18	28913
1992	1351	77	406	23	1757	2012	25254	82	5607	18	30861
1993	1519	76	482	24	2001	2013	26526	79	7200	21	33726
1994	1754	73	643	27	2397	2014	27242	79	7315	21	34557
1995	2233	72	885	28	3118	2015	28662	79	7530	21	36192
						Total / Avg.	318709	81	74727	19	393436

of papers and total # of publications with Turkish affiliations (1976-2015)
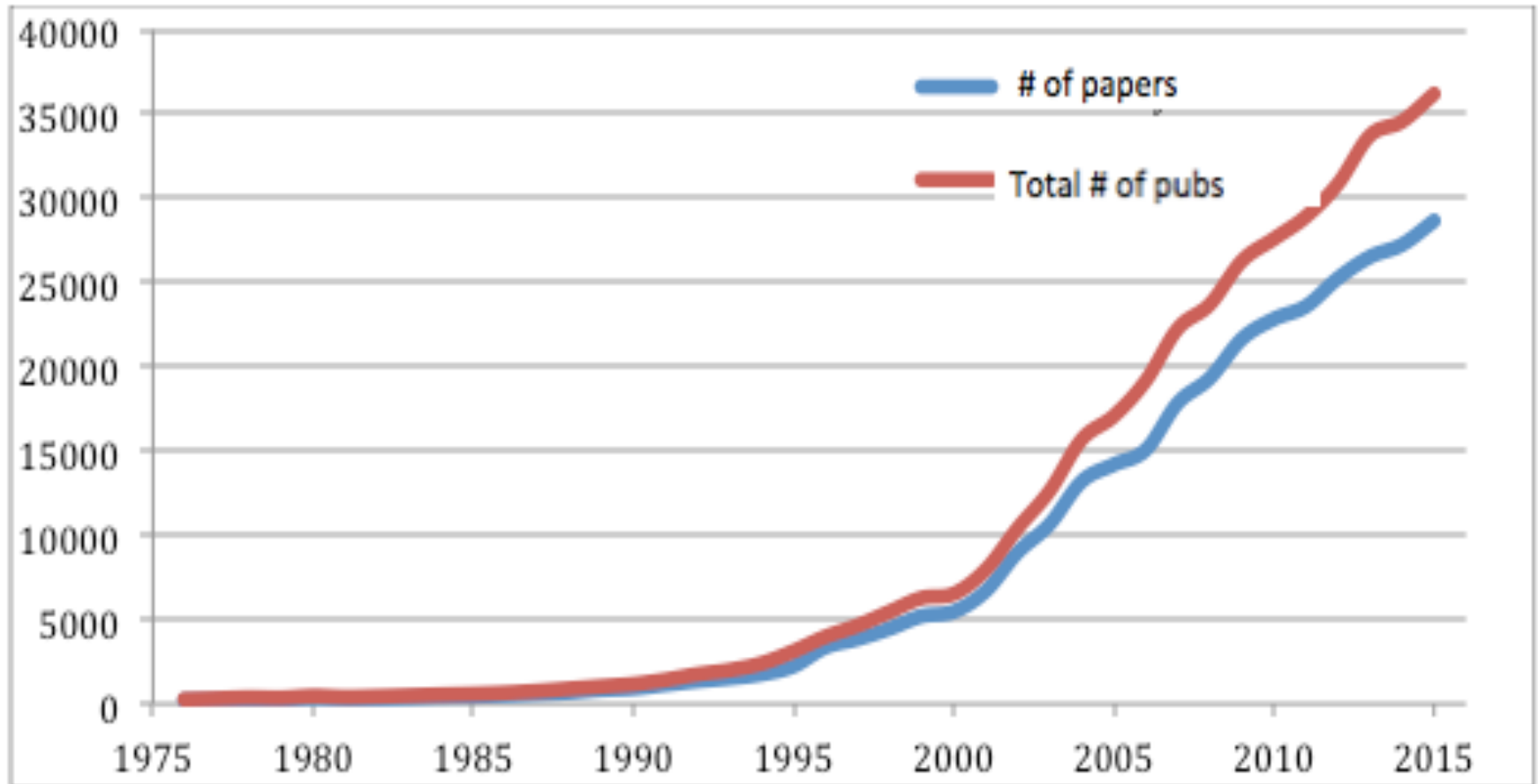
of papers supported by TÜBİTAK (1997-2015)

