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Nobody's Gonna Slow Me Down? The Effects of a Transportation Cost Shock on Firm Performance and Behavior

Abstract

This paper takes a deep and comprehensive look into the firm-level behavioral reactions to a massive transportation cost shock. Exploiting rich data encompassing the universe of Portuguese private firms and a natural experiment we find that the introduction of tolls on previously toll-free highways caused a substantial decrease of turnover and firm profits. In response to the tolls, firms reduced expenses, cutting employment-related expenses and purchases of other inputs in a similar magnitude. Labor costs were reduced by employment cuts rather than by wage cuts. We find evidence for increased firm exit in treated municipalities, but not for increased re-location.

JEL-Codes: R48, L25, R12

Keywords: Road tolls; infrastructure; firm performance; firm behavior; location; Portugal

April 2022

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1 Introduction

Transport infrastructure is key for economic development. Not only does it allow for circulation of people, it is a fundamental piece in the exchange of goods. At the same time, transport infrastructure is rather expensive. Thus, it is essential to understand the relationship between transport infrastructure and economic outcomes in order to adequately design transport policy. Given the importance of this topic, studies on the effect of transport infrastructure on aggregate economic outcomes are quite abundant (Redding and Turner, 2015). However, micro level studies on the effect of transport infrastructure on the performance of firms are rather limited (Holl, 2016).[1] This paper contributes to the literature by taking a deep and comprehensive look into the firm-level behavioral reactions to a massive transportation cost shock. Making use of a unique micro-level data set encompassing the whole universe of Portuguese private firms we rigorously analyze how introducing tolls on previously toll-free highways affects various dimensions of firm performance, and how firms react to mitigate the adverse effects of the transportation cost shock.

Estimating the causal effect of transport infrastructure on economic outcomes is not straightforward, as this kind of infrastructure is usually not randomly assigned. Therefore, it would not be clear if firm-level outcomes are varying due to a change in transportation costs caused by this infrastructure or due to other unobserved characteristics. A common solution in the literature for this endogeneity problem is to use an Instrumental Variable (IV) or the inconsequential places approach (Redding and Turner, 2015). Although less common, some papers alternatively rely on a natural experiment.[2] The latter is exactly what we do in this paper.

The SCUT highway system started being built in 1990 and came into completion in 2008 in Portugal. Portuguese authorities made this network toll free for its users, hence the name SCUT ("**S**em **C**usto para o **Ut**ilizador" or "Without Cost for the User"). One of the main motivations behind its conception was to create an alternative network to the old and deteriorated (municipal) roads. This new and more modern system sought to make travelling safer and a lot faster. By the end of 2008, SCUTs accounted for almost 1000km which was nearly a third of the Portuguese highway grid at that time (Statistics Portugal, 2008).

All of this changed in 2010. At the onset of the European sovereign debt crisis, the Portuguese government was forced to consolidate its financial position, cutting spending and increasing revenues (Financial Times, 2013). Thus, the national budget could no longer sustain the provision of a toll-free network. Tolls were then introduced in two waves, first by the end of 2010 and, then, by the end of 2011.

This event provides a unique setting for a natural experiment, which allows one to study the impact of an exogenous variation of transportation costs on firm related outcomes.[3] This is only possible because tolls were introduced purely out

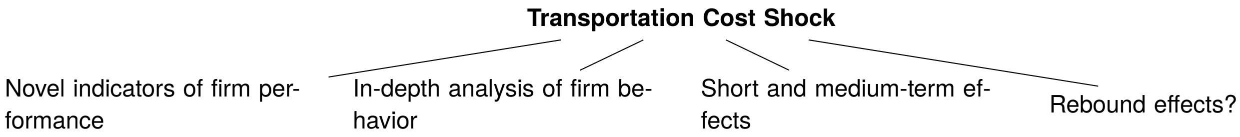
[1]Some studies explore the effect of transport infrastructure on micro-level outcomes, such as: firms' exports (Martincus et al., 2012; Martincus and Blyde, 2013; Martincus et al., 2014, 2017), inventories (Datta, 2012; Li and Li, 2013; Shirley and Winston, 2004), and productivity (Lall et al., 2004; Gibbons et al., 2019; Holl, 2012, 2016; Martin-Barroso et al., 2015; Graham, 2007b,a; Fiorini et al., 2021).

[2]For some examples of papers which also use a natural experiment as source of exogenous variation in infrastructure see Martincus et al. (2014), Martincus and Blyde (2013), and Brooks and Donovan (2020).

[3]In Portugal, the transportation of goods is mainly done through road transports. According to Statistics Portugal (2015), in 2010, 76% of goods were delivered via road transportation. Moreover, there were no changes in the provision or in the capacity of railroads in this period. Municipal roads were also constant in our sample period.

of the necessity to regulate government budget. In other words, this decision was made without special consideration for the firms (or municipalities) in those regions. Two earlier studies have used the same natural experiment in their analyzes to assess the impact of the unexpected introduction of road tolls on road safety and regional economic performance. Pereira et al. (2021) show that the introduction of tolls resulted in the increase of the number of (light) accidents and road injuries, whereas Audretsch et al. (2020) find that it had a negative impact on macroeconomic outcomes (firm numbers and employment) in the affected municipalities. The current paper goes far beyond previous research, making use of a new firm-level micro dataset, encompassing more than 300 000 firms per year. This allows us to investigate the medium-run impact of tolls on a wide array of firm-level performance indicators (including turnover, value-added, productivity, imports, and exports), to analyze firms' adaptation strategies in response to the tolls and to critically assess whether the tolls have induced inter-regional firm migration.

Figure 1: Main contributions of this paper



The paper contributes to the literature in four different ways (see Figure 1). First, it examines the impact of interurban road tolls on a novel and wide array of firm-level performance measures. Second, it goes far beyond existing research by focusing on the behavioral reactions of firms to the transportation cost shock. We analyze firm level reactions on input (goods and labor) markets as well as potential exit and re-location, providing new insights and inferences for policy. Third, the analysis covers a relatively long time period after the introduction of tolls, which allows us to disentangle short-run from medium-run effects. And fourth, the rich firm- level dataset allows us to test the validity of our identifying assumption by checking for potential re-bound effects in terms of increased firm migration to or new firm formation in non-treated regions within Portugal. This is – to the best of our knowledge – also something that has not been done in the literature before.

As the tolls increase firms' transportation costs they can, ceteris paribus, be expected to decrease turnover, to reduce firms' profit margin and to threaten their competitiveness. Decreasing turnover is a likely result for the following reason: assuming that a typical firm pursues a number of projects that can be ordered by decreasing profitability, all projects that yield a profitability larger than or equal to zero are pursued, whereas projects with (expected) negative profitability are cancelled. The rapid increase in transportation costs renders some projects that were profitable before the introduction of tolls non-profitable. As a consequence, a reduced number of projects is pursued and turnover decreases. Moreover, we expect profits to decrease as the number of profitable projects goes down and the profit margin of the remaining projects is further decreased. The expected effect of the tolls on value-added and labor productivity are less clear-cut. A decrease in turnover tends to decrease value-added, but this could be compensated by firms reducing their purchase of inputs or intermediary products. Likewise, a decrease in turnover tends to decrease labor productivity, but this could be compensated by a reduction of labor input (employment). There are several channels by which firms could react to the transportation cost shock. In order to stay competitive and to not lose too many customers, a possible behavioral reaction is that firms try to cut their other (not transport-related) expenditures. These other expenditures relate to inputs of goods and services as well as labor costs. Moreover, the firms most strongly affected by the transportation cost shock could exit the market or re-locate to other (less-affected) municipalities within Portugal.

Our findings provide important insights into the various firm-level effects and behavioral responses to a massive transportation cost shock that are new to the literature. We find that the introduction of tolls caused a 10.7% decrease of turnover in firms located in affected municipalities *vis-à-vis* firms in the remaining areas. Other measures of firm performance, such as profits and value added, reduced by more than 16.3% and 12.2% in these areas, respectively. By contrast, labor productivity was not significantly affected, a possible interpretation being that those firms that stayed in the market managed to remain competitive in terms of productivity by reducing their sales output and by accepting lower profits. Domestic turnover and exports to the European Union (EU) declined sharply, whereas exports to the rest of the world were not significantly hit.

With respect to firm behavior, we find a significant cut of total expenditure. This expenditure cut affects employment-related expenditures in a similar order of magnitude (about 7%) as other input-related expenses. Domestic purchases and imports from the EU were stronger reduced than imports from the rest of the world. Taking a closer look at labor input, we find that firms cut wage costs mainly by reducing employment rather than by cutting wages, which can be explained by the strong downward wage-rigidity in Portugal. Full-time employees suffered more from the employment cuts than part-time employees. In addition, we find increased exit of firms in treated municipalities. The majority of effects for all these outcomes are short- to medium-term, i.e., still persistent six years after the introduction of tolls. Testing the validity of our identifying assumption we find no evidence for increased firm migration to or increased firm formation within regions not (or less) affected by the treatment.

The rest of the paper is structured as follows. Section 2 presents a brief literature review and Section 3 details the institutional background. Section 4 presents the data and discusses the methodology and possible identification threats. Section 5 shows how the tolls affected key measures of firm performance whereas Section 6 presents and discusses firm-level responses to the transportation cost shock. Section 7 tests our identifying assumption by shifting the focus to potential rebound effects in terms of firm migration to or higher firm formation rates within municipalities that are not (or only indirectly) affected by the treatment. Section 8 concludes.

2 Literature Review

The majority of research on the economic impact of infrastructure provision and pricing focuses on the macro (country or region) level and looks at macroeconomic variables. Some of the most prominent papers study the impact of transport infrastructure on: population growth (Baum-Snow, 2007; Baum-Snow et al., 2017; Michaels et al., 2012; Garcia-López et al., 2015), aggregate trade (Duranton et al., 2014; Storeygard, 2016; Donaldson, 2018), and GDP/ aggregate income (Banerjee et al., 2012; Faber, 2014; Jaworski and Kitchens, 2019).[4] However, studies carried out at aggregate levels of analysis provide little insights in the actual mechanisms by which improvements or deterioration of infrastructure affect firm performance (Haughwout, 2002). Moreover, these studies ignore mobility of firms and responses to local price changes caused by modifications in infrastructure provision and pricing (Holl, 2006).

