

# The Effects of State Aid on Total Factor Productivity Growth

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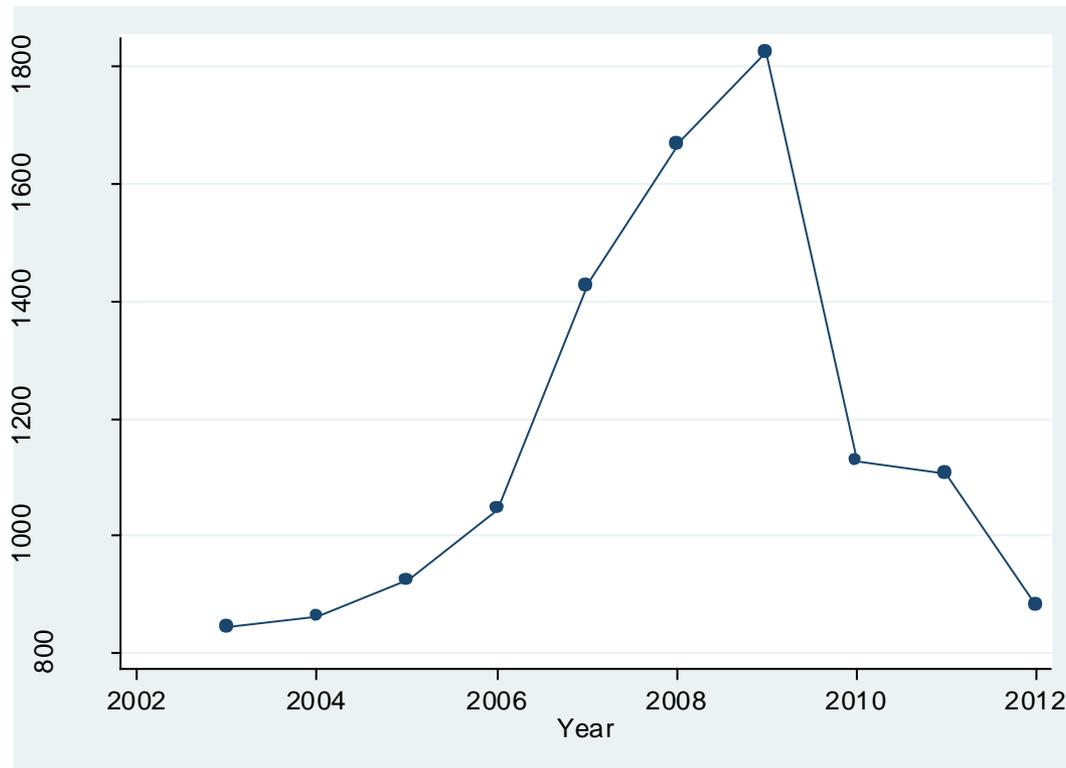
University of Leuven

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# 1. Motivation (i)

## The number of cases initiated

The number of EU State Aid cases, that were initiated, increased dramatically since 2007.



# 1. Motivation (ii)

- In principle EU member states are **not** allowed to provide state aid, as it could distort competition.
- However, under **article 107** of the Lisbon Treaty, the EU allows under a number of *specific conditions* member states to *provide state aid* in order to correct for market failure. However, with the financial crisis these conditions have been relaxed, such as the ‘de minimus’ rule, i.e. the minimum amount that firms can receive as a subsidy has been increased and the eligibility rules have been relaxed.
- **Key question:** Have the EU state aid schemes succeeded in *dealing* with *market failures*, such as increased *financial constraints* during the crisis?
- **This paper** therefore uses all EU state aid cases between 2003 and 2011 to analyze its *impact on firm level productivity growth* before and during the crisis.