Year	# of papers supported by TÜBİTAK	# of papers with Turkish affiliations (WoS)	Percentage supported (%)
1997	2247	3844	58
1998	2657	4460	60
1999	3088	5201	59
2000	3298	5462	60
2001	4216	6684	63
2002	5888	8985	66
2003	7517	10662	71
2004	9511	13199	72
2005	7036	14194	50
2006	8122	15070	54
2007	10551	17853	59
2008	10411	19327	54
2009	11554	21655	53
2010	11592	22833	51
2011	9574	23588	41
2012	10641	25254	42
2013	10203	26526	38
2014	10257	27242	38
2015	8014	28662	28
Total	146377	318709	46

of papers listed in WoS w/ Turkish addresses & supported by TÜBİTAK (1997-2015)
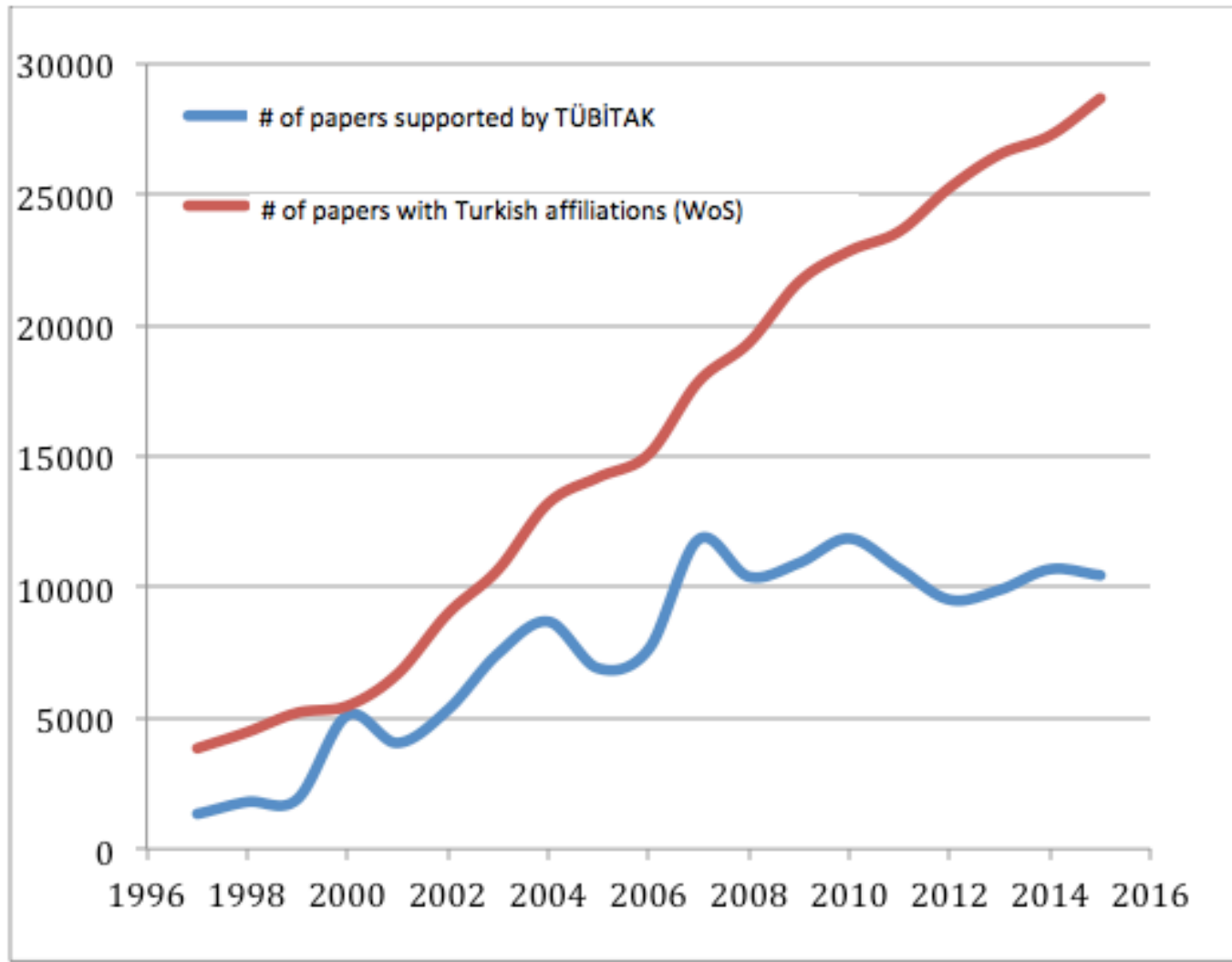
Method