Given the above, researchers have begun to analyze the effects of transportation infrastructure on firm level performance variables. Holl (2012) investigates the influence of transportation infrastructure on firm-level productivity through its effects on market potential in Spain, finding that growth of market access has a positive impact on firm-level output growth. Holl and Mariotti (2018) use detailed geo-referenced data to study the effects of highway development on firm level performance in the Spanish logistics sector. They find that highways have significant implications for logistics' firm performance, although with important spatial heterogeneity. While improved highway access increases the productivity performance of urban logistics firms, the impact on productivity growth of rural logistics firms that remain outside of highway corridors is found to be negative. Gibbons et al. (2019) estimate the impact of new road infrastructure on employment and labor productivity using firm level longitudinal data for Britain. They measure exposure to transport improvements through changes in accessibility and find that improved accessibility increases output per worker, wages, and use of intermediate inputs for existing establishments. Several (recent) studies suggest that infrastructure provision positively affects firm performance in a developing country context. Chauvet and Ferry (2020) investigate the relationship between taxation and firm performance in developing countries, finding that taxation benefits firm growth in developing countries, especially in lower-income countries, through the financing of public infrastructure. Barzin et al. (2018) estimate the effect of roads on firms' output growth in Colombia, finding elasticities of output with respect to road infrastructure ranging from 0.13% to 0.15%, which is clearly larger than what is found in comparable work for developed countries.

While the recent literature has made substantial progress in addressing the possibility that infrastructure and transportation costs are not assigned to regions randomly,[5] the majority of research is unable to distinguish between growth (or decline) and reorganization of economic activity. As Gibbons et al. (2019) put it, "In common with all empirical work that estimates causal effects from statistical comparisons across time and place, it is impossible to know for sure whether these employment increases are additional to the economy as a whole" (Gibbons et al. (2019), p. 45). However, as is well-known since the seminal paper by Fogel (1964), the assessment of the economic impact of infrastructure depends critically on whether transport cost changes the level of economic activity or just leads to a reorganization (or relocation)

[4]A related line of research deals with the impact of transport infrastructure and transportation costs on spatial structure (Baum-Snow, 2020; Behrens et al., 2018).

[5]The most recurrent strategy found in the literature to solve this problem is the use of an instrumental variable. According to Redding and Turner (2015) the use of instrumental variables in this literature can be categorized into three main strategies: planned route IV (Baum-Snow, 2007; Michaels, 2008; Michaels et al., 2012; Hornung, 2015; Jedwab and Moradi, 2016; Mayer and Trevien, 2017; Möller and Zierer, 2018), historical route IV (Duranton and Turner, 2011, 2012; Duranton et al., 2014; Hsu and Zhang, 2014; Garcia-López et al., 2015; Percoco, 2016; Baum-Snow et al., 2017; Martincus et al., 2017; Agrawal et al., 2017), and the inconsequential place approach (Chandra and Thompson, 2000; Banerjee et al., 2012; Datta, 2012; Faber, 2014; Ghani et al., 2016; Fretz et al., 2022; Ahlfeldt and Feddersen, 2018). An attractive alternative to these standard approaches is the use of natural experiments (Bröcker et al., 2019).

of existing activity. Quite obviously, the welfare implications of a new road that creates new firms and employment are quite different than those that just lead to a re-location of pre-existing economic activity (Redding and Turner, 2015).

The same is true for the economic effects of road tolls. If the tolls lead to a deterioration of economic activities (losses in value added, employment etc.) this is – from an overall economic point of view – quite different from a mere relocation of economic activities to other (less or non-affected) regions. We know from the pertinent literature that such relocation effects can be quite substantial. Duranton et al. (2014), who investigate the effects of within-city motorways on intercity trade within the US, find that the main effect of within-city highways is to relocate economic activity, and not to create it. Besides Chandra and Thompson (2000), who study the effects of access to the US interstate highways system in rural counties, find that access to these highways increases firm earnings in treated counties mainly at the expense of their untreated neighbour counties. It is thus important to not only tackle the endogeneity problem, but also to check for indirect (rebound) effects in the regions that are not or only indirectly affected by the tolls. Our experimental design and our rich firm-level data base that contains information about movement of firms allows us to do both: the natural experiment creates quasi-exogeneity of the introduction of tolls and the rich firm level dataset allows us to examine whether the firms respond to the tolls by migration to other (less or non-affected) regions in Portugal.

3 Institutional Background

Since joining the EU in 1986, Portugal invested substantial resources to close the gap with the core of Europe in terms of road infrastructure (Fernandes and Viegas, 1999; Melo et al., 2021).[6] The large scale of public funding allocated to transportation infrastructure and the rapid development of the Portuguese highway system makes Portugal an ideal case study to examine the economic effects of transportation infrastructure and has triggered a lot of important and insightful research (see, for instance (Holl, 2004; Pereira and Andraz, 2005; Audretsch et al., 2020; Melo et al., 2021; Rocha et al., 2021). During the 1990s, however, these investments became a heavy financial burden. The need to guarantee the necessary funds without breaching the EU rules on member state budget deficits spurred the cooperation with private enterprises through public private partnerships (PPPs) to expand and operate road infrastructures (Fernandes et al., 2005). In 1997, a new kind of PPP scheme was introduced: a system of modern, toll-free highways, the so-called SCUTs (acronym for "Sem Custos para o Utilizador"/without costs for the users).[7] Private investors were ensured a long-term rent paid by the central government budget based on the traffic volume and operation standards (Sarmento, 2010).[8]

The SCUT highways were constructed between 1990 and 2008 at a cost of about 3 billion Euro, and cover nearly 1000 km, i.e., about one-third of the total Portuguese highway system. This new PPP scheme allowed for a swift

[6]By 2017, Portugal had the fifth highest motorway density relative to population in the EU (Rocha et al., 2021).

[7]According to the Court of Accounts, these projects were financed essentially through loans from commercial banks (45%), the European Investment Bank (40%), and equity (12%). Fernandes et al. (2016) compute that the financing costs of SCUT highways are, on average, 370 basis points above the cost of raising public debt. Moreover, they argue that the transaction costs (which include banking fees and diligence costs and the impact of all cash distribution traps, such as reserve accounts or minimum-level of debt ratios) account for around 40% of that financial premium.

[8]The same rationale can be found, for example, in the UK, Spain, and Australia.

expansion of the highway system in Portugal at low initial costs for the public sector, and helped cut average travel time between Lisbon and the Spanish border (as well as between the capital and some areas) by more than 40%. However, these large investments also generated a severe pressure for the country's budget over the next 25-30 years (Sarmento, 2010; Santos and Santos, 2012).

In the course of the European sovereign debt crisis, the financial strain on the central budget became so tough that the Portuguese authorities had no choice but to enforce sizeable tolls on the formerly toll-free SCUT highways. As the Financial Times wrote, "To help keep Portugal's 78bn bailout on track, the government has been forced to introduce charges on more than 900 km of roads where there was previously none" (Financial Times of 25 August 2013). When the tolls were established in 2011, the price was 9 cents/km for cars, which was significantly higher than for the other highways (Audretsch et al., 2020) – and the cost increase for larger vehicles was even more substantial. In 2010, the President of the National Association of Public Road Transporters of Goods (ANTRAM) stated that the owner of a truck that circulated daily in the areas of the newly-tolled SCUT highways could face a monthly cost increase in the order of 2,500 euros.[9] This massive cost increase had a substantial adverse impact on traffic and implied that many commercial users shunned the SCUT highways and increasingly used slower alternative options such as municipal roads. According to a study by the Institute for Road Infrastructures, traffic along the SCUT highways decreased substantially between the first quarter of 2011 and the first quarter of 2012. There were no noteworthy congestion cases on the SCUTs highways when tolls were introduced (INIR 2011). This shock was purely driven by financial reasons and did not consider local conditions. The mayors of the SCUTs regions were against the introduction of tolls (even those who belonged to the same party as the national government), and there were massive protests from the local populations.[10]

With the improvement of the financial conditions, and in reaction to the decrease in traffic and the widespread criticism in the public, the new Portuguese Socialist government decided to cut back the tolls on SCUT highways by 15% from 1 August 2016 onwards. This decision was supported by a report from the public entity responsible for managing the road infrastructure that estimated that decreasing the tolls by 15% would increase public revenues.[11]

4 Data and Empirical Approach

4.1 Data and variables

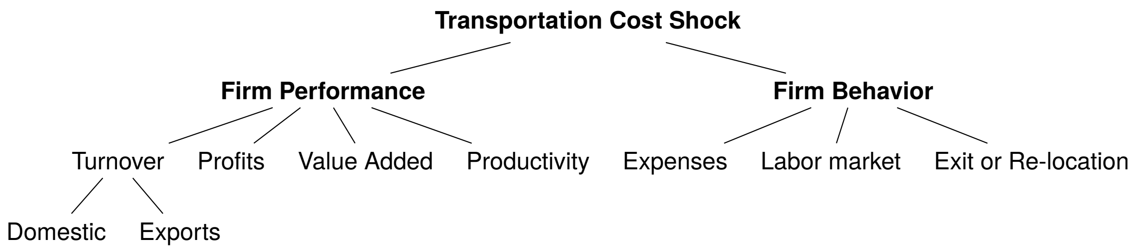
We combine several datasets. The firm-level information comes from the *Central Balance Sheet*, and is harmonised and provided to researchers by *Banco de Portugal*.[12] It consists of a wealth of economic and financial information on virtually all private non-financial firms in the country (such as financial balance sheet indicators, location, number of

[9]Source: https://cnnportugal.iol.pt/economia/camioes/scut-portagens-custam-2-500-euros-por-mes-a-cada-camiao.
[10]See, for instance, https://www.jornaldenegocios.pt/empresas/transportes/detalhe/parlamento-rejeita-fim-das-portagens-na-via-do-
[11]See, for instance, https://www.tsf.pt/economia/descer-portagens-nas-antigas-scut-e-bom-negocio.html.
[12]The data in this database is collected through *Simplified Business Information (IES - Informação Estatística Simplificada)* since 2006. *IES* is an annual report that must be filled online by firms. This report is mandatory and non-compliants are penalized. The quality of this data is then monitored by Statistics Portugal who check with respondents on a regular basis.

employees, size, among other indicators). This is quite an extensive dataset comprises 554,497 firms during the period of 2006-2016, amounting to a total of 3,680,060 firm-year observations.[13] Note that it is an unbalanced dataset, as not all firms have observations for all the years in this period. Additionally, only firms in Portugal mainland were considered, hence corporations from Madeira and Azores are not part of the analysis.

This unique micro dataset enables us to perform an in-depth analysis of the effects of a sharp and unexpected increase in transportation costs relying on a variety of firm-level outcomes to shed light on different mechanisms. Figure 2 illustrates the different dimensions of firm performance and firm behavior that we study in this paper.

Figure 2: Dimensions of firm performance and firm behavior analyzed in this paper



In Section 5, we consider four key indicators of firm performance. Turnover is defined as the amount of sales of goods and services after any allowances, discounts, and returns are considered. Our measure of profitability – EBT or taxable income – is defined as earnings before taxes, but after interest payments, depreciation, and amortisation. Value added is the value of output minus the value of intermediate consumption and labor productivity is value added divided by the number of employees.

