

The effect of portfolio size changes on patent renewal decisions

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Motivation

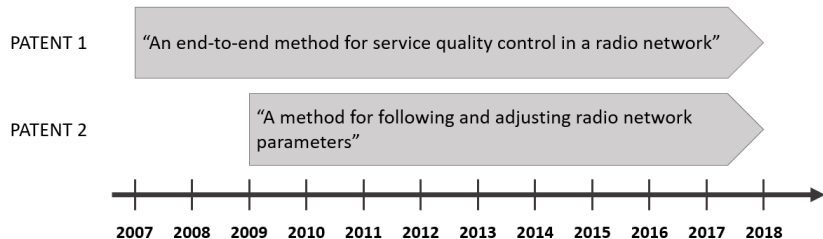
Institutional context

A patent gives exclusive rights to an invention. Maximum length of patent protection 20 years.

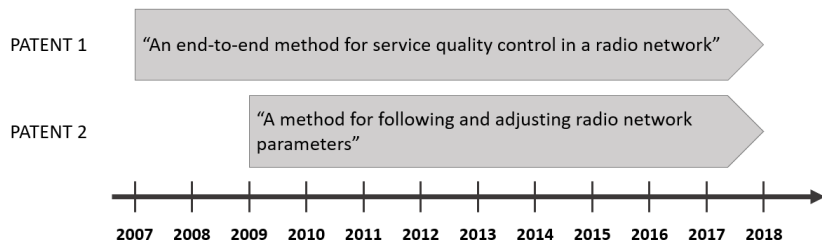
Firms need to pay yearly renewal fees to keep a patent valid. Half of all patents are not renewed past age 10.

I study renewal decisions of individual patents owned by Finnish firms from 1970s to 2018.

Patent portfolio history of one firm in the data



Patent portfolio history of one firm in the data



Research question: How is the probability of renewing a patent affected by the arrival (or departure) of another patent in the patent owner's portfolio?

Why is this important?

Are patents in a firm's portfolio complements or substitutes (or neither)?

The answer has implications on how we should estimate the value of patents

- Patent portfolio literature stresses the importance of a portfolio of related patents
- Empirical estimates of patent value often ignore the portfolio aspect

If patents in a portfolio are complements, the arrival of a patent should increase the renewal probability of an existing patent (and its value).

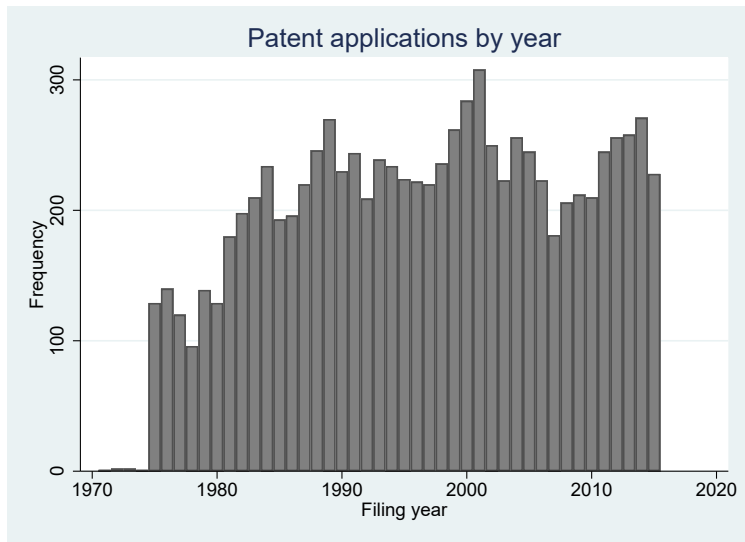
Data

Patent applications by Finnish firms from 1972 to 2015 from Finnish National Board of Patents and Registrations

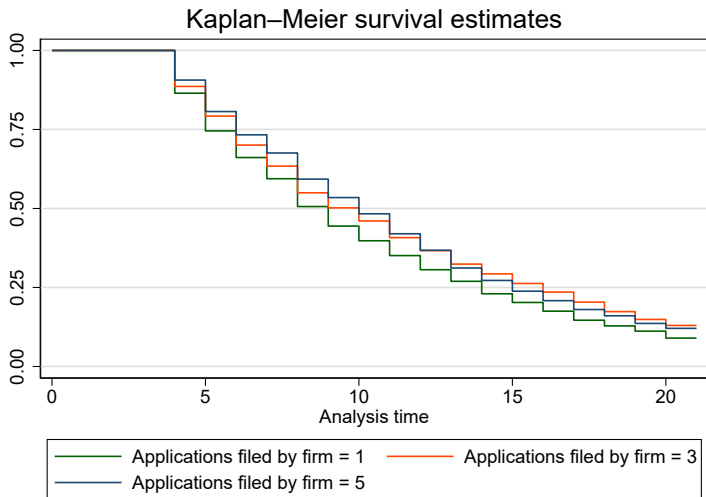
Sample restricted to firms with at most five applications in the data (88 % of firms, 25 % of applications)

4,559 firms, 7,032 patent applications, 53,320 renewal decisions between 1973 and 2018.

