GEE Papers

Número 107

Junho de 2018

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Abstract

The paper studies the impact of a switch from free to charged highway provision on firm numbers and private sector employment in a panel of Portuguese municipalities covering the period 2007–2013. It exploits the fact that tolls on certain highways in Portugal were unexpectedly introduced in reaction to the sovereign debt crisis to establish causality. Results from a difference-in-differences analysis indicate a significantly negative effect of highway tolls on number of firms and employment in treated municipalities vis-à-vis the comparison group. We also find negative effects of tolls in municipalities not directly traversed by the treated highways, with larger firms and manufacturing firms being most strongly affected. (JEL: R48, L25, R12)

Keywords: infrastructure provision, highway tolls, regional economic development, natural experiment

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[1] The authors are indebted to Treb Allen, Rui Baptista, Nathaniel Baum-Snow, Pierre-Philippe Combes, Florence Goffette-Nagot, Robert Gold, Stephan Heblich, Alfredo Marvão Pereira, José Tavares, and Elisabet Viladecans for most helpful suggestions. We thank participants at the 7th European Meeting of the Urban Economics Association, the 32nd Congress of the European Economic Association, the IAB International Workshop on Establishment Panel Analyses, and the GATE Workshop on "Public Policies, Cities, and Regions" for their comments on earlier versions of the paper. João Pereira dos Santos gratefully acknowledges financial support by FCT – Fundação para a Ciência e Tecnologia - PD/BD/128121/2016. The usual disclaimer applies.

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1. Introduction

Highways connect people. They facilitate economic exchange and bring distant locations – in economic terms – closer to one another. Highways shape a country's economic geography by, for instance, decentralizing urban populations or connecting remote areas with the centers of economic activity (Baum-Snow 2007). However, highway infrastructure is expensive. In modern economies the transportation sector as a whole typically accounts for about five percent of GDP, and large highway construction programs like the US Interstate Construction Program or the construction of the Chinese National Trunk Highway System are among the largest investments ever made (Redding and Turner 2015). In view of the substantial costs in terms of taxpayers' money, it is crucial to carefully assess the costs and benefits of highway infrastructure.

In the political discussion, it is often claimed that new highways are worth the investment, as they stimulate, among other effects, activity in the private business sector and lead to an increase in economic exchange, firm formation, and employment growth. In fact, however, it is very difficult to substantiate such claims. The core problem in determining causal effects of highways (or other kinds of infrastructure) on spatial economic activity is that highways are not assigned to locations randomly. It is, therefore, not clear ex ante whether observed changes in outcome variables such as firm numbers or employment are caused by the highways or by other, unobserved location characteristics. To deal with this fundamental endogeneity problem, the recent empirical literature has mainly used three approaches: Planned routes IV, historical routes IV and the inconsequential places approach. "While these approaches remain open to criticism and refinement, they are about as good as can be hoped for in an environment where experiments seem implausible" (Redding and Turner 2015, p. 1393).

While acknowledging the progress and insights brought about by the above-mentioned approaches, the current paper pursues a different – yet complimentary – strategy, making use of a unique natural experiment that has taken place in Portugal just recently.

In an effort to move the country closer to the core of Europe, Portuguese authorities have built a system of modern, toll-free highways, the so-called SCUTs (acronym for "Sem Custos para o Utilizador"/ Without Costs for the Users) between 1999 and 2007. The SCUT system accounted for nearly 1000 kilometers, which is more than one third of the total Portuguese highway net, and helped cut average travel time between Lisbon and the Spanish border (as well as between Lisbon and provincial cities) by more than 40 percent.

However, in the course of the sovereign debt crisis, the toll-free provision could no longer be maintained, as the Portuguese government was forced to cut down public spending and to increase public revenues. As the Financial Times put it: "To help keep Portugal's €78bn bailout on track, the government has been forced to introduce charges on more than 900km of roads where there was previous none, triggering angry protests, increasing business costs and confusing tourists." (Financial Times of August 25, 2013) The tolls on the (former toll-free) SCUT highways were so high that they had a substantial negative effect on traffic[5]. In reaction

[5] In 2011, when the tolls were introduced, the price was 9 cents per km. According to a study by the Institute for Road Infrastructures (INIR) traffic along the SCUT highways decreased substantially between the first quarter 2011 and the first quarter 2012 (The Portugal News 2012).

to the decrease in traffic and the widespread criticism in the public, the Portuguese government has decided to cut back the tolls on SCUT highways by 15% from August 1st, 2016 on.[6]

While bad news for Portuguese drivers and business people affected by the high tolls, the events in Portugal provide a unique natural experiment to study the causal effects of a drastic increase in the price of modern transport infrastructure on firm formation and employment dynamics, as the introduction of tolls was exclusively motivated by budgetary reasons and not by considerations with respect to employment or new business formation.[7] Moreover, the tolls were not meant as an instrument to internalize external effects (congestion), as there was no notable congestion on the SCUTs highways when the tolls were introduced (INIR 2011).

The current paper is – to the best of our knowledge – the first that makes use of a natural experiment to rigorously analyze the impact of highway tolls on firm numbers and employment in the private business sector.[8] We find strong evidence for a negative impact of highway tolls on firm numbers and firm employment. Given that the average population in treated municipalities is about 45,000 inhabitants, the results imply that the treatment has cost the treated municipalities on average 14 firms and 238 employees as compared to non-treated municipalities. The negative effects of the tolls are not restricted to municipalities which are directly traversed by the SCUTs highways but affect – to a somewhat lesser extent and with some interesting modifications – more distant municipalities as well.

The paper is organized as follows: Section 2 provides a brief review of the pertinent literature and puts the original features of the approach pursued in the current paper into perspective. Section 3 presents the empirical strategy and the data. Section 4 presents and discusses the results, and Section 5 concludes.

2. Highway infrastructure and economic development: a complex relationship Review

The relationship between highway infrastructure and regional economic development is a complex one. Due to its network properties, transportation infrastructure has the ability to shift market areas and to affect communication and business channels (Rietveld 1989). Transportation infrastructure may be viewed as a (local) public input into private agent's production processes and may thus affect their locational decisions (Dohse 1998), as well as households' residential choices, by lowering commuting costs (Rephann and Isserman 1994). Moreover, the availability of infrastructure may also affect economic agents' decision to start a new business as well as the post-entry performance of new-firm startups (Audretsch, Heger and Veith 2015b).[9]

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[6] Note that all other highways in Portugal were subject to charges long before the sovereign debt crisis and the magnitude of the charges was not affected by the crisis.

[7] Note that municipal peculiarities played no role in the decision as this was a purely national matter. 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 – and still are (see, for example, http://www.jornaldenegocios.pt/empresas/transportes/detalhe/parlamento-rejeita-fim-das-portagens-na-via-do-infante) – massive protests from the local populations too.

[8] The large majority of previous research considers the consequences of new infrastructure provision. In our case, the infrastructure is already there, but it becomes costly.

[9] Infrastructure might affect the decision to become an entrepreneur in three important ways. First, by enhancing the connectivity (potential linkages and networks) of nascent entrepreneurs, infrastructure also enhances the information and ideas available and therefore the set of entrepreneurial opportunities. Second, as emphasized by

The discussion today remains influenced by the highly prominent debate triggered by Aschauer's work in the late 1980s and early 1990s (see, for instance Aschauer 1989; Munnell 1992; Gramlich 1994). Aschauer estimated an aggregate Cobb Douglas production function including infrastructure investment as an additional input alongside with the conventional labor and private capital inputs. Using both cross-sectional as well as time-series data for the US, Aschauer (1989) found a substantial impact of infrastructure investment on the growth rate of GDP. Issues that were important in the following scientific research concern among others the type of data used (time series, cross section, panel data), the way of dealing with dynamics (analysis in terms of levels or first differences), and the spatial level (national versus regional data). One common result was that estimated benefits of infrastructure investment appear larger in aggregate analyses than in disaggregated (i.e. region or state level) studies (Munnell 1992).[10] The early studies by Aschauer, Munnell and others were, however, not free of logical and econometric problems, as discussed in Gramlich's review essay (Gramlich 1994).

Subsequent research tried to provide broader evidence for other countries, differentiated by sectors and different kinds of infrastructure. Survey articles by Afraz et al. (2006) and Romp and de Haan (2007) suggest that the majority of studies find small but non-negligible effects of public infrastructures expenditure on production and GDP growth, although there are large differences with respect to countries, regions and sectors and although – most importantly – the causality issue is not settled. The results of a recent meta-analysis by Melo, Graham and Braga-Ardao (2013) indicate that the productivity effect of transport infrastructure varies among main industry groups and tends to be stronger for manufacturing and construction industries than for service industries. Moreover, there is evidence of higher productivity effects for roads, compared to other transport modes such as airports, railways, and ports and a higher output elasticity of transport for the US economy, compared to European countries, which is not too surprising, given that the US on the whole is more dependent on road transport than European economies (Melo, Graham and Braga-Ardao 2013, p. 704).

In recent years the causality issue has come to the fore and the pertinent empirical literature has mainly used three approaches to tackle it, namely historical route IV, planned route IV and the inconsequential units approach (Redding and Turner 2015).

The idea behind historical route IV is to make use of old transportation routes as a source of quasi random variation in observed contemporary infrastructure. The historical route IV approach has been pioneered by Gilles Duranton and Matthew Turner in their work on the US interstate highway network (Duranton and Turner 2012). They use maps of historical transportation networks, such as the US railway network in the late 19th century as well as the routes of major expeditions of exploration in the early days of the US, as a source of quasi random variation in the modern US interstate highway network, predicting economic outcomes at the level of Metropolitan Statistical Areas. The validity of these instruments requires that they affect economic outcomes only through their effect on the initial stock of roads (Duranton and Turner 2012, p. 10). The same authors (Duranton and Turner 2011, and Duranton et al. 2014)

the resource-based view of the entrepreneurial firm (Alvarez and Busenitz 2001), it facilitates the access of entrepreneurs to the requisite resources, including labor and technological capabilities. Third, better and less expensive access to infrastructure enhances the ability of entrepreneurial firms to access a broader range of geographic markets, enabling startups to achieve higher rates of post-entry growth and survival.

[10] This result was often attributed to geographic spillovers in productivity benefits that are not captured by disaggregated analyses (see, for instance Munnell 1992). However, a study by Holtz-Eakin and Schwartz (1993) analyzing the effects of state highway investments in the US finds no evidence of quantitatively important productivity spillovers beyond the narrow confines of each state's borders. Their result is in line with Gramlich (1990), who finds that even on major interstate highways most drivers are from within the state.

applied historical route instruments in regressions predicting metropolitan-level employment changes and trade flows between cities as functions of the interstate highway network. Historical route IV has also been applied to other regions and contexts: Baum-Snow et al. (2017) make use of Chinese road and rail networks in the 1960's; Martincus et al. (2017) rely on ancient Inca roads for Peru; Garcia-Lopez et al. (2015) use Roman roads for Spain and Hsu and Zhang (2014) perform a similar analysis as Duranton and Turner (2011) using Japanese data. Further prominent studies using historical route IV include Holl (2016) for Spain and Peroco (2016) for Italy.

The idea behind planned route IV is using planning maps and comparable documents as sources of quasi random variation in the observed infrastructure. The seminal contribution by Nathaniel Baum-Snow (2007) uses the 1947 interstate highway network plan in the US as a source of quasi-random variation to understand if the construction of new highways has caused central city population decline. The validity of this IV hinges on the assumption that the military purposes under which this plan was developed are orthogonal to post-war commuters' needs. The study finds that one new highway passing through a central city has contributed to a population reduction of 18 percent. Donaldson (2018), in his study of the economic impact of the Indian railway network, makes use of 'placebo' railroad lines, i.e. over 40.000 km of railroad lines that were planned and came close to being constructed but were – for different reasons – never actually built.[11] Further studies using planned route IV include Michaels (2008), Hornung (2015), Jedwab and Moradi (2016), Mayer and Trevien (2017), and Möller and Zierer (2018).

