Econometric Analysis of Flight Times and the Effects of Performance Based Navigation

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MOTIVATION

- On-time performance ⟶ Efficiency and Quality of Service:

Airlines; ANSPs; Airports.

- Delays ⟶ Extra costs, inconveniences, constraints, etc.

MOTIVATION

- One hour of delay costs airlines from $1,400 to $4,500. Costs for passengers range from $35 to $63 (FAA, 2018).

- Cost of delays in US domestic market hit $32.9 billion in 2007 (Ball et al, 2010);

- European airspace network generated a total of 19.1 million minutes of en route delay in 2018 (Eurocontrol, 2019).

MOTIVATION

- The investigation of flight delay causes along with means of mitigating them is essential to improve air transport quality;
- ANSP and aviation authorities expect Performance Based Navigation (PBN) implementations to reduce delays
- PBN real effects are still undefined in literature.

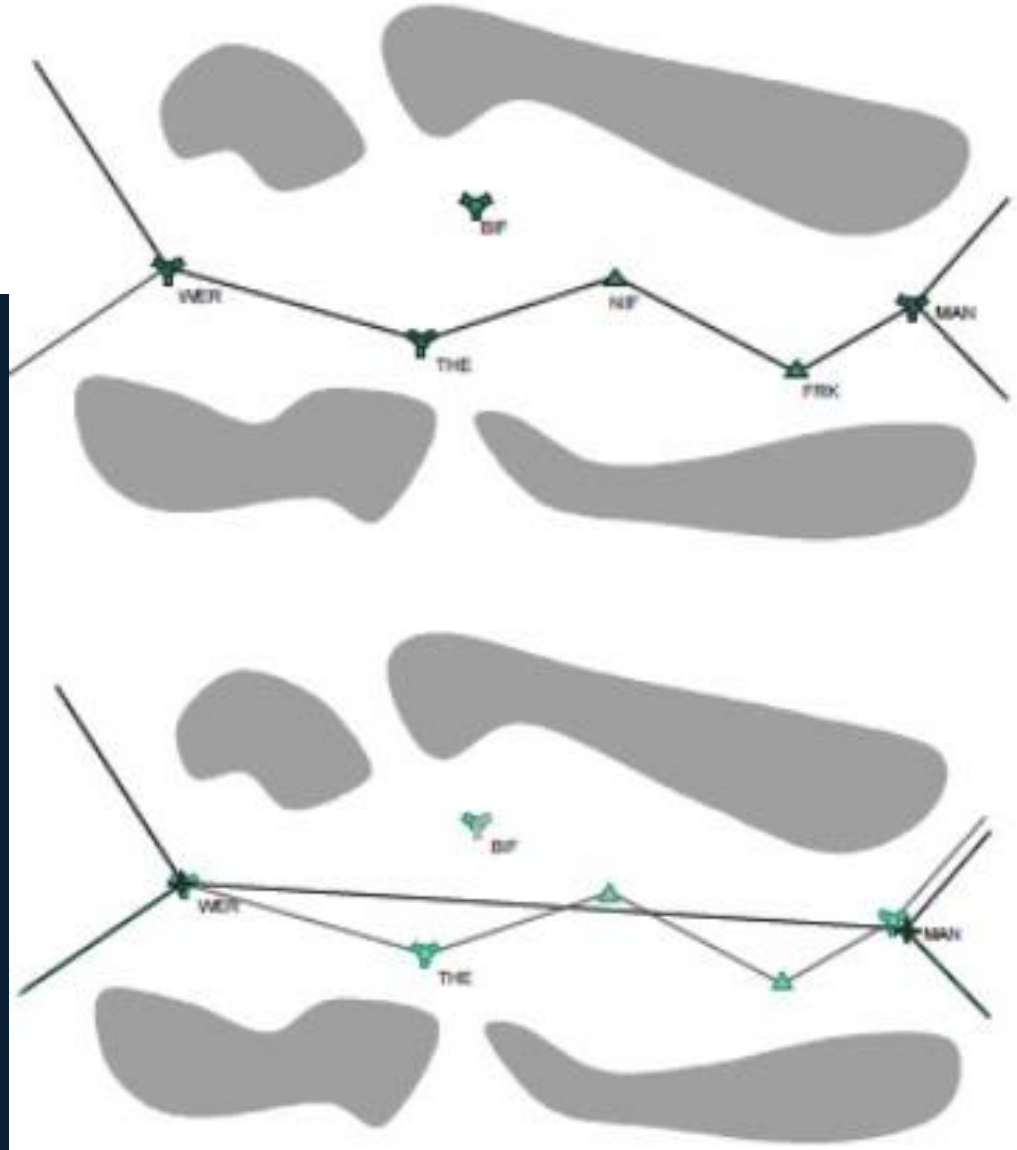
PBN-Sul: rotas mais curtas reduzirão 6 milhões Kg de CO_2 emitidos por ano

Source: DECEA

PBN

- Change from sensor based navigation to Performance Based Navigation.
- A set of systems need to comply with a specific required performance.

  - Shorter flights.
  - More precise flights may increase airspace capacity and reduce congestion.



Conventional op. vs PBN. Source: ICAO (2013)

RESEARCH QUESTIONS

- What factors contribute to increased flight time?
- How much does PBN affect flight times?

LITERATURE REVIEW

Flight-related factors

- Weather;
- Congestion;
- Peak-periods;
- Flight schedules;
- ATM measures.

- Demand;
- Slot cordination;
- Aircraft mix;

Market Characteristics

- Economic factors;
- Hub airports;
- Hub airlines;
- Market Concentration;
- Competition;
- Costs;
- Season.

LITERATURE REVIEW

Flight-related factors

Hansen and Hsiao (2005;2006)
Hansen and Xiong (2007)
Deshpande and Arıkan (2012)
Wang and Vaze (2016)
Pérez–Rodríguez et al. (2017)
Lall (2018)
Borsky and Unterberger (2019)
Guzhva, Abdelghany and Lipps (2014)

Market Characteristics

Mayer and Sinai (2003)
Mazzeo (2003)
Rupp, Owens and Plumly (2006)
Prince and Simon (2009)
Santos and Robin (2010)
Bendinelli, Bettini and Oliveira (2016)
Aydemir et al. (2017)

DATA & ESTIMATION

- Panel data;
- 1560 city-pairs;
- 116 528 observations (from 2000 to 2018);
- Two-way Fixed Effects (month/route);
- Robust standard errors;
- Dependent variable: natural logarithm of Flight Time (lnFLTIME).

