THE IMPACT OF WILDFIRES ON ASSETS AND EMPLOYMENT

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Agenda

- Motivation
- Research questions
- Literature review
- Data
- Empirical strategy
- Results
- Conclusions and next steps

Motivation

- Climate models predict an increase in the frequency and intensity of wildfires linked to climate change
- Southern Europe was impacted by a significant number of wildfires in recent years
- Negative consequences to households and firms (more details in the next slides)
- Relevant for policy makers
  - Room for Government intervention

Research questions

- What are the impacts of wildfires on firms' inputs factors? (if any)
  - Capital
  - Labour
- Do we find heterogeneous impacts, considering different effects according to firms' asset structure?
- Do these impacts depend on the characteristics of the firm, such as their sector of activity, size, age and export status?

What are the policy implications of these findings? How can they contribute to the design of cost-effective policies to compensate firms for their losses?

Literature review

- Stream of literature explores the impact on capital and/or labor markets of other natural disasters, such as floods (A. M. Leiter et al, 2009) and hurricanes (Belasen and Polacheck, 2008)
- Other papers about the impact of wildfires, but focused on households (Issler et al., 2019)

Firm data

- **From Simplified Business Information (IES)**
  - Companies that annually fulfill their reporting obligations
- **BPLim, the Microdata Lab from Banco de Portugal**
- **Yearly information**
  - From 2006 to 2019
- **What kind of information does it have?**
  - Characteristics, such as location, size, age and sector of activity
  - Balance sheet and profit and loss data

Wildfire data

- **Geographic coordinates of the burnt area**
  - Shape files sourced from Instituto da Conservação da Natureza e das Florestas (ICNF)
  - Burnt areas above 1 ha
- **Yearly information**
  - From 2011 to 2019
- **Information for Portugal mainland**

Wildfire data
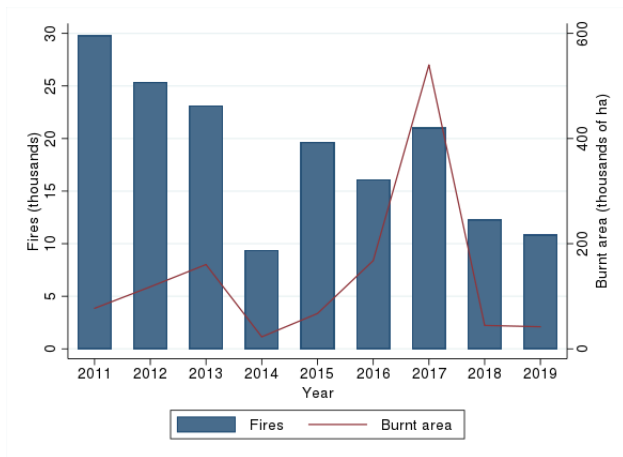
- **Years analysis** - from 2015 to 2018

Matching wildfire data and firm data

- **Identify the 7-digit postal codes whose centroid is in a burnt area for a given year**
  - **Treatment group**: firms with a 7-digit postal code whose centroid is in a burnt area only in 2017
  - **Control group**: firms with a 7-digit postal code in a non-burnt area from 2015 to 2018
- **Exclude firms with more than one establishment**
  - The assessment of the effects of the wildfires on firms relies critically on their location
  - Guarantee a one-to-one relationship between firms and geographical location at national level

Scope

- Analysis considers the firms where the **losses are direct and immediate**, according to the literature, and whose primary sector of activity is one of the following:

	Total	Distribution
Agriculture	3100	31.2%
Animal production	3726	37.5%
Forestry and logging	1134	11.4%
Manufacture of wood	1717	17.3%
Manufacture of pulp/paper	261	2.6%
Total	**9938**	**100.0%**