In addition, we assess whether domestic turnover or international trade were most affected by the increase in highway tolls. We distinguish between the turnover destined to the domestic market and exports, separating those from the European Union (EU) and the rest of the world. We further investigate how the tolls affected export propensity.

In Section 6, we investigate different dimensions of firm behavior in response to the transportation cost shock. We start by examining how firm expenses (net of interest payments, taxes, and depreciation) changed after the shock. In addition, we distinguish between wage-related expenses (considering not only transfers to the workforce, but also social security and insurance payments) and other expenses. Among those, we analyze the costs associated with goods purchased and material consumed and with supplies and external services. Furthermore, we look into the origin of purchases, devoting attention to the extensive and the intensive margins of importing, as well as the division between the EU or extra EU origin.

We then focus on labor input and study, in particular, how firms managed to cut temporary and permanent employment in response to the shock.

Finally, we consider the behavior of firms according to other margins of adjustment. We inspect if entrepreneurs

[13]This corresponds to the total number of observations after dropping firms with no municipality reported, non positive levels of turnover, and non positive number of employees. This last drop is meant to eliminate cases of self-employment from the sample.

decide to exit from the market in response to the increased costs. Moreover, this rich dataset further allows us to follow the location of firms across time.[14] Hence, we are able to observe if firms tried to mitigate or circumvent the effects of the treatment by moving to municipalities less affected by the rapid transport cost increases.

We complement the firm-level data with administrative municipal information, for all the 278 mainland municipalities, which allows us to control for time-variant covariates. Local socio-demographic characteristics, such as the population density and the age dependency ratio, were gathered from Statistics Portugal. Moreover, information on per capita electricity consumption was retrieved from *Direção Geral de Energia e Geologia* (DGEG) and data on municipal expenditures was acquired from *Direção Geral das Autarquias Locais* (DGAL) to proxy for the wealth of the region.

Table 1 presents the descriptive statistics on the firm- and municipal-level variables used in this study.

4.2 Empirical Strategy

The validity of our strategy relies on the fact that the introduction of tolls on SCUT highways was forced by an exogenous shock (the sovereign debt crisis) upon the Portuguese political authorities. Being a national matter, municipal authorities played no role in this decision nor were they able to directly intervene.[15] At the same time, there was no discrimination nor favoritism towards these municipalities.[16]

The effect of an increase in transportation costs on outcome y is estimated using the following difference-in-differences specification for unit of analysis firm f, in municipality m, NUTS 2 or NUTS 3 region n, and year t, during the period 2006-2016, according to:

$$y_{fmnt} = \alpha_f + \delta_m + \lambda_{nt} + \gamma Treated_m \times PostPeriod_{mt} + X^{'}_{mt}\beta + \epsilon_{fmnt} \quad (1)$$

where α_f denotes firm fixed effects, δ_m municipality fixed effects, and λ_{nt} represents NUTS 2 (or NUTS 3) $\times$ year fixed effects. The coefficient of interest is γ as it gives us the treatment effect. $Treated \times PostPeriod$ represents the interaction between the $Treated$ dummy and the $PostPeriod$ dummy.

Outcome variables y can either be integers, shares, or binary indicators. In the case of integers, we use the inverse hyperbolic sine transformation. This technique approximates the natural logarithm of that variable, but presents an important advantage as it allows retaining zero or negative-valued observations (Bellemare and Wichman, 2020).[17] When the outcome variable is a binary variable, we compute a linear probability model.

We define treatment as the introduction of tolls in the SCUT highways.[18] As such, municipalities are divided into a

[14] An important limitation of this strategy is that we are not able to observe if the *same* entrepreneur decides to close a firm in a given municipality and open a *different* firm in another area.

[15] Even though, there were huge protests made by SCUT highway users and local mayors, they had no saying in this decision. (See https://www.jornaldenegocios.pt/empresas/transportes/detalhe/municipios_e_utentes_perdem_accoes_contra_portagens)

[16] Audretsch et al. (2020) show that there was no political attempt to favor municipalities aligned with the parties in central government.

[17] A previous version of this paper used log(y+1) to deal with zero-values. All the results using that method are remarkably similar to those we present in this paper and are available from the authors upon request.

[18] Audretsch et al. (2020) and Pereira et al. (2021) use a similar identification strategy.

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.
Treated	0.244	0.430
Firm Performance		
Turnover	885.095	21389.33
Profits	40.128	6361.093
Value Added	202.454	4266.332
Labor Productivity	18.241	1352.733
Turnover – Domestic	721.677	17516.630
Prob of Export	0.143	0.350
Exports	163.418	7191.246
Exports – EU	112.061	4667.122
Exports – extra EU	51.356	3685.152
Firm Behavior		
Total Expenses	866.954	21218.280
Employee Expenses	126.232	1747.205
Costs of goods and materials consumed	478.686	17409.970
Supplies and external services	215.037	4711.432
Purchases – Domestic	330.613	10959.950
Prob of Import	0.157	0.363
Imports	153.669	10916.240
Imports – EU	124.281	9344.458
Imports – extra EU	29.388	5357.542
Average Wage	9.812	8.926
Paid Employment	7.351	81.992
Full-Time Paid Employment	7.602	73.104
Part-Time Paid Employment	0.690	27.800
Prob of Exit	0.033	0.133
Prob of Re-location	0.018	0.134
Municipal-level outcomes		
Number of firms	1203.421	3018.726
Number of start-ups	66.913	162.041
Controls		
Population density	1717.197	2131.935
Age dependency ratio	0.534	0.095
Electricity consumption per capita	4.880	3.421
Municipal expenses per capita	0.507	0.235

Notes: All monetary values in thousands of euros.

treatment group and a comparison group. All municipalities that have a segment of the SCUT highway network belong to the treatment group. These amount to 59 municipalities in the treatment group and 219 in the comparison group.[19] Note that municipalities in the comparison group can have other (non-SCUT) highways. However, it is important to point out that these other highways were already subject to charges a long time before the European sovereign debt crisis and that these charges remain unchanged by the shock. $Treated$ variable thus takes the value one for municipalities

[19] In Table A.1, there's a list with the municipalities which were affected by this shock and in Figure A.1, there's a geographical display of these municipalities.

in the treatment group and zero otherwise.[20]

Regarding the treatment period, it is important to highlight that, in some treated municipalities, tolls were introduced on the 15^{th} of October 2010 while in others, this happened on the 8^{th} of December 2011. However, there were important anticipation effects suggesting that these areas expected that they would be eventually treated.[21] Accordingly, we define $PostPeriod$ as a binary indicator that equals one from 2011 onwards. Recent developments in the difference-in-differences literature discuss challenges in designs that exploit staggered treatments (Goodman-Bacon, 2021; Athey and Imbens, 2022). In this paper, we do not face these problems. In fact, Callaway and Sant'Anna (2020) and Borusyak et al. (2021), *inter alia*, discuss the importance of properly considering possible anticipatory effects.

For all the main variables, we show that results are robust when we substitute the NUTS 2 by NUTS 3 $\times$ year fixed effects and include a vector of time-variant municipal-level controls X'_{mt}. To take into account the socio-demographic characteristics, we include the age dependency ratio, population density, electricity consumption per capita, and municipal expenses per capita to control for municipal income.[22]

Robust standard errors are clustered at the municipal level to correct for heteroskedasticity and autocorrelation, since treatment varies at this level (Bertrand et al., 2004). However, a few firms change municipality during the period under study. Therefore, the municipality at the time of the treatment was used to cluster the standard errors, i.e., the location of the firm in the year 2009 just before the treatment. For firms that do not have an observation for this year (since this is an unbalanced panel), the location of the firm at the time it first appears in the sample was used.

In some specifications, namely when we test if start-ups react to the introduction of tolls in SCUT areas, we aggregate firm-level data into municipal-level outcomes. In those cases, we estimate a regression as follows:

$$y_{mnt} = \delta_m + \lambda_{nt} + \gamma Treated_m \times PostPeriod_{mt} + X'_{mt}\beta + \epsilon_{mnt} \tag{2}$$

where all variables are defined as before.

4.3 Identification threats

The internal validity of a difference-in-differences estimation model relies on the parallel trends assumption (Angrist and Pischke, 2008). This assumption states that in absence of treatment, the average outcome of the treatment group would have changed in a similar trend as the average outcome of the comparison group. For a careful test on the validity of the parallel trends assumption, we rely on event study designs for the main outcome variables. An event study has two main advantages. First, it allows us to observe whether the strength of the treatment varies with time. Second, it provides a more rigorous test on whether the common trend assumption holds in the pre-treatment periods (i.e., 2006-2009 in our sample). The estimating equation for the event study of firm f, in municipality m, NUTS 2 region n, and year t is:

[20] We relax this assumption by constructing a continuous distance decay function of treatment in a robustness test.

[21] See, for example, https://www.publico.pt/2010/06/30/politica/noticia/governo-propoe-portagens-nas-outras-scuts-a-partir-de-201

[22] We acknowledge that controlling for municipal level covariates could also be problematic, as they can also respond to the treatment (Sant'Anna and Zhao, 2020). Nevertheless, the results are remarkably similar with and without these controls.

$$y_{fmnt} = \alpha_f + \delta_m + \lambda_{nt} + \sum_{t=2006}^{2009} \psi_t Treated_m \cdot Year_t + \sum_{t=2011}^{2016} \psi_t Treated_i \cdot Year_t + \epsilon_{fmnt} \quad (3)$$

and all variables are defined as before. The coefficients of interest are ψ, capturing the dynamic effects of the treatment, before and after the introduction of tolls in SCUT highways. Notice that, in Equation (3), the interaction terms for all pre- and post-treatment years are included, except for 2010. This way, all the coefficients are estimated relative to the last pre-treatment year.

Another threat to our identification strategy arises if there are any other contemporaneous shocks than the treatment occurring during the time period under analysis. In this study, our time period includes one of the greatest recessions in recent history, forcing the Portuguese government to request an international bailout. Given that this crisis might have affected municipalities differently, region-year fixed effects, either at the NUTS 2 or NUTS 3 levels, are used to mitigate this problem.[23] On top of this, we also include a rich vector of municipal-level yearly controls, in some specifications, to take into consideration the socio-demographic and the economic context of these regions.

A further confounding factor is the existence of potential spillover effects. It can be that firms in treated areas decide to re-locate. As mentioned, we specifically address this issue in Sections 6.3 and 7.

To further mitigate possible identification threats, we perform several robustness checks discussed in the next subsection.