City Pairs

1560 in sample

source - www.gcmap.com

Passenger Density

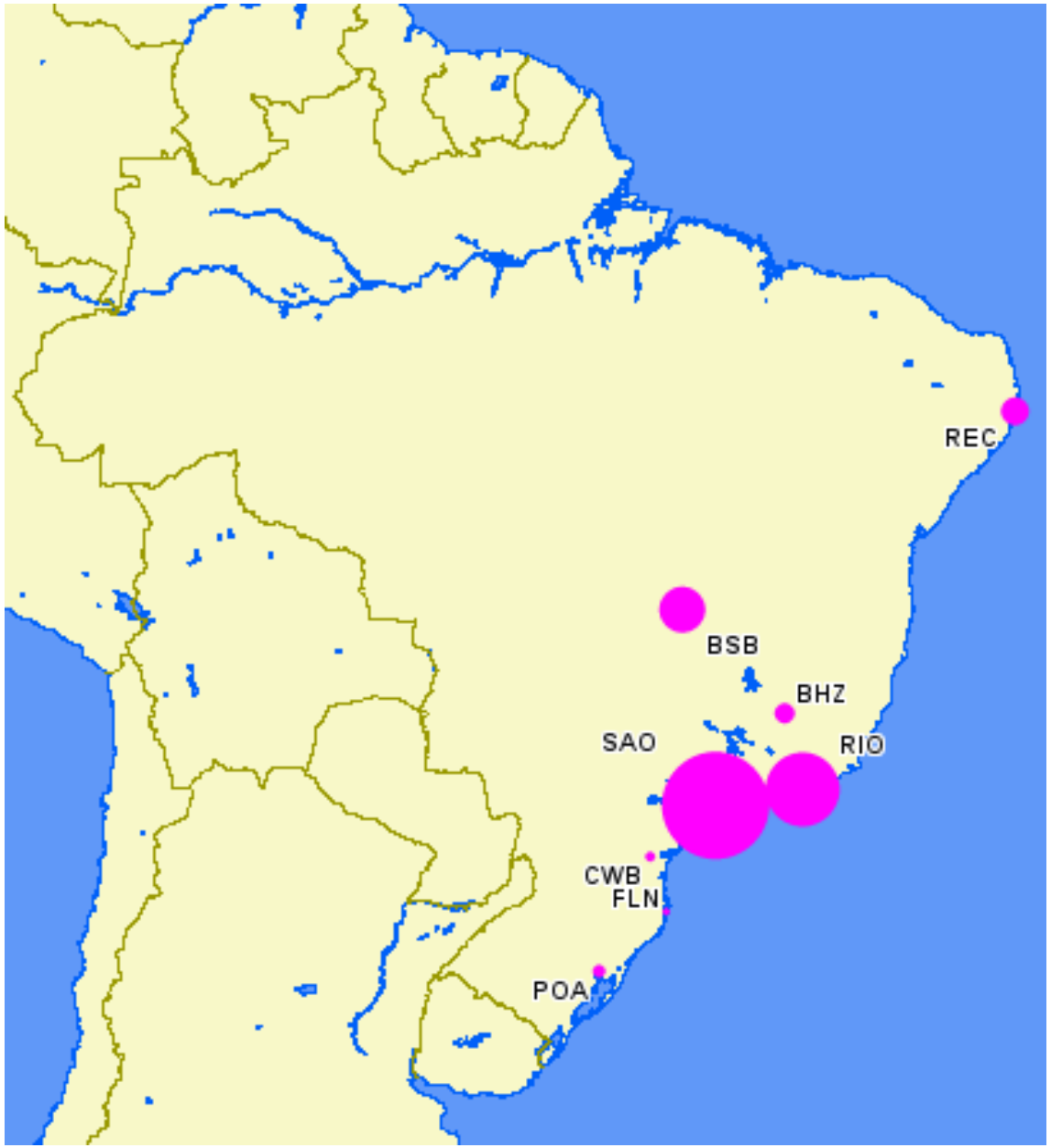
source - www.gcmap.com

PBN OPERATIONS

PBN operations at:

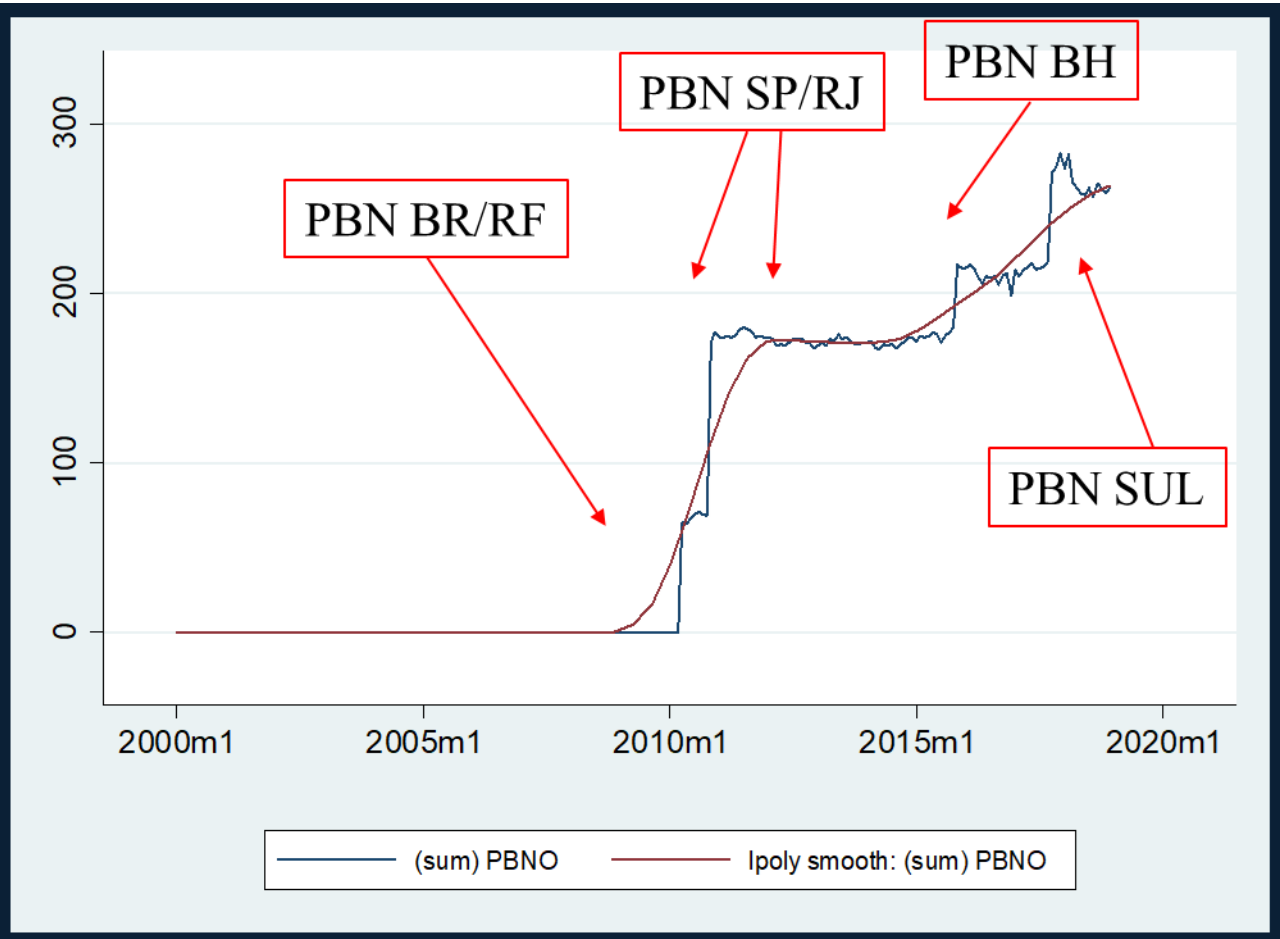
- Recife (2009);
- Brasília (2009);
- SP/RJ (2009);
- SP/RJ (2011);
- SP/RJ (2013);
- Belo Horizonte (2015);
- Sul (2017).