The idea behind the inconsequential units approach is that infrastructure links between big cities traverse economically small units only randomly. Hence, unobserved characteristics of small units between large cities are inconsequential to the choice of the route (Redding and Turner 2014, p.21), which implies that the connection status of the small units may be viewed as exogenous. The inconsequential units approach has been pioneered in the study by Chandra and Thompson (2000), in which they analyze the impact of access to the US interstate highway system on rural counties. They argue that highway access for rural counties may be viewed as exogenous, as these counties have received interstate highways only by chance, i.e. by the fact that they are located between major cities. The inconsequential units approach has also been applied to major highway projects in India (Datta 2012; Ghani et al. 2016), China (Banerjee et al. 2012; Faber, 2014), and Switzerland (Fretz et al., 2017).[12]

Notwithstanding the remarkable progress in the recent literature, the validity of the identification strategies discussed above "… depends sensitively on the details of their implementation and is sometimes contentious" (Redding and Turner 2015, p. 1368). In fact, there is relatively little critical reflection of conceptual problems in the approaches that have become standard in the recent empirical literature.

As infrastructure investments are extremely costly, decisions in favor of or against certain connections are typically highly prominent and need good arguments in line with the main goals

[11] Berger and Enflo (2017) study the short and long-term impact of railroads in Sweden and follow a similar approach using 'placebo' railroad lines as well an inconsequential units argument to deal with the endogeneity issue.

[12] A further possibility is to use variation over time within targeted locations. Gibbons et al. (2017) propose a very detailed continuous index of accessibility to make use of variation in the intensity of treatment (road improvement) on employment and productivity using plant level longitudinal data for Britain. Their findings suggest positive effects on employment and numbers of plants for small-scale geographical areas, but for incumbent firms, they find negative effects on employment.

of infrastructure policy in the respective country. Decision criteria could be, for instance, superior growth prospects of regions connected by the new infrastructure or – in countries with other political priorities – the support of lagging or remote regions. Against this background, the use of "placebo routes", i.e. routes that have been planned but not realized in the end, as sources of quasi-random variation in infrastructure decisions should be viewed with some caution. If infrastructure decisions in a given country follow a certain logic that is consistent over a longer period of time, there is little reason to assume that the choice to realize part of a planned infrastructure project and to not realize other parts is taken randomly. Hence, it is not a priori clear – and, in fact, rather unlikely – that regions traversed by planned routes that have never been realized make a good yardstick for those regions that have actually received the infrastructure connection.

While the inconsequential units approach avoids this kind of problem, its applicability is limited to a sub-set of regions. By definition, the inconsequential units approach focusses on economically small units (rural areas or minor cities) located between economically more important units (e.g. larger cities). While helpful to estimate the effects of infrastructure connections in the economically minor regions of a country, the approach is less well-suited to assess the effects of infrastructure in the economically most important regions of a country.

Natural experiments – although rare events in the field of infrastructure policy – are an obvious alternative and complement to the established IV and inconsequential units approaches discussed above. The current paper exploits such a rare natural experiment, the introduction of highway tolls on formerly toll-free highways in Portugal, that was forced on the country as an inevitable consequence of the sovereign debt crisis.

3. Empirical approach

3.1. Identification strategy

Our identification strategy relies on the fact that the decision to introduce tolls on the prior SCUT highways was forced by an exogenous shock (the sovereign debt crisis) on the Portuguese political system that left no room for discretionary favouring or discrimination of municipalities. We use all 278 mainland Portuguese municipalities as unit of observation, and the observation period is 2007 – 2013.

The treatment group consists of municipalities which have a segment of the SCUT highway network.[13] Before 2010, none of the SCUT highways had direct user costs. Between October 2010 and December 2011, tolls were introduced on each of the seven SCUT highways, which traverse 59 municipalities. Table 1 shows which municipalities were affected and Figure 1 displays their geographical distribution. Our comparison group consists of the remaining 219 municipalities in Portugal. The 1,482 km of highways in the municipalities which do not have SCUTs are tolled motorways. Note that these other ("non SCUT") highways were subject to

[13] Note that all 59 municipalities in the treatment group are traversed by a SCUT highway and have direct access (a ramp) to that SCUT highway.

charges long before the sovereign debt crisis and the magnitude of the charges was not affected by the crisis.[14] The secondary network of national and municipal roads is not tolled.

[Insert Table 1 here]

[Insert Figure 1 here]

We run difference-in-differences (diff-in-diff) regressions to estimate the effects of exogenously increasing transportation costs by comparing the pre- and post-treatment differences in the outcome Y_{it} of a treatment (Scut=1) and a comparison group (Scut=0) as follows:

$$Y_{it} = \beta_0 + \gamma_t + \delta_1 Scut \cdot dT_i + \alpha_i + \beta_1 X_{it} + e_{it} \qquad (1)$$

Municipalities and time are indexed by i and t, respectively. The main variable of interest in equation (1) is $Scut \cdot dT_i$, the interaction of the *Scut*-dummy and the *treatment period*-dummy (dT_i). The treatment period is defined as follows: for the municipalities where the introduction of tolls occurred on October 15th, 2010, the treatment period dummy dT_i equals 1 from 2011 onwards. Similarly, for the ones where the introduction of tolls happened on December 8th, 2011, dT_i equals 1 in 2012 and 2013. The term α_i denotes municipality fixed effects (characteristics of municipalities that do not change over time), γ_t are year fixed effects, and e_{it} is an error term. We include a vector of time-varying covariates (controls) X_{it} in order to rule out by design that omitted variables induce any considerable bias. Clustered standard errors per municipality are corrected for hetereskodestacity and autocorrelation issues (Bertrand, Duflo and Mullainathan 2004).

It might be argued, however, that firms in municipalities not directly crossed by SCUT highways could also use the SCUT highways for at least part of their journey and are thus also affected by the introduction of tolls, although indirectly and (presumably) to a lesser extent. We capture this possibility by constructing a second, distance-dependent treatment variable (d-dtv), defined as

$$[(1-p)/100]^{dist}. dT_i$$

where *dist* denotes the driving distance between the city center (town hall) of the municipality in which the firm is located and the nearest SCUT highway and p is a given distance decay rate. Figures 2 and 3 illustrate driving distances in km between municipalities (town halls) and charged (former toll-free) SCUT highways in 2011 (Figure 2) and from 2012 on (Figure 3).

[Insert Figures 2 and 3 here]

Our second treatment which may be seen as a test of effect heterogeneity (dependent on distance), may thus be written as

$$Y_{it} = \beta_0 + \gamma_t + \delta_1 [(1-p)/100]^{dist} \cdot dT_i + \alpha_i + \beta_1 X_{it} + e_{it} \qquad (2)$$

Our empirical strategy is similar in spirit to Datta (2012) who makes use of the 'Golden Quadrilateral' project in India to investigate the impact of highway infrastructure on private business activity and constructs similar treatment groups. However, the current study uses a more general distance decay function and has a clear focus on firm numbers and firm performance (in terms of employment), whereas the focus of Datta's study is on days of

[14] Moreover, no railroads have been constructed in the period considered here.

inventory held and change of supplier relations, i.e. rather indirect measures of firm performance. Moreover, in our data more than one pre-treatment period is available, which enables us perform placebo tests (see section 4.3) and to test the crucial assumption that firms inside and outside the treatment group have common trends during the pre-treatment period (see Sections 3.3 and 4.3).

3.2. Data description

Dependent variables

The number of firms and the number of employees working in these firms between 2007 and 2013 are calculated from the Simplified Business Information IES (*Informação Estatística Simplificada*) micro database, an annual census conducted by the Portuguese Ministry of Finance.[15] Our definition of firm encompasses all strictly private businesses with at least one paid employee in mainland Portugal (cases of self-employment are thereby excluded). Moreover, we restrict our sample to firms' headquarters that do not have branches somewhere else to make a more careful comparison between municipalities. Therefore, we dismiss from our analysis, for example, firms operating in the financial sector. In addition, non-profit organizations are omitted from the dataset.

We also provide a more refined analysis dividing our two dependent variables by sector of activity and by size. The data allow us to distinguish between primary, secondary and tertiary sector firms on the one hand, and between micro (with one or two paid employees), small (from three to ten), and medium and large firms (more than eleven workers) on the other hand.

Controls

To take care of possible confounds (interregional differences not caused by the treatment) we include municipal fixed effects and a vector of time-variant controls to rule out other possible mechanisms affecting our results.[16] For this end, we merge several data sources.

Among the standard controls considered in the literature on regional determinants of new firm formation and employment growth are measures of population density, the share of working age population in total population, regional unemployment and measures reflecting the business cycle (see, for instance, Armington and Acs 2002 or Audretsch, Dohse and Niebuhr 2015a). Following Bleakley and Lin (2012) we measure *population density* by the number of inhabitants per square kilometer. We consider the age structure of the regional population by the *age dependency ratio* (number of people above 65 and below 15 divided by the active population). Audretsch, Dohse and Niebuhr (2015a) have shown that not only the level but also the structure of regional unemployment matter for new firm formation. We thus consider not only the *regional unemployment rate* but also the *share of unemployed that have prior working experience* (and are thus more likely to start a new firm than unemployed without working experience). As for Portugal there is no data available for municipal GDP, we use as a proxy of municipal income and purchasing power the *Sales Index* computed by Marktest, as proposed by

15 IES gathers information reported by firms for statistical, tax administration, business registry, and financial supervision purposes. All information must be reported on-line in a single coherent operation with multiple automatic editing rules. Reporting is mandatory and penalties apply in case of non-compliance. In addition, Statistics Portugal monitors the quality of the data with regularly checks with respondents. For data description, please see the Appendix. Table A1 describes all variables in more detail as well as their specific sources.

16 Moreover, we check the crucial common trends assumption and run placebo regressions in later parts of the paper.

several papers studying local political business cycles in Portugal (see, for example, Martins and Veiga 2014).

Moreover, our rich municipal level data set allows us to control for institutional and political differences among municipalities that might affect firm formation (and closure) as well as employment growth in the respective municipalities. These include the *business tax rate* (set by the municipal assembly), *mayor tenure* (i.e. the number of consecutive years that the mayor of a given municipality is in power) and a dummy for *same political party*, indicating whether the mayor of a given municipality belongs to the same political party as the prime minister.[17] Finally, we consider a *highways* dummy which takes the value one if there is at least one highway (SCUT or a normal one) crossing a given municipality and zero otherwise.[18]

Table 2 displays descriptive statistics for all the variables used in our analysis, and Table A1 provides a detailed description of the variables, including their data sources.[19]

[Insert Table 2 here]

3.1. Internal validity considerations

Internal validity of a diff-in-diff framework relies on two main assumptions: i) municipal characteristics in treated and comparison municipalities must be balanced in the pre-treatment period; and ii) the parallel trends assumption, i.e. the trend in each of the dependent variables must be the same in both groups of municipalities in the absence of treatment. A comparison of mean differences between treatment group and comparison municipalities, in the period 2007-2010 shows no significant statistical differences except for the age dependency ratio, as can be seen from Table 3. The latter difference is, however, statistically and economically very small.

[Insert Table 3 here]

In addition, one common technique to test the parallel trends assumption is to compare the evolution of the different outcome variables in treated and comparison units during the pre-treatment period (Angrist and Pischke 2009, p. 231). Figure 4 shows the pre-treatment evolution for all our dependent variables.

[Insert Figure 4 here]

As can be seen from Figure 4, graphical inspection does not provide substantive hints on distinct trends between treatment and comparison regions which could undermine the empirical strategy.[20]

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[17] The same political party dummy is expected to have a positive sign, as mayors from the same political party as the prime minister are likely to attract more federal funding to their municipality. *Mayor tenure*, by contrast, may have opposing effects: More experience in managing the town hall and a better understanding of the necessities of the region may be beneficial for firm performance in the region. On the other hand, a long mayor tenure and less political competition may be linked with structural conservatism and more corruption, such that the expected overall effect is ambiguous.

