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Do clusters enhance the ability of their members to react to positive demand shocks? An empirical study of the Tenerrdis cluster in France

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Abstract

Clusters have been a concept with a growing interest among policymakers and researchers. The advantages that those geographic formations entail justify this interest as clusters can provide benefits ranging from enhanced innovation to increased productivity and employment. This thesis studies the effect that a cluster has on its members in the presence of a positive demand shock. The shock studied was a regulation change in the French renewable energy sector that happened in 2015. The treatment group was composed of French firms located in the Tenerrdis cluster. This group was compared to other isolated, but comparable, firms through a difference-in-difference regression coupled with the synthetic control method. The empirical results obtained helped draw the conclusion that firms belonging to a cluster have clear advantages in terms of growth and performance when facing a large demand increase. The findings of this thesis can be of crucial interest to policymakers as advice for future economic decisions that attempt to leverage the advantages of clusters. For managers, the results highlight the importance of location choices and could help predict firm behavior after a positive demand shock.

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1. Introduction

The growing globalization and interconnectedness of the world economy have generated an important evolution of competition between economic actors and the development of technologies that alter the impact of traditional aspects of location (Porter, 2000). This change prompted an additional focus from policymakers on regional economic performance as a key aspect of economic studies. Porter (2003) illustrated how clusters have a relevant impact on the firms that compose them and how geographic context remains important. Across researchers, the preferred framework of study in the domain of clusters remains the one outlined by Porter (1998, 2000). Porter (1998) defines clusters as being the "geographic concentrations of interconnected companies and institutions in a particular field, encompassing an array of linked industries and other entities important to competition". Porter (2000) further elaborates that definition by including specialized suppliers, service providers, firms in related industries, and associated institutions such as universities or research centers.

The main goal of this paper is to explore the idea that firms within a cluster are better suited to react to positive demand shocks. Such findings can have a significant impact on several levels. At the governmental level, findings about clusters could inform policymakers about the advantages and functioning of such regional formations to further guide local institutions in developing them through investments in infrastructure, education, or similar public goods and services (Porter, 1998). At the managerial level, understanding how firms interact and develop advantages within a cluster can help managers and entrepreneurs determine the optimal location for their company, considering that its needs evolve and change throughout its growth and development (Stam, 2007). Clusters, as previously mentioned, are regional entities that significantly influence the economic performance of the geographic area they occupy, yet they remain complex entities with specific mechanisms and functions. Delgado et al. (2014) found the co-existence of convergence of industries at the regional level with agglomeration economies across related industries. This implies that within a cluster, several related industries can experience enhanced growth. This aspect of clusters is crucial for several political entities. For example, the European Commission has included clusters in its studies of competitiveness across EU members only in the last decade. This interest is fueled by the fact that clusters entail productivity levels 25% above average, varying depending on the industries, and export advantages coupled with effects on employment as clusters comprise 23% of the total European labor force (European commission et al., 2020). The European Commission used the same definition of cluster provided by Porter (2000) and expanded its scope by ranking clusters depending on their performance both in terms of productivity and employment. This shows the crucial role that clusters are expected to play, further underlined by the fact that 2,950 individual clusters were identified (European commission et al., 2020).

Various lenses are used to study industrial clusters, all with the goal of better understanding and predicting their functioning. The idea of industrial clusters is not new; Marshall (1920) already wrote about the concentration of specialized industries in particular locations, defining them based on the ready availability of labor and their developed trade systems. However, most of the modern research on clusters uses the framework developed by Porter (1998, 2000) and expands it to investigate specific research questions. In this paper, the focus is on the ability of clusters to enhance the reactivity of their members to positive demand shocks. Cluster literature is rich in arguments in favor of it. To better react to positive demand shocks, innovation, knowledge sharing, and productivity advantages are crucial factors.