# 2. Current state of knowledge (i)

## **Competition and industrial policy**

- Rodrik (1992), Ederington and McCalman (2008), Konings and Vandebussche (2008): when firms are temporarily protected from international competition, this can induce domestic firms to restructure and accelerate the speed of adoption of more efficient production technologies.
- Aghion, Dewatripont, Du, Harrison and Legros (2012): Effect of competition preserving (i.e. dispersed) state aid on TFP levels

## 2. State of knowledge (ii)

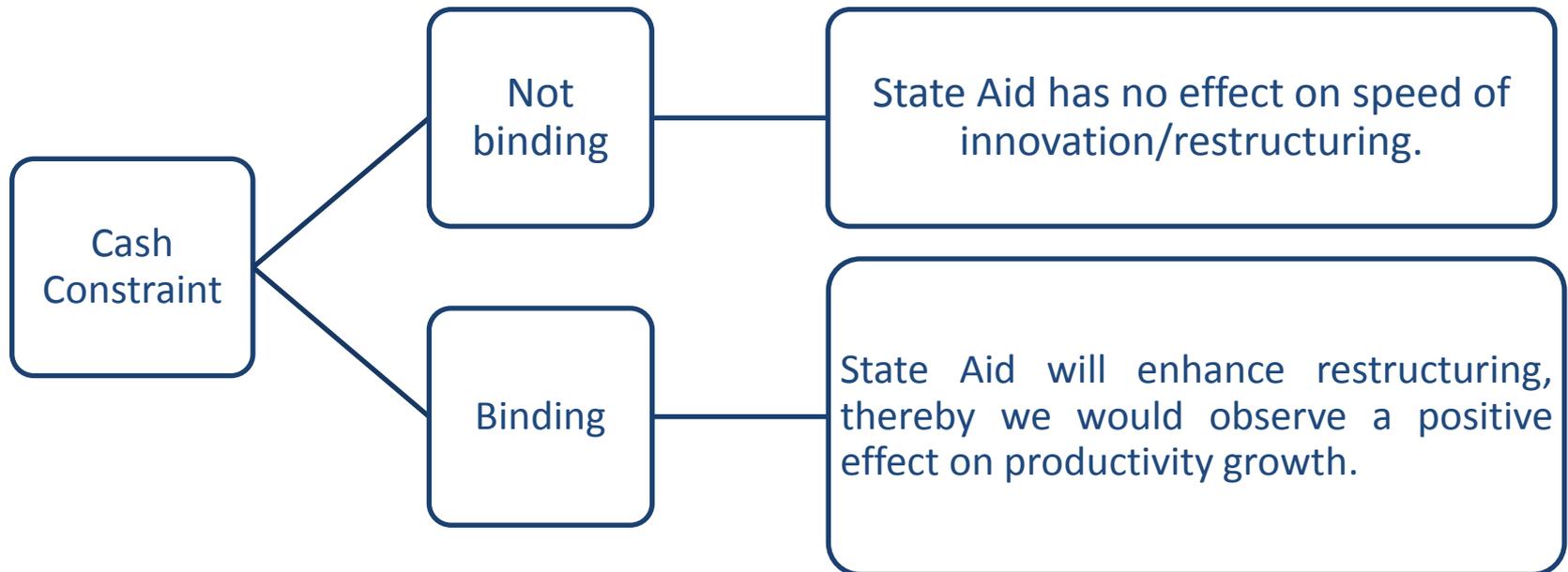
### **Competition and innovation:**

- Nickell (1995): Firms in high competitive markets are triggered to innovate/restructure more.
- Boone (2000); Aghion et al. (2005): inverted U relationship between competition and innovation. When competition is reduced (e.g. through trade protection or state aid), laggard firms have a stronger incentive to innovate and hence reduce the technology gap.

# 3. Framework

## Industry dynamics

- Sutton (1998), Sutton (2012), Tóth (2012)
- **Kamien and Schwartz (1978)**: Self-financing of an R&D projects: Defining an optimal development path by profit maximizing firms under self-financing of R&D projects