[18] As will be shown later, skipping the highways dummy does not change the main results.

[19] The correlation matrix (Table A2 in the Appendix) shows that correlation between most right-hand side variables is rather low. An exception is the relatively high correlation between sales index and population density. We thus ran robustness checks excluding the sales index from the list of control variables, finding that this has no impact on the main results.

[20] A more rigorous test of the common trends assumption is provided in Section 4.3.1.

4. Results

4.1. The baseline model

All results discussed in this section include municipal and year fixed effects and have robust standard errors clustered at the municipal level. All dependent variables considered are divided by 100 inhabitants.

Tables 4 and 5 present our baseline results for the diff-in-diff estimations. Table 4 displays the effect of the introduction of tolls on the number of firms per municipality, whereas Table 5 shows the results for the number of employees. Both tables use a binary variable to capture the treatment status for the full sample of mainland Portuguese municipalities. Even columns contain a series of covariates (as discussed in section 3) to control for differences in observables between the treatment and comparison groups. The point estimates for the whole vector of time-varying controls can be found in the Appendix (Tables A3 and A4).

In all specifications, and in all cuts of the data, our main variable of interest is the causal effect of the introduction of tolls on the SCUTs highways, represented by the interaction term ($Scut \cdot dT_i$).

[Insert Table 4 here]

[Insert Table 5 here]

As can be seen from Tables 4 and 5, the introduction of highway tolls had a significantly negative impact on both, the total number of private firms and on the total number of employees working in these firms in the municipalities traversed by the SCUT highways. This finding is robust with respect to different model specifications (with and without controls) and applies to the majority of sectors and firm size classes that were investigated.[21] The results are not only statistically significant, but economically meaningful. Given that the average population in treated municipalities is about 45,000 inhabitants, the results for total firms (per 100 inhabitants) and total employees (per 100 inhabitants) imply that the treatment has cost the treated municipalities on average 14 firms and 238 employees as compared to non-treated municipalities.

There are, however, some important sectoral and size-related differences:

Firms in the agricultural sector, and even more importantly, industrial and manufacturing firms seem to have been hit most severely by the tolls, whereas service sector firms appear to be not much affected. We consider this a plausible result, since most service sector firms serve a local market, whereas manufacturing firms, in particular, serve more distant markets or export their products, such that they are more dependent on affordable highway usage than service sector firms. Moreover, firm size seems to play a role as well: while micro firms seem to be not much affected, the implementation of tolls had a significantly negative impact on relatively larger firms. Again, this appears to be a plausible result, given that larger firms are more likely to export their outputs, not only to other countries but also to other municipalities within

[21] The controls in Tables 4 and 5 include a dummy for highways, capturing both SCUT and non-SCUT highways. Note that the highway dummy is never significant (Tables A3 and A4). Moreover, excluding the highway dummy does not change the main results, as can be seen from Table A5 in the Appendix.

Portugal.[22] In the following sections we will omit the results for service sector and micro firms since results are always not statistically significant for these two subsamples.

4.2. Effect heterogeneity

Considering more distant municipalities

In the baseline model, the treatment group consists of municipalities which are directly crossed by the SCUT highways. As argued in Section 3, it might be, however, that firms in municipalities further away from the SCUTs are also affected by the tolls, although (presumably) to a lesser extent.[23] We capture this possibility by constructing a second, distance-dependent treatment variable that takes values between 1 and 0. It is close to 1 for municipalities very close to the SCUT highways and becomes smaller, the further a municipality is away from the next SCUT highway.[24]

As it is not a priori clear which distance decay rate p is most adequate – and as the pertinent literature gives little guidance in this respect – we present results for a wide range of plausible values of p ($0.05 \leq p \leq 0.15$). As can be seen from Table 6, the results for different values of p are rather similar: If we consider all (mainland) Portuguese municipalities weighted with inverse distance from the SCUTs, the negative significant impact of the road tolls on total employment in private firms is confirmed, whereas the effect on total firm numbers is negative (as expected) but not significant. Hence, it seems that the negative effect of highway tolls on total firm numbers is restricted to the municipalities directly traversed by (or very close to) the SCUTs, whereas the negative employment effect also holds for regions in greater distance to the SCUT highways.

[Insert Table 6 here]

The negative effect on firm numbers is significant, however, for firms in the primary and secondary (manufacturing) sector and – in particular – for larger firms (regardless of the sector). A similar picture emerges for the employment effect: The negative and significant effect of highway tolls on private firms' employment is particularly strong in the manufacturing sector and for larger firms (all sectors).[25]

To sum up, the negative effect of highway tolls on private firm numbers and private firm employment is most obvious in the municipalities directly crossed by the SCUT highways, but firm numbers and firm employment in more distant municipalities are affected as well, which is evident in particular for manufacturing firms and for larger firms with more than 10 employees.

Excluding municipalities close to Lisbon and large urban areas

Lisbon is not only the capital, but also the largest market for consumer goods and intermediate products in Portugal. Moreover, Lisbon is better connected with the outside world (via ship and

[22] As Caves and Porter (1977) and Porter (1979) argue and provide compelling empirical evidence, the smallest firms tend to occupy what they term as "strategic niches" with limited market opportunities. By contrast, larger firms have the opportunity to access larger markets but are also challenged by a higher cost structure and, in particular, by changes of transport costs. Moreover, larger firms are more flexible to adjust. With few employees, it might just be infeasible to fire people without having to shut down the firm.

[23] Quite obviously, they depend less on the SCUT highways as only part of their journey is affected and they are more likely to circumvent them than firms directly located at the SCUT highways.

[24] See Section 3.1 for details.

[25] We performed the same exercise with other functional forms of the distance decay function (simple linear and simple quadratic distance decay) which yielded similar results.

air-transport) than the rest of the country, which implies that many producers from other regions in Portugal have to transport their goods to Lisbon, either to serve the Lisbon market or to export their goods via Lisbon.

One might thus hypothesize that distance to Lisbon aggravates the effects of the tolls, as producers in greater distance to Lisbon have on average a longer way to their customers and are more dependent on affordable highway usage. As a further check of effect heterogeneity, we have, therefore, excluded all municipalities in close spatial proximity (distances less than 100 or 150 km) to Lisbon from the sample. The results, displayed in Table 7, are in line with expectations. While there are no changes in the signs, the size of the coefficients is in almost all models higher than in the baseline regressions, suggesting that the negative impact of the tolls on firm numbers and employment is aggravated by distance to Lisbon.

[Insert Table 7 here]

Similar results are yielded when we exclude Lisbon and Oporto metropolitan areas from the sample (see Table 8) or when we exclude the 18 Portuguese district capitals (Table 9), suggesting that firms located outside the economic centers of Portugal suffered most from the introduction of tolls.

[Insert Table 8 here]

[Insert Table 9 here]

4.3. Further robustness checks

4.3.1. Event study

In the baseline model and all its modifications analyzed so far, we have identified the average treatment effect over several years in which Portuguese firms were faced with tolls on SCUT highways. We now turn to a parametric event study which allows us (i) to assess whether the strength of the treatment effect varies with the duration of the treatment, and (ii) to assess the validity of the common trends assumption underlying the DID approach more rigorously than before.

The estimation equation for the event study follows the pertinent literature[26] and extends the baseline regression in the following way:

$$Y_{it} = \beta_0 + \gamma_t + \sum_{t=2007}^{2009} \delta_t \cdot Scut \cdot year_t + \sum_{t=2011}^{2013} \delta_t \cdot Scut \cdot year_t + \alpha_1 Scut + \beta_1 X_{it} + e_{it} \quad (3)$$

In equation 3 we consider interaction terms for each single pre-treatment year (except 2010) and for each single year of the treatment period. All coefficients are estimated relative to the year 2010, i.e. relative to the last year before the treatment set in.

Table 10 displays the coefficients that were estimated from equation (3) for both, total number of firms and total employment.

[Insert Table 10 here]

[26] See Falck, Gold and Heblich 2016, and Pierce and Schott 2016 for similar approaches.

As can be seen, the estimated interaction terms for all pre-treatment years are small and not significantly different from zero. Hence, the results of the event study provide strong support for the common trends assumption underlying our DID approach and confirm the findings from the visual inspection reported in Section 3.3.

Only from 2011 on (i.e. after the treatment has set in) the interaction terms become significantly negative. The results imply that already in the first year after the tolls on SCUT highways have been introduced there is a statistically significant difference between SCUT-regions and Non-SCUT regions, both in terms of firm numbers and in terms of employment. There is, however, an interesting difference in detail between our dependent variables. While the negative impact of the introduction of highway tolls on firm numbers is strongest in the first year and tends to become smaller over time, the negative impact on employment appears to increase over time.[27]

In sum, the results of the event study do not only support the common trends assumption, but also confirm the results of the baseline model discussed in Section 4.1.

4.3.2. Placebo regressions

The special structure of our data set with four pre-treatment years (years 2007–2010) allows us to perform an additional validity check: We split the pre-treatment period into two (2007–2008 and 2009–2010) and regress pre-treatment outcomes (years 2009–2010) on treatment.

The results of the placebo regressions are displayed in Table 11.

[Insert Table 11 here]

The findings from the placebo test imply that the previous results for agricultural (sector 1) firms have to be seen with a grain of salt, as the interaction term ($Scut \cdot dT_i$) has a significant negative impact on firm numbers in agriculture in the pre-treatment period (2009–2010) already. We thus cannot interpret the significant effect found in the treatment period as caused by the introduction of highway tolls in the SCUT regions.

The only other significant interaction term in the placebo regressions is found in the regression for firm numbers (firms with more than 10 employees). The effect in the pre-treatment period is, however, only weakly significant and much smaller than in the treatment period (see Table 4 for comparison). It does, therefore, not necessarily contradict our previous interpretation.

All other interaction term parameters in the placebo regressions are insignificant. This is, in particular, true for all models in which the number of employees is the dependent variable.

We consider this strong evidence that the significantly negative coefficients of the interaction terms in the treatment period (as found in Tables 4 and 5) are indeed caused by the unexpected introduction of highway tolls, rather than reflecting unobserved SCUT region-specific influences.

4.3.3. Including District Trends

As a further robustness check, we run our baseline regression (Equation (1)) adding district trends to account for possible remaining unobserved regional heterogeneity at higher regional

[27] A possible interpretation is that firms that were most strongly affected (e.g. small firms that could not adapt to the shock by reducing employment) reacted instantaneously by leaving or not entering the market, whereas others (presumably larger firms) reacted by continuously reducing employment.

aggregation levels than municipalities. We make use of the fact that Portuguese municipalities are classically grouped into 18 districts created in 1835. The results are depicted in Table 12.

[Insert Table 12 here]

The findings remain robust and are, in fact, quite similar to those of the baseline regressions.

4.4. Growth versus re-location

A problem that plagues empirical analyses of the economic effects of infrastructure is that it is hard to distinguish growth effects from re-organization effects. (see Redding and Turner 2015: 1383, for a detailed discussion.). However, some tentative conclusions concerning the relative contributions of (negative) growth and re-location effects to the losses in firm numbers and employment may be drawn by comparisons of different sets of estimation results. A critical task in this context is to identify ex ante the most likely target regions of firm re-location.

Following similar arguments in the pertinent literature (e.g. Chandra and Thomson 2000 or Berger and Enflo 2017), one might assume that business re-locations caused by changes in infrastructure typically take place within small distances, such that the main beneficiaries of re-locations from treated municipalities would be their untreated neighbors. The idea that the nearest neighbors are the main target of re-location activities is plausible in so far as re-location costs are likely to increase with re-location distance (possible loss of employees, long-term suppliers, social contacts, etc.).[28] However, in the context of the current paper another aspect has to be considered as well: If a firm decides to re-locate because of a substantial increase in the costs of highway usage, this implies that transportation infrastructure and transportation costs are crucial for this firm. Such a firm would probably only re-locate to a neighboring region if this neighboring region has a direct highway access. In view of these considerations, the most likely target regions of firm re-location are either neighboring, un-treated regions that have direct highway access (group A) or locations that minimize highway transportation costs (group B). Such locations that minimize highway transportation costs are presumably municipalities in both the Lisbon and Oporto metropolitan areas, and municipalities close to Portugal's biggest harbors.[29]

Given the above considerations are correct, we can distinguish negative growth effects of highway tolls from re-location effects by splitting our comparison sample (consisting of all non-treated municipalities) into the most likely target regions of relocation (group A or B mentioned above) and all other non-treated municipalities.