4.4 Robustness and Heterogeneity

We perform a battery of robustness checks and exploit the heterogeneity in our sample to shed light on the mechanisms driving our results. Regarding the robustness tests, we show whether our findings hold if we exclude *i)* firms in the municipalities of the Lisbon metropolitan area; *ii)* firms in the 18 district capitals.[24] In the first exercise, we remove from our sample firms that are located in the more urban comparison areas. The second exercise is inspired by the inconsequential place approach, described in Section 2, where we drop from our sample the most important cities in each area (district capitals). For the remaining (minor) cities located close to a major transportation infrastructure, it can be argued that they happen to be "accidentally" located between two important agglomeration local centres. These specifications present the additional advantage that they exclude most of the outliers (e.g., bigger firms) that are located in more urban regions. In two additional exercises, we focus *iii)* on single establishment firms (which account for more than 95% of firm numbers), and *iv)* we relax the assumption that all municipalities are either treated or non-treated. We do it by considering a distance decay function from the address of the town hall of each of the 278 municipalities to

[23]Moreover, Tavares and Pereira dos Santos (2018) show that the allocation of European funds is important for business firms dynamics in Portugal. Since this allocation is done at the NUTS2-level, using regional-year fixed effects can help accounting for this effect.

[24]In 2003, the Portuguese municipalities were allowed to organize themselves into inter-municipal communities and the two metropolitan areas of Lisbon and Porto. Since then, administrative, financial, and political competencies have been transferred to these entities. Districts in mainland Portugal still serve as a basis for electoral constituencies.

the closest SCUT highway computed using geographical information system techniques. Therefore, we rely on a more continuous treatment assignment: this variable takes values close to one for treated municipalities and closer to zero the further away a municipality is from the next SCUT highway. More details are presented in Appendix C.

To take into account potential effect heterogeneity, we divide the universe of Portuguese private firms between tradable and non-tradable, and between manufacturing and service sectors. In principle, firms in tradeables sectors and in manufacturing may be more strongly affected by the tolls than firms in non-tradeables and services sectors as they tend to be, on average, more reliant on transportation.

5 Firm performance

We start by analysing the impact of the introduction of tolls on previously toll-free highways on four key indicators of firm performance in Section 5.1. In Section 5.2 we take a deeper look into the destination of sales (i.e., to the domestic market or to the export market), and analyze which markets were most strongly affected by the tolls.

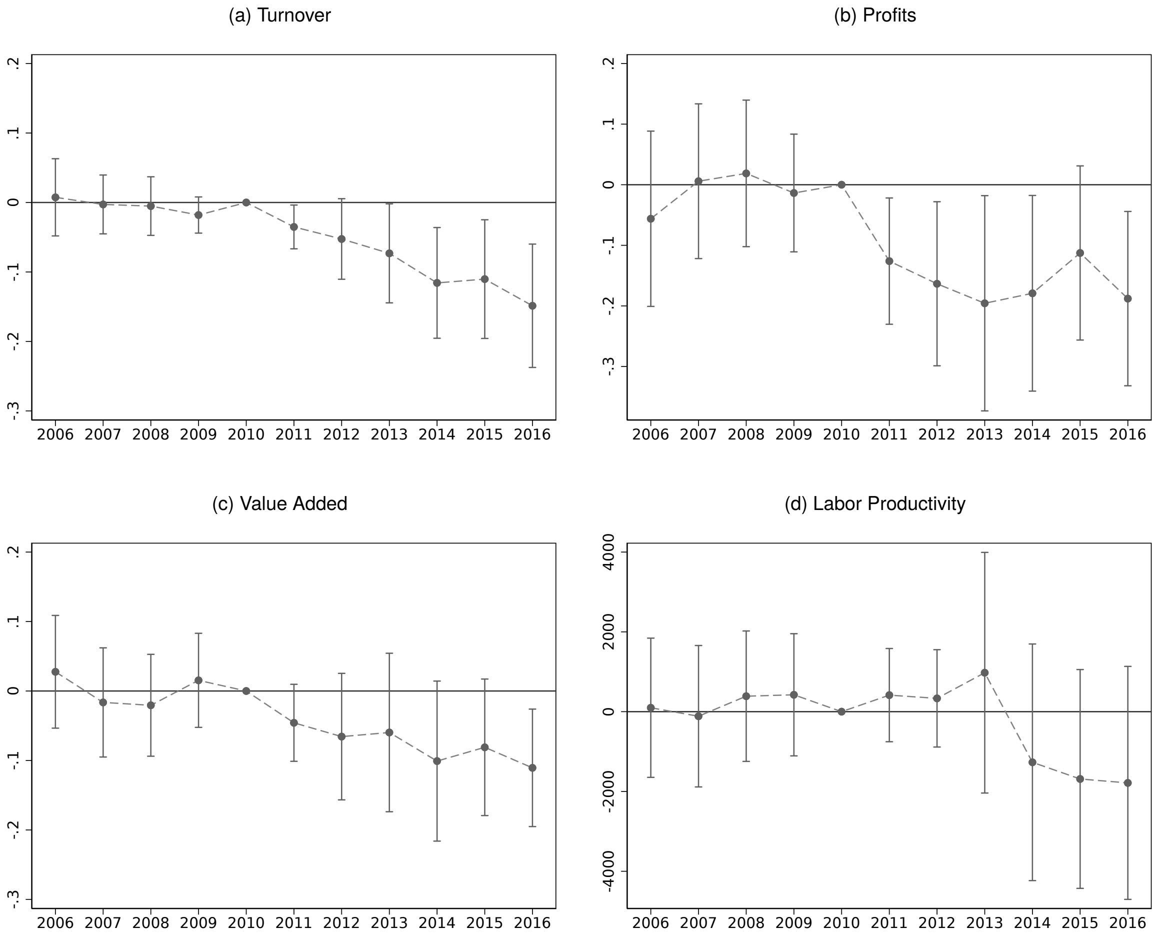
5.1 Turnover, Profits, Value Added and Productivity

We present the event study estimates for four key outcome variables, computed as in Equation (3), in Figure 3: firm turnover (in panel a), profits (in panel b), value added (in panel c), and labor productivity (in panel d). For all these indicators, our results corroborate the parallel trends assumption, suggesting that there are no significant differences between the treatment and the comparison group in the years 2006-2009 before the treatment set in. We find that firms in treated municipalities, when compared with firms in comparison areas, experienced a significant reduction in their turnover and profits. Furthermore, value added and labor productivity decreased in treated areas after the transportation shock, but results are only statistically significant for value added in 2016.

The event study results are confirmed in the difference-in-differences specifications, estimated using Equation (1), and presented in Table 2. On top of showing the results with Nuts 2 $\times$ year fixed effects, we underline that they are robust (and more precise) when we consider a more demanding specification with Nuts 3 $\times$ year fixed effects and a vector of time-variant municipal controls. We find that firms located in treated municipalities experienced, on average, a decrease of 7.9% in turnover *vis-à-vis* firms located in comparison regions when we consider the specification in column (1) and 10.7% when we consider the specification in column (2). Importantly, profits are similar in both specifications and decreased by 15.3% (in column 3) and by 16.3% (in column 4), on average. Moreover, value added deteriorated by around 12% (in column 6). Finally, we observe a reduction in labor productivity, although non-statistically significant (columns 7 and 8).

Overall, we find that the tolls led to a medium-term decrease in firm output (turnover) and firm profits, whereas labor productivity was not significantly affected. We interpret these findings in the following way: assuming that each firm pursues a number of projects that can be ranked by (expected) profitability, the rapid increase in transportation

Figure 3: Event Studies – Firm Performance



Notes: The first three variables are measured using the inverse hyperbolic sine transformation. Graphs were computed with Firm, Municipality, and NUTS 2 × Year fixed effects. The 90% confidence levels are calculated using clustered standard errors at the municipal level.

costs renders some projects non-profitable. As a consequence, a reduced number of projects is pursued and turnover decreases. Firm profits decrease, on average, because the number of profitable projects decreases and the profit margin of the projects still pursued shrinks as well.[25]

The results are robust to limiting the influence of outliers by winsorization of the outcome variables at the 90th percentile and to an alternative logaritmic specification, as can be seen in Table AR.1 in the Appendix. Moreover, removing firms in municipalities in the Lisbon metropolitan area and in district capitals from the sample, as shown by Table AR.2 in the Appendix, does not change baseline conclusions. These results also hold if we only consider single establishment firms and an alternative continuous measure using a distance decay function from the town hall address to the closest SCUT highway, as displayed in Table AR.3. Lastly, results seem to be heterogeneous across firms since

[25]Some of the higher costs might be passed on to consumers, but it is highly unlikely that consumer demand is completely price-inelastic.

Table 2: Firm performance deteriorated with the introduction of tolls

	Turnover		Profits		Value added		Labor Productivity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Treated \times Post$	-0.079*	-0.107***	-0.153*	-0.163**	-0.075	-0.122**	-512.689	-380.933
	(0.043)	(0.037)	(0.082)	(0.083)	(0.054)	(0.059)	(1,155.294)	(1,858.985)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	No	Yes	No	Yes	No	Yes	No
NUTS 3 $\times$ Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Controls	No	Yes	No	Yes	No	Yes	No	Yes
R^2	0.607	0.607	0.451	0.451	0.547	0.54 7	0.214	0.215
$N \times T$	3,635,121		3,635,021		3,635,110		2,826,431	

Notes: Standard errors in parenthesis are clustered at the municipal level. The first three variables are measured using the inverse hyperbolic sine transformation. The vector of socio-demographic and economic controls includes electricity consumption per capita, age dependency ratio, population density and municipal expenses per capita. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

the shock affects tradable sectors more than nontradable sectors (see Table AH.1 in the Appendix) and the profits in the manufacturing sector more than in the services sector (see Table AH.2 in the Appendix).