Source: AICs.



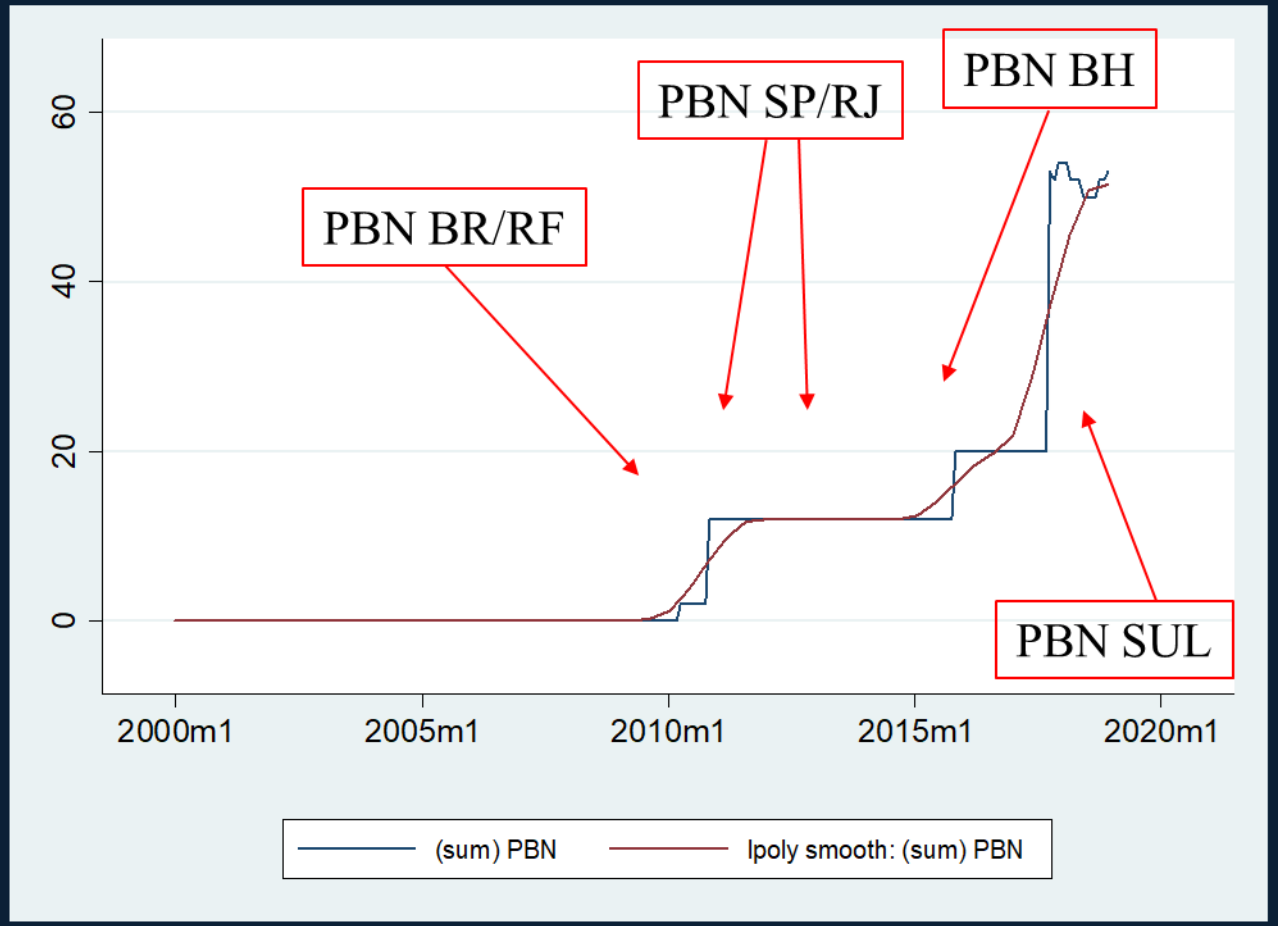
source - www.gcmap.co

ROUTES WITH PBN PER MONTH



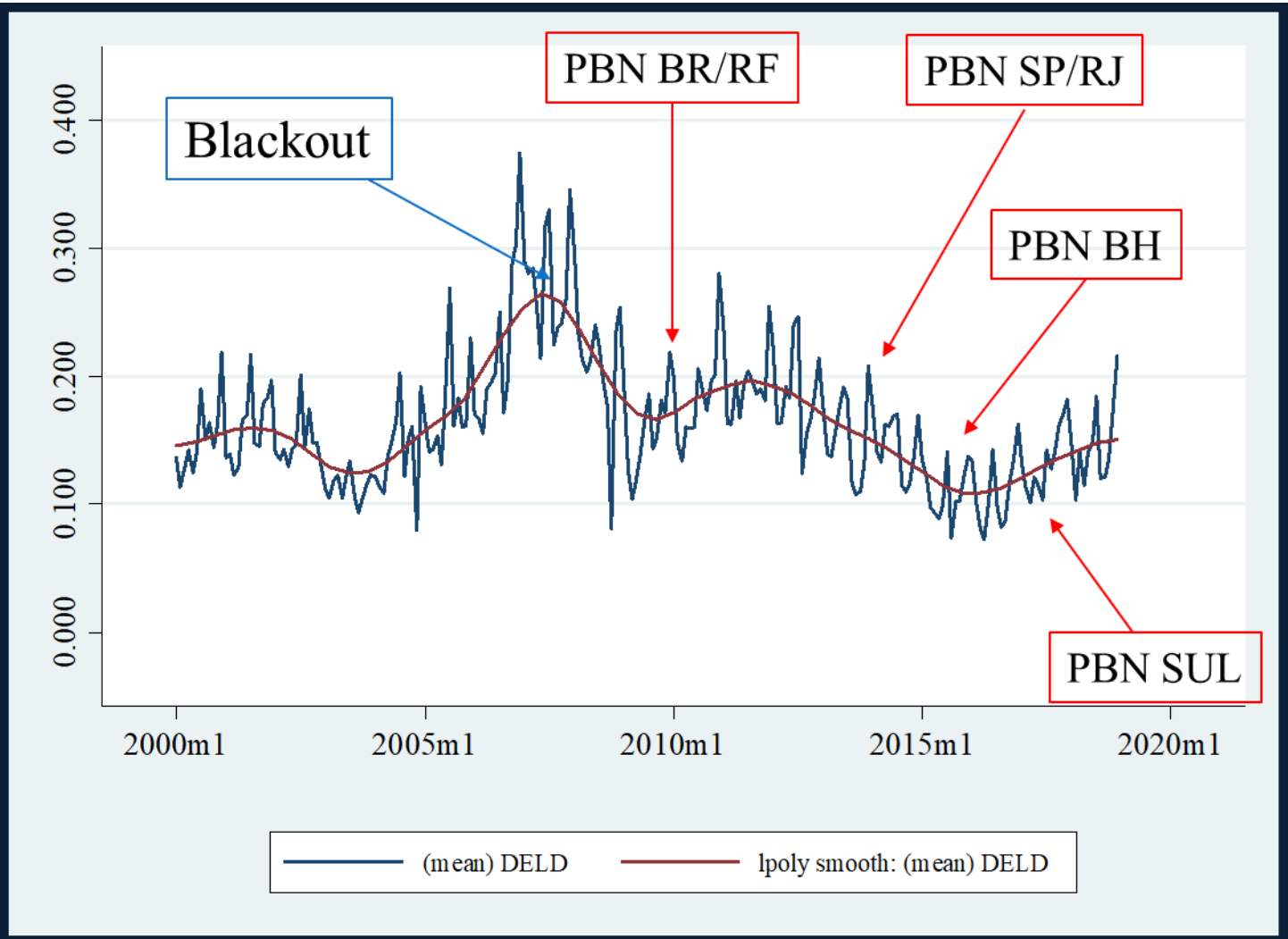
PBN at origin

ROUTES WITH PBN PER MONTH



PBN at origin and destination

PROPORTION OF DELAYED FLIGHTS



Variables	Description
DENSITY	Number of passengers divided by 10000
LF	Load Factor. RPK/ASK
FREQ	Total flights in a route/1000
ASIZE	Aircraft size. Seats/take-offs
AIRCRAFT_MIX	Proportion of each aircraft type
FUELP	Proxy for fuel price
NET_15_44	Cities with 14-44 destinations
NET_45_69	Cities with 45-69 destination
NET_70	Cities with more than 70 destinations
CON_10_20	Cities with 10-20% of pax in connection
CON_20_30	Cities with 20-30% of pax in connection
CON_30	Cities with more than 30% of of pax in connection

Variables	Description
SLOTPR	Proportion of flights in slot-controlled airports
HHI	Market concentration metric of the route.
MAXHHI	Max HHI, of origin or destination
DELO	Proportion of delayed flights at origin
DELD	Proportion of delayed flights at destination
PBN	PBN at origin and destination
PBNO	PBN at origin
PBND	PBN at destination

Variables	Description
PBN_SP_RJ_1	1º implementation in SP/RJ. PBN at origin and destination
PBN_SP_RJ_2	2º implementation in SP/RJ. PBN at origin and destination
PBN_SP_RJ_3	3º First implementation in SP/RJ. PBN at origin and destination
PBNO_SP_RJ_1	1º implementation in SP/RJ. PBN at origin
PBNO_SP_RJ_2	2º implementation in SP/RJ. PBN at origin
PBNO_SP_RJ_3	3º First implementation in SP/RJ. PBN at origin
PBND_SP_RJ_1	1º implementation in SP/RJ. PBN at destination
PBND_SP_RJ_2	2º implementation in SP/RJ. PBN at destination
PBND_SP_RJ_3	3º First implementation in SP/RJ. PBN at destination

MODELS

- **Model 1**: PBN.
- **Model 2**: PBNO and PBND.
- **Model 3**: Phases of implementation in SP/RJ.
- **Model 4:** Phases in SP/RJ with PBNO_* and PBND*.