If we observe that treated municipalities perform clearly worse than either group A or group B, but not significantly worse than all other non-treated municipalities, this would be a strong hint at the existence of re-location effects. By contrast, if the results using either group A or group B as comparison group are similar to (or weaker as) the results when the comparison group consists of all non-treated municipalities, this would suggest that re-location plays not a particularly strong role.

[28] The 'home-field advantage' or 'local bias in entrepreneurship' is well documented in the literature. See Michelacci and Silva (2007) for the U.S. and Italy, and Figueiredo, Guimarães, and Woodward (2002) for Portugal.
[29] The biggest seaports in the comparison group of regions are Sines and Figueira da Foz.

Table 13 shows the results when the comparison group consists of municipalities A (line 1), [30] of municipalities B (line 2) [31] and of all non-treated municipalities (baseline model from Tables 4 and 5).

[Insert Table 13 here]

As can be seen, the treated municipalities perform relatively better when the comparison group is either group A or group B (i.e. the most likely target regions of firm re-location) rather than the entire group of non-treated municipalities. This is, in particular, evident when the comparison group is group B, i.e. the group of municipalities that are likely to minimize highway transportation costs. Hence, the results give no hint on the existence of strong re-location effects at all.

5. Concluding Remarks

The introduction of highway tolls in response to the sovereign debt crisis had negative effects on firm numbers and private sector employment in Portuguese municipalities traversed by these highways. We also find negative effects in municipalities not directly traversed by the treated highways, although these effects tend to become smaller with distance and are mainly found for larger firms and for firms in the manufacturing sector. The results are robust to different model specifications and a variety of further robustness checks.

The results are not only statistically significant, but economically meaningful: Given that the average population in treated municipalities is about 45,000 inhabitants, the results imply that the treatment has cost the treated municipalities on average 14 firms and 238 employees as compared to non-treated municipalities.

In other words: Imposing fees for access to key infrastructure, such as highways, can be detrimental to the high priority policy goals of generating entrepreneurship and employment. In this context it is important to mention, again, that even before the tolls were introduced there was no problem with congestion on SCUT highways and the tolls were only introduced for budgetary reasons. We may thus conclude that the introduction of tolls on formerly uncharged highways – which may have been inevitable for budgetary reasons in the short run – imposes a substantial cost in terms of foregone firm formation and employment in the longer run. [32]

While the adverse effects of the tolls on the treated municipalities are quite obvious, the overall effects on the Portuguese economy as a whole are hard to determine. A problem that plagues empirical analyses of the economic effects of infrastructure and that is not perfectly solved in the literature right now is that it is hard to distinguish growth effects from re-organization effects. Modifying an approach that has in a similar form been used in the recent literature we find no hint on the existence of strong re-location effects. This finding suggests that while the treated municipalities have suffered most, the overall effect on firm numbers and employment in the Portuguese economy is likely to be negative as well.

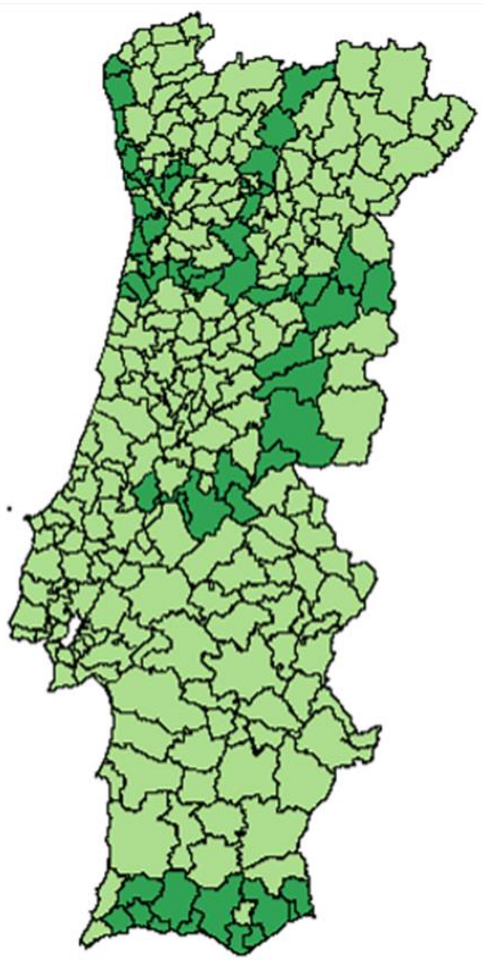
[30] Neighboring, un-treated regions that have direct highway access.
[31] Locations that minimize (highway) transportation costs.
[32] The 15% reduction of tolls announced by the Portuguese government in August 2016 indicates that policymakers have begun to realize that the true social costs of highway tolls might be higher than expected.

Two broad topics related to the questions investigated in this paper are left for future research: The first is to gain a better understanding of the mechanisms by which private businesses react to an increase of transportation costs on certain highways. When do firms look for alternative routes, when do they reduce employment and when do they decide to close or to re-locate their business? Second, it is evident that different firms react differently to a rise in transportation costs, and there remains much to be learned about the impact of firm characteristics (such as size, age, sector, export-orientation, weight of output, etc.) on their reaction mode.

Table 1. SCUT highways and affected municipalities

Highway	Affected Municipalities
Tolls introduced on *October 15th, 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 *December 8th, 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, Constância, Abrantes, Mação, Gavião, Vila Velha de Rodão, Vila Nova da Barquinha, Castelo Branco, Fundão, Belmonte, Covilhã, 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	Ílhavo, Aveiro, Albergaria-a-Velha, Sever do Vouga, Oliveira de Frades, Vouzela, Viseu, Mangualde, Fornos de Algodres, Celorico da Beira, Guarda, Pinhel, Almeida

Figure 1. Geographical distribution of municipalities with and without SCUT Highways



Note: Treated municipalities in dark green. Comparison group of municipalities in light green.

Figure 2. Driving distances from Portuguese municipalities (town halls) to charged (formerly free) SCUT highways in 2011

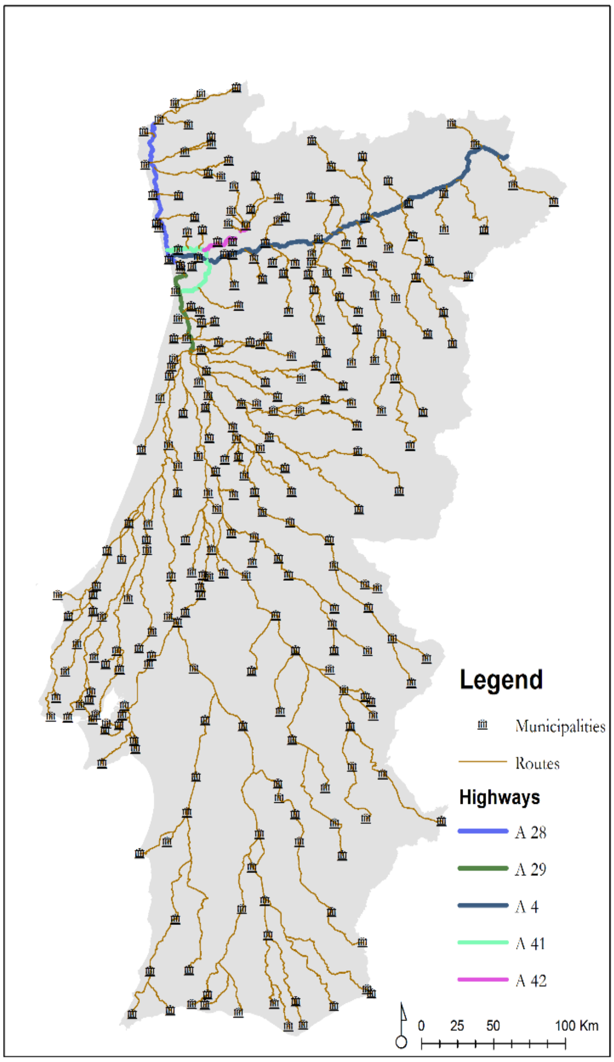


Figure 3. Driving distances from Portuguese municipalities (town halls) to charged (formerly free) SCUT highways from 2012 on

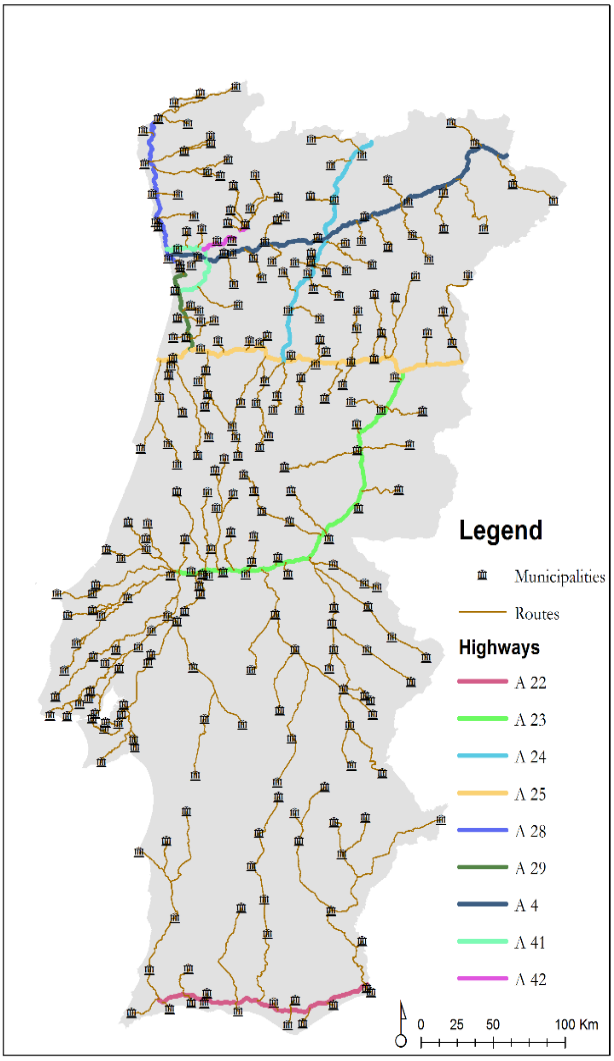


Table 2. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Firms					
Total_PC	1946	1.956	0.587	0.798	5.103
Sector 1_PC	1946	0.147	0.146	0	0.880
Sector 2_PC	1946	0.549	0.250	0.077	1.530
Sector 3_PC	1946	1.260	0.498	0.308	4.621
Size Micro_PC	1946	0.874	0.284	0.282	2.859
Size Small_PC	1946	0.844	0.261	0.270	1.918
Size Medium to Large_PC	1946	0.238	0.126	0	0.716
Employees					
Total_PC	1946	13.277	6.732	2.572	46.650
Sector 1_PC	1946	0.922	1.300	0	14.390
Sector 2_PC	1946	6.375	5.016	0.231	33.905
Sector 3_PC	1946	5.979	3.852	0.809	40.828
Size Micro_PC	1946	1.266	0.403	0.382	3.909
Size Small_PC	1946	4.249	1.378	1.416	9.781
Size Medium to Large_PC	1946	7.762	5.575	0	38.106
Vector of controls					
Population Density	1946	0.310	0.844	0.005	7.384
Age Dependency Ratio	1946	0.591	0.119	0.376	1.088
Unemployment Rate	1946	0.090	0.083	0.004	0.194
Unemp Share_Not First	1946	0.894	0.047	0.693	0.990
Sales Index	1946	3.597	7.882	0.190	113.230
Mayor Tenure	1946	10.520	7.445	1.000	37.000
Business Tax Rate	1946	0.009	0.007	0	0.015
Same Political Party dummy	1946	0.405	0.491	0	1
Highways dummy	1946	0.562	0.496	0	1

Notes: PC stands for “per 100 inhabitants”. For a detailed description of the variables (including data sources) see Table A1.