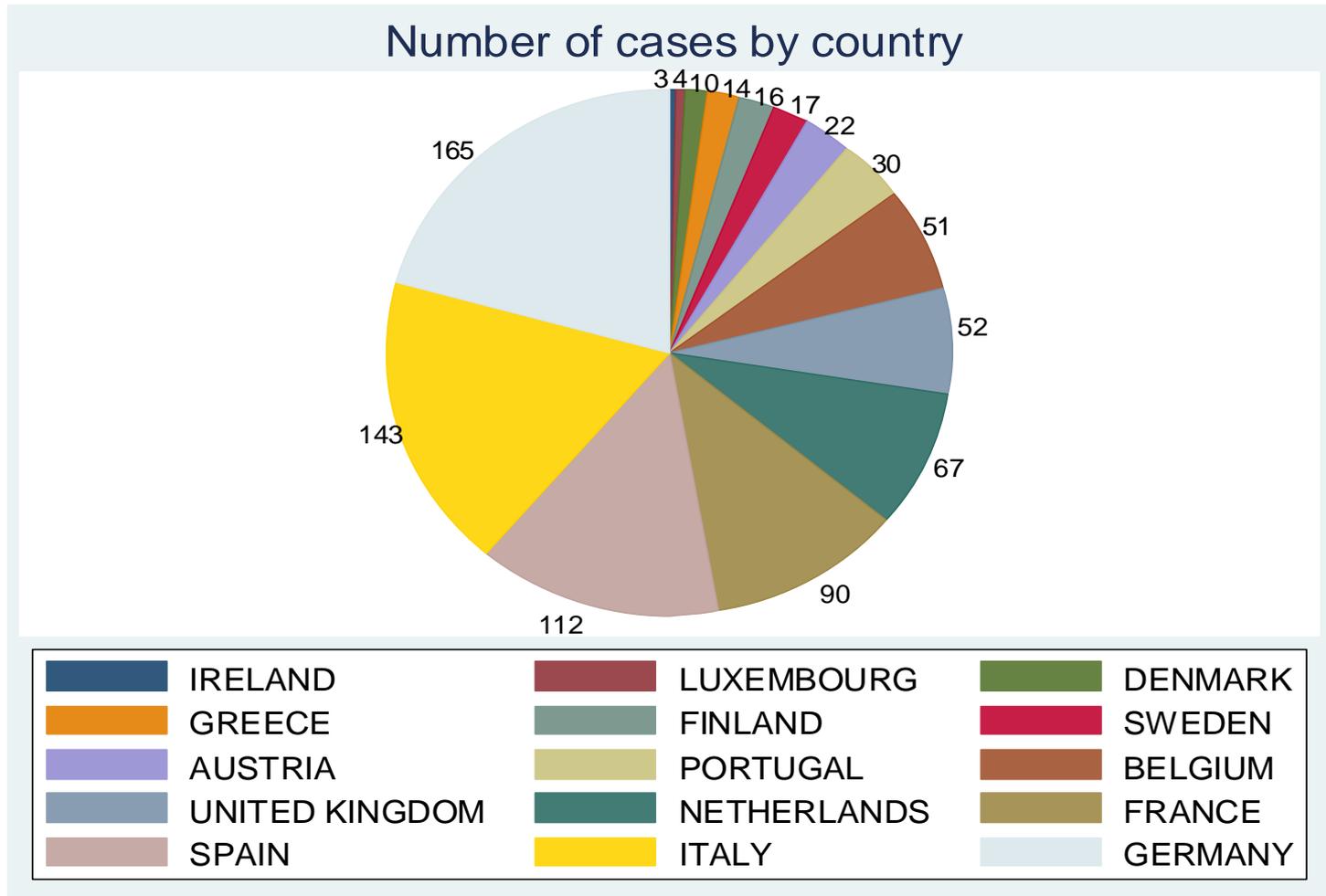
# 4. Testable predictions

- **State Aid** should affect **TFP growth** (as a measure of restructuring/innovation), when **financial constraints are binding**, which was more likely the case during the financial crisis.
- **'Laggard' firms** are more likely to be financially constraint and hence state aid should have a positive effect on TFP growth for laggard firms.
- Firms facing more **competition** are more likely financially constraint, hence state aid should have a stronger effect in highly competitive markets.