Patent applications by year



Renewal shares by patent age



Empirical strategy

Dif-in-Dif using de Chaisemartin & D'haultfoeuille estimator

Treated patents: Those that receive or lose a patent in their owner's portfolio

Control patents: Those that have not yet experienced a change in their owner's portfolio ("not-yet treated")

Treatment variable: Portfolio size (discrete, values between 1 and 5)

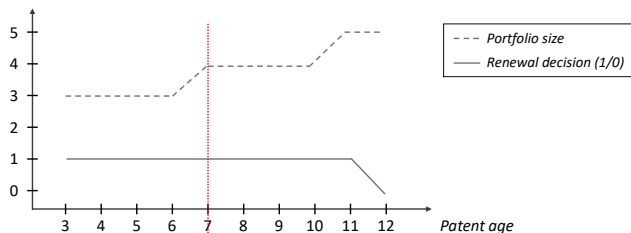
Outcome variable: Renewal decision (1/0)

TWFE not suitable, nor Callaway Sant'Anna:

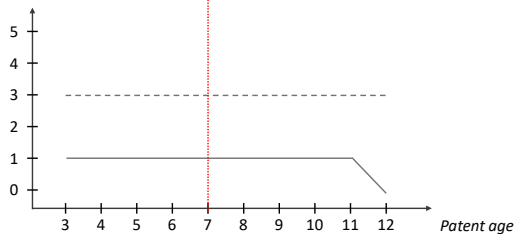
- The treatment effect can vary both wrt. to time since treatment AND between treatment cohorts (at what age the patent gets treated).
- Treatment not staggered, since treatment status can go up and down over time

Illustration of de Chaisemartin & D'Haultfoeuille estimator

*Treated patent:
portfolio size
changes at least
once*



*Control patent:
portfolio size stays
constant*



Diff-in-diff equation

$$DID_{g,l} = Y_{g,F_g+l} - Y_{g,F_g-1} -$$

$$\sum_{g': D_{g',1}=D_{g,1}, F_{g'} > F_g + l} \frac{1}{N_{F_g+l}^g} (Y_{g',F_g+l} - Y_{g',F_g-1})$$

Notation

- F_g : Patent age of first change in treatment (portfolio size)
- Y_{g,F_g+l} : Outcome of treated patent g , l periods after first treatment
- $N_{F_g+l}^g$: Number of control patents, for we observe the $F_g + l$ th renewal decision

Aggregation into an estimator

Step 2: aggregating over all patents:

$$DID_{+,l} = \sum_{g: R_g=1, F_g \leq T_+-1} \frac{1}{N_l^+} DID_{g,l}$$

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Aggregation into an estimator

Step 2: aggregating over all patents:

$$DID_{+,I} = \sum_{g:R_g=1, F_g \leq T_+-1} \frac{1}{N_I^+} DID_{g,I}$$
$$DID_{-,I} = \sum_{g:R_g=0, F_g \leq T_- -1} \frac{1}{N_I^-} (-DID_{g,I})$$

Step 3: Aggregating over positive and negative initial changes

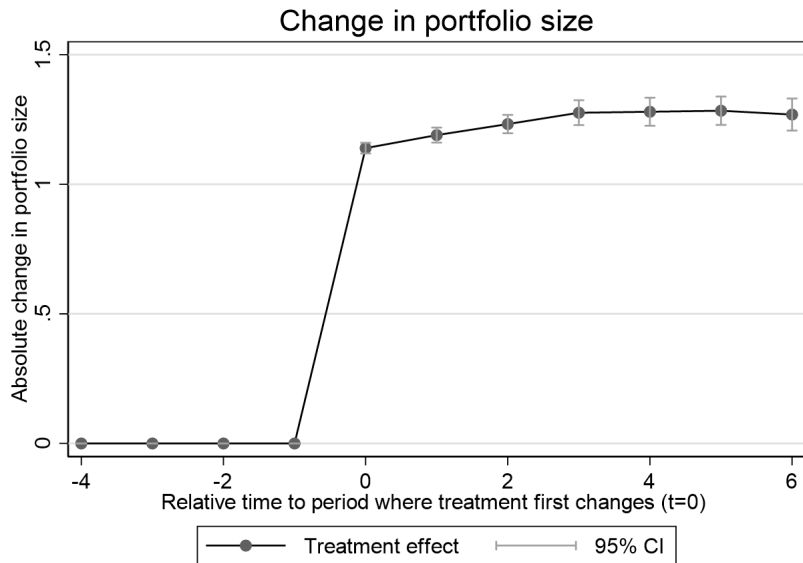
$$DID_I = \frac{N^+}{N^+ + N^-} DID_{+,I} + \frac{N^-}{N^+ + N^-} DID_{-,I}$$