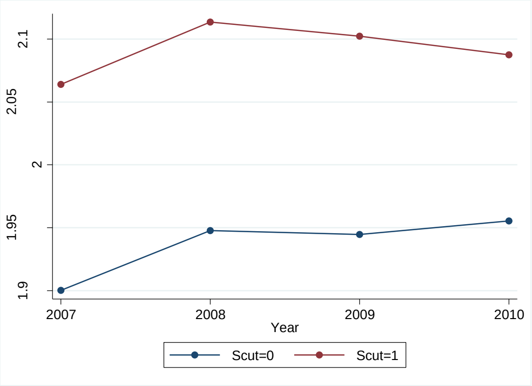
Table 3. Balance test

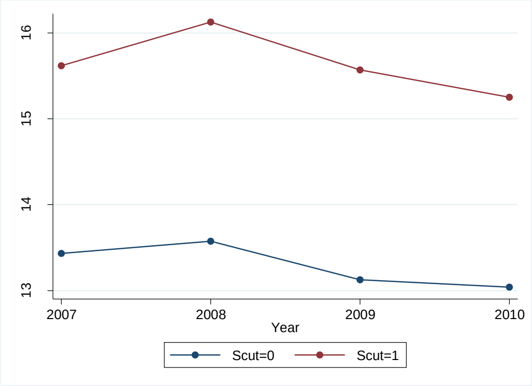
Variable	Treatment group	Comparison group	Difference
Population Density	0.358	0.299	0.059
Age Dependency Ratio	0.551	0.601	-0.05***
Unemployment Rate	0.07	0.078	-0.008
Unemp Share_ NotFirst	0.902	0.892	0.01
Sales Index	4.336	3.398	0.937
Mayor Tenure	9.538	10.285	-0.747
Business Tax Rate	0.009	0.008	0.001
Same Political Party dummy	0.356	0.387	-0.031

Notes: Standard errors are clustered at the municipal level and robust to heteroscedasticity. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). The results are computed taking the averages for the pre-treatment period (2007-2010). These results still hold if we consider only the last pre-treatment year. i.e. 2010.

Figure 4. Parallel trends assumption

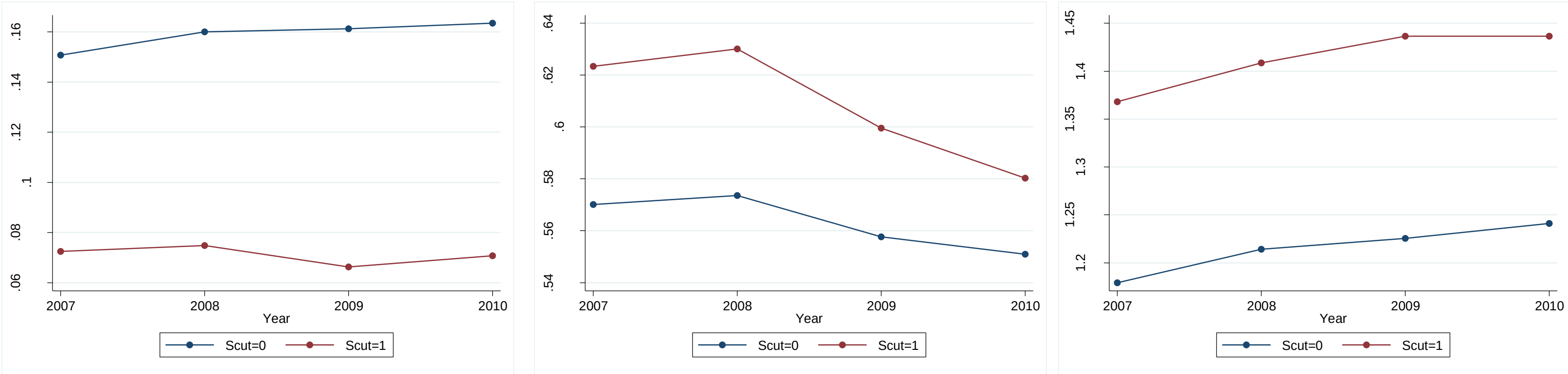
1. Number of Firms and Number of Employees (total, per 100 inhabitants)



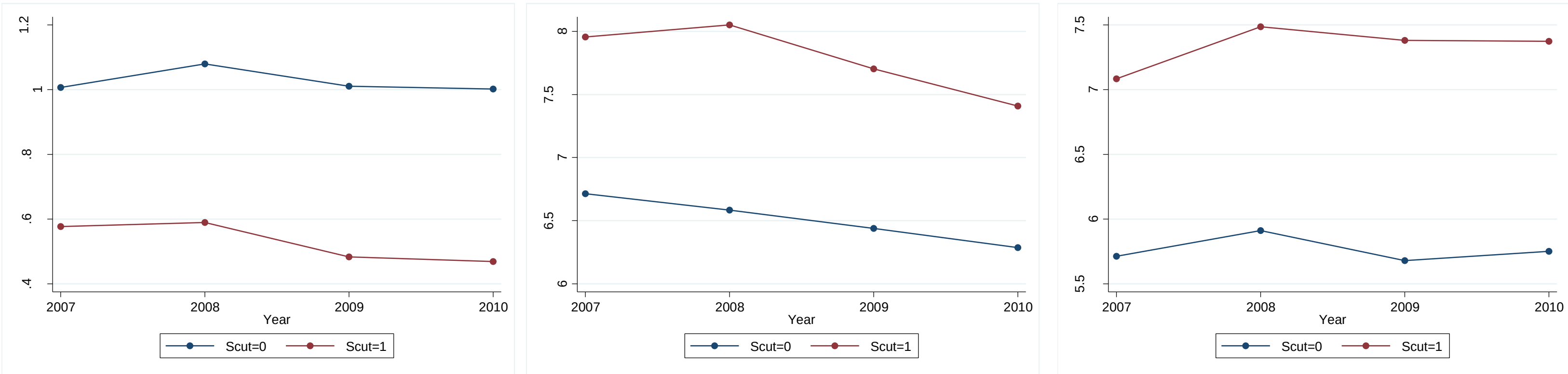


2. Number of Firms and Number of Employees per sector (sector 1, sector 2, and sector 3)

(a) Number of Firms

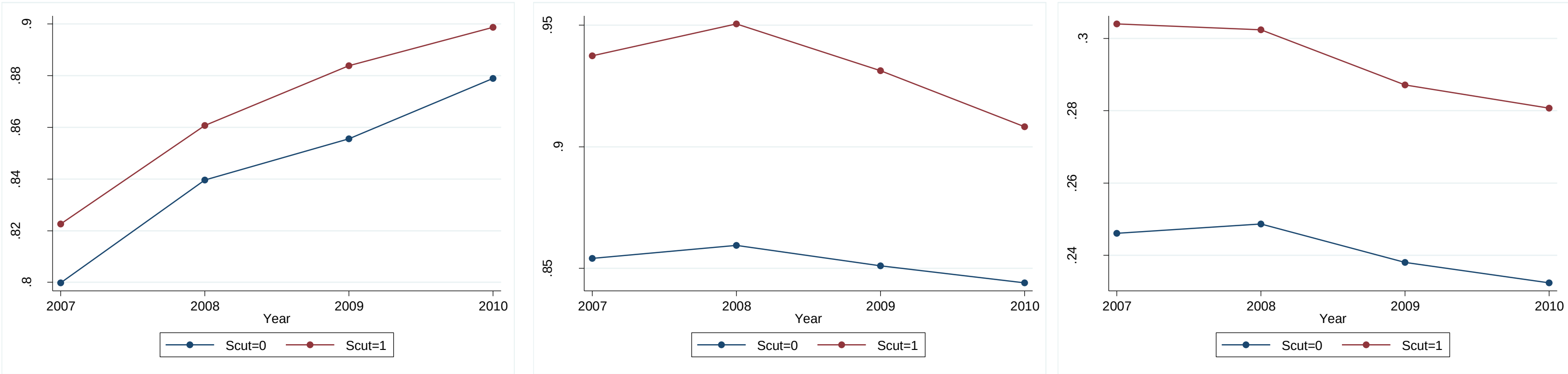


(b) Employees

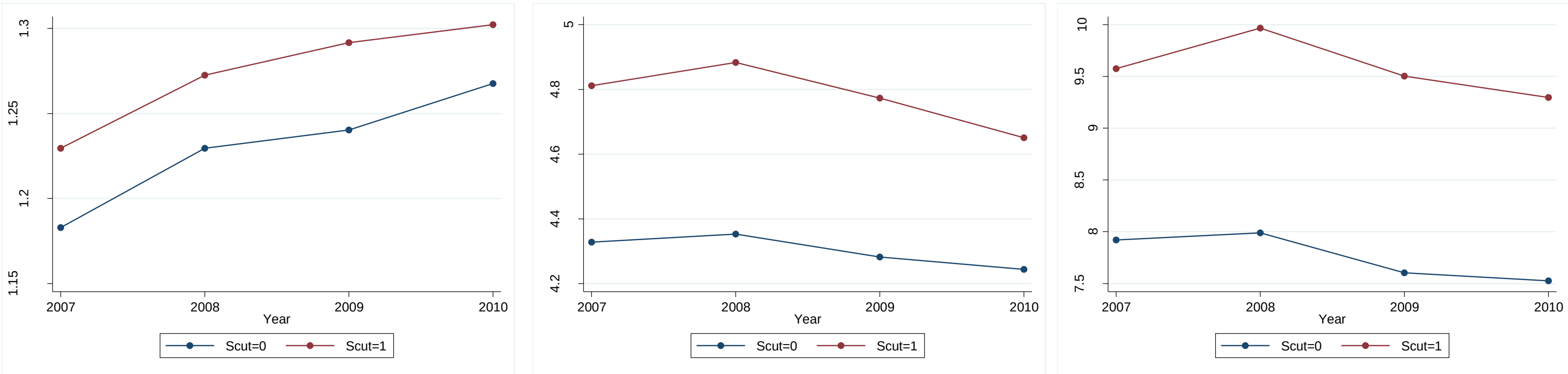


3. Number of Firms and Number of Employees by Firm size

(a) Number of Firms



(b) Employees



Notes: Firm size 'micro' = 1 – 2 employees; 'small' = 3–10 employees; 'medium and large' = more than 10 employees

Table 4. Baseline Results: Number of Firms (per 100 inhabitants)

	Total		**Sector of Activity**						**Firm Size (No. of Workers)**					
			Sector 1		Sector 2		Sector 3		Size 1-2		Size 3-10		Size >10	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
$Scut \cdot dT_i$	-0.036**	-0.031*	-0.009**	-0.008**	-0.026**	-0.023**	-0.001	-0.000	0.006	0.004	-0.029**	-0.022**	-0.014***	-0.014***
	(0.018)	(0.017)	(0.004)	(0.004)	(0.010)	(0.010)	(0.011)	(0.012)	(0.009)	(0.009)	(0.011)	(0.011)	(0.005)	(0.005)
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2	0.057	0.094	0.098	0.12	0.259	0.28	0.072	0.085	0.263	0.271	0.213	0.266	0.367	0.371

Notes: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Uneven columns display the results without consideration of control variables, whereas even columns show the results for the treatment variable when the whole vector of controls is considered. The vector of time-varying controls includes Population Density, Age Dependency Ratio, Unemployment Rate, Unemp Share_Not First, Sales Index, Mayor Tenure, Business Tax Rate, Same Political Party dummy, and a Highways dummy. For a detailed description of these variables see Table A1. Table A3 presents the point estimates for the vector of time-varying controls. Stars indicate significance levels of 10% (*), 5% (**), and 1% (***).