Both Paci and Usai (2000), and Moreno et al. (2005, 2006) explore the advantages that geographic concentrations of companies and knowledge bring to innovation. Innovation can, in fact, enhance the reactivity of firms to positive demand shocks as it improves their product development speed and their overall competitivity (Porter, 2000). Their insights imply clear innovation advantages for firms within clusters and can be extrapolated as providing an additional advantage for the ability of clustered firms to react to positive demand shocks. This knowledge aspect of clusters is further expanded by Tallman et al. (2004) by introducing a knowledge-sharing aspect. Tallman et al. (2004) developed a model describing knowledge flows as critical sources of competitive advantage for clusters and the firms within them. This insight further develops the argument that clusters generate advantages for their members. This resource-sharing view is crucial for the rest of the paper as it represents a major aspect of the theory leveraged to investigate clusters. In fact, the resource-based view, which focuses on the sources of sustainable competitive advantage, is often applied to clusters, and can help argue in favor of the advantages they present. This new view was based on the initial findings of Porter (1985, 1990, 1991). It was further expanded by Barney (1991), by emphasizing that some firms have characteristics and resources that give them a sustainable competitive advantage. This internal focus highlights that resources need to be rare, imperfectly imitable, non-substitutable and valuable to generate an advantage (Barney, 1991). Through the lens of the resource-based view, Wilk and Fensterseifer (2003), Li and Geng (2012) and Hervás-Oliver and Albors-Garrigós (2007), all found that clusters generate advantages by leveraging the resources that are common to their members. This resource-sharing aspect represents a valuable research focus that provides arguments explaining the way clusters can impact their members capacity to react to positive demand shocks through their ability to share knowledge and cluster-specific resources.

A large part of the literature focuses on the ability of clusters to enhance the performance of the firms that compose them, but much fewer papers focus on the resilience that belonging to a cluster gives to a firm. Nevertheless, most of these papers only explored the concept of regional resilience, arguing that it referred to the ability of regions to withstand or recover from shocks to their economic systems (Simmie J., & Martin, 2010; Martin & Sunley, 2003, 2015). The focus was then on negative economic shocks, with very little emphasis on how clusters impact firms' reactivity to positive economic events. For example, Cainelli et al. (2019) investigated how and to what extent firms' external relations, such as belonging to a local cluster or a business group, affected the probability of firms' survival and economic performance after the 2008 Great Recession. The authors found that belonging to a local cluster mitigated the adverse effects of the economic and financial shocks (Cainelli et al., 2019). However, it was also highlighted that the results were sector-specific. These findings on adverse shocks enhance the relevance of investigating what benefits clusters present when faced with positive demand shocks, as this topic is often overlooked in the literature. The investigation of the Tenerrdis cluster could help shed light on the advantages of a cluster when faced with a policy-induced demand increase.

The aim of this paper is to empirically observe if industrial clusters present an advantage for their members when faced with a positive demand shock. This leads to the following research questions: Does an industrial cluster enhance the ability of its members to react to positive demand shocks induced by a legislative change? The investigation's focus is on the Tenerrdis cluster and its members. Through a difference-in-difference model, the performance and growth of firms are studied to evaluate if clusters impact their ability to react to the legislative change and the demand shock it generated. The law No. 2015-992 for the energetic transition and for green growth from 2015 is used as an exogenous event, and a control group is built using the synthetic control method and a pool of isolated companies. The period from 2013 to 2018 is considered, and 31 firms are included in the treatment group compared to 40 firms in the initial pool from which the synthetic control group is built, the latter is instead composed of 31 entities. The first hypothesis explored is that clusters enhance the performance of their members when responding to a positive demand shock. This is followed by the second hypothesis, which is that clusters enhance the growth of their members when facing a positive demand shock. The main findings of this paper confirm the hypotheses studied. In fact, following the demand shock induced by the law change, firms within the cluster displayed a larger increase in performance and growth.

These insights could help expand the empirical understanding of industrial clusters. By focusing on their ability to react to positive demand shocks such as those generated by policy changes, this paper can further expand the literature around this topic. For policymakers, the insight from this thesis could be relevant when evaluating the efficiency of policy changes and, more specifically, how they differentially impact firms depending on their location. By better understanding the advantages of clusters, insights from others such as Porter (2000) could be even more relevant, and their findings better applied. Instead, for managers, the empirical findings can help guide crucial decisions on the location of firms, both for entrepreneurs and their startups, as well as for managers with the expansions or relocation of existing firms. The additional understanding of how positive demand shocks differentially impact clusters and isolated firms can help management teams better react to or prepare for law changes or similar exogenous shocks.