Table: Firms by Sector of Activity

Impact channels

- **Capital**
  - **Wildfires can affect the soil**, infiltration and erosion processes, impacting agriculture and forest sectors
  - Animal production also affected by the **death/injury of animals**, and indirect effects, such as starvation and lack of water
  - **Forests that support wood-based industries might also be affected/destroyed**, compromising the availability and quality of wood
  - **Destruction/damages on land, buildings, offices and warehouses**
- **Labor**
  - **Evacuation, human deaths and business disruptions** can lead to a decrease in workers
  - **Suppression efforts, reconstruction and recovery activities** can boost employment levels, especially if locally sourced

Empirical strategy

- **Difference-in-differences design technique**
- Focus here on two different dependent variables:
  - The physical capital stock expressed by firms' **total assets** (*lassets*)
  - Labour measured via the **number of workers** (*lempl*)

Standard DID

$$\log(Y_{ispt}) \quad = \quad \beta_0 \; + \; \beta_1 POST_t \; + \; \beta_2 T_p \; + \; \beta_3 (POST_t.T_p) \; + \; \varepsilon_{ispt} \quad (1)$$

- The outcome variable is (Y_{ispt} can be either total assets (*lassets*) or employment (*lempl*))
- The indices represent a firm *i* in a sector of activity *s* in a 7-digit postal code *p* at time *t*
- **POST** is a dummy variable equal to 1 in the period after the shock and **T** is a dummy variable equal to 1 if the firm is in the treatment group
- We alternatively run this with **firm fixed effects** and with the **following controls**: the **initial stock of the outcome variable** (either *lassetsi* or *lempli*), the **date of constitution** of the firm (*lstart*). We also include **regional and sectoral effects**

Exploring heterogeneity

$$\log(Y_{ispt}) = \beta_0 + \beta_1 POST_t + \beta_2 T_p + \beta_3 (POST_t.T_p) + \beta_4 lY i_{isp}$$
$$+ \beta_5 lstart_{isp} + \beta_6 sland\_s_{ispt} + \beta_7 (POST_t.T_p.sland\_s_{ispt}) + \gamma_s + \delta_p + \varepsilon_{ispt} \quad (2)$$

- **Hypothesis**: a higher share of land and buildings, which are more prone to be damaged or destroyed by wildfire, on tangible and intangible fixed assets of the firm determines the impacts of wildfires

  - $sland\_s_{ispt}$ is the standardized value for the share of land and buildings on tangible and intangible fixed assets of the firm

- Note that lYi_{isp} controls for the corresponding initial value in 2015

- **IV: instrument the initial capital/employment values** using alternatively:
  - (i) the average amount of total assets/workers for the 3-digit sector of activity
  - (ii) the industry specific minimum efficient scale (following A. M. Leiter et al, 2009)
    MES

Estimates of Wildfire on Assets - Standard DD Specification

VARIABLES	OLS (1)	OLS (2)	OLS (3)	OLS (4)	IV (5)
1.POST	0.071***	0.071***	0.071***	0.071***	0.071***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
1.T	-0.415***		-0.005	-0.011	-0.016
	(0.123)		(0.013)	(0.013)	(0.015)
1.POST#1.T	-0.089***	-0.089***	-0.089***	-0.103***	-0.103***
	(0.026)	(0.026)	(0.026)	(0.027)	(0.027)
lassetsi			0.978***	0.978***	
			(0.004)	(0.004)	
lassetsi_hat					0.955***
					(0.036)
lstart			3.644***	3.213***	1.983
			(0.649)	(0.622)	(1.945)
sland_s				-0.024***	-0.021***
				(0.007)	(0.004)
DID_sland				-0.046**	-0.044**
				(0.020)	(0.021)
Observations	23,496	23,496	23,496	23,493	23,493
R-squared		0.030			0.945
Number of firms	5,874	5,874	5,874	5,874	
FIRM FE		YES			
SECTOR OF ACTIVITY			YES	YES	YES
DISTRICT			YES	YES	YES
F stat					5.828
Wu-Hausman F stat					0.474
p-values Wu-Hausman F stat					0.492