Table 5. Baseline Results: Number of Employees (per 100 inhabitants)

	Total		**Sector of Activity**						**Firm Size (No. of Workers)**					
			Sector 1		Sector 2		Sector 3		Size 1-2		Size 3-10		Size >10	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
$Scut \cdot dT_i$	-0.648***	-0.529**	-0.079**	-0.070**	-0.442**	-0.365*	-0.126	-0.094	0.005	0.003	-0.166***	-0.133**	-0.487**	-0.399**
	(0.232)	(0.221)	(0.033)	(0.030)	(0.198)	(0.187)	(0.103)	(0.104)	(0.015)	(0.014)	(0.062)	(0.059)	(0.213)	(0.203)
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2	0.267	0.285	0.007	0.010	0.254	0.265	0.076	0.085	0.146	0.158	0.264	0.301	0.206	0.216

Notes: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Uneven columns display the results without consideration of control variables, whereas even columns show the results for the treatment variable when the whole vector of controls is considered. The vector of time-varying controls includes Population Density, Age Dependency Ratio, Unemployment Rate, Unemp Share_Not First, Sales Index, Mayor Tenure, Business Tax Rate, Same Political Party dummy, and a Highways dummy. For a detailed description of these variables see Table A1. Table A4 presents the point estimates for the vector of time-varying controls. Stars indicate significance levels of 10% (*), 5% (**), and 1% (***).

Table 6. Considering more distant municipalities and distance decay (p)

	Number of Firms PC					Number of Employees PC				
	Total	**Sector of Activity**		**Size**		**Total**	**Sector of Activity**		**Size**	
		Sector 1	Sector 2	Size 3-10	Size >10		Sector 1	Sector 2	Size 3-10	Size >10
p=0.05	0.004	-0.011*	-0.018	-0.005	-0.013**	-0.495*	-0.095	-0.467**	-0.045	-0.489*
	(0.025)	(0.006)	(0.012)	(0.015)	(0.006)	(0.286)	(0.058)	(0.223)	(0.077)	(0.254)
p=0.1	-0.022	-0.012*	-0.031**	-0.02	-0.020***	-0.739**	-0.102*	-0.592**	-0.123	-0.645**
	(0.027)	(0.006)	(0.014)	(0.017)	(0.007)	(0.329)	(0.056)	(0.261)	(0.088)	(0.293)
p=0.15	-0.032	-0.013*	-0.035**	-0.025	-0.024***	-0.850**	-0.110*	-0.644**	-0.148	-0.726**
	(0.030)	(0.007)	(0.017)	(0.019)	(0.009)	(0.372)	(0.059)	(0.294)	(0.101)	(0.334)
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2										
p=0.05	0.053	0.098	0.254	0.208	0.364	0.261	0.007	0.252	0.258	0.204
p=0.1	0.053	0.098	0.256	0.209	0.367	0.263	0.006	0.253	0.259	0.205
p=0.15	0.054	0.097	0.256	0.209	0.367	0.263	0.006	0.252	0.259	0.204

Notes: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Results with the set of controls considered in Tables 4 and 5 are very similar. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). PC stands for “per 100 inhabitants”.

Table 7. Results excluding municipalities close to Lisbon

	Number of Firms PC					**Number of Employees PC**				
	Total	**Sector of Activity**		**Size**		**Total**	**Sector of Activity**		**Size**	
		Sector 1	Sector 2	Size 3-10	Size >10		Sector 1	Sector 2	Size 3-10	Size >10
Excluding all municipalities in distances below 100 km to Lisbon										
$Scut \cdot dT_i$	-0.091***	-0.008**	-0.054***	-0.060***	-0.022***	-0.995***	-0.059**	-0.664***	-0.339***	-0.634***
	(0.019)	(0.004)	(0.011)	(0.013)	(0.006)	(0.249)	(0.029)	(0.222)	(0.067)	(0.230)
N	1 309	1 309	1 309	1 309	1 309	1 309	1 309	1 309	1 309	1 309
Adjusted R2	0.091	0.107	0.179	0.145	0.322	0.223	0.015	0.201	0.201	0.180
Excluding all municipalities in distances below 150 km to Lisbon										
$Scut \cdot dT_i$	-0.069***	-0.011***	-0.040***	-0.047***	-0.019***	-0.934***	-0.097**	-0.580***	-0.047***	-0.019***
	(0.018)	(0.004)	(0.011)	(0.012)	(0.005)	(0.237)	(0.038)	(0.204)	(0.012)	(0.005)
N	1 596	1 596	1 596	1 596	1 596	1 596	1 596	1 596	1 596	1 596
Adjusted R2	0.063	0.114	0.196	0.159	0.322	0.222	0.006	0.213	0.159	0.322
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Results with the set of controls considered in Tables 4 and 5 are very similar. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). PC stands for "per 100 inhabitants".

Table 8. Results excluding Large Urban Regions (Lisbon and Oporto Metropolitan Areas)

	Number of Firms PC					Number of Employees PC				
	Total	**Sector of Activity**		**Size**		**Total**	**Sector of Activity**		**Size**	
		Sector 1	Sector 2	Size 3-10	Size >10		Sector 1	Sector 2	Size 3-10	Size >10
$Scut \cdot dT_i$	-0.054***	-0.011**	-0.030**	-0.039***	-0.016***	-0.775***	-0.098***	-0.482**	-0.220***	-0.550**
	(0.020)	(0.004)	(0.012)	(0.013)	(0.006)	(0.277)	(0.038)	(0.237)	(0.072)	(0.256)
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2	0.051	0.112	0.207	0.167	0.321	0.227	0.007	0.210	0.218	0.174

Notes: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Results with the set of controls considered in Tables 4 and 5 are very similar. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). PC stands for "per 100 inhabitants".

Table 9. Results excluding District Capitals

	Number of Firms PC					Number of Employees PC				
	Total	**Sector of Activity**		**Size**		**Total**	**Sector of Activity**		**Size**	
		Sector 1	Sector 2	Size 3-10	Size >10		Sector 1	Sector 2	Size 3-10	Size >10
$Scut \cdot dT_i$	-0.038**	-0.038**	-0.030***	-0.030**	-0.016***	-0.764***	-0.093***	-0.519**	-0.176***	-0.595**
	(0.019)	(0.019)	(0.011)	(0.012)	(0.005)	(0.255)	(0.035)	(0.219)	(0.066)	(0.236)
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2	0.052	0.098	0.242	0.191	0.348	0.253	0.006	0.247	0.240	0.198

Notes: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Results with the set of controls considered in Tables 4 and 5 are very similar. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). PC stands for "per 100 inhabitants".

Table 10. Parametric Event Study

	No of Firms PC	No of Employees PC
	Total	**Total**
Scut * Year_2007	0.024	-0.120
	(0.023)	(0.298)
Scut * Year_2008	0.018	0.194
	(0.019)	(0.249)
Scut * Year_2009	0.013	0.089
	(0.014)	(0.186)
Scut * Year_2011	**-0.049*** **	**-0.446***
	(0.018)	**(0.270)**
Scut * Year_2012	**-0.039****	**-0.561****
	(0.018)	**(0.267)**
Scut * Year_2013	**-0.036**	**-0.725****
	(0.023)	**(0.320)**
Scut Dummy	Yes	Yes
Year Fixed Effects	Yes	Yes
N	1 946	1 946
Adjusted R2	0.388	0.393

Notes: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Results with the set of controls considered in Tables 4 and 5 are very similar. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). PC stands for “per 100 inhabitants”.

Table 11. Placebo Regressions

	Number of Firms PC					Number of Employees PC				
	Total	**Sector of Activity**		**Size**		**Total**	**Sector of Activity**		**Size**	
		Sector 1	Sector 2	Size 3-10	Size >10		Sector 1	Sector 2	Size 3-10	Size >10
$Scut \cdot dT_i$	-0.020	-0.012***	-0.019	-0.015	-0.007*	-0.041	-0.070	-0.162	-0.058	0.019
	(0.015)	(0.004)	(0.012)	(0.010)	(0.004)	(0.199)	(0.055)	(0.211)	(0.051)	(0.183)
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2	0.084	0.033	0.078	0.029	0.123	0.072	0.009	0.059	0.04	0.062

Notes: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Results with the set of controls considered in Tables 4 and 5 are very similar. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). PC stands for "per 100 inhabitants".

Table 12. Including District Trends

	Number of Firms PC					Number of Employees PC				
	Total	**Sector of Activity**		**Size**		**Total**	**Sector of Activity**		**Size**	
		Sector 1	Sector 2	Size 3-10	Size >10		Sector 1	Sector 2	Size 3-10	Size >10
$Scut \cdot dT_i$	-0.037**	-0.009**	-0.027***	-0.029**	-0.014***	-0.634***	-0.077**	-0.432**	-0.168***	-0.471**
	(0.018)	(0.004)	(0.010)	(0.012)	(0.005)	(0.231)	(0.032)	(0.197)	(0.062)	(0.211)
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District-Specific Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2	0.057	0.098	0.259	0.214	0.367	0.271	0.008	0.258	0.265	0.214

Notes: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Results with the set of controls considered in Tables 4 and 5 are very similar. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). PC stands for "per 100 inhabitants".

Table 13. Results for different comparison groups

	Number of Firms PC					Number of Employees PC				
	Total	**Sector of Activity**		**Size**		**Total**	**Sector of Activity**		**Size**	
		Sector 1	Sector 2	Size 3-10	Size >10		Sector 1	Sector 2	Size 3-10	Size >10
Comparison group A										
$Scut \cdot dT_i$	-0.039	0.001	-0.020	-0.021	-0.006	-0.280	0.013	-0.017	-0.140*	-0.119
	(0.025)	(0.005)	(0.014)	(0.014)	(0.007)	(0.321)	(0.025)	(0.261)	(0.074)	(0.289)
N	626	626	626	626	626	626	626	626	626	626
Adjusted R2	0.106	0.081	0.349	0.393	0.471	0.345	0.097	0.304	0.431	0.262
Comparison group B										
$Scut \cdot dT_i$	0.066***	0.009***	0.016	0.038***	0.003	0.331	-0.018	0.130	0.151**	0.128
	(0.023)	(0.003)	(0.010)	(0.014)	(0.005)	(0.262)	(0.031)	(0.172)	(0.072)	(0.228)
N	602	602	602	602	602	602	602	602	602	602
Adjusted R2	0.300	0.078	0.483	0.532	0.581	0.418	0.076	0.351	0.554	0.299
Baseline Results										
$Scut \cdot dT_i$	-0.031*	-0.008**	-0.023**	-0.022**	-0.014***	-0.529**	-0.070**	-0.365*	-0.133**	-0.399**
	-0.017	-0.004	-0.01	-0.011	-0.005	-0.221	-0.03	-0.187	-0.059	-0.203
N	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2	0.094	0.12	0.28	0.266	0.371	0.285	0.01	0.265	0.301	0.216
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Results with the set of controls considered in Tables 4 and 5 are very similar. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). PC stands for “per 100 inhabitants”.