- Interrupted time series (ITS) analysis (or intervention analysis)

- Intervention: 1993 (TÜBİTAK's support program)

- Program's impact measured in 1994, 1997 & 2003

- $Y_t = \beta_{pre} + \beta_{post} + e_t$

  - Y_t = t'th observation in the time series
  - β_{pre} = level of series before the intervention
  - β_{post} = level of series after the intervention
  - e_t = error related with Y_t

- Used MS Excel and SPSS 23 for data analysis

Source: McDowall et al. (1980, p. 12)

Time series data prepared for ITS analysis

| Zaman_dizisi	Yayin_sayisi	Makale_sayisi	Evre	Etki	Mudahale_oncesi_1	Mudahale_sonrasi_1	Mudahale_oncesi_4	Mudahale_sonrasi_4	Mudahale_oncesi_10	Mudahale_sonrasi_10	Mudahale_oncesi_21	Mudahale_sonrasi_21
1	269	216	0	0	1	0	1	0	1	0	1	0
2	320	229	0	0	2	0	2	0	2	0	2	0
3	380	272	0	0	3	0	3	0	3	0	3	0
4	362	256	0	0	4	0	4	0	4	0	4	0
5	466	343	0	0	5	0	5	0	5	0	5	0
6	409	299	0	0	6	0	6	0	6	0	6	0
7	447	315	0	0	7	0	7	0	7	0	7	0
8	495	354	0	0	8	0	8	0	8	0	8	0
9	549	420	0	0	9	0	9	0	9	0	9	0
10	592	447	0	0	10	0	10	0	10	0	10	0
11	657	506	0	0	11	0	11	0	11	0	11	0
12	762	588	0	0	12	0	12	0	12	0	12	0
13	899	672	0	0	13	0	13	0	13	0	13	0
14	1038	829	0	0	14	0	14	0	14	0	14	0
15	1173	912	0	0	15	0	15	0	15	0	15	0
16	1424	1134	0	0	16	0	16	0	16	0	16	0
17	1757	1351	0	0	17	0	17	0	17	0	17	0
18	2001	1519	0	0	18	0	18	0	18	0	18	0
19	2397	1754	1	19	19	0	22	-3	28	-9	40	-21
20	3118	2233	1	20	19	1	22	-2	28	-8	40	-20
21	3982	3359	1	21	19	2	22	-1	28	-7	40	-19
22	4640	3844	1	22	19	3	22	0	28	-6	40	-18
23	5461	4460	1	23	19	4	22	1	28	-5	40	-17
24	6279	5201	1	24	19	5	22	2	28	-4	40	-16
25	6521	5462	1	25	19	6	22	3	28	-3	40	-15
26	7955	6684	1	26	19	7	22	4	28	-2	40	-14
27	10419	8985	1	27	19	8	22	5	28	-1	40	-13
28	12640	10662	1	28	19	9	22	6	28	0	40	-12
29	15687	13199	1	29	19	10	22	7	28	1	40	-11
30	17071	14194	1	30	19	11	22	8	28	2	40	-10
31	19169	15070	1	31	19	12	22	9	28	3	40	-9
32	22267	17853	1	32	19	13	22	10	28	4	40	-8
33	23706	19327	1	33	19	14	22	11	28	5	40	-7
34	26282	21655	1	34	19	15	22	12	28	6	40	-6
35	27593	22833	1	35	19	16	22	13	28	7	40	-5
36	28913	23588	1	36	19	17	22	14	28	8	40	-4
37	30861	25254	1	37	19	18	22	15	28	9	40	-3
38	33726	26526	1	38	19	19	22	16	28	10	40	-2
39	34557	27242	1	39	19	20	22	17	28	11	40	-1
40	36192	28662	1	40	19	21	22	18	28	12	40	0