The paper starts with the theoretical background, highlighting the main framework used to define clusters and the resource-based view that will be used to evaluate the effect that they can have on their members. Through the lens of the resource-based view, two examples will then show the already proven relevance of the latter in the context of clusters. Following that, and using the theoretical framework built, Tenerrdis, namely the cluster of interest, will be analyzed to evaluate its coherence within the theory. Next, the law itself is summarized and its salient parts highlighted with a focus on the sectors of interest. The methodology and the results will follow. Finally, the discussion will interpret the results through the lens of the theory previously explained.

2. Theoretical framework

2.1. Brief Historical Overview of Cluster Theory

The idea of a cluster is not new and has been often studied in the past to investigate the advantages of urban areas and cities. Marshall (1920) introduced the concept of clusters and identified three primary economic sources within those agglomerations. The latter was defined by Rosenthal and Strange (2004) as an aggregate of activity and industries. Knowledge spillovers, local non-traded inputs, and the local availability of a skilled labor pool were the sources identified by Marshall (1920). Knowledge spillovers are the ability of employees to create relationships across firms and to generate a transfer of information and knowledge across them (Vernon Henderson, 2007). This idea was also developed by McCann (2013) and defined as "Tacit knowledge" that is shared within a cluster. Local non-traded inputs instead facilitate access to specialized inputs and reduce transportation costs (Marshall, 1920). Finally, the last source mentioned by Marshall (1920) is the presence of a local pool of skilled labor, generated by firms from the same industry accumulating in a defined area and enhancing the overall quality of workers found within specific geographic bounds.

2.2. Porter's Cluster Framework

2.2.1. Porter's Idea of Cluster

Governments and policymakers around the world have become aware of this concept thanks to Porter's developed cluster framework, as Martin (2001) described. Porter (2000) states that clusters represent an innovative way of thinking about national and local economies and that they require changes to the strategic roles of the different economic entities involved, such as companies, governments, and other institutions. As previously mentioned, clusters are "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions in a particular field that compete but also cooperate" (Porter, 1990, 2000). Those same entities are also found to provide a crucial forum for dialogue that enhances the efficiency and functioning of local economies, especially the cooperation between governments, suppliers, and firms. This new and modern view of clusters was brought forward along with a new wave of economic geography theory that better defines the mechanisms that help firms use their corporate networks to recover resources, capital, technologies, and other inputs from global markets (Porter, 2000). Another notable addition is the idea that clusters have very dynamic boundaries that evolve in shape and scope with the addition of firms and the emergence and decline of industries (Porter, 2000). This first section precisely defines Porter's definition of a cluster. In the following part the focus shifts to the location of firms themselves and the role it plays in the theoretical framework of this thesis.

2.2.2. Impact of Location

Clusters serve as an additional unit of competitive analysis, complementing the firm- and industry-level ones. Additionally, it is suggested that a large part of the competition happens outside of the company and even outside the industry, shifting it to the location of business units instead (Porter, 2000). Since the cluster is defined as a group of interconnected companies and institutions, its geographic scope gains interest and can range from a city to a region or even a state (Porter, 2000). Location plays a crucial role in the framework; it provides a context for firms, affecting the availability and quality of inputs, the strategic context, the supplier's availability, and the demand conditions (Porter, 2000). The combination of all those factors is responsible for the existence of a competitive advantage and productivity growth (Porter, 2000). Porter (1994) argues that despite the growing disinterest in location in an increasingly global economy, the empirical evidence continues to suggest that location plays a relevant role, especially in determining static efficiencies in agglomeration economies (Marshall, 1920). Location keeps its importance even though the main basis of competitive advantage has shifted to dynamic improvements, making innovation capacities play an important role in enhancing performance (Porter, 1994). The local context determines and encourages investments and cluster upgrading, fueled by competition with local rivals. The location's characteristics affect the factor conditions, availability of natural, human, and capital resources, or administrative and research infrastructures. Glaeser and Maré (2001), for example, show that within urban environments there is a significantly higher concentration of skilled labor, corroborating the insight from Marshall (1920), and determining that there are significant locational advantages in areas with higher labor quality, such as cities or urban agglomerations. This concentration of specific inputs is representative of the factor quality and specialization present within clusters, shifting rivalry between firms from low wages to low total cost, requiring upgrades to the efficiency of manufacturing and quality of services (Porter, 2000). The local demand conditions and supporting industries will modify the offerings of firms, dictated by the local demand and the quality of those supporting sectors. More specifically, the quality of local demand plays a crucial role in the ability of firms to perform in global markets, as local customers can help firms discover new segments and unveil specific future needs (Porter, 2000). In the following section the focus shifts to the competitive advantages that a cluster presents. It explores the insights from Porter (1998, 2000) and highlights how firms can benefit from their membership to a cluster.