MAIN ESTIMATION RESULTS

- **Model 1**: PBN
- **Model 2**: PBNO and PBND.
- **Model 3**: Phases of SP/RJ implementation.
- **Model 4:** Phases of SP/RJ with PBNO_* and PBND*

	(4) lnFLTIME	(3) lnFLTIME	(2) lnFLTIME	(1) lnFLTIME
DENSITY	0.0100***	0.0109***	0.0094***	0.0091***
LF	-0.0145***	-0.0134***	-0.0143***	-0.0134***
FREQ	-0.0103***	-0.0101***	-0.0100***	-0.0101***
ASIZE	-0.0008***	-0.0008***	-0.0008***	-0.0008***
FUELP	-0.0514***	-0.0518***	-0.0512***	-0.0499***
SLOTPR	-0.0042	-0.0075***	-0.0037	-0.0010
HHI	-0.0054**	-0.0066**	-0.0056**	-0.0057**
MAXHHI	-0.0038	-0.0048	-0.0038	-0.0039
DELO	0.0174***	0.0154***	0.0175***	0.0180***
DELD	0.0758***	0.0725***	0.0761***	0.0764***
NET_15_44	-0.0080***	-0.0074***	-0.0081***	-0.0083***
NET_45_69	-0.0031	0.0006	-0.0033	-0.0036
NET_70	0.0108***	0.0176***	0.0103***	-0.0015
CON_10_20	0.0098***	0.0089***	0.0101***	0.0099***
CON_20_30	0.0170***	0.0156***	0.0171***	0.0170***
CON_30	0.0239***	0.0238***	0.0239***	0.0240***
PBN	-0.0149***			
PBNO		-0.0084***		
PBND		-0.0225***		
PBN_SP_RJ1			0.0156**	
PBN_SP_RJ2			-0.0298***	
PBN_SP_RJ3			-0.0084	
PBNO_SP_RJ1				0.0144**
PBNO_SP_RJ2				-0.0012
PBNO_SP_RJ3				-0.0182***
PBND_SP_RJ1				0.0322***
PBND_SP_RJ2				-0.0068
AIRCRAFT_MIX	yes	yes	yes	yes
R2_Adj	0.9847	0.9848	0.9847	0.9848
RMSE	0.0658	0.0657	0.0658	0.0657
N_Obs	116528	116528	116528	116528

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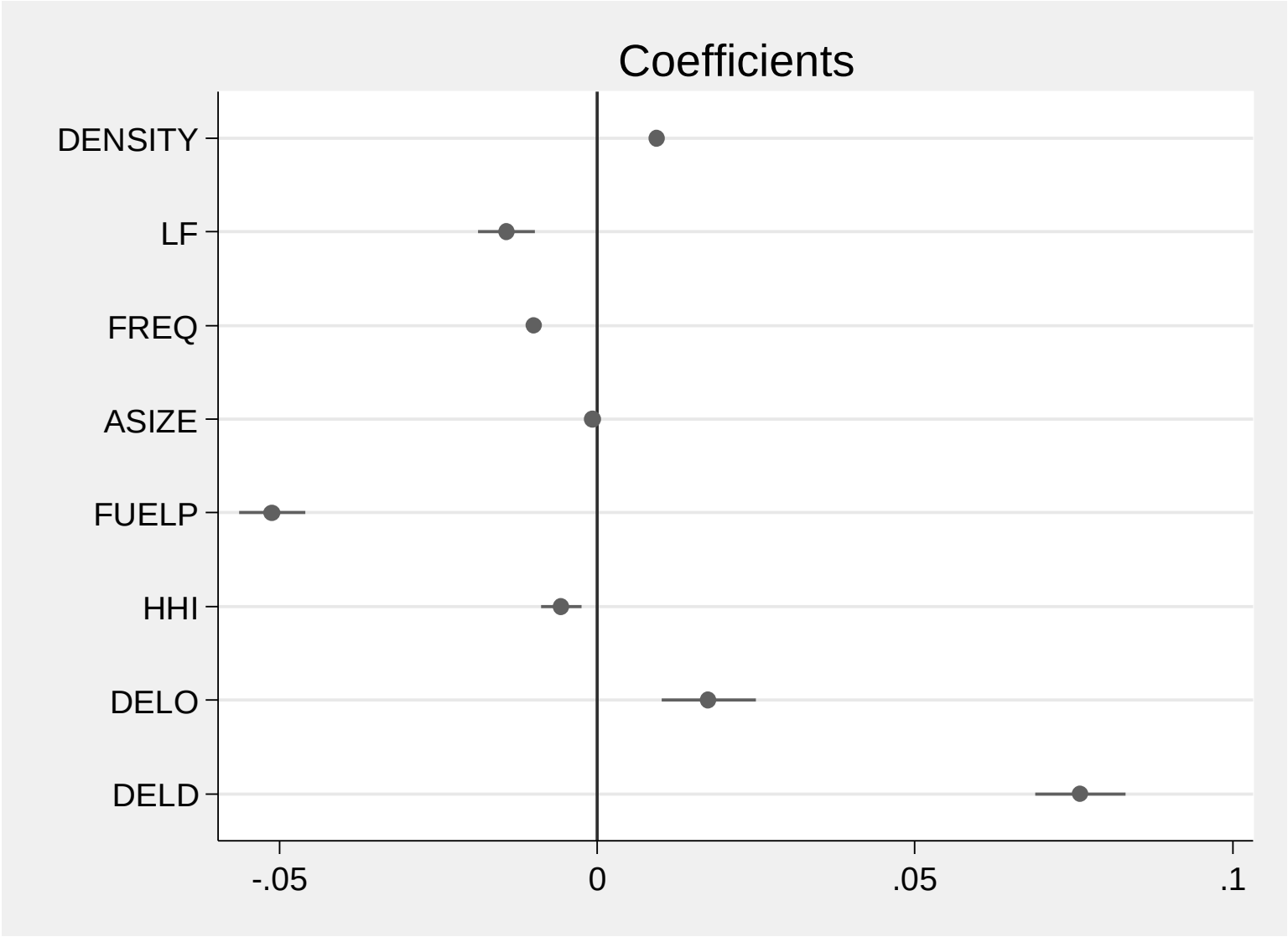