Hypothesis

$$H_0 = \beta_{pre} - \beta_{post} = 0$$

- "no statistically significant difference between the levels of series before and after the intervention"
- (i.e., support program has had no impact on the increase in the # of papers with Turkish affiliations)
- ITS is a quasi-experimental method
- Control group: other publications –non-papers
  - Only 3% of support went to non-papers (19% of all pubs) (only 1% in 2013)

Source: McDowall et al. (1980, p. 12)

ARIMA Model

- Used for non-static series whose arithmetic means, variances and co-variances change as time passes

- This model is expressed as ARIMA (*p, d, q*)

  - where *p, d* and *q* represent the autoregressive operator (AR), the integrated operator (I), and the moving average operator (MA), respectively.

  - If time series data is not stationary (*d*), it will first be made stationary to make its mean and variance constant over the years studied.

Time path graph of papers with Turkish affiliations (1976-2015)

Time path graph (1976-2015)
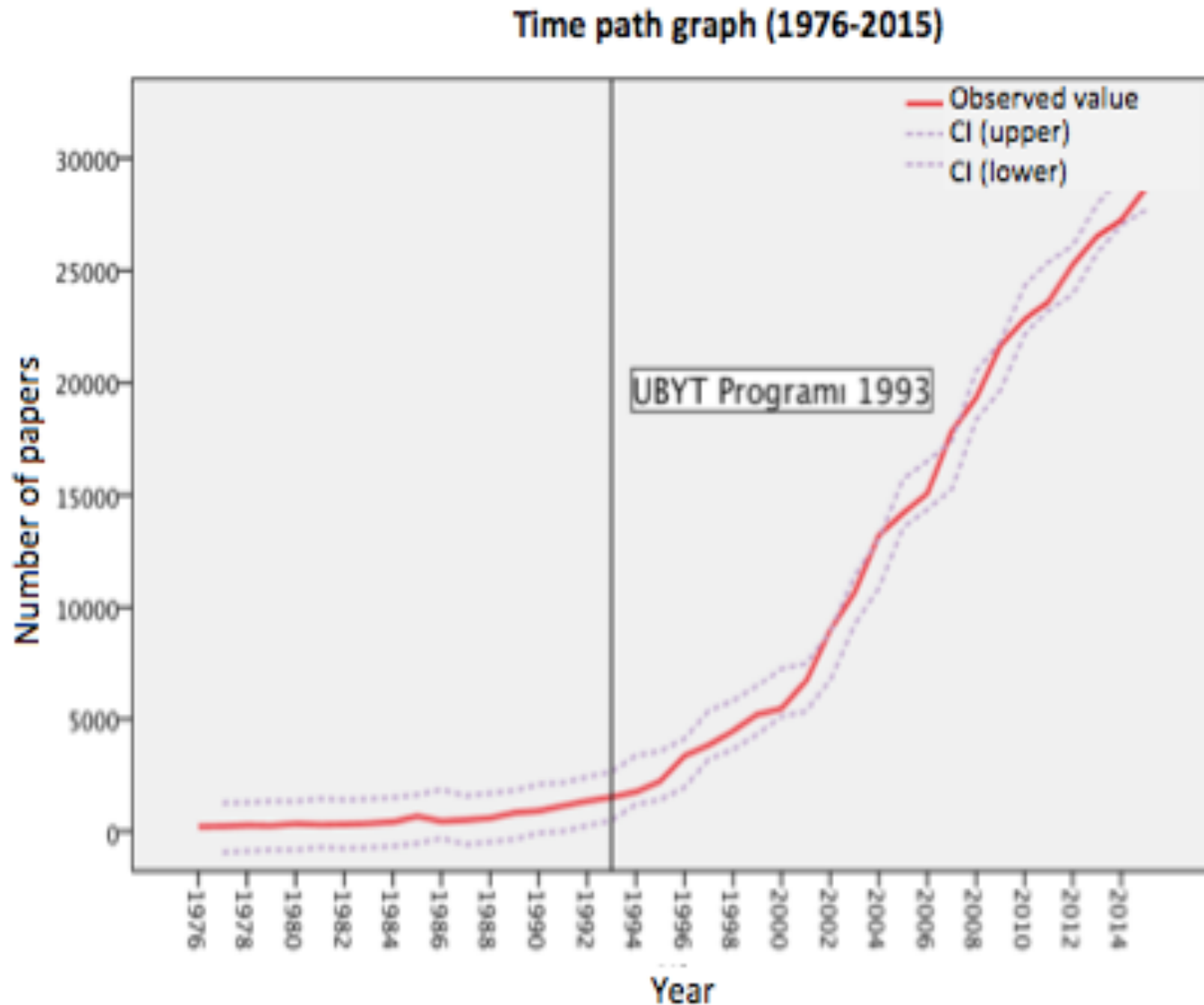
Trend of Increase in Time Series