5.2 Destination of turnover: which markets are affected?

It is not a priori clear if sales to domestic markets should be more or less affected than sales to foreign countries by the transportation cost shock in Portugal. On the one hand, SCUT highways connect several locations in Portugal. On the other hand, some of these highways are the most important routes to Spain. Moreover, it is a well-known stylised fact that exporting firms usually constitute a small share in their own industry. They also tend to be larger and more productive than their domestic counterparts (Melitz, 2003). Hence, they may be more robust to adverse shocks.[26]

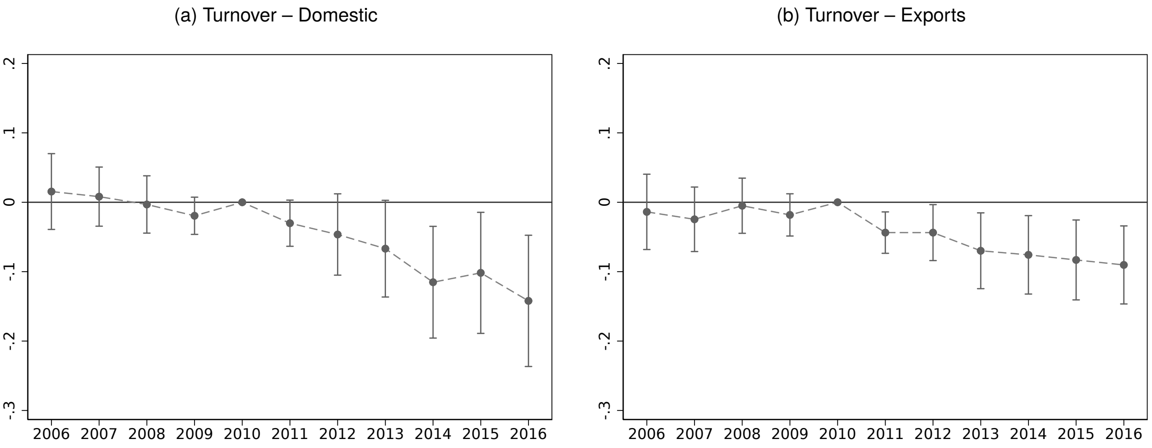
The results of estimating Equation (3) are presented in Figure 4 for domestic turnover (in panel a) and exports (in panel b). For both outcomes, we find evidence suggesting that the parallel trend assumption holds. Importantly, our results show an increasing deterioration with persistent effects for firms in SCUT regions. The decrease in exports sets in directly after the introduction of tolls, whereas the decrease in domestic turnover comes with a time lag of three years. However, the long-run decrease in domestic turnover is stronger than the decrease in exports.

We further decompose these effects computing difference-in-differences regressions as in Equation (1). Our findings are displayed in Table 3. Recall that, in Table 2, we showed that total turnover decreased by 10.7%.

First, we analyze the impact on turnover that is destined to the domestic market. We find that firms subject to this shock experienced a decrease in turnover from internal market by 7.7% (in column 1) and by 10.6% (in column 2) when we consider a more demanding set of fixed effects and a vector of time-variant municipal-level controls.

[26] In Portugal, Bastos and Silva (2010) demonstrate that, controlling for distance, exporters in 2005 charged higher prices for goods sold to richer destination markets within narrow product categories. Moreover, Bastos et al. (2018) show that exporting to richer countries leads Portuguese firms to pay higher prices for inputs, raising the average quality of goods they produce.

Figure 4: Event Studies – Turnover by destination



Notes: Outcome variables are measured using the inverse hyperbolic sine transformation. Graph computed with Firm, Municipality, and NUTS 2 × Year fixed effects. The 90% confidence levels are calculated using clustered standard errors at the municipal level.

Second, we focus on the extensive and intensive margins of selling abroad. Our results clearly suggest that the introduction of tolls did not impact the probability of firms to enter export (in column 3). However, the same is not true for the intensive margin. When we look into exports, we observe that the exports of treated firms decreased by 5.4% (in column 4) relative to the comparison group. The results are, however, non-significant in a more demanding specification when we include Nuts 3 × year fixed effects and municipal controls.

Finally, we go one step further to separately analyze the exports destined to the EU market and the ones destined to the rest of the world. One can see that exports to the EU area (in column 6) were significantly hit while no significant effect was found for the ones directed to the non-EU market (in column 7). More precisely, exports to the EU decreased by 6.7% for firms in treated areas. The results obtained for the sales to the EU and the internal market can be explained by the heavy dependence of these two markets on road transportation.

Regarding the EU market, it is important to highlight that Spain is one of the main trading partners of Portugal[27] and Portugal's gate to the rest of the EU. As mentioned, some of the affected highways are the most important roads to Spain, and Spain's proximity to Portugal makes trade between these two countries particularly dependent on road transportation. By contrast, a large part of Portugal's exports to the "rest of the world" is transferred by ship and thus relatively less dependent on road transport than Portugal's trade with the EU. This could possibly explain the stronger decrease in exports to the EU market.

These results are robust to the winsorization or to a logarithmic transformation of outcome variables, and to the exclusion of all firms in the Lisbon metropolitan area and in district capitals. They are also robust to restricting the sample to single establishment firms, and replacing the binary indicator for treatment for a distance decay function. This can be seen in Table AR.4, Table AR.5, and in Table AR.6 in the Appendix. However, the impact on exports are

[27] In 2010, Portugal's exports to Spain accounted for 32% of the total exports made to the EU area.

Table 3: Sales to domestic and foreign EU consumers were affected

	Domestic		Prob of Export	Exports		EU	extra EU
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Treated \times Post$	-0.077*	-0.106***	-0.004	-0.054*	0.005	-0.067**	0.022
	(0.044)	(0.035)	(0.003)	(0.031)	(0.027)	(0.030)	(0.018)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	No	Yes	Yes	No	Yes	Yes
NUTS 3 $\times$ Year FE	No	Yes	No	No	Yes	No	No
Controls	No	Yes	No	No	Yes	No	No
R^2	0.615	0.615	0.654	0.721	0.721	0.718	0.664
$N \times T$	3,635,121		3,635,121	3,635,121			

Notes: Standard errors in parenthesis are clustered at the municipal level. The vector of socio-demographic and economic controls includes electricity consumption per capita, age dependency ratio, population density and municipal expenses per capita. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

less precisely estimated and are not statistically different from zero in these specifications. Lastly, heterogeneity results highlight that negative effects are concentrated in the tradable sectors (in Table AH.3 in the Appendix). We do not find large differences between manufacturing and service firms (in Table AH.4 in the Appendix).

6 Firm behavior

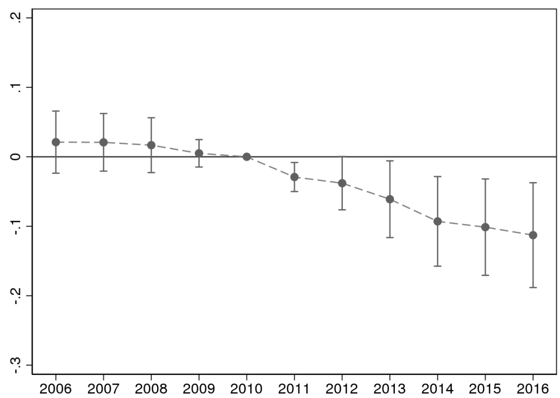
There are several channels by which firms could react to the transportation cost shock. In order to stay competitive and not lose too many customers, a possible behavioral reaction is that firms try to cut their other (non-transport related) expenditures. These âotherâ expenditures include inputs of goods and services as well as labor costs, and firms have different options to cut these costs. Moreover, the firms most strongly affected by the shock could exit the market or re-locate to other (less-impacted) municipalities within Portugal. Accordingly, we investigate three possible modes of adjustment in response to the increase in transportation costs. First, we study how private firms adapted several types of expenses for the purchase of inputs in response to the shock, also analyzing possible differences with respect to the origin of purchases. Second, we focus on the labor market consequences and analyze the mechanisms by which firms cut their wage costs. Third, we shed light on whether entrepreneurs decide to close or relocate their businesses to other municipalities. For the main outcomes, we present a plethora of robustness checks and look into possible effect heterogeneity.

6.1 Expenses

We first focus on how firms adjusted their expenses in reaction to the shock using the event study strategy described in Equation (3). The results are presented in Figure 5. Once again, we find evidence suggesting that the parallel trends assumption holds in this setting. In addition, we observe an increasing deterioration of expenses after the introduction of tolls.

Figure 5: Event Studies – Expenses

(a) Total Expenses



Notes: The variable is measured using the inverse hyperbolic sine transformation. Graphs were computed with Firm, Municipality, and NUTS 2 × Year fixed effects. The 90% confidence levels are calculated using clustered standard errors at the municipal level.

The difference-in-differences results, displayed in Table 4, confirm that total expenses in treated firms decreased by, on average, between 7.5% (in column 1) and 9.9% (in column 2). Importantly, the level of detail in the dataset allows us to divide expenses in several categories: employee expenses (in column 3), costs of goods purchased and material consumed (in column 4), and costs associated with supplies and external services provided to the firm (in column 5). Employee expenses includes wages, social security expenses, and insurance schemes for accidents at work and occupational diseases. Our findings suggest that the adjustment from the expenditure side impacted labor-related costs to a similar degree (about 7%, on average) as the expenses for goods and services.

Table 4: Firm expenses adjusted after the introduction of tolls

	Total Expenses		Employee	Costs of goods	Supplies Ext serv
	(1)	(2)	(3)	(4)	(5)
$Treated \times Post$	-0.079**	-0.107***	-0.068*	-0.070*	-0.074**
	(0.036)	(0.029)	(0.038)	(0.039)	(0.036)
Firm FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	No	Yes	Yes	Yes
NUTS 3 $\times$ Year FE	No	Yes	No	No	No
Controls	No	Yes	No	No	No
R^2	0.635	0.635	0.730	0.816	0.654
$N \times T$	3,635,116	3,635,116	3,635,121	3,635,121	3,635,121

Notes: Standard errors in parenthesis are clustered at the municipal level. The vector of socio-demographic and economic controls includes electricity consumption per capita, age dependency ratio, population density and municipal expenses per capita. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

We also analyze the effect of an increase in transportation costs on the origin of firm's purchases using difference-in-differences regressions in Table A.2 in the Appendix. We investigate the following outcome variables: purchases from the domestic market (in columns 1 and 2), the probability of importing (in column 3) and the amount of imports (in columns 4 and 5). We find that, whereas the probability of import is not affected, both purchases from the domestic and the international market were impacted: purchases from domestic products were reduced by 6.2% to 9.9%, on average, while total imports were reduced by 4.9% in treated areas. The result for imports is, however, not statistically significant in our most demanding specification, suggesting that the expenditure cuts mainly hit the domestic market.

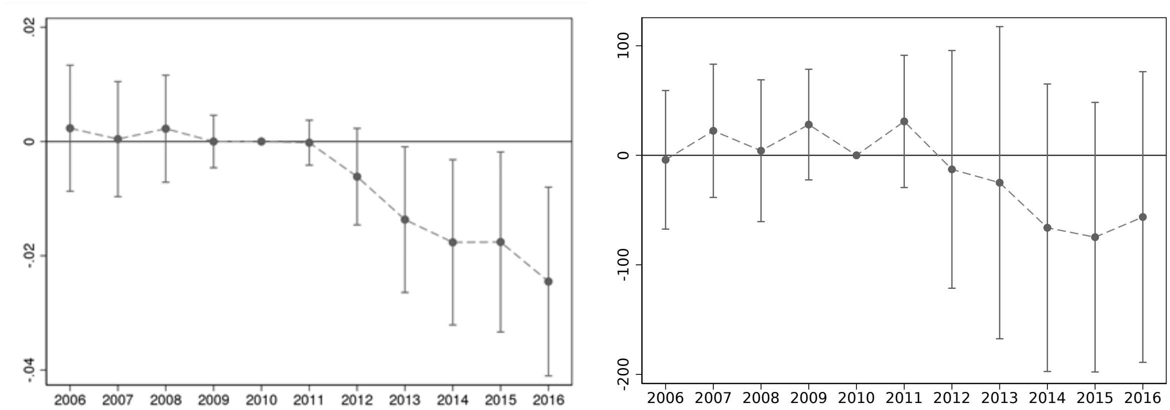
6.2 How firms cut labor costs: employment reduction versus wage reduction

We now investigate the labor market consequences of the tolls. We distinguish between the extensive margin (i.e., if the shock caused a reduction in employment) and the intensive margin (i.e., if those who stayed employed experienced a wage cut). We present the event study results, estimated using Equation (3), for labor related outcomes in Figure 6, finding that the introduction of tolls had a significantly negative effect on (paid) employment numbers (in panel a) and these effects seem to deteriorate further between 2013 and 2016.