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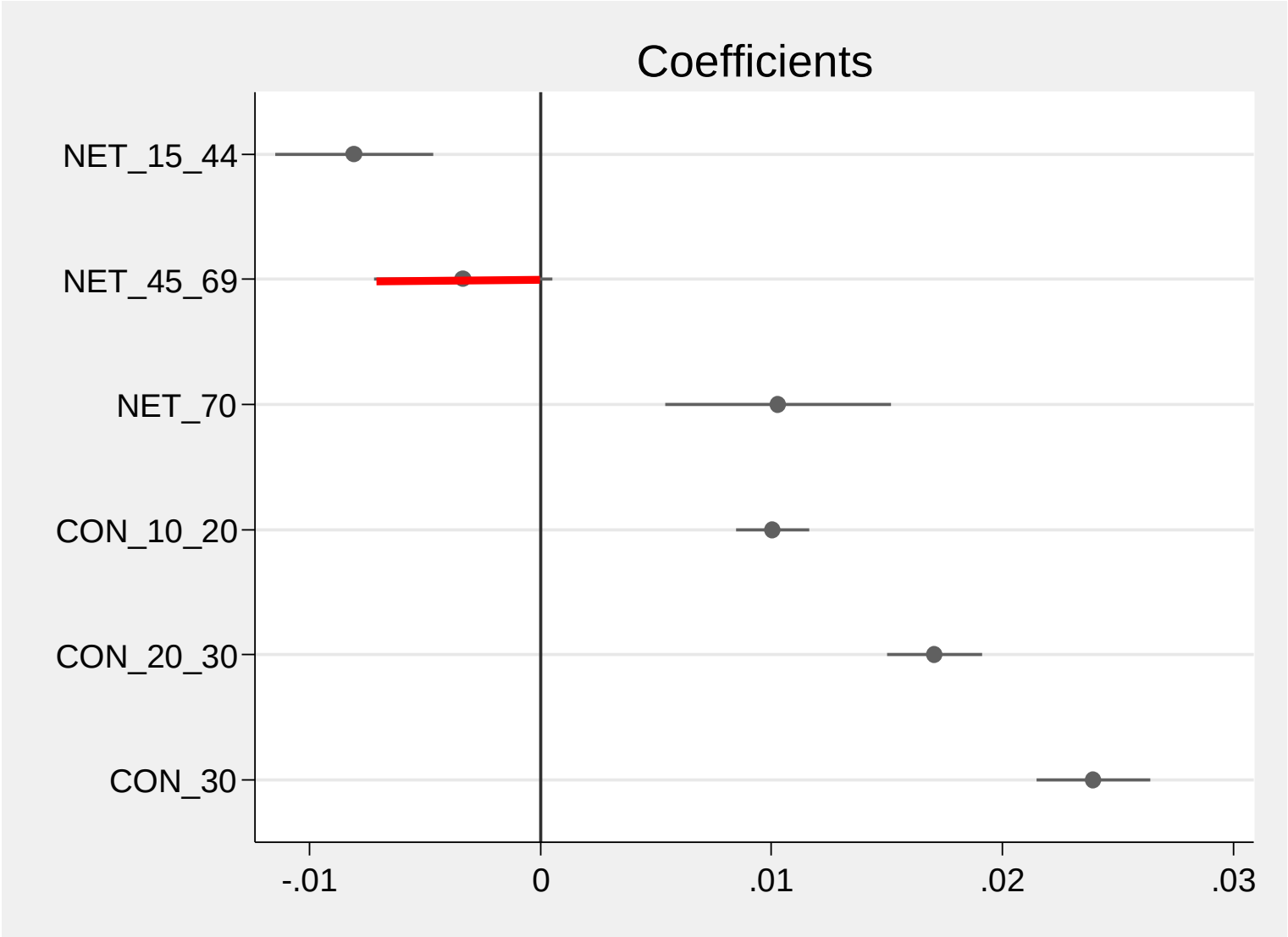

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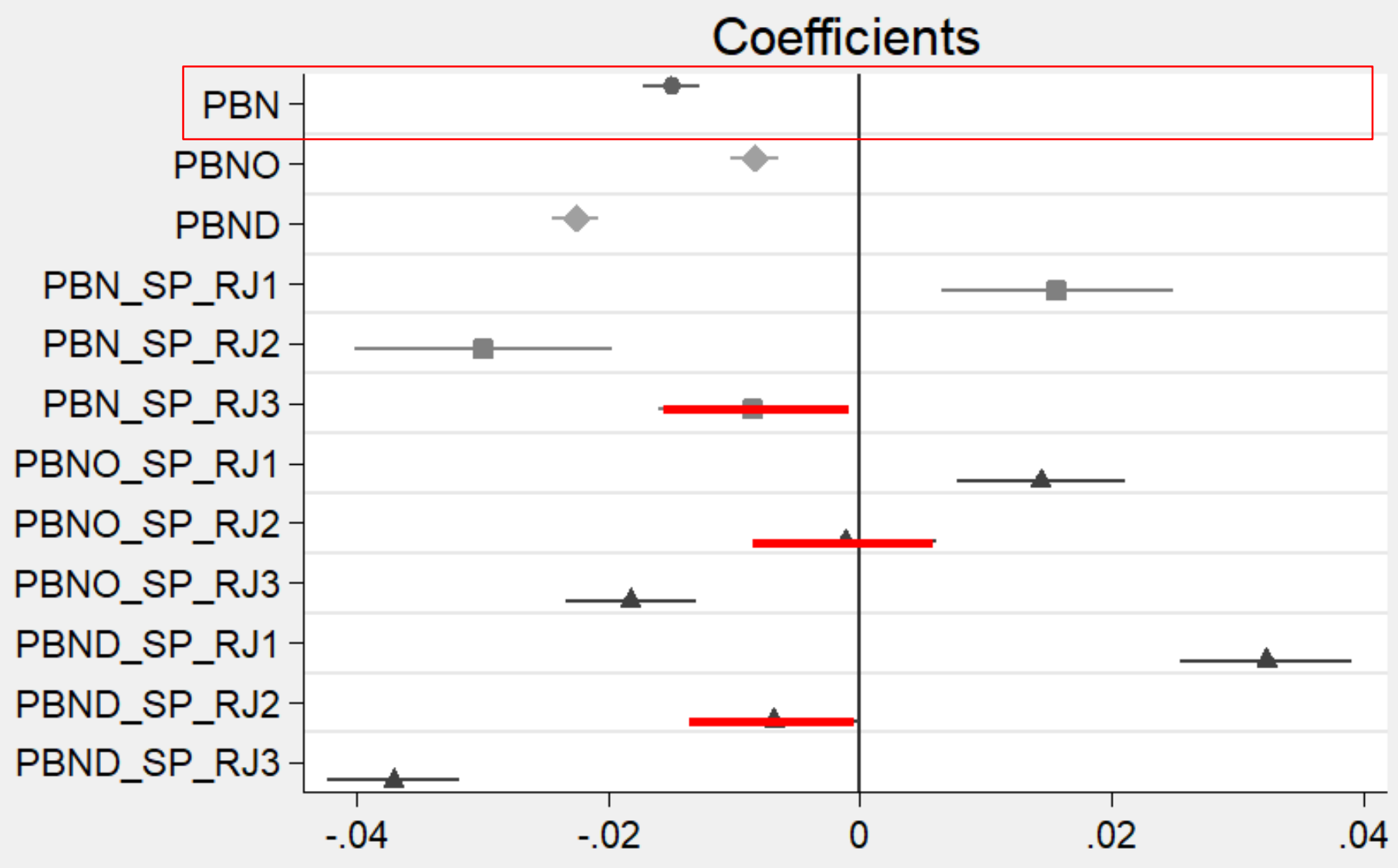