- A trend of increase in the number of papers exists both before and after the intervention

- Therefore, the difference of the time series from the 1st level (d=1) was taken to make the series stationary

- Then, the auto-correlation function (ACF) and partial ACF (PACF) of the time series became static within the confidence intervals

Autocorrelation functions correlograms
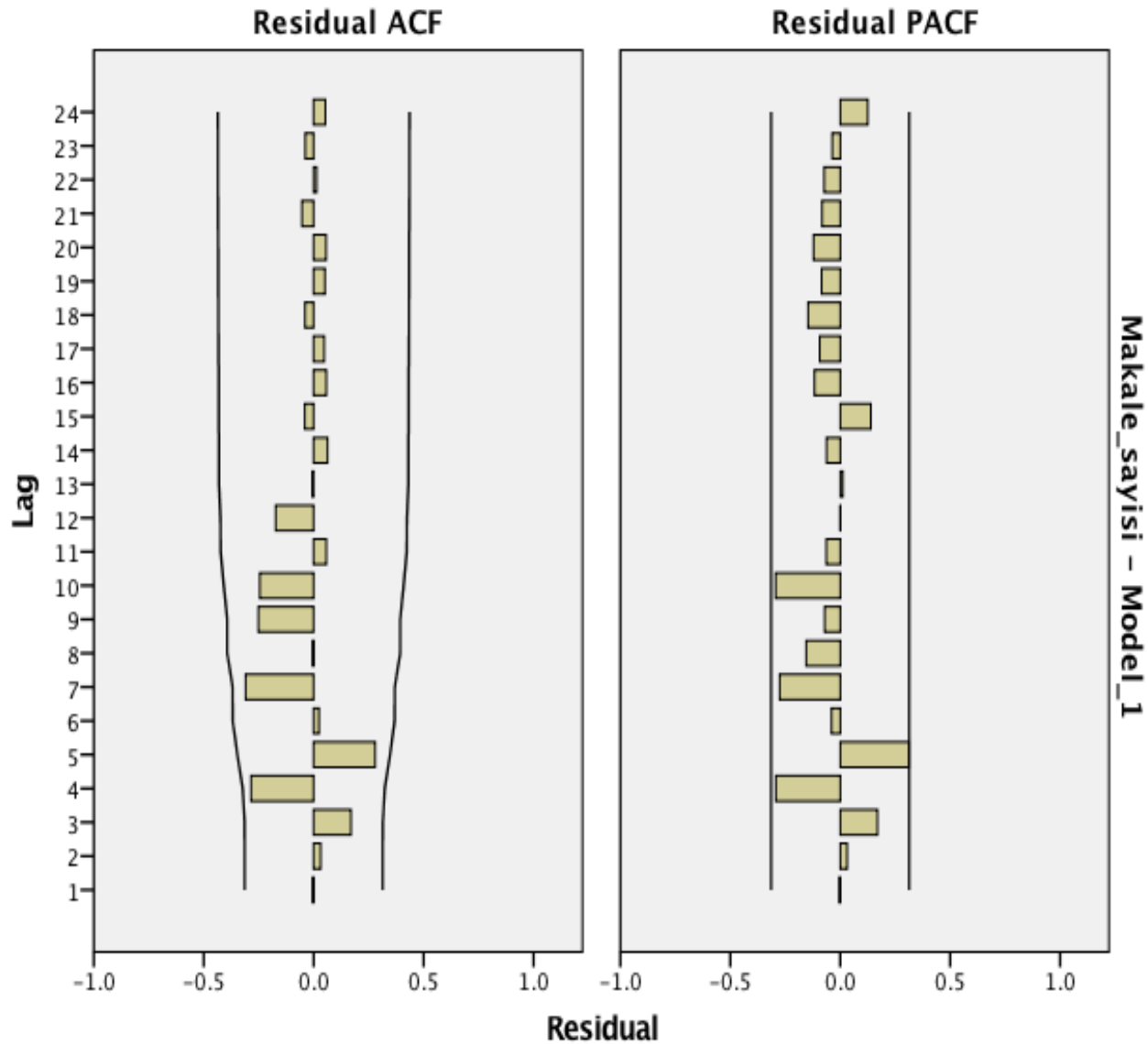
ARIMA (1,1,0) Model