APPENDIX

Table A1: Variable description and data sources

Variable	Operational Description	Data source
Dependent Variables		
Number of Firms	Number of strictly private businesses, without branches, with at least one paid employee	*IES*
Number of Employees	Number of employees working in strictly private businesses, without branches, with at least one paid employee	*IES*
Treatment		
Scut	Scut dummy. Binary indicator that takes value one if the municipality is traversed by a SCUT highway and has direct access (a ramp) to that SCUT highway. For more information see Table 1	*ANSR*
dTi	Treatment period dummy. Binary indicator that takes value one in periods after the introduction of tolls and zero otherwise. More information is given in the text.	
Controls		
Population density	Total number of citizens inhabiting a given municipality divided by the respective total area	*INE*
Age Dependency Ratio	Ratio of individuals typically not in the labor force (aged 0-14 and 65+) and active population (aged 15-64)	*INE*
Unemployment Rate	Ratio of registered unemployed per 100 active aged individuals in the municipality (Percentage)	*IEFP*
UnempShare_Not First	Share of the unemployed that were already employed, at least once, in the past per municipality (Percentage)	*IEFP*
Sales Index	This index takes into account both population and wealth in each municipality. It is computed according to the following equation: $$Sales\ Index\ m = 0.2\ Pop\ m + 0.8\ (\sum_{j=1}^{5} Wmj)/5$$ Where $Pop\ m$ is the share of municipality m in the national population, and Wmj is the weight of the municipality m in the country total regarding each of the five variables j (fiscal burden, electricity consumption, number of cars sold, number of bank agencies, and number of retail commercial establishments). $Sales\ Index$ is normalized so that a value of 100 corresponds to the country average	*Marktest*
Mayor Tenure	Number of consecutive years that the mayor of a given municipality remains is in power	*DGAL*
Business Tax Rate	Tax rate set by the Municipal Assembly that is paid by the firms in each municipality	*DGAL*
Same Political Party dummy	Binary variable that takes the value one if the prime minister and the mayor of a given municipality belong to the same national party	*CNE*
Highways dummy	Binary variable that takes the value one if there is at least one highway crossing a given municipality	*ANSR*

Note: Simplified Business Information IES (*Informação Estatística Simplificada*) database; INE (*Statistics Portugal*); IEFP (*Instituto de Emprego e Formação Profissional*) - National Employment Agency; Marktest, a private company that builds indicators for Portuguese municipalities; DGAL (*Direção Geral das Autarquias Locais*) - government body for local institutions; CNE (*Comissão Nacional de Eleições*) - government body for elections; ANSR (*Autoridade Nacional de Segurança Rodoviária*) - government body for road security.

Table A2: Correlation Matrix.

	Firms: Total_PC	Employees: Total_PC	Population Density	Age Dependency Ratio	Unemployment Rate	Unemp Share_Not First	Sales Index	Mayor Tenure	Business Tax Rate	Same Political Party dummy	Highways dummy
Firms: Total_PC	1										
Employees: Total_PC	0.792	1									
Population Density	0.391	0.318	1								
Age Dependency Ratio	-0.436	-0.541	-0.277	1							
Unemployment Rate	-0.067	-0.044	-0.029	-0.049	1						
Unemp Share_Not First	0.364	0.311	0.263	-0.297	0.081	1					
Sales Index	0.510	0.412	0.693	-0.254	-0.057	0.241	1				
Mayor Tenure	0.018	-0.015	-0.004	-0.040	-0.020	0.024	-0.010	1			
Business Tax Rate	0.298	0.327	0.245	-0.388	0.021	0.265	0.259	0.034	1		
Same Political Party dummy	-0.019	-0.037	-0.017	0.031	0.010	-0.015	-0.037	0.007	-0.006	1	
Highways dummy	0.341	0.397	0.195	-0.402	0.001	0.297	0.288	-0.022	0.343	0.013	1

Table A3: Number of Firms

	Total_PC	Total_PC	Sector 1_PC	Sector 1_PC	Sector 2_PC	Sector 2_PC	Sector 3_PC	Sector 3_PC	Size Micro_PC	Size Micro_PC	Size Small_PC	Size Small_PC	Size Medium and Large_PC	Size Medium and Large_PC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
$Scut \cdot dT_i$	-0.036**	-0.031*	-0.009**	-0.008**	-0.026**	-0.023**	-0.001	-0.000	0.006	0.004	-0.029**	-0.022**	-0.014***	-0.014***
	(0.018)	(0.017)	(0.004)	(0.004)	(0.010)	(0.010)	(0.011)	(0.012)	(0.009)	(0.009)	(0.011)	(0.011)	(0.005)	(0.005)
Population Density		0.069		0.008		-0.001		0.062		0.067*		0.002		0.000
		(0.065)		(0.008)		(0.021)		(0.045)		(0.040)		(0.034)		(0.010)
Age Dependency Ratio		-1.404***		-0.256**		-0.622***		-0.525**		-0.199		-1.136***		-0.068
		(0.425)		(0.104)		(0.221)		(0.242)		(0.275)		(0.206)		(0.077)
Unemployment Rate		-0.094		-0.069		-0.043		0.018		0.033		-0.068		-0.060
		(0.199)		(0.052)		(0.103)		(0.100)		(0.107)		(0.145)		(0.049)
UnempShare_NotFirst		-0.236		-0.112**		-0.035		-0.088		-0.210**		0.006		-0.032
		(0.193)		(0.049)		(0.096)		(0.120)		(0.104)		(0.117)		(0.041)
Sales Index		0.002		-0.001		0.005		-0.003		-0.001		0.003		0.001
		(0.005)		(0.001)		(0.003)		(0.006)		(0.006)		(0.003)		(0.002)
Mayor Tenure		-0.000		0.000		-0.000		-0.000		0.001*		-0.001		-0.000
		(0.001)		(0.000)		(0.001)		(0.001)		(0.001)		(0.001)		(0.000)
Business Tax Rate		-0.765		-0.485*		0.215		-0.496		-0.267		-0.587		0.089
		(1.502)		(0.293)		(0.875)		(0.880)		(0.733)		(0.879)		(0.359)
Same Political Party dummy		0.006		-0.000		-0.002		0.008		0.003		0.002		0.001
		(0.010)		(0.002)		(0.005)		(0.006)		(0.005)		(0.006)		(0.002)
Highways dummy		0.010		0.003		0.003		0.004		-0.034		0.038		0.005
		(0.049)		(0.010)		(0.020)		(0.030)		(0.030)		(0.026)		(0.012)
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2	0.057	0.094	0.098	0.120	0.259	0.280	0.072	0.085	0.263	0.271	0.213	0.266	0.367	0.371

Note: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Stars indicate significance levels of 10% (*), 5% (**), and 1% (***). PC stands for "per 100 inhabitants".

Table A4: Number of Employees

	Total_PC	Total_PC	Sector 1_PC	Sector 1_PC	Sector 2_PC	Sector 2_PC	Sector 3_PC	Sector 3_PC	Size Micro_PC	Size Micro_PC	Size Small_PC	Size Small_PC	Size Medium and Large_PC	Size Medium and Large_PC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
$Scut \cdot dT_i$	-0.648***	-0.529**	-0.079**	-0.070**	-0.442**	-0.365*	-0.126	-0.094	0.005	0.003	-0.166***	-0.133**	-0.487**	-0.399**
	(0.232)	(0.221)	(0.033)	(0.030)	(0.198)	(0.187)	(0.103)	(0.104)	(0.015)	(0.014)	(0.062)	(0.059)	(0.213)	(0.203)
Population Density		-0.059		0.038		-0.095		-0.002		0.077		0.037		-0.172
		(0.815)		(0.046)		(0.248)		(0.651)		(0.049)		(0.168)		(0.710)
Age Dependency Ratio		-9.991***		-0.175		-5.916**		-3.900***		-0.511		-5.385***		-4.094
		(3.278)		(0.862)		(2.578)		(1.487)		(0.393)		(1.172)		(2.741)
Unemployment Rate		-2.770		0.605		-2.327		-1.048		0.028		-0.247		-2.552
		(2.574)		(0.617)		(2.121)		(1.544)		(0.164)		(0.791)		(2.363)
UnempShare_NotFirst		-0.810		-0.648		1.042		-1.204		-0.319**		0.129		-0.621
		(1.779)		(0.570)		(1.415)		(0.834)		(0.158)		(0.603)		(1.497)
Sales Index		-0.064		0.006		-0.020		-0.050		-0.002		0.010		-0.073*
		(0.044)		(0.005)		(0.040)		(0.059)		(0.007)		(0.013)		(0.041)
Mayor Tenure		-0.024		-0.005		-0.012		-0.007		0.002		-0.005		-0.020
		(0.018)		(0.007)		(0.010)		(0.009)		(0.001)		(0.005)		(0.016)
Business Tax Rate		-6.856		-4.330		0.368		-2.894		0.659		-2.206		-5.309
		(15.032)		(2.772)		(11.846)		(8.023)		(1.164)		(4.455)		(12.793)
Same Political Party dummy		-0.176*		0.006		-0.155*		-0.027		-0.001		0.003		-0.177*
		(0.106)		(0.023)		(0.084)		(0.049)		(0.008)		(0.031)		(0.091)
Highways dummy		0.303		0.046		0.194		0.062		-0.052		0.132		0.222
		(0.477)		(0.082)		(0.327)		(0.182)		(0.046)		(0.117)		(0.371)
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2	0.267	0.285	0.007	0.010	0.254	0.265	0.076	0.085	0.146	0.158	0.264	0.301	0.206	0.216

Note: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). PC stands for "per 100 inhabitants".

Table A5: Results of Baseline Model without Highway Dummy

	No of Firms							No of Employees						
	Total_PC	Sector 1_PC	Sector 2_PC	Sector 3_PC	Size Micro_PC	Size Small_PC	Size Medium and Large_PC	Total_PC	Sector 1_PC	Sector 2_PC	Sector 3_PC	Size Micro_PC	Size Small_PC	Size Medium and Large_PC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	-0.032*	-0.008**	-0.023**	-0.000	0.005	-0.023**	-0.014***	-0.541**	-0.072**	-0.372**	-0.096	0.005	-0.138**	-0.408**
	(0.017)	(0.004)	(0.010)	(0.012)	(0.009)	(0.011)	(0.005)	(0.221)	(0.030)	(0.186)	(0.103)	(0.014)	(0.058)	(0.203)
Population Density	0.070	0.008	-0.001	0.063	0.064	0.005	0.001	-0.031	0.042	-0.077	0.004	0.072	0.049	-0.151
	(0.065)	(0.008)	(0.020)	(0.045)	(0.040)	(0.032)	(0.010)	(0.817)	(0.045)	(0.243)	(0.653)	(0.050)	(0.163)	(0.713)
Age Dependency Ratio	-1.402***	-0.256**	-0.622***	-0.525**	-0.205	-1.130***	-0.067	-9.941***	-0.168	-5.884**	-3.889***	-0.519	-5.364***	-4.058
	(0.425)	(0.104)	(0.221)	(0.242)	(0.275)	(0.206)	(0.077)	(3.279)	(0.862)	(2.578)	(1.486)	(0.395)	(1.172)	(2.742)
Unemployment Rate	-0.093	-0.069	-0.043	0.019	0.030	-0.064	-0.059	-2.744	0.609	-2.310	-1.042	0.024	-0.235	-2.532
	(0.198)	(0.053)	(0.103)	(0.100)	(0.109)	(0.145)	(0.049)	(2.573)	(0.616)	(2.120)	(1.543)	(0.167)	(0.792)	(2.362)
UnempShare_NotFirst	-0.232	-0.111**	-0.034	-0.087	-0.222**	0.020	-0.030	-0.701	-0.632	1.113	-1.182	-0.337**	0.177	-0.540
	(0.190)	(0.049)	(0.095)	(0.119)	(0.105)	(0.117)	(0.041)	(1.762)	(0.570)	(1.408)	(0.827)	(0.159)	(0.597)	(1.488)
Sales Index	0.002	-0.001	0.005	-0.003	-0.001	0.002	0.001	-0.065	0.006	-0.021	-0.051	-0.001	0.010	-0.074*
	(0.005)	(0.001)	(0.003)	(0.006)	(0.006)	(0.003)	(0.002)	(0.043)	(0.005)	(0.041)	(0.058)	(0.007)	(0.014)	(0.040)
Mayor Tenure	-0.000	0.000	-0.000	-0.000	0.001	-0.001	-0.000	-0.023	-0.005	-0.011	-0.007	0.002	-0.005	-0.020
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.019)	(0.007)	(0.010)	(0.009)	(0.001)	(0.005)	(0.016)
Business Tax Rate	-0.772	-0.487*	0.214	-0.499	-0.242	-0.615	0.085	-7.075	-4.363	0.228	-2.939	0.696	-2.302	-5.469
	(1.502)	(0.293)	(0.876)	(0.880)	(0.735)	(0.880)	(0.359)	(15.024)	(2.771)	(11.838)	(8.021)	(1.167)	(4.454)	(12.785)
Same Political Party dummy	0.006	-0.000	-0.002	0.008	0.003	0.002	0.001	-0.176*	0.006	-0.155*	-0.027	-0.001	0.002	-0.178*
	(0.010)	(0.002)	(0.005)	(0.006)	(0.005)	(0.006)	(0.002)	(0.106)	(0.023)	(0.085)	(0.049)	(0.008)	(0.031)	(0.092)
Municipal Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946	1 946
Adjusted R2	0.094	0.121	0.280	0.086	0.270	0.264	0.371	0.285	0.010	0.265	0.086	0.156	0.300	0.217