# 5. DATA (i)

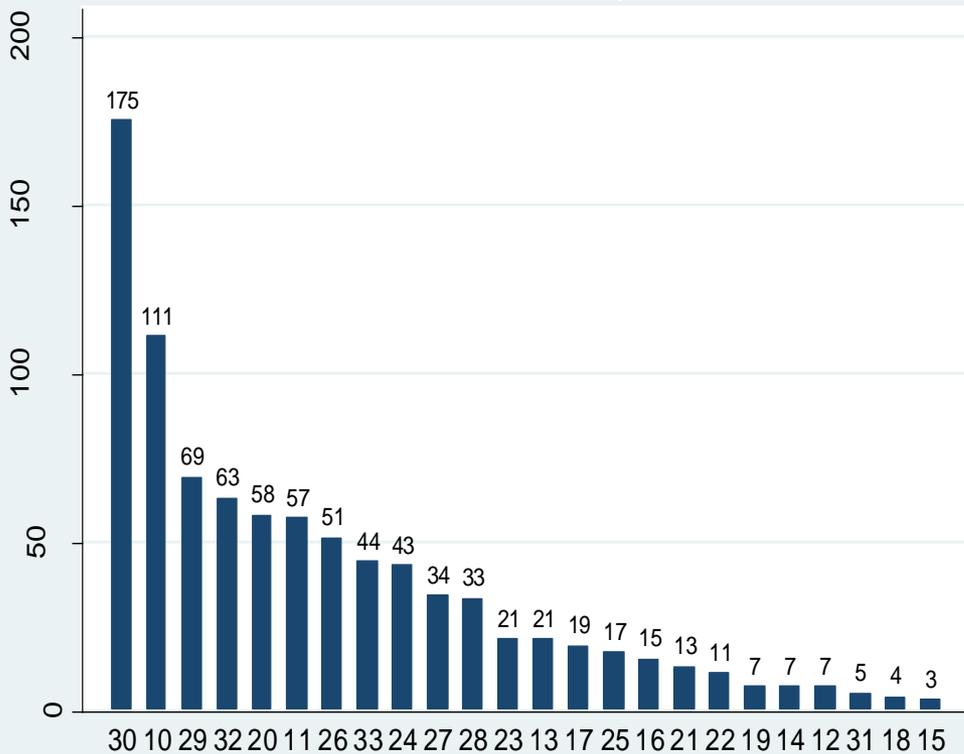
- The data has been constructed from the **European Commission websites**, e.g. [http://ec.europa.eu/competition/state\\_aid/overview/](http://ec.europa.eu/competition/state_aid/overview/)
- Information on **all state aid cases** that have been the object of a Commission decision since 1st January 2000 till present
- These are used to construct an sector-country specific indicator of state aid.
- We focus only on manufacturing state aid cases, which results in 797 cases that were initiated since the year 2000.
- These are matched with firm level data from Amadeus, a commercial dataset from Bureau Van Dijk containing financial information for public and private companies across Europe
- We use **278,676 firms in EU manufacturing between 2003 and 2011**

# 5. Data (ii)



# 5. Data (iii)

Number of cases by sector



Top 10 of aid-receiving sectors

Nace	Description
30	transport equipment
10	food products
29	motor vehicles, trailers
32	Other manufacturing
20	chemicals and chemical products
11	beverages
26	computer, electronic and optical products
33	Repair and installation of machinery and eqp.
24	basic metal
27	electrical equipment

# 6. Specification

Our main estimation equation is:

$$dTFP_{it+1} = \beta_0 + \beta_1 AID_{jct} + \gamma_1 distance_i + \gamma_2 distance_i * AID_{jct} \\ + \delta_1 Competition_{jct} + \delta_2 Competition_{jct} * AID_{jct} + \alpha_j + \alpha_c + \alpha_t + \varepsilon_{it}$$

where

- $dTFP_{it+1}$  is the growth rate of TFP between period  $t$  and  $t + 1$
- $distance_i$  is a measure of the distance to the frontier and defined as the ratio of  $TFP$  of firm  $i$  and  $TFP$  of the frontier firm
  - ➔ **'Laggard' firms are more likely to be in need for more restructuring.**
- $Competition_{jct}$  is defined as  $1 - Lerner$ 
  - ➔ **More competitive pressure results in low profits and hence more financial constraints**
- $AID_{jct}$  is a dummy variable equal to one if aid was granted in sector  $j$  in country  $c$  at time  $t$
- All specifications include sector ( $\alpha_j$ ), country ( $\alpha_c$ ) and time ( $\alpha_t$ ) fixed effects

# 7. Estimation

- **Step 1** : We estimate firm level TFP using Wooldridge estimation procedure (2009)
- **Step 2** : We analyze the impact of state aid on TFP growth, taking into account initial distance to the frontier firm.