Identifying assumptions

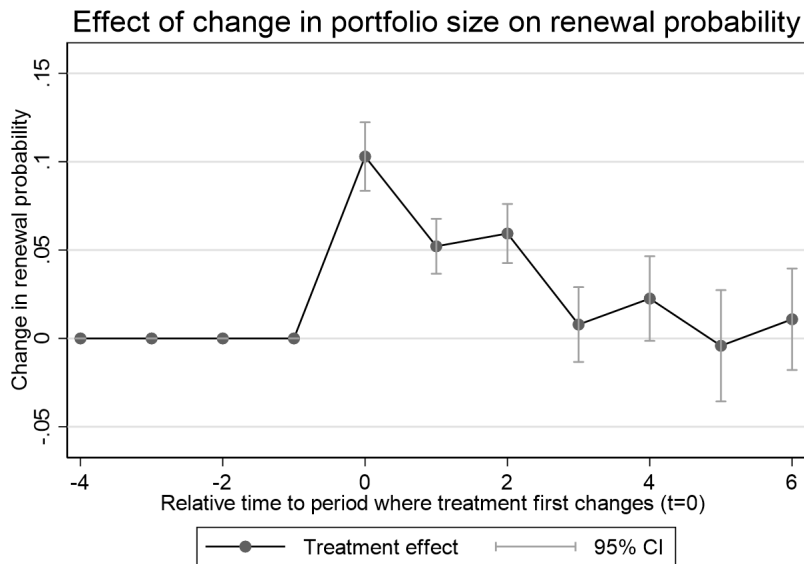
- 1 No anticipation effects
- 2 Common trends prior the first change in treatment status
- 3 "Stable Unit Treatment Values Assumption"
- 4 Strong exogeneity