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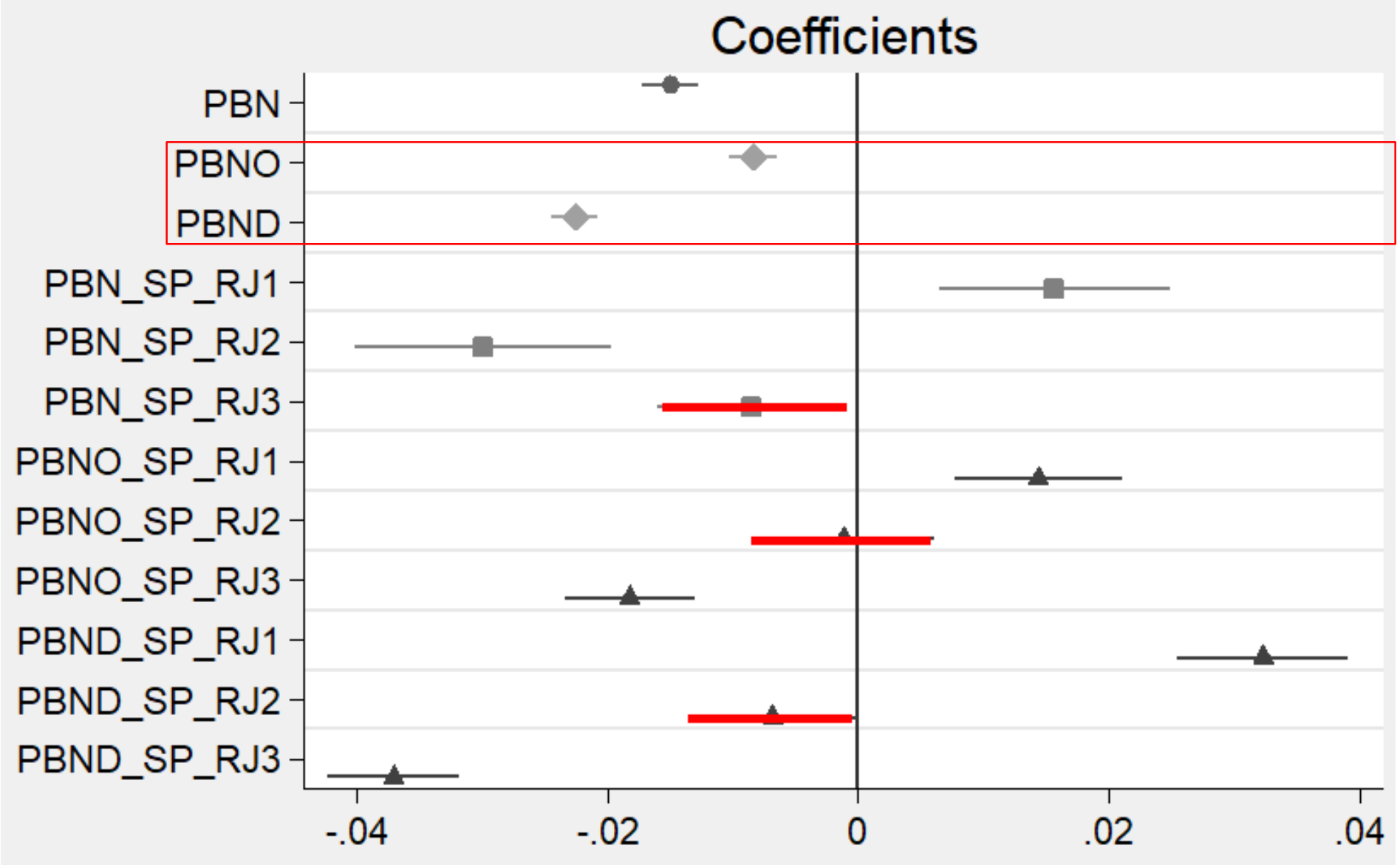