And what happened to the wages of those who managed to keep their job in these firms? To answer this question, we provide the event study specifications of averages wages (in panel b). We find a non significant negative impact caused by the introduction of tolls in treated SCUT highways. This non-finding can be explained by the fact that there is a strong downward nominal wage rigidity in Portugal (Dias et al., 2013). Legal restrictions on nominal wage cuts and periods of close-to-zero inflation leave employers with limited margin to adjust real wages. As a consequence, in periods of crisis, employment becomes the main margin of adjustment (Carneiro et al., 2014).[28] In any case, results are substantially noisier than in the pre-treatment years.

Figure 6: Event Studies – Labor market

(a) Paid Employment (b) Average Wages



Notes: The first variable is measured using the inverse hyperbolic sine transformation. Graphs were computed with Firm, Municipality, and NUTS 2 $\times$ Year fixed effects. The 90% confidence levels are calculated using clustered standard errors at the municipal level.

The difference-in-differences results, computed as in Equation (1), are presented in Table 5 and confirm the event study insights. We find a negative, although non-statistically significant, effect for averages wages (in columns 1 and 2). However, we would like to point out that the point estimate of the average yearly decrease is below 40 euros. This constitutes a small effect, even if we consider that, during this period, the minimum monthly wage was below 550 euros (Alexandre et al., 2022).

At the same time, we find a significant reduction of paid employment (in columns 3 and 4) of close to 2% on average, for firms in affected municipalities *vis-à-vis* firms in the comparison group.[29] In addition, our dataset allows us to distinguish between full-time (shown in column 5) and part-time employment (in column 6). Our findings highlight that the effects are concentrated on full-time workers with an estimated decrease of 1.5% in treated areas.

In Section 6.1 and in this subsection, we provide evidence suggesting that firms reduced several types of inputs in response to the transportation cost shock. The results for expenses and labor market outcomes are robust to several checks and modifications of the baseline model. First, winsorizing or using a logarithmic transformation of outcome variables, presented in Table AR.7 does not change baseline conclusions. Second, removing firms in municipalities in the Lisbon metropolitan area and in district capitals from the sample, as shown in Table AR.8 in the Appendix, do not

[28]The nominal minimum wage was frozen between 2011 and 2014 at 485 euros.

[29]These results are consistent with the findings of Audretsch et al. (2020), who documented a significantly negative impact on employment at the municipal-level.

Table 5: Employment decreased with the introduction of tolls

	Average Wage		Paid Employment		Full-Time	Part-Time
	(1)	(2)	(3)	(4)	(5)	(6)
$Treated \times Post$	-37.880	-36.804	-0.013*	-0.023***	-0.015**	0.002
	(69.547)	(63.798)	(0.008)	(0.007)	(0.007)	(0.004)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	No	Yes	No	Yes	Yes
NUTS 3 $\times$ Year FE	No	Yes	No	Yes	No	No
Controls	No	Yes	No	Yes	No	No
R2	0.702	0.702	0.844	0.844	0.854	0.709
$N \times T$	2,826,431		3,621,415		3,291,641	2,140,383

Notes: Standard errors in parenthesis are clustered at the municipal level. The employment variables are measured using the inverse hyperbolic sine transformation. The vector of socio-demographic and economic controls includes electricity consumption per capita, age dependency ratio, population density and municipal expenses per capita. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

seem to change our baseline results. The only difference is that we find evidence suggesting that annual average wages decreased by about 130 euros when we exclude all firms in district capitals. Third, results are very similar if we focus on single establishment firms or if we relax the assumption of binary treatment using a distance decay function, as displayed in Table AR.9 in the Appendix, although they are noisier in the second case. Furthermore, negative impacts seem to be, once again, concentrated in tradable sectors, as can be seen in Table AH.5 in the Appendix. Employment-related impact in the manufacturing sector is less precisely estimated, as can be seen in Table AH.6 in the Appendix.

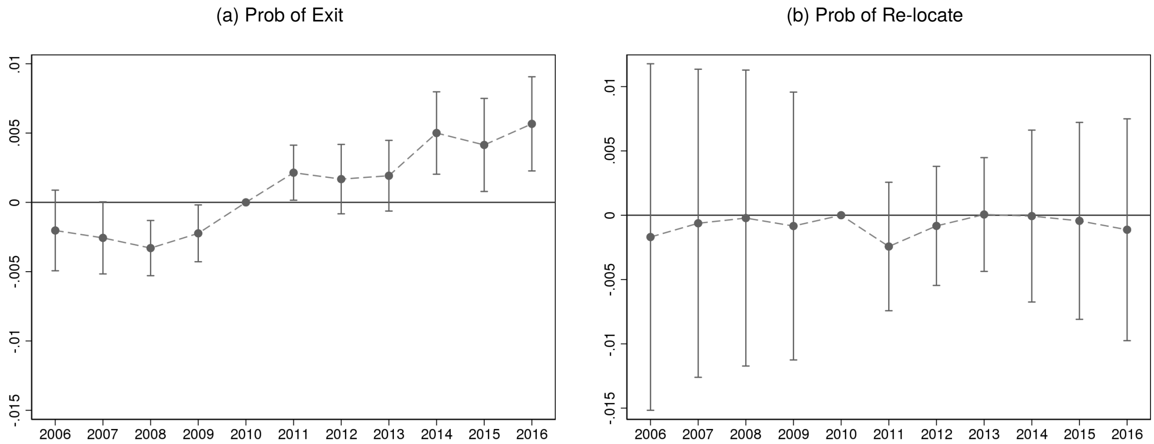
6.3 Exit or re-location?

A rather strong firm reaction to the tolls could be market exit or re-location to another, less-affected municipality within Portugal. Our unique data and setting also allows us to rigorously analyze these options using linear probability models. Our dependent variables are now two indicator variables that take value one if i) a firm decides to exit the market and zero otherwise, or ii) a firm decides to move to another municipality and zero otherwise.

We present the event study results in Figure 7, examining the impact on the probability of exit (in panel a) and the probability of inter-municipal firm migration (in panel b). Our findings show that the probability of leaving the market increases in treated areas. Note that even despite the parallel trends being challenged in the pre-treatment period, these precisely measured point estimates are very close to zero and seem to be increasing over time. On the contrary, we do not find any evidence pointing towards a re-location of businesses to other areas, with tightly estimated zeros. If anything, these zeros are even more narrow after the implementation of tolls in SCUT highways.

These results are confirmed when we examine the difference-in-differences obtained from estimating Equation (1) for the probability of firms exiting the market (in columns 1 and 2) and changing to another municipality (in columns 3 and 4). We find that firms in SCUT municipalities have a higher probability of exiting (on average, close to 0.5%), but no

Figure 7: Event Studies – Exit and re-location



Notes: Graphs were computed with Firm, Municipality, and NUTS 2 × Year fixed effects. The 90% confidence levels are calculated using clustered standard errors at the municipal level.

effect on the probability of leaving to another area as all estimated coefficients are extremely small and not statistically significant. The results are consistent with earlier findings suggesting that Portuguese entrepreneurs tend to have a strong home-bias in deciding the municipality where to locate their firms (Figueiredo et al., 2002).

Table 6: Exit or re-location

	Prob of Exit		Prob of Re-locate	
	(1)	(2)	(3)	(4)
$Treated \times Post$	0.005***	0.005***	-0.000	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No
Controls	No	Yes	No	Yes
R^2	0.350	0.350	0.223	0.223
$N \times T$	3,635,121		3,635,121	

Notes: Standard errors in parenthesis are clustered at the municipal level. The vector of socio-demographic and economic controls includes electricity consumption per capita, age dependency ratio, population density and municipal expenses per capita. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Finally, these results are robust to excluding all firms located in *i)* the Lisbon metropolitan area, *ii)* in the 18 district capitals, and *iii)* restrict our attention to single establishment firms. This is also the case when we rely on a continuous treatment assignment. All these results can be seen in Table AR.10 and Table AR.11 in the Appendix. Exploring heteregoneity regarding firms in tradable and non-tradable sectors of activity or between those in manufacturing industries and services sectors does not change these conclusions. The results for these exercises are presented in Table AH.7

and Table AH.8 in the Appendix.

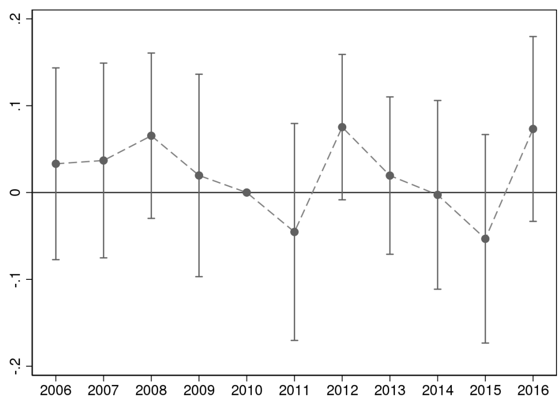
7 Checking for indirect effects in terms of induced firm migration and new firm formation

So far, we have documented that the transportation cost shock has significantly hit firm turnover and firm profits in the treated municipalities and led to multiple behavioral reactions by the affected firms. It might, however, be that the deterioration of economic activity in the SCUT-municipalities has indirect (“rebound") effects in the rest of Portugal. The transportation cost shock in the SCUT-municipalities might render the rest of the country a (relatively) more attractive firm location, thereby inducing migration of existing firms from treated to untreated municipalities and giving a push to new firm formation in untreated municipalities. Such indirect effects could threaten our identifying assumption that the comparison group of municipalities is not affected by the shock. We therefore complete our empirical analysis by checking whether our comparison group of municipalities could benefit from induced firm migration or increased start-up activity.