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

Estimates of Wildfire on Assets by Sector of Activity - Standard DD Specification

	Agriculture, animal production and forestry			Manufacture of wood			Pulp paper manufacture		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1.POST	0.075***	0.075***	0.075***	0.047***	0.047***	0.047***	0.069**	0.069**	0.069**
	(0.006)	(0.006)	(0.006)	(0.011)	(0.011)	(0.011)	(0.031)	(0.031)	(0.031)
1.T	-0.363**		-0.002	-0.471**		-0.005	-1.974***		0.003
	(0.154)		(0.016)	(0.236)		(0.027)	(0.190)		(0.053)
1.POST#1.T	-0.092***	-0.092***	-0.092***	-0.059	-0.059	-0.059	-0.252***	-0.252***	-0.252***
	(0.031)	(0.031)	(0.031)	(0.046)	(0.046)	(0.046)	(0.031)	(0.031)	(0.031)
lassetsi			0.965***			1.008***			1.026***
			(0.004)			(0.005)			(0.015)
lstart			2.924***			5.153***			5.303
			(0.768)			(1.135)			(3.629)
Observations	19,072	19,072	19,072	3,820	3,820	3,820	604	604	604
R-squared		0.033			0.016			0.030	
Number of firms	4,768	4,768	4,768	955	955	955	151	151	151
FIRM FE		YES			YES			YES	
SECTOR ACTIVITY			YES			YES			YES
DISTRICT			YES			YES			YES

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

- Impacts on agriculture, animal production and forestry mainly driven by the agricultural sector
- The pulp paper manufacture sector is vulnerable to wildfires, despite the involvement of own combat materials for some of these firms

	Micro	Small
1.POST	0.147***	0.122***
	(0.008)	(0.009)
1.T	-0.421***	-0.091
	(0.103)	(0.241)
1.POST#1.T	-0.111**	0.018
	(0.055)	(0.030)
Observations	34,026	4,884
Number of firms	8,818	1,635

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

Robustness Checks (1/2)

- **Sectoral placebo test**: run the regression for sectors supposedly not impacted by wildfires, or where effects are expected in a smaller magnitude, such as: i) construction , ii) wholesale and retail trade, and repair of motor vehicle and motorcycles and iii) professional, scientific and technical activities
  Results from sectoral placebo test

- **Regional subsamples**: consider a subsample of firms in a specific region allows us to compare outcomes from firms in the treatment and control groups located in the same area, in order to control for regional effects. This allows us to check the robustness of our previous results, where regional controls were added   Results with regional subsamples

Robustness Checks (2/2)

- **Stringency of the control group**: exclude from the control groups the firms that are *close enough* to the burnt area, that are more likely to suffer from the effects of wildfires; we consider only firms that are more than 1, 10 or 25 kilometers distant of the burnt area in 2017, while keeping the same treatment group ⬤ Results with stringent control groups

Results from the robustness checks are qualitatively similar to the main specifications

Conclusions

- We find evidence that the **treatment effect of wildfires is -10.3% for assets and -9.4% for employment**
- **Firms with higher shares for land and buildings seem to present higher vulnerabilities** when affected by wildfires
- Firms in the **agriculture and in manufacture pulp/paper seem to be more affected by wildfires**, as well as smaller and non-exporting firms
- Data on the **overall distribution of beneficiaries of the governmental financial support in 2017** is broadly aligned with the results from the analysis of the heterogeneous effects, in terms of sector of activity, size, age and export status Financial support
- The quantification of these heterogeneous impacts are relevant to **inform public policy that design *ex-post* supporting measures** for firms affected by wildfires

Other ideas for the next steps

- **Time dimension of the treatment:** exploit the difference-in-differences approach in the case of varying start dates or different treatment durations

Thank for your attention!