- ARIMA (1,1,0) Model defined
- Model was suitable for the time series data (X^2 = 23.531, DF = 17, p = .133)

Test statistic (Ljung Box)

Model Statistics

Model	Number of predictors	Model Fit statistics Stationary R-squared	Ljung Box Q (18) Statistics	DF	Sig.	Number of Outliers
Makale sayısı-Model_1	3	.607	23.531	17	.133	0

Findings

- No statistically significant difference exists before and after the intervention (coefficient = .153, SE = .170, t = 0,899, p = .375)

ARIMA parameters

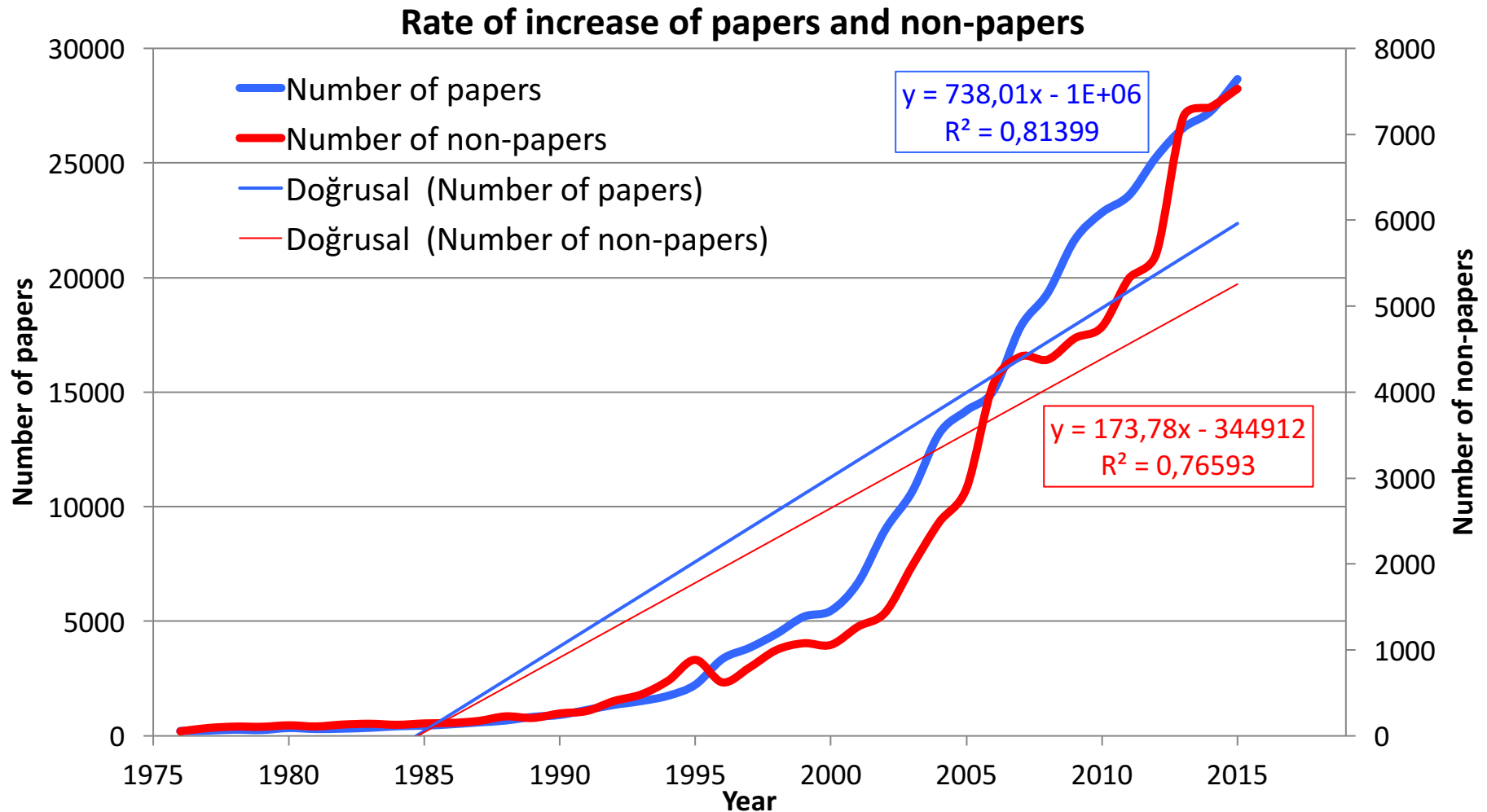|					Estimate	SE	t	Sig.
# of papers Model 1	# of papers	No transformation	Constant AR	Lag 1	-57.138 .153	334.811 .170	-.171 .899	.866 .375
			Difference		1			
	Time series	No transformation	Numerator	Lag 0	14.051	29.910	.470	.642
	Before/after Support Program	No transformation	Numerator	Lag 0	11.258	708.202	.016	.987
	Effect	No transformation	Numerator	Lag 0	29.091	36.715	.792	.434

Delayed Effect of the Support Program

- The effect was measured in 1994, 1997 and 2003
- Additional numbers of papers published due to support program in these years were negligible (564, 651 and 826 papers, respectively)
- **So, the support program had no significant effect**

| Year	Predicted increase	SE	t-value	p-value
1994	563.633	390.084	1.446	.157
1997	651.241	431.129	1.510	.140
2003	825.784	571.279	1.446	.157
2015	1,174.941	947.761	1.240	.224

Control Group

- The rate of increase of non-papers is on a par with that of papers (7K pa), although only a few hundred non-papers got supported

Rate of increase of papers and non-papers

Legend:
- Number of papers
- Number of non-papers
- Doğrusal (Number of papers)
- Doğrusal (Number of non-papers)

$y = 738{,}01x - 1E{+}06$
$R^2 = 0{,}81399$

$y = 173{,}78x - 344912$
$R^2 = 0{,}76593$

Y-axis (left): Number of papers
Y-axis (right): Number of non-papers
X-axis: Year