Note: Standard errors (in brackets) are clustered at the municipal level and robust to heteroscedasticity. Stars indicate significance levels of 10% (*). 5% (**). and 1% (***). PC stands for “per 100 inhabitants

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Annex 1 – Description of reform indicators

World competitiveness index indicators	
Institutions	Determined by the legal and administrative framework within which individuals, firms, and governments interact to generate wealth. Considers management of public finances, private-sector transparency, property rights among others.
Infrastructure	Considers modes of transport, electricity supplies and a solid and extensive telecommunications network to measure the extension and efficiency of a country's infrastructure.
Health and primary education	Takes into account the quantity and quality of the basic education received by the population, in addition to the investment in the provision of health services.
Higher education and training	Measures secondary and tertiary enrollment rates as well as the quality of education as evaluated by business leaders. The extent of staff training is also taken into consideration.
Goods market	Considers healthy market competition, both domestic and foreign and demand conditions such as customer orientation and buyer sophistication.
Labor market	Takes into account the flexibility to shift workers from one economic activity to another rapidly and at low cost, and to allow for wage fluctuations without much social disruption as well as the incentives for employees and the promotion of meritocracy at the workplace. Considers also the equity in the business environment between women and men.
Financial market	Measures the sophistication of financial markets: sound banking sector, well-regulated securities exchanges, venture capital, and other financial products, as well as, the trustworthiness and transparency of the banking sector.
Technological readiness	Measures the agility with which an economy adopts existing technologies to enhance the productivity of its industries, with specific emphasis on its capacity to fully leverage information and communication technologies (ICTs) in daily activities and production processes for increased efficiency and enabling innovation for competitiveness.
Business sophistication	Concerns two elements that are intricately linked: the quality of a country's overall business networks and the quality of individual firms' operations and strategies.
Innovation	Considers the environment that is conducive to innovative activity and supported by both the public and the private sectors. In particular, it means sufficient investment in (R&D), especially by the private sector; the presence of high-quality scientific research institutions; extensive collaboration in research and technological developments between universities and industry; and the protection of intellectual property.
Doing Business indicators	
Starting a business	This topic measures the paid-in minimum capital requirement, number of procedures, time and cost for a small- to medium-sized limited liability company to start up and formally operate in economy's largest business city. In this paper the indicator considered covers the number of procedures.
Paying taxes	This topic records the taxes and mandatory contributions that a medium-size company must pay or withhold in a given year, as well as measures the administrative burden in paying taxes and contributions. In this paper the indicator considered is the tax rate.
Resolving insolvency	This topic identifies weaknesses in existing insolvency law and the main procedural and administrative bottlenecks in the insolvency process. The indicator considered in our analysis is the recovery rate.
OECD Product Market Reforms indicator	
Network sectors	Summarizes regulatory provisions in seven sectors: telecoms, electricity, gas, post, rail, air passenger transport, and road.

Annex 2 – Reform indicators – 2006-2014

Reform variables	Source	2006	2007	2008	2009	2010	2011	2012	2013	2014
Institutions (1-7; 7 best)	WCI	4,91	4,87	4,75	4,49	4,37	4,20	4,28	4,32	4,43
Infrastructure (1-7; 7 best)	WCI	4,83	4,98	5,07	5,23	5,30	5,48	5,50	5,55	5,66
Health and primary education (1-7; 7 best)	WCI	6,56	6,04	6,00	5,95	6,13	6,12	6,19	6,28	6,39
Higher education and training (1-7; 7 best)	WCI	4,62	4,62	4,59	4,58	4,76	4,82	4,98	5,15	5,37
Goods market (1-7; 7 best)	WCI	4,49	4,59	4,53	4,39	4,32	4,27	4,31	4,26	4,58
Labor market (1-7; 7 best)	WCI	4,12	4,14	4,18	4,04	3,85	3,79	3,80	3,79	4,09
Financial market (1-7; 7 best)	WCI	4,80	4,94	4,71	4,26	4,26	3,98	3,71	3,50	3,65
Technological readiness (1-7; 7 best)	WCI	4,09	4,28	4,51	4,73	4,63	5,31	5,27	5,24	5,42
Business sophistication (1-7; 7 best)	WCI	4,23	4,37	4,39	4,28	4,19	4,19	4,17	4,18	4,29
Innovation (1-7; 7 best)	WCI	3,70	3,71	3,66	3,69	3,77	3,77	3,86	3,93	4,08
Starting a Business (N Procedures)	DB	8,00	7,00	6,00	6,00	6,00	6,00	6,00	5,00	5,00
Paying Taxes (Total tax rate)	DB	43,80	42,90	42,50	42,30	42,60	42,60	41,90	42,30	42,30
Resolving Insolvency (Recovery rate)	DB	75,00	74,00	69,40	69,40	72,60	70,90	74,60	71,60	72,20
Network sectors (0-6; 0 best)	OECD	2,57	2,55	2,55	2,55	2,37	2,31	2,31	2,18	-

Annex 3 – Regression output – equation (1) – dependent variable: firm-level TFP growth

Regression (1)

	Total factor productivity growth													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Institutions	Infrastructure	Health&Prim education	Goods market	Labor market	Higher education	Financial market	Technological readiness	Business sophistication	Innovation	Starting a business - procedures	Paying Taxes - Tax rate	Resolving insolvency - recovery rate	Network sectors
D.lnFront	0,898***	0,898***	0,898***	0,898***	0,898***	0,898***	0,898***	0,898***	0,898***	0,898***	0,898***	0,898***	0,898***	0,898***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
L.DTF	0,545***	0,545***	0,545***	0,545***	0,545***	0,545***	0,545***	0,545***	0,545***	0,545***	0,545***	0,545***	0,545***	0,545***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
L.Reform variable	0,140***	-0,11***	0,299***	0,362***	-0,129***	-0,115***	0,064***	-0,072***	-0,126***	-0,144***	0,027***	-0,012***	0,024***	0,211***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
country effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
industry effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R-squared														
within	0,366	0,366	0,366	0,366	0,366	0,366	0,366	0,366	0,366	0,366	0,366	0,366	0,366	0,366
between	0,079	0,079	0,079	0,079	0,079	0,079	0,079	0,079	0,079	0,079	0,079	0,079	0,079	0,079
overall	0,112	0,112	0,112	0,112	0,112	0,112	0,112	0,112	0,112	0,112	0,112	0,112	0,112	0,112
Number of observations	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224

Annex 4 – Regression output – equation (2) – dependent variable: firm-level TFP growth

Regression (2)

	Total factor productivity growth													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Institutions	Infrastructure	Health&Prim education	Goods market	Labor market	Higher education	Financial market	Technological readiness	Business sophistication	Innovation	Starting a business - procedures	Paying Taxes - Tax rate	Resolving insolvency - recovery rate	Network sectors
D.lnFront	1,090***	1,091***	1,095***	1,091***	1,088***	1,092***	1,093***	1,093***	1,090***	1,092***	1,094***	1,095***	1,095***	1,090***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
L.DTF	0,604***	0,604***	0,604***	0,604***	0,604***	0,604***	0,604***	0,604***	0,604***	0,604***	0,604***	0,604***	0,604***	0,604***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
L.Reform	0,147***	-0,139***	0,289***	0,370***	-0,164***	-0,146***	0,066***	-0,077***	-0,16***	-0,183***	0,029***	-0,015***	0,023***	0,221***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
D.Frontier	1,439***	-0,061***	1,128***	2,016***	1,647***	0,161***	1,026***	0,333***	2,039***	-0,246***	0,934***	2,955***	0,966***	1,278***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
D.Frontier*L.Reform	-0,153***	0,154***	-0,062***	-0,289***	-0,227***	0,123***	-0,065***	0,087***	-0,304***	0,264***	-0,030***	-0,052***	-0,003***	-0,219***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
country effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
industry effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R-squared														
within	0,417	0,417	0,416	0,417	0,417	0,417	0,417	0,417	0,417	0,417	0,417	0,417	0,416	0,417
between	0,149	0,149	0,150	0,150	0,149	0,150	0,150	0,149	0,150	0,150	0,149	0,149	0,150	0,150
overall	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188
Number of observations	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224

Annex 5 – Regression output – equation (3) – dependent variable: firm-level TFP growth

Regression (3)

	Total factor productivity growth													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Institutions	Infrastructure	Health & Prim education	Goods market	Labor market	Higher education	Financial market	Technological readiness	Business sophistication	Innovation	Starting a business - procedures	Paying Taxes - Tax rate	Resolving insolvency - recovery rate	Network sectors
D.lnFront	5,856***	-2,705***	6,574***	9,489***	4,106***	1,299	2,262***	-1,037***	6,778***	2,015	2,358***	18,393***	11,766***	2,095***
P>|z|	[0,000]	[0.008]	[0,000]	[0,000]	[0,000]	[0,110]	[0,000]	[0,049]	[0,000]	[0,175]	[0,000]	[0,000]	[0,000]	[0,001]
L.DTF	0,438***	0,822***	1,489***	0,035	0,106***	1,187***	0,48***	0,712***	-0,601***	1,592***	0,621***	1,249***	1,352***	0,217***
P>|z|	[0,000]	[0,000]	[0,000]	[0.477]	[0,001]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
L.Reform	0,116***	-0,142***	0,419***	0,253***	-0,168***	-0,15***	0,039***	-0,057***	-0,16***	-0,187***	0,032***	-0,015***	0,033***	0,068***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
Dummy_Front	1,309***	0,113***	1,851***	1,565***	1,253***	0,642***	0,926***	0,42***	1,072***	0,569***	0,949***	3,479***	1,584***	0,966***
P>|z|	[0,000]	[0.002]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]
Dummy_Front*L.Reform	-0,124***	0,121***	-0,18***	-0,186***	-0,127***	0,022**	-0,042***	0,069***	-0,077***	0,047***	-0,032***	-0,064***	-0,012***	-0,09***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,014]	[0,000]	[0,000]	[0,000]	[0,018]	[0,000]	[0,000]	[0,000]	[0,000]
D.lnFront*L.Reform	-1,057***	0,724***	-0,901***	-1,911***	-0,748***	-0,038	-0,274***	0,449***	-1,326***	-0,238***	-0,213***	-0,407***	-0,15***	-0,396
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,001]	[0,828]	[0,001]	[0,000]	[0,002]	[0,000]	[0,001]	[0,001]	[0,000]	[0,105]
L.DTF*L.Reform	0,037***	-0,042***	-0,144***	0,13***	0,126***	-0,122***	0,029***	-0,023***	0,284***	-0,263***	-0,003*	-0,015***	-0,01***	0,16***
P>|z|	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,000]	[0,076]	[0,000]	[0,000]	[0,000]
country effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
industry effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R-squared														
within	0,418	0,418	0,417	0,418	0,418	0,418	0,418	0,418	0,418	0,418	0,417	0,417	0,417	0,418
between	0,149	0,149	0,147	0,149	0,149	0,148	0,149	0,149	0,149	0,148	0,149	0,149	0,150	0,148
overall	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,187	0,188	0,188
Number of observations	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224	1900224