	Construction	Wholesale and retail	Technical activities
1.POST	0.077***	0.056***	0.078***
	(0.005)	(0.002)	(0.006)
1.T	-0.241	-0.092	-0.091
	(0.162)	(0.070)	(0.205)
1.POST#1.T	0.044	-0.020	-0.014
	(0.039)	(0.019)	(0.033)
Observations	20,236	87,221	24,175
Number of firms	5,183	22,135	6,156

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

	Coimbra				Leiria			
	Selected Sectors	Construction	Wholesale and retail	Technical activities	Selected Sectors	Construction	Wholesale and retail	Technical activities
1.POST	0.053**	0.088***	0.046***	0.074***	0.090***	0.071***	0.067***	0.106***
	(0.026)	(0.017)	(0.008)	(0.022)	(0.018)	(0.013)	(0.006)	(0.018)
1.T	-0.319	-0.110	0.095	-0.444***	0.303	-0.877	0.327***	1.375**
	(0.239)	(0.266)	(0.123)	(0.121)	(0.780)	(0.872)	(0.055)	(0.631)
1.POST#1.T	-0.106**	0.049	0.007	-0.008	-0.465***	-0.102	-0.175***	-0.007
	(0.045)	(0.054)	(0.025)	(0.039)	(0.138)	(0.124)	(0.028)	(0.033)
Observations	793	1,005	3,835	954	1,681	1,684	6,221	1,352
Number of firms	202	256	971	245	426	430	1,584	345

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

Results with stringent control groups - Estimates of Wildfire on Assets

	1 km	10 km	25 km
1.POST	0.071***	0.084***	0.127***
	(0.005)	(0.014)	(0.033)
1.T	-0.440***	-0.786***	-0.939***
	(0.124)	(0.142)	(0.295)
1.POST#1.T	-0.089***	-0.102***	-0.145***
	(0.026)	(0.029)	(0.042)
Observations	20,588	2,956	384
Number of firms	5,147	739	96