# Estimates of the production function

sector	description	$\beta_l$	$\beta_k$	sector	description	$\beta_l$	$\beta_k$
		Mean	Mean			Mean	Mean
10	Food products	0.702932	0.064131	23	Other non-metallic mineral products	0.691757	0.055458
11	Beverages	0.639899	0.119844	24	Basic metals	0.760559	0.047492
12	Tobacco	0.694182	0.648919	25	Fabricated metal products	0.804088	0.047112
13	Textiles	0.74206	0.041341	26	Computer, electronic and optical products	0.786203	0.064113
14	Wearing Apparel	0.710856	0.067876	27	Electrical equipment	0.728943	0.051806
15	Leather	0.713055	0.060663	28	Machinery and equipment	0.779875	0.043774
16	Wood	0.744299	0.048459	29	Motor vehicles, trailers and semi-trailers	0.740443	0.058595
17	Paper and paper products	0.738571	0.060492	30	Other transport equipment	0.81698	0.056198
18	Printing and reproduction of recorded media	0.78937	0.044718	31	Furniture	0.739929	0.038024
19	Coke and refined petroleum products	0.426727	0.061877	32	Other manufacturing	0.760292	0.058393
20	Chemicals and chemical products	0.722585	0.063507	33	Repair and installation of machinery and equipment	0.885243	0.046971
21	Pharmaceutical products	0.681818	0.044375				
22	Rubber and plastic products	0.720724	0.056199	Total		0.756262	0.053179

*Notes: TFP coefficients are estimated by sector/country level. This table accordingly gives the average on the sector level.*

# 8. Results (i)

First, we look at the mere correlation of state aid and TFP growth conditional on time and firm fixed effects.

<b>Baseline Results</b>	
<b>Dependent variable:</b>	(1)
<b><i>TFP</i> growth</b>	Overall
<i>AID</i>	<b>0.00810***</b> (0.00182)
<i>Constant</i>	0.0475*** (0.00128)
Observations	829,121
R-squared	0.014
Number of firms	207,965
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1	

# 8. Results (i)

The positive effect of State Aid on firm performance seems to be mainly driven by the post-crisis period.

<b>Baseline Results</b>			
<b>Dependent variable:</b>	(1)	(2)	(3)
<b><i>TFP</i> growth</b>	Overall	Before crisis	After crisis
<i>AID</i>	0.00810*** (0.00182)	-0.00182 (0.00350)	<b>0.0254***</b> (0.00405)
<i>Constant</i>	0.0475*** (0.00128)	0.0452*** (0.00148)	-0.0676*** (0.00257)
Observations	829,121	390,420	438,701
R-squared	0.014	0.002	0.006
Number of firms	207,965	154,506	168,227
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1			

## 8. Results (ii): Laggard Firms

'Laggard' firms have more need to restructure in order to increase their productivity, but are also more likely to experience liquidity constraints. State aid alleviates those constraints and thereby accelerates this catching-up process

<b>Laggards and State Aid</b>	
<b>Dependent variable:</b>	(1)
<b>TFP growth</b>	Overall
<i>AID</i>	0.00683* (0.00385)
<i>distance</i>	<b>-0.338***</b> (0.0310)
<i>distance * AID</i>	<b>-0.105*</b> (0.0519)
Constant	0.129*** (0.0131)
Observations	829,121
R-squared	0.017

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 8. Results (ii): Laggard Firms

The catching-up process is more pronounced before the crisis. However, state aid is more able to accelerate this process during the crisis, since firms are more likely to be cash constraint when the economy is characterized by a global recession.