Limitations of the Study

- Multiple regression analysis
  - unreliable results (D-W: 0.921)
  - probably due to existence of serial autocorrelation between variables
- Other "event(s)" may have occurred during the study, triggering the increase in # of papers
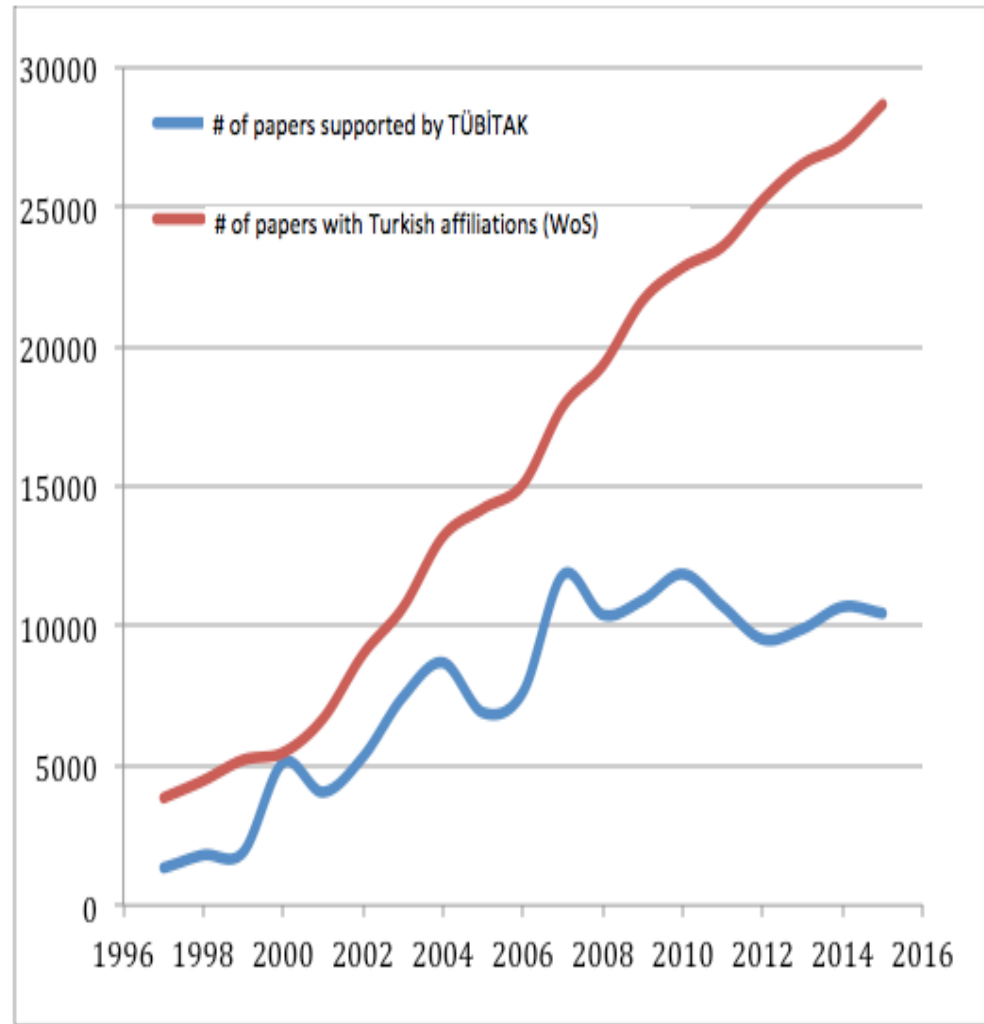
Conclusions

- Program had no impact on increase of # of papers
- # of papers may have increased due to some other factor(s) (e.g., changes in academic promotion criteria; maturing research systems & researchers; etc.)
- "Micropayments" to researchers publishing in low-impact journals did not seem to help (2/3 of payments to 285K authors were ≤ 230 USD)
- "Side effects" of the program
- Transaction costs of micropayments
- Opportunity costs of the support program

Sources Used

For all references used, see the full paper at:
http://bit.ly/2kXc9cJ

- Herbst, M. (2007). *Financing Public Universities: The Case of Performance Funding*. Dordrecht: Springer.

- McDowall, D., McCleary, R., Meidinger, E.E. & Hay, R.A. (1980). *Interrupted Time Series Analysis*. Newbury Park: Sage.

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