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

Burnt Area by Municipality
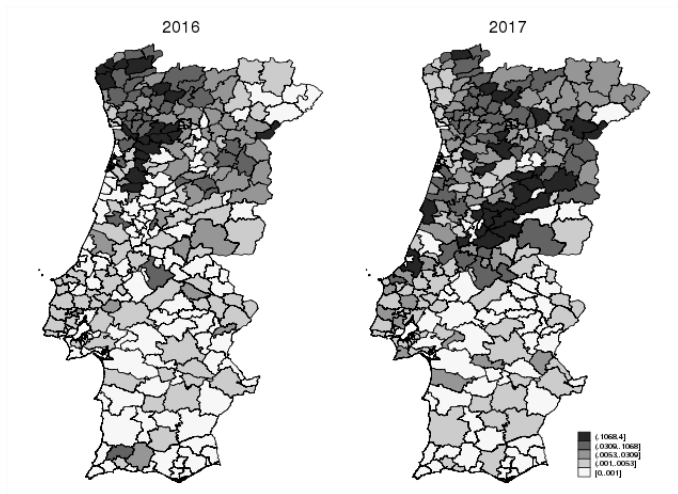
- This Figure maps the total burnt area weighed by the area by municipality in mainland Portugal, in 2016 and 2017.
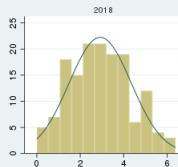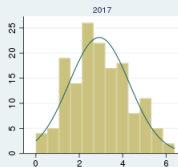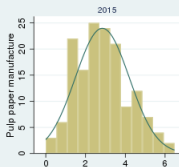
Common trend assumption for assets
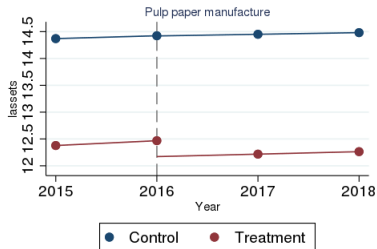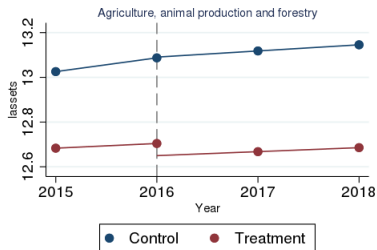
Common trend assumption for employment
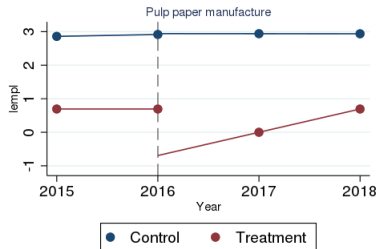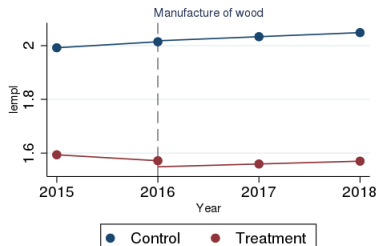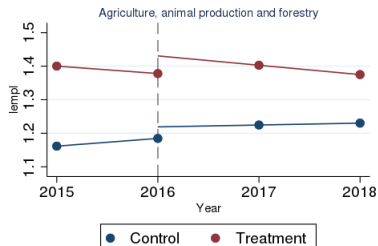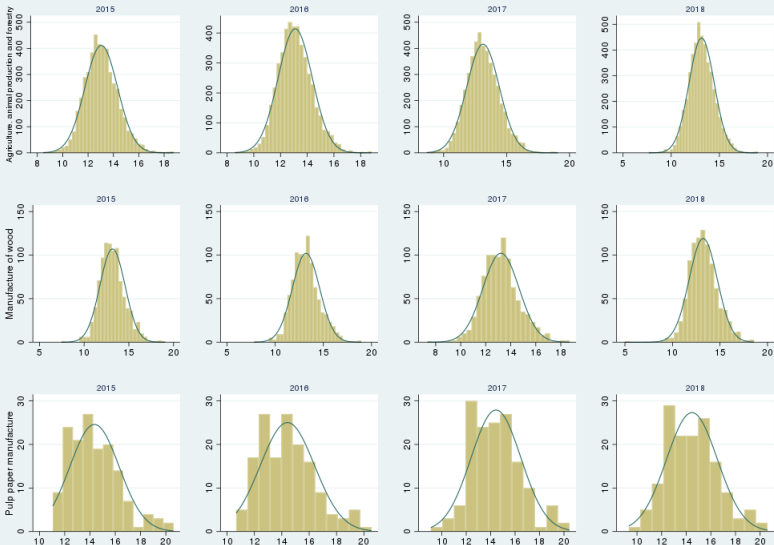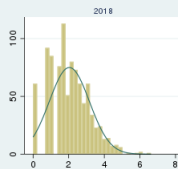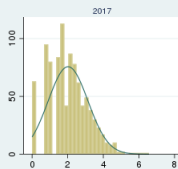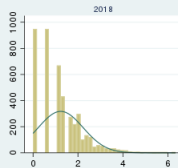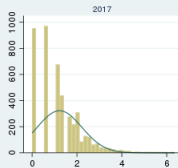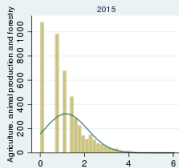
Event Study for Outcome Variable lassets by Sector of Activity