Results

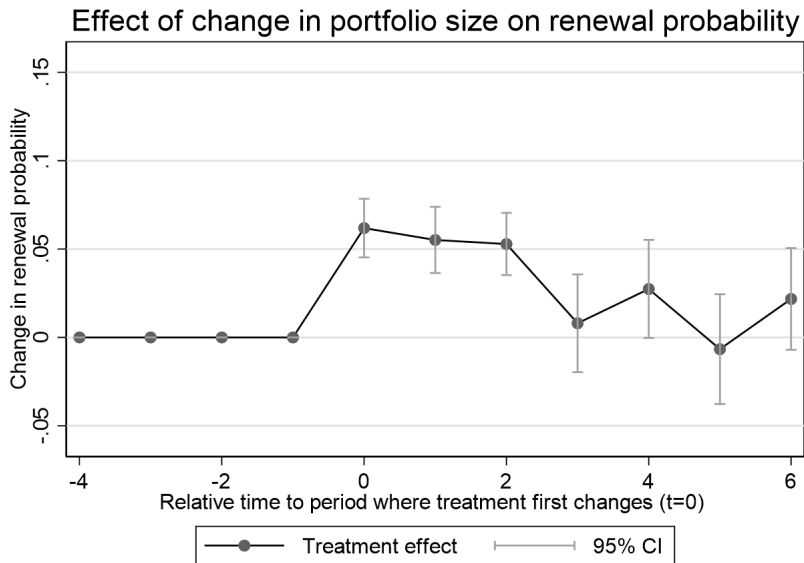
Change in treatment status



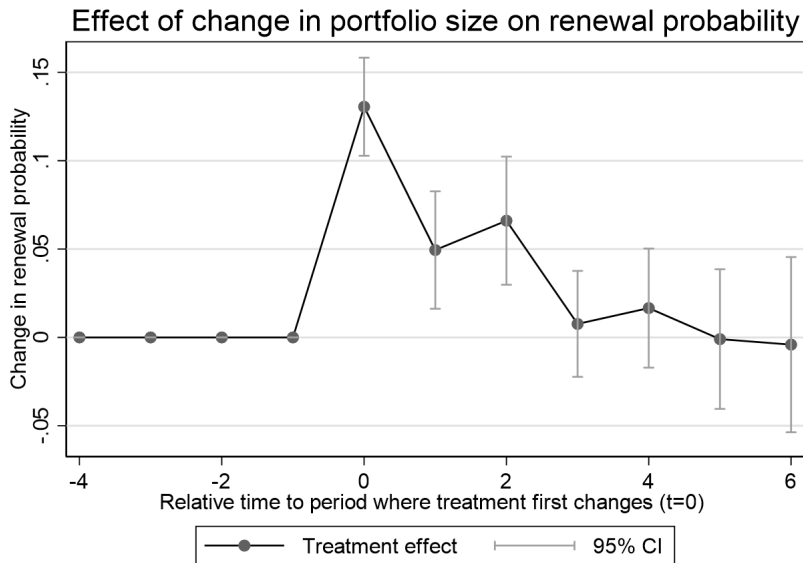
Main outcome



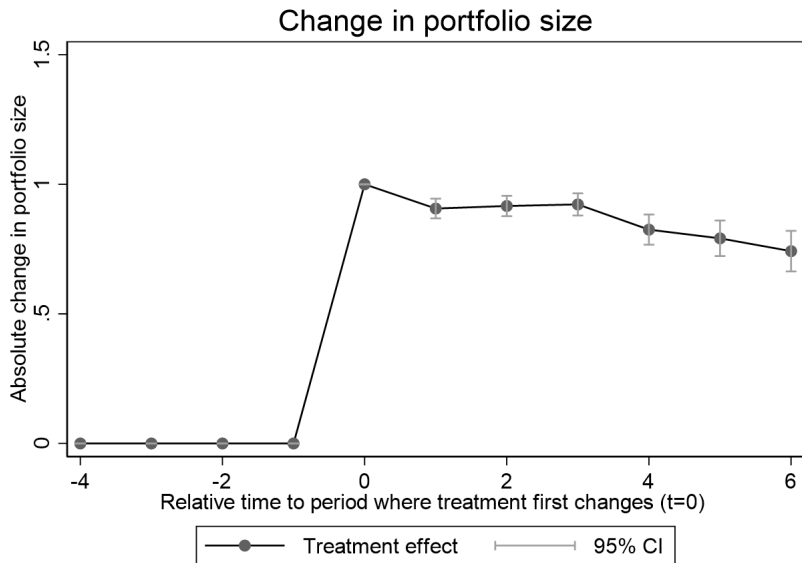
Switchers-in



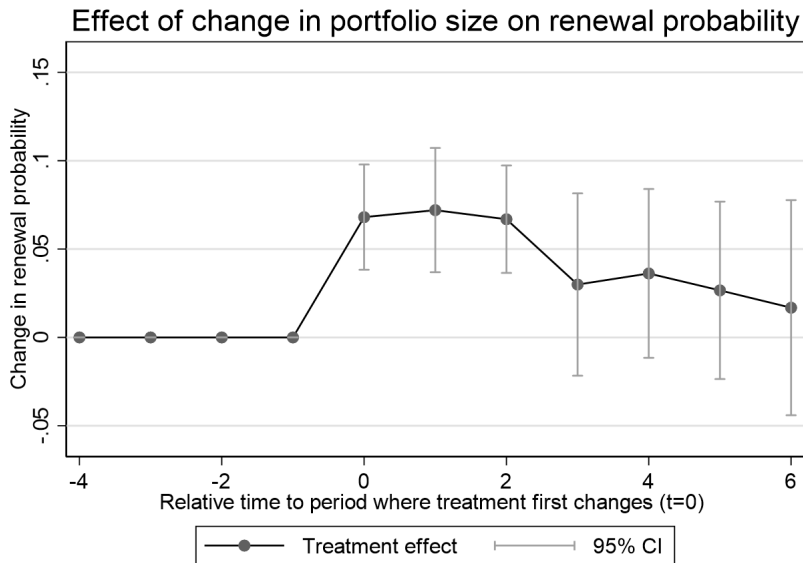
Switchers-out



"SUTVA" robustness check - First patents of a firm



"SUTVA" robustness check - First patents of a firm



Comparison: TWFE results

VARIABLES	(1) Two-Way Fixed Effects
Portfolio size	0.05*** (0.00)
Constant	0.86*** (0.01)
Observations	53,230
Number of application	7,032
R-squared	0.13
Patent FE	YES
Year FE	YES
Clustering	APPLICANT

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Conclusions

An increase in portfolio size leads to a 10.3% point increase (12 % higher than the average renewal probability of 86 %) in the renewal probability of an existing patent in the portfolio

The positive treatment effect appears to be short-lived, disappearing by year three after the treatment

The results suggest that ignoring the portfolio dimension may lead to biased estimates of patent value