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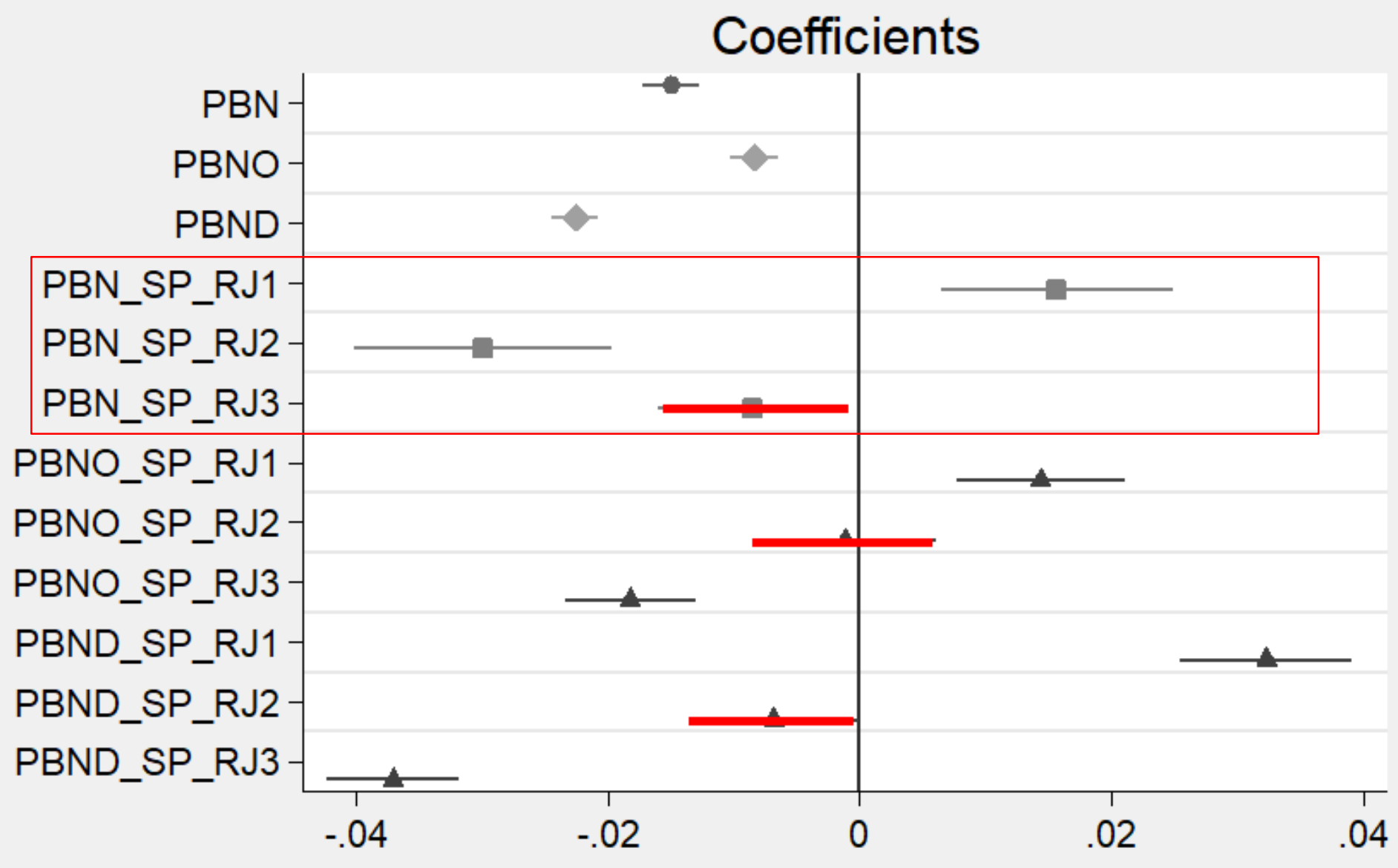

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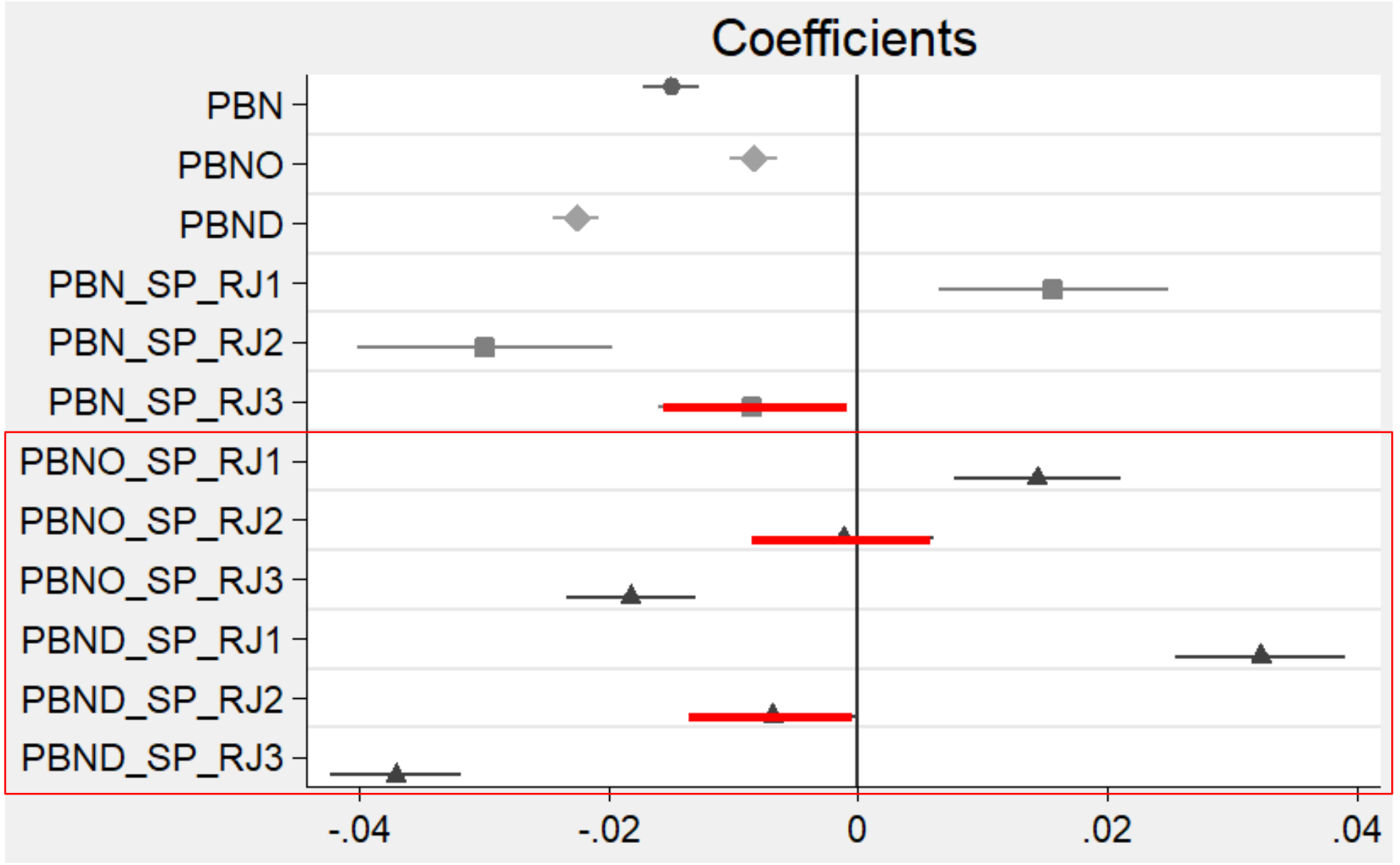

CONCLUSIONS

- Results indicate that PBN reduced flight times by 1-2%, on average.
- 1º phase in SP/RJ increased flight times by ~1.5%, while 2º and 3º phases reduced flight times by ~3%.
- Contribute to increased flight time:
  - Route density;
  - Airport size;
  - Hub size;
  - Delay.

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See on ResearchGate

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This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.