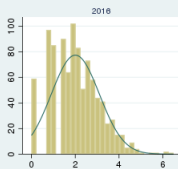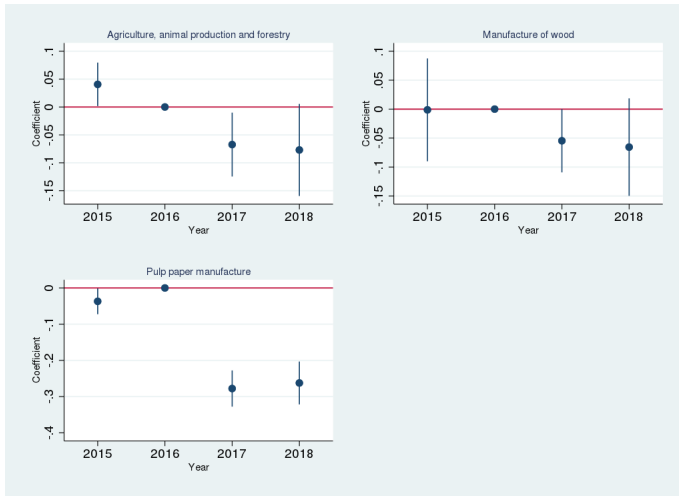# Event Study for Outcome Variable lempl by Sector of Activity
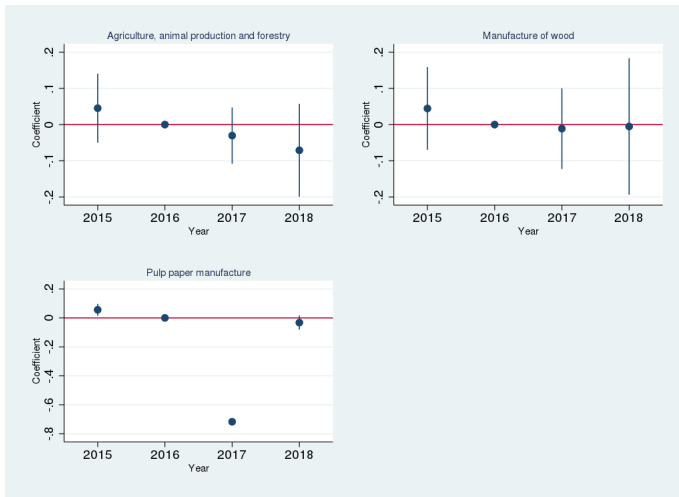
Key variables of control and treatment groups for 2015 and 2016 (averages and t-tests)

	Treatment group	Control group	Difference	T-test	Unit
Assets	486,7	1219,1	732,4	0.3183	10^3 euros
Tangible assets	227,3	572,6	345,3	0.3094	10^3 euros
Equity	158,6	494,3	335,7	0.2368	10^3 euros
Sales	321,1	779,6	458,5	0,4338	10^3 euros
Other expenses	4,7	11,4	6,7	0.2312	10^3 euros
ROA	-1,4	-5,3	-3,8	0.8522	%
Workers	5,3	6,7	1,4	0.2958	Number
Worked hours	9066,6	11491,0	2424,6	0.3044	Number
Size	1,13	1,16	0,03	0.2413	Categorical
Constitution year	2002,8	2002,4	-0,4	0.6624	Date (year)

Financial support received by firms due to wildfires

Financial support	Scope	Beneficiary firms	Coverage
Measures to restore the productive capacity	Protection of productive potential	Agricultural holdings and livestock firms	Investments in livestock, agricultural machinery and other equipment, greenhouses and other infrastructure
		Other firms	The reconstruction of buildings and other equipment; means to ensure that employers can continue to assume their responsibilities towards the workers
Support for losses lower than 1053,31 eur	Support the acquisition of immediate assets	Farmers	Investment in animals, plantations, machines, equipment and support spaces related to agricultural activity
	Measures to support employment and training	Other firms	Financial incentive to firms to safeguard the existing jobs and development of training sessions
Support for losses between 1053,31 eur and 5000 eur	Compensation of losses in tangible assets	Farmers	Support is granted 100% in the form of a non-repayable grant (from 1053,31 eur to 5000 eur)
Specific support to vineyards	Specific funds to the recovery of vineyards	Wine producers	Investment made in the restructure and conversion of vineyards and compensation for the loss revenue