<b>Laggards and State Aid</b>			
<b>Dependent variable:</b>	(1)	(2)	(3)
<b><i>TFP</i> growth</b>	Overall	Before crisis	After crisis
<i>AID</i>	0.00683* (0.00385)	0.00219 (0.00749)	0.0178*** (0.00523)
<i>distance</i>	-0.338*** (0.0310)	<b>-0.475***</b> (0.0467)	<b>-0.214***</b> (0.0249)
<i>distance * AID</i>	-0.105* (0.0519)	-0.110 (0.104)	<b>-0.161***</b> (0.0451)
Constant	0.129*** (0.0131)	0.139*** (0.0261)	0.0349*** (0.0109)
Observations	829,121	390,420	438,701
R-squared	0.017	0.015	0.012

Robust standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 8. Results (iii): Competition

Competitive pressure within the sector lowers the profits, and thereby decreases the liquidity available to restructure. By providing state aid, this cash constraint can be alleviated.

<b>Competition and State Aid</b>			
<b>Dependent variable:</b>	(1)	(2)	(3)
<b><i>TFP</i> growth</b>	Overall	Before crisis	After crisis
<i>AID</i>	-0.353** (0.153)	0.0258 (0.201)	-0.391* (0.221)
<i>Competition</i>	0.346 (0.256)	0.113 (0.164)	0.843*** (0.284)
<i>Competition * AID</i>	<b>0.390**</b> (0.167)	-0.0253 (0.218)	<b>0.438*</b> (0.241)
Constant	-0.287 (0.242)	-0.0964 (0.153)	-0.828*** (0.275)
Observations	829,121	390,420	438,701
R-squared	0.012	0.005	0.011

Robust standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

# 8. Results (iv)

The benefits of state aid in terms of total factor productivity growth are more pronounced for ‘laggard’ firms and in sectors where competitive pressure is higher.

<b>Competition, Laggards and State Aid</b>	
<b>Dependent variable:</b>	(1)
<b><i>TFP</i> growth</b>	Overall
<i>AID</i>	-0.317* (0.182)
<i>distance</i>	-0.337*** (0.0318)
<i>distance * AID</i>	<b>-0.116**</b> (0.0552)
<i>Competition</i>	0.434 (0.281)
<i>Competition * AID</i>	<b>0.355*</b> (0.197)
Constant	-0.283 (0.269)
Observations	829,121
R-squared	0.017

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

# 8. Results (iv)

These effects are more pronounced during the financial crisis since cash constraints are more likely to occur (demand for liquidity) and firms are more keen to restructure (demand for liquidity)

<b>Competition, Laggards and State Aid</b>			
<b>Dependent variable:</b>	(1)	(2)	(3)
<b>TFP growth</b>	Overall	Before crisis	After crisis
<i>AID</i>	-0.317* (0.182)	0.207 (0.328)	-0.389* (0.224)
<i>distance</i>	-0.337*** (0.0318)	-0.476*** (0.0469)	-0.210*** (0.0281)
<i>distance * AID</i>	-0.116** (0.0552)	-0.116 (0.104)	<b>-0.185***</b> (0.0467)
<i>Competition</i>	0.434 (0.281)	0.297 (0.269)	0.926*** (0.302)
<i>Competition * AID</i>	0.355* (0.197)	-0.224 (0.358)	<b>0.449*</b> (0.245)
Constant	-0.283 (0.269)	-0.130 (0.252)	-0.853*** (0.291)
Observations	829,121	390,420	438,701
R-squared	0.017	0.015	0.013

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

# 9. Robustness

Using **alternative measures** of

- Cash constraint
  - ❑ EBITDA dummy = 1 if  $EBITDA < 0$
  - ❑ 'minsky' measure = 1 if  $interest\ paid / cash\ flow > 1$
- Competition → Profit Elasticity: measures the percentage fall in profits due a percentage increase in (marginal) costs (Boone et al., 2007)
- Distance to frontier → Initial productivity level
- TFP growth → Labor productivity growth

## 9. Robustness: Alternative measures (i)

The EBITDA dummy measures whether or not a firm is able to finance its operating activity by its current earnings, and provides a more direct measure of a potential cash constraint.