We have already analyzed re-location of existing firms in Section 6.3, finding no significant differences (neither before nor after the introduction of tolls on SCUT highways) between treated and comparison municipalities. We now scrutinize what happened to new firm formation in treated municipalities and in the comparison group of municipalities (the rest of Portugal). As can be seen from Figure 8, we do not find any statistically significant difference between treatment and comparison regions with respect to start-ups after the transportation cost shock.

Figure 8: Event Studies – Number of start-ups

(a) Number of start-ups



Notes: The variable, aggregated at the municipal level, is measured using the inverse hyperbolic sine transformation. Graphs were computed with Municipality and Year (for the first three outcomes) and NUTS 2 × Year fixed effects (for the last). The 90% confidence levels are calculated using clustered standard errors at the municipal level.

Moreover, the difference in differences results displayed in Table 7 confirm that the introduction of tolls did not lead to a significant increase in the number of start-ups in the comparison group of municipalities.

Table 7: Firm numbers deteriorated with the introduction of tolls

	Number of Start-ups	
	(1)	(2)
$Treated \times Post$	-0.020	-0.015
	(0.032)	(0.033)
Municipality FE	Yes	Yes
Year FE	Yes	No
Controls	No	Yes
R^2	0.944	0.944
$N \times T$	3,058	

Notes: Standard errors in parenthesis are clustered at the municipal level. Outcome variables are measured using the inverse hyperbolic sine transformation. The vector of socio-demographic and economic controls includes electricity consumption per capita, age dependency ratio, population density and municipal expenses per capita. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Summed up, we find no hints that the comparison group of municipalities could benefit from “rebound" effects in terms of re-location of existing firms or increased start-up activity. This confirms the validity of our identifying assumption. Moreover, it suggests that the effects of the transportation cost shock that led to a deterioration of economic activity in the SCUT regions were not compensated by firm migration to or new firm formation in the comparison group of municipalities.

8 Conclusion

The current paper is – to the best of our knowledge – the first that provides a deep and comprehensive look into the various adaptation mechanisms that firms have at their disposal when hit by a massive transportation cost shock. Based on a unique firm-level data set covering virtually the whole universe of private firms in a country the paper provides evidence on the importance and actual relevance of the different firm-level adaptation mechanisms.

We find that the introduction of tolls on previously free highways led to a long-term decrease in sales (turnover) and firm profits, whereas labor productivity was not significantly affected. A possible interpretation is that those firms that stayed in the market managed to remain competitive (in terms of productivity) by reducing their sales output and by accepting lower profits. Domestic turnover and exports to the EU declined significantly, whereas exports to the rest of the world were not affected. This is a plausible result since domestic turnover and exports to the EU depend heavily on road transport, whereas exports to the rest of the world depend mainly on sea transport.

With respect to firm behavior, we find a significant cut of total, not transport-related expenditure. This expenditure cut affects employment-related expenses in a similar order of magnitude (about 7%) as other input-related expenses. Domestic purchases and imports from the EU were more strongly reduced than imports from the rest of the world.

Taking a closer look at the labor market, we find that firms cut wage costs mainly by reducing employment rather than by cutting wages, which can be explained by the strong downward wage-rigidity in Portugal. Full-time employees suffered more from the employment cuts than part-time employees. We find evidence for increased exit of firms in treated municipalities, whereas there is no evidence for increased firm migration to or increased firm formation within regions not (or less) affected by the treatment. The majority of effects for all these outcomes are medium- to long-term, i.e. still persistent six years after the introduction of tolls. All our results are robust to a plethora of exercises restricting both the treatment and the comparison group. In this regard, the exercise where we exclude all firms in the major cities of the country is especially interesting as it resembles the inconsequential places approach that is also common in the urban and trade literature.

Our findings do not only contribute to a better understanding of the behavior of firms confronted with an exogeneous shock, but provide policymakers with insights into the firm-level reactions to policy-induced distortions that can help them design better policies. We hope that this study will stimulate further research on the complex private sector effects of government intervention into the transportation sector. A fruitful area of future research is further disentangling the impact of a transportation cost shock on the financial conditions of firms, depending on their pre-shock level of debt and their relations with the banking system.

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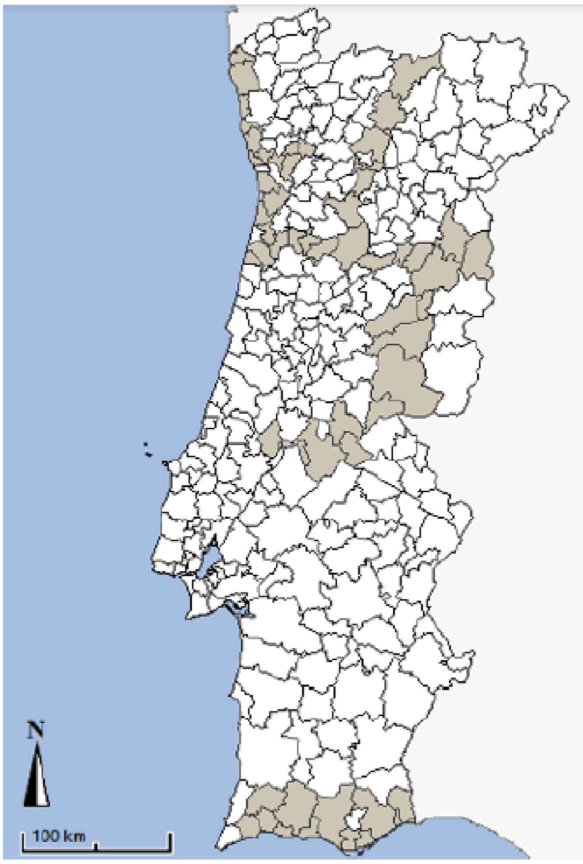
A Figures

Figure A.1: Geographical Distribution of Affected Municipalities



Note: Darkened regions represent treated municipalities whereas light regions depict municipalities in the comparison group.

B Tables

Table A.1: Municipalities Affected by the Introduction of Tolls in the SCUT Highways

SCUT Highway	**Municipalities Affected**
Tolls introduced on the 15^{th} October 2010	
SCUT Grande Porto - 79 Km	
A4: AE Transmontana	Matosinhos, Maia.
A41: CREP - Circular Regional Exterior do Porto	Matosinhos, Valongo, Santa Maria da Feira, Espinho.
A42: AE Douro Litoral	Valongo, Paços de Ferreira, Paredes, Lousada.
SCUT Litoral Norte -113 Km	
A28	Matosinhos, Vila do Conde, Póvoa de Varzim, Esposende, Viana do Castelo, Caminha.
SCUT Costa da Prata – 110 Km	
A29	Estarreja, Ovar, Espinho, Vila Nova de Gaia.
Tolls introduced on the 8^{th} December 2011	
SCUT Algarve – 133 Km	
A22	Lagos, Monchique, Portimão, Lagoa, Silves, Albufeira, Loulé, Faro, Olhão, Tavira, Castro Marim, Vila Real de Sto. António.
SCUT Beira Interior – 217 Km	
A23	Torres Novas, Entroncamento, Constancia, Abrantes, Marvão, Gavião, Vila Velha de Rodão, Vila Nova da Barquinha,Castelo Branco, Fundão, Belmonte, Covilha, Guarda.
SCUT Interior Norte – 162 Km	
A24	Viseu, Castro Daire, Lamego, Peso da Régua, Vila Real, Vila Pouca de Aguiar, Chaves.
SCUT Beiras Litoral e Alta – 173 Km	
A25	Íhavo, Aveiro, Albergaria-a-Velha, Sever do Vouga, Oliveira de Frades, Vouzela, Viseu, Mangualde, Fornos de Algodres, Celorico da Beira, Guarda, Pinhel, Almeida.

Further Results

Table A.2: Purchases by geographic region

	Domestic		Prob of Import	Imports		EU	extra EU
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Treated \times Post$	-0.062	-0.099***	-0.004	-0.049*	-0.000	-0.042	-0.013
	(0.038)	(0.029)	(0.003)	(0.027)	(0.022)	(0.026)	(0.011)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	No	Yes	Yes	No	Yes	Yes
NUTS 3 $\times$ Year FE	No	Yes	No	No	Yes	No	No
Controls	No	Yes	No	No	Yes	No	No
R^2	0.812	0.812	0.659	0.734	0.733	0.731	0.679
$N \times T$	3,635,121		3,635,121	3,635,121			

Notes: Standard errors in parenthesis are clustered at the municipal level. The vector of socio-demographic and economic controls includes electricity consumption per capita, age dependency ratio, population density and municipal expenses per capita. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Robustness Tests

Table AR.1: Firm performance Robustness: i) Winsor ii) outcome variables measured in ln(1+y)

	Turnover		Profits		Value Added		Labor Productivity	
	Winsor	ln(1+y)	Winsor	ln(1+y)	Winsor	ln(1+y)	Winsor	ln(1+y)
$Treated \times Post$	-0.074*	-0.076*	-0.142*	-0.073**	-0.069	-0.052	-179.360	-0.015
	(0.042)	(0.041)	(0.079)	(0.034)	(0.052)	(0.034)	(134.451)	(0.012)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.591	0.613	0.447	0.709	0.546	0.701	0.678	0.600
$N \times T$	3,635,121	3,635,121	3,635,121	2,137,233	3,635,121	2,995,421	2,826,431	2,499,762

Notes: Standard errors in parenthesis are clustered at the municipal level. The first columns of the first three variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AR.2: Firm performance Robustness: excluding i) the Lisbon metropolitan area and ii) district capitals

	Turnover		Profits		Value Added		Labor Productivity	
	no Lisbon	no Capitals	no Lisbon	no Capitals	no Lisbon	no Capitals	no Lisbon	no Capitals
$Treated \times Post$	-0.079*	-0.134***	-0.154*	-0.206**	-0.074	-0.139**	-524.569	138.618
	(0.043)	(0.049)	(0.082)	(0.104)	(0.054)	(0.063)	(1,158.388)	(1,112.071)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.610	0.611	0.456	0.450	0.551	0.546	0.213	0.211
$N \times T$	2,431,368	2,555,134	2,431,341	2,555,086	2,431,365	2,555,130	1,931,176	2,023,946

Notes: Standard errors in parenthesis are clustered at the municipal level. The first three variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AR.3: Firm performance Robustness: i) only single establishments and ii) continuous treatment

	Turnover		Profits		Value Added		Labor Productivity	
	Single	Continuous	Single	Continuous	Single	Continuous	Single	Continuous
$Treated \times Post$	-0.078*		-0.158*		-0.068		-169.329	
	(0.045)		(0.084)		(0.057)		(1,181.832)	
$Distdecay \times Post$		-0.043*		-0.231*		-0.092*		885.160
		(0.023)		(0.135)		(0.048)		(807.530)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.603	0.607	0.451	0.451	0.546	0.547	0.559	0.214
$N \times T$	3,519,597	3,635,121	3,519,514	3,635,021	3,519,588	3,635,110	2,715,722	2,826,431