Average and MES by sector - Assets

	Average (M€)	MES (m€)
Agriculture	1,3	410,0
Animal production	1,2	434,4
Forestry and logging	1,9	471,3
Manufacture of wood	1,9	464,3
Manufacture of pulp/paper	19,6	1431,3

	Average	MES
Agriculture	7,6	3
Animal production	4,8	3
Forestry and logging	7,6	4
Manufacture of wood	14,8	7
Manufacture of pulp/paper	45,1	16

back

Estimates of Wildfire on Assets by Sector of Activity: Agriculture, Animal Production and Forestry and Logging - Standard DD Specification

	Agriculture	Animal Production	Forestry and Logging
1.POST	0.083***	0.065***	0.101***
	(0.009)	(0.006)	(0.016)
1.T	0.250	-0.541**	-0.756***
	(0.409)	(0.227)	(0.200)
1.POST#1.T	-0.242*	-0.049	-0.041
	(0.130)	(0.073)	(0.035)
Observations	7,856	9,636	1,580
Number of firms	1,964	2,409	395

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

VARIABLES	<1996	1996-2004	2005-2010	>2010
1.POST	0.026***	0.038***	0.079***	0.339***
	(0.008)	(0.009)	(0.010)	(0.015)
1.T	-0.366	-0.546**	-0.097	-0.443**
	(0.267)	(0.236)	(0.201)	(0.224)
1.POST#1.T	0.000	-0.086*	-0.048	-0.230*
	(0.041)	(0.044)	(0.075)	(0.124)
Observations	9,736	8,448	7,771	13,695
Number of firms	2,435	2,114	1,945	3,429

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

Estimates of Wildfire on Assets - Heterogeneity by Export Status

	Non-exporting	Exporting
1.POST	0.151***	0.108***
	(0.007)	(0.011)
1.T	-0.447***	-0.402
	(0.116)	(0.351)
1.POST#1.T	-0.109**	-0.046
	(0.048)	(0.102)
Observations	36,290	3,360
Number of firms	9,345	1,237

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

Estimates of Wildfire on Workers - Standard DD Specification

VARIABLES	OLS (1)	OLS (2)	OLS (3)	OLS (4)	IV (5)
1.POST	0.031***	0.031***	0.032***	0.032***	0.033***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
1.T	0.091		-0.009	-0.013	-0.012
	(0.111)		(0.020)	(0.020)	(0.020)
1.POST#1.T	-0.067*	-0.067*	-0.067*	-0.084**	-0.094**
	(0.037)	(0.037)	(0.037)	(0.037)	(0.038)
lempli			0.953***	0.951***	
			(0.005)	(0.005)	
lempli_hat					0.986***
					(0.047)
lstart			1.852***	1.487**	2.620
			(0.653)	(0.646)	(1.786)
sland_s				-0.016***	-0.016***
				(0.004)	(0.006)
DID_sland				-0.052	-0.080
				(0.043)	(0.051)
Observations	22,775	22,775	22,775	22,772	22,772
R-squared		0.004			0.890
Number of firms	5,758	5,758	5,758	5,758	
FIRM FE		YES			
SECTOR OF ACTIVITY			YES	YES	YES
DISTRICT			YES	YES	YES
F stat					15.92
Wu-Hausman F stat					0.572
p-values Wu-Hausman F stat					0.450

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

Estimates of Wildfire on Assets - Heterogeneity by Intensity in Land and Buildings

	Agriculture, animal production and forestry		Manufacture of wood	
	Low	High	Low	High
1.POST	0.285***	0.079***	0.131***	0.074***
	(0.016)	(0.009)	(0.020)	(0.012)
1.T	-0.277	-0.227	-0.606*	-0.737*
	(0.231)	(0.306)	(0.318)	(0.441)
1.POST#1.T	-0.198	-0.208***	-0.007	-0.174*
	(0.129)	(0.064)	(0.109)	(0.092)
Observations	10,907	7,952	2,763	1,712
Number of firms	2,733	1,988	693	428

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