EBITDA dummy as an alternative measure for cash constraint				
Dependent variable:	(1)	(2)	(3)	(4)
<i>TFP growth</i>	Overall	Overall	Before crisis	After crisis
<i>AID</i>	0.00540 (0.00330)	-0.235 (0.163)	0.210 (0.306)	-0.295 (0.205)
<i>distance</i>	-0.293*** (0.0285)	-0.291*** (0.0290)	-0.415*** (0.0431)	-0.178*** (0.0264)
<i>Distance * AID</i>	-0.0963* (0.0476)	<b>-0.103*</b> (0.0507)	-0.103 (0.0948)	<b>-0.168***</b> (0.0431)
<i>Competition</i>		0.208 (0.269)	0.183 (0.251)	0.648** (0.258)
<i>Competition * AID</i>		0.263 (0.177)	-0.226 (0.334)	0.342 (0.224)
<i>constraint</i>	0.210*** (0.00974)	0.209*** (0.00948)	0.206*** (0.00673)	0.213*** (0.0139)
<i>constraint * AID</i>	0.0323* (0.0167)	<b>0.0314*</b> (0.0166)	0.00593 (0.0142)	<b>0.0403*</b> (0.0226)
Constant	0.111*** (0.0138)	-0.0873 (0.258)	-0.0526 (0.237)	-0.566** (0.250)
Observations	828,970	828,970	390,400	438,570
R-squared	0.047	0.047	0.042	0.047

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 9. Robustness: Alternative measures (ii)

The insufficiency of the cash flow to cover the interest paid indicates that a firm is severely liquidity constraint. Our results suggest that under these conditions, the positive effect of state aid is no longer statistically significant.

Minsky measure as an alternative measure of the cash constraint				
Dependent variable:	(1)	(2)	(3)	(4)
<i>TFP growth</i>	Overall	Overall	Before crisis	After crisis
<i>AID</i>	0.0133** (0.00591)	-0.290 (0.176)	0.228 (0.322)	-0.345 (0.224)
<i>distance</i>	-0.176*** (0.0216)	-0.280*** (0.0248)	-0.394*** (0.0388)	-0.173*** (0.0241)
<i>Distance * AID</i>	-0.142*** (0.0444)	-0.0997* (0.0529)	-0.101 (0.0922)	-0.162*** (0.0461)
<i>Competition</i>		0.257 (0.283)	0.159 (0.252)	0.742** (0.279)
<i>Competition * AID</i>		0.322 (0.190)	-0.248 (0.348)	0.396 (0.242)
<i>minsky</i>	0.123*** (0.00800)	0.123*** (0.00589)	0.126*** (0.00549)	0.122*** (0.00771)
<i>minsky * AID</i>	0.0109 (0.00850)	<b>0.00955</b> (0.00818)	0.00399 (0.0158)	<b>0.0103</b> (0.00797)
Constant	0.00566 (0.0113)	-0.155 (0.271)	-0.0503 (0.239)	-0.706** (0.269)
Observations	437,512	826,918	389,406	437,512
R-squared	0.029	0.034	0.033	0.030

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

# 9. Robustness: Alternative measures (iii)

Including PE as additional measure of the competitive environment does not alter previous conclusions.

Profit Elasticity as alternative measure of competition			
Dependent variable:	(1)	(2)	(3)
<i>TFP</i> growth	Overall	Before crisis	After crisis
<i>AID</i>	-0.00338 (0.00779)	-0.00321 (0.0118)	-0.0135 (0.0178)
<i>distance</i>	-0.293*** (0.0282)	-0.415*** (0.0425)	-0.183*** (0.0244)
<i>Distance * AID</i>	<b>-0.0991*</b> (0.0487)	-0.0987 (0.0978)	<b>-0.160***</b> (0.0391)
<i>PE</i>	0.000421 (0.00365)	-0.00176 (0.00618)	-0.00247 (0.00301)
<i>PE</i>   * <i>AID</i>	0.00434 (0.00412)	0.00284 (0.00667)	<b>0.0136*</b> (0.00723)
<i>constraint</i>	0.209*** (0.00974)	0.207*** (0.00679)	0.214*** (0.0144)
<i>constraint * AID</i>	<b>0.0322*</b> (0.0167)	0.00550 (0.0143)	<b>0.0408*</b> (0.0230)
Constant	0.110*** (0.0203)	0.116*** (0.0329)	0.0641*** (0.0137)
Observations	828,970	390,400	438,570
R-squared	0.047	0.041	0.046