Notes: Standard errors in parenthesis are clustered at the municipal level. The first three variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AR.4: Trade Robustness: i) Winsor ii) outcome variables measured in ln(1+y)

	Domestic Turnover		Exports	
	Winsor	ln(1+y)	Winsor	ln(1+y)
$Treated \times Post$	-0.072*	-0.074*	-0.041*	-0.051*
	(0.043)	(0.042)	(0.025)	(0.029)
Firm FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
NUTS 2 × Year FE	Yes	Yes	Yes	Yes
R^2	0.601	0.621	0.675	0.724
$N \times T$	3,635,121	3,635,121	3,635,121	3,635,121

Notes: Standard errors in parenthesis are clustered at the municipal level. The first columns of the first three variables are winsorized (90%) and measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AR.5: Trade Robustness: excluding i) the Lisbon metropolitan area and ii) district capitals

	Domestic Turnover		Exports	
	no Lisbon	no Capitals	no Lisbon	no Capitals
$Treated \times Post$	-0.076*	-0.077*	-0.053*	-0.054*
	(0.044)	(0.044)	(0.031)	(0.031)
Firm FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
NUTS 2 × Year FE	Yes	Yes	Yes	Yes
R^2	0.035	0.039	0.004	0.003
$N \times T$	2,431,368	3,635,121	2,431,368	3,635,121

Notes: Standard errors in parenthesis are clustered at the municipal level. All variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AR.6: Trade Robustness: i) only single establishments and ii) continuous treatment

	Domestic Turnover		Exports	
	Single	Continuous	Single	Continuous
$Treated \times Post$	-0.076		-0.053*	
	(0.046)		(0.031)	
$Distdecay \times Post$		-0.041*		-0.026
		(0.024)		(0.029)
Firm FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
NUTS 2 × Year FE	Yes	Yes	Yes	Yes
R^2	0.037	0.056	0.003	0.007
$N \times T$	3,556,604	1,668,469	3,556,604	1,668,469

Notes: Standard errors in parenthesis are clustered at the municipal level. All variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AR.7: Inputs Robustness: i) Winsor ii) outcome variables measured in ln(1+y)

	Average Wage		Paid Employment		Total Expenses	
	Winsor	ln(1+y)	Winsor	ln(1+y)	Winsor	ln(1+y)
$Treated \times Post$	-43.221	-0.008	-0.010	-0.011*	-0.031*	-0.070**
	(52.955)	(0.008)	(0.007)	(0.006)	(0.016)	(0.035)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.758	0.638	0.812	0.853	0.777	0.659
$N \times T$	2,826,431	3,621,415	3,621,415	3,621,415	3,635,121	3,633,757

Notes: Standard errors in parenthesis are clustered at the municipal level. The first columns of the first three variables are winsorized (90%) and measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AR.8: Inputs Robustness: excluding i) the Lisbon metropolitan area and ii) district capitals

	Average Wage		Paid Employment		Total Expenses	
	no Lisbon	no Capitals	no Lisbon	no Capitals	no Lisbon	no Capitals
$Treated \times Post$	-38.640	-137.544**	-0.013*	-0.018**	-0.079**	-0.108***
	(68.903)	(67.329)	(0.008)	(0.009)	(0.035)	(0.040)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.685	0.688	0.843	0.844	0.640	0.641
$N \times T$	1,931,176	2,023,946	2,422,977	2,545,863	2,431,366	2,555,130

Notes: Standard errors in parenthesis are clustered at the municipal level. The last two variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AR.9: Inputs Robustness: i) only single establishments and ii) continuous treatment

	Average Wage		Paid Employment		Total Expenses	
	Single	Continuous	Single	Continuous	Single	Continuous
$Treated \times Post$	-40.635		-0.013*		-0.079**	
	(71.821)		(0.008)		(0.037)	
$Distdecay \times Post$		-45.637		0.002		-0.013
		(62.406)		(0.005)		(0.029)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.699	0.702	0.836	0.844	0.629	0.635
$N \times T$	2,715,722	2,826,431	3,505,952	3,621,415	3,519,593	3,635,116

Notes: Standard errors in parenthesis are clustered at the municipal level. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AR.10: Exit or Re-locate Robustness: i) excluding the Lisbon metropolitan area, ii) excluding district capitals

	Prob of Exit		Prob of Re-locate	
Exclude	no Lisbon	no Capitals	no Lisbon	no Capitals
$Treated \times Post$	0.005***	0.006***	-0.000	-0.001
	(0.002)	(0.002)	(0.002)	(0.001)
Firm FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes
R^2	0.354	0.355	0.240	0.250
$N \times T$	2,431,368	2,555,134	2,431,368	2,555,134

Notes: Standard errors in parenthesis are clustered at the municipal level. Linear probability models. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AR.11: Exit or Re-locate Robustness: i) single establishment firms, and ii) continuous treatment

	Prob of Exit		Prob of Re-locate	
	Single	Continuous	Single	Continuous
$Treated \times Post$	0.005***		-0.000	
	(0.002)		(0.002)	
$Distdecay \times Post$		0.001		0.000
		(0.002)		(0.001)
Firm FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes
R^2	0.354	0.350	0.229	0.223
$N \times T$	3,519,597	3,635,121	3,519,597	3,635,121

Notes: Standard errors in parenthesis are clustered at the municipal level. Linear probability models. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Heterogeneity Tests

Table AH.1: Firm performance Heterogeneity: Tradables vs non-tradables

	Turnover		Total Expenses		Value Added		Profits	
	T	NT	T	NT	T	NT	T	NT
$Treated \times Post$	-0.105**	-0.054	-0.279**	-0.045	-0.134*	-0.021	-1,614.967	570.191
	(0.045)	(0.047)	(0.122)	(0.089)	(0.075)	(0.060)	(2,825.926)	(526.795)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.613	0.609	0.443	0.463	0.549	0.548	0.214	0.472
$N \times T$	1,608,599	2,022,832	1,608,514	2,022,817	1,608,591	2,022,829	1,290,478	1,532,650

Notes: Standard errors in parenthesis are clustered at the municipal level. The first three variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AH.2: Firm performance Heterogeneity: Manufacturing vs Services

	Turnover		Total Expenses		Value Added		Profits	
	M	S	M	S	M	S	M	S
$Treated \times Post$	-0.084	-0.078*	-0.475***	-0.028	-0.177	-0.041	-2,143.525	164.065
	(0.070)	(0.041)	(0.149)	(0.073)	(0.112)	(0.051)	(3,999.295)	(608.336)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.609	0.612	0.422	0.466	0.537	0.550	0.673	0.394
$N \times T$	877,193	2,646,751	877,173	2,646,672	877,189	2,646,745	717,459	2,025,939

Notes: Standard errors in parenthesis are clustered at the municipal level. The first three variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AH.3: Trade Heterogeneity: Tradables vs non-tradables

	Domestic Turnover		Exports	
	T	NT	T	NT
$Treated \times Post$	-0.107**	-0.050	-0.062*	-0.044
	(0.047)	(0.047)	(0.033)	(0.033)
Firm FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes
R^2	0.619	0.619	0.744	0.691
$N \times T$	1,608,599	2,022,832	1,608,599	2,022,832

Notes: Standard errors in parenthesis are clustered at the municipal level. All variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AH.4: Trade Heterogeneity: Manufacturing vs Services

	Domestic Turnover		Exports	
	M	S	M	S
$Treated \times Post$	-0.079	-0.075*	-0.089	-0.027
	(0.065)	(0.042)	(0.057)	(0.021)
Firm FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes
R^2	0.045	0.034	0.009	0.003
$N \times T$	439,117	2,682,601	439,117	2,682,601

Notes: Standard errors in parenthesis are clustered at the municipal level. All variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AH.5: Inputs Heterogeneity: Tradables vs non-tradables

	Average Wage		Paid Employment		Total Expenses	
	T	NT	T	NT	T	NT
$Treated \times Post$	-16.127	-45.927	-0.022**	-0.004	-0.075**	-0.079*
	(95.829)	(63.495)	(0.009)	(0.008)	(0.036)	(0.040)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.713	0.697	0.854	0.838	0.647	0.633
$N \times T$	1,290,478	1,532,650	1,603,142	2,014,574	1,608,595	2,022,831

Notes: Standard errors in parenthesis are clustered at the municipal level. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AH.6: Inputs Heterogeneity: Manufacturing vs Services

	Average Wage		Paid Employment		Total Expenses	
	M	S	M	S	M	S
$Treated \times Post$	-112.097	5.130	-0.018	-0.012*	-0.100*	-0.071**
	(80.879)	(72.217)	(0.018)	(0.007)	(0.058)	(0.032)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.671	0.711	0.850	0.838	0.646	0.636
$N \times T$	717,459	2,025,939	874,533	2,635,937	877,193	2,646,746

Notes: Standard errors in parenthesis are clustered at the municipal level. The last two variables are measured using the inverse hyperbolic sine transformation. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AH.7: Exit or Re-locate Heterogeneity: Tradables vs non-tradables

	Prob of Exit		Prob of Re-locate	
	T	NT	T	NT
$Treated \times Post$	0.005**	0.005**	-0.001	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes
R^2	0.358	0.347	0.227	0.231
$N \times T$	1,608,599	2,022,832	1,608,599	2,022,832

Notes: Standard errors in parenthesis are clustered at the municipal level. Linear probability models. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

Table AH.8: Exit or Re-locate Heterogeneity: Manufacturing vs Services

	Prob of Exit		Prob of Re-locate	
	M	S	M	S
$Treated \times Post$	0.003	0.006***	-0.001	-0.000
	(0.002)	(0.002)	(0.001)	(0.002)
Firm FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
NUTS 2 $\times$ Year FE	Yes	Yes	Yes	Yes
R^2	0.359	0.349	0.239	0.225
$N \times T$	877,193	2,646,751	877,193	2,646,751

Notes: Standard errors in parenthesis are clustered at the municipal level. Linear probability models. Asterisks indicate significance levels of 10% (*), 5% (**), and 1%(***), respectively.

C Continuous treatment variable

In this case, instead of Equation (1), we run the following model for unit of analysis firm f, in municipality m, NUTS 2 or NUTS 3 region n, and year t, during the period 2006-2016, according to:

$$y_{fmnt} = \alpha_f + \delta_m + \lambda_{nt} + \omega[(1-\rho)/100]^{dist} \times PostPeriod_{mt} + \epsilon_{fmnt} \quad (4)$$

where ρ is a distance decay rate (0.25) and *dist* is a driving distance, in kilometres, between municipalities (town halls) and the closest charged (former toll-free) SCUT. ω is the coefficient of interest. All other variables are measured as in Equation (1).