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

# 9. Robustness: Alternative measures (iv)

Labor productivity is a commonly used alternative to measure firm performance. Our results remain valid.

<b>Labor productivity growth as dependent variable</b>			
<b>Dependent variable:</b>	(1)	(2)	(3)
<b>Labor productivity growth</b>	Overall	Before crisis	After crisis
<i>AID</i>	0.206 (0.121)	0.260 (0.198)	-0.0410 (0.118)
<i>distance_l</i>	-0.0355*** (0.00534)	0.0283*** (0.00479)	-0.0857*** (0.00597)
<i>distance_l * AID</i>	<b>-0.0431**</b> (0.0180)	0.000383 (0.0133)	<b>-0.0483***</b> (0.0114)
<i>competition</i>	0.324*** (0.0850)	0.229* (0.120)	0.250*** (0.0819)
<i>competition * AID</i>	-0.222 (0.130)	-0.286 (0.215)	<b>0.0520</b> (0.128)
Constant	-0.294*** (0.0787)	-0.174 (0.111)	-0.271*** (0.0786)
Observations	829,345	390,517	438,828
R-squared	0.009	0.005	0.018

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

# 9. Robustness: Alternative measures (v)

As an alternative measure of the efficiency of firms, we replace our distance measure by the initial TFP level. Firms with lower TFP level benefit more from state aid, in particular in during the crisis. The other results remain valid.

Initial TFP level as an alternative measure for 'laggards'			
Dependent variable:	(1)	(2)	(3)
<i>TFP growth</i>	Overall	Before crisis	After crisis
<i>AID</i>	-0.242*** (0.0417)	0.00138 (0.701)	-0.306*** (0.0575)
<i>initialTFP</i>	-0.0758*** (0.00296)	-0.0934*** (0.00414)	-0.0575*** (0.00265)
<i>initialTFP * AID</i>	0.00175 (0.00324)	-0.000560 (0.00466)	<b>-0.00702**</b> (0.00318)
<i>Competition</i>	0.169*** (0.0363)	0.0334 (0.0608)	0.611*** (0.0497)
<i>Competition * AID</i>	0.267*** (0.0455)	7.77e-05 (0.0767)	<b>0.343***</b> (0.0628)
<i>constraint</i>	0.196*** (0.00290)	0.181*** (0.00428)	0.208*** (0.00394)
<i>constraint * AID</i>	<b>0.0317***</b> (0.00446)	0.00618 (0.00722)	<b>0.0370***</b> (0.00575)
Constant	-0.139*** (0.0347)	-0.0427 (0.0587)	-0.591*** (0.0476)
Observations	828,970	390,400	438,570
R-squared	0.058	0.058	0.054

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

# 10. Conclusions

1. State aid enhances TFP growth.
2. 'Laggard' firms catch up with more efficient firms, i.e. experience higher TFP growth
3. 'Laggard' firms benefit more from state aid. Although less efficient firms are catching up, their development pace can be hastened by state aid measures
4. State aid is more growth enhancing when granted in highly competitive sectors
5. The most important results obtained are mainly driven by the post-crisis years.
6. Our results are consistent with the cash-constraint theory, in which state aid is able to resolve the market failure resulting from binding cash-constraints.

# 11. Future Research

1. Determining the optimal use of state aid measures in pursuit of sustainable growth by focusing on the underlying industry dynamics specific to an internal market, both theoretical and empirical, can provide a deeper insight of the results obtained in this paper.
2. Identifying the effectiveness of state aid on maintaining/increasing employment rates as well as a potential trade-off between the different goals set out by the Lisbon Strategy