2.2.3. Clusters' Competitive Advantages

Location plays a crucial role in determining the performance of firms, notably by determining the availability of inputs. Since clusters are defined by the concentration of firms within a specific geographic area, another important component of the framework developed by Porter (1998, 2000) is the competitive advantage that arises from the cluster itself. By locating within a cluster, firms can have access to low cost and high-quality specialized inputs such as components, machinery, business services, while also seeing a facilitated access to formal alliances with outside entities (Porter, 2000). Porter (2000) identifies three ways in which clusters impact competitive advantage. Firstly, clusters increase the static productivity of their members. Secondly, they increase the capacity of their participants for innovation and productivity growth. Thirdly, clusters stimulate business formation, with, for example, the creation of start-ups (Porter, 2000). Those three influences come from the network of individuals and firms that, through exchanges of resources and information, promote the effectiveness of the cluster constituents.

There are several promoters of productivity growth within a cluster, the first being the local availability of skilled labor, as previously mentioned. These skilled workers are often distributed across suppliers and partner companies since clusters foster specialization (Porter, 1998). Another source is the ready availability of information, especially technical and specialized information, at a low cost and at a small geographic distance (Porter, 2000).

Additional performance gains are obtained through complementarities that clusters can successfully facilitate between their members (Porter, 1998, 2000). The latter can come in three main forms: first, as complementary products for buyers, by enhancing value through the co-location of firms to achieve better product-service coordination and promote internal improvements (Porter, 2000). The second complementarity source is related to marketing, namely the advantage found by concentrating firms from related industries in a specific area. This way clusters can generate opportunities for joint marketing and increase the overall reputation of the location. Finally, the third source was linked to the ability of clusters to align the activities of their members and create linkages between firms and up- and downstream entities (Porter, 2000). Delgado et al. (2014) found empirical proof of such complementarities within clusters and managed to show that those enhance the performance of members.

2.2.4. Clusters and innovation

Innovation is often crucial not only for the viability of companies but also when it comes to increasing productivity, giving the creation of knowledge an even larger role within clusters (Tallman et al., 2004). These geographic agglomerations offer major advantages compared to isolated locations. Presence within a cluster offers advantages for the perception of new buyer needs and new technological possibilities (Porter, 2000). This advantage stems from the proximity of rivals, the collaboration with other firms, and the presence of research institutions and universities. Anselin et al. (1997) already documented this advantage by demonstrating the presence of local geographic spillovers that benefited innovation in firms. Paci and Usai (2000) showed, by investigating patent data across Europe that, within clusters, higher levels of innovation were achieved. Others, like Engel (2015), showed that the advantages that clusters offer for innovation are especially salient when clusters are technologically advanced. He further expanded on the crucial role that universities play in the formation of such concentrations of firms.

Another advantage of cluster formations is their ability to foster new business creation by incentivizing entrepreneurship as this concentration of firms acts as a signal for opportunities (Porter, 2000). New firms benefit from joining clusters because of the ready availability of specialized assets and, overall, for the same reasons that make cluster members more performant. Through the concentration of high-quality inputs, efficient infrastructure and beneficial relationships, cluster members are expected to benefit from their location. The next part will dive into the resource-based view to argue that the uniqueness of the characteristics of cluster resources plays a role in their potential success.

2.3. Resource-Based View of Clusters

2.3.1. Barney's Resource-Based View

In the previous part, the framework that encompasses the idea of clusters was described by following the insights from Porter (2000). The resource-based view is explored to delve deeper into the reasons behind the performance-enhancing capacities of clusters. This follows the idea that the specific set of inputs and factors available within clusters is one of the major sources of their competitive advantage (Porter, 2000).

The resource-based view (RBV) presents an alternative way of considering sustainable competitive advantage by focusing on the specific resources available to firms (Barney, 1991). In the context of this paper, those resources will be at the cluster level. Black and Boal (1994) further argued in favor of a resource-level analysis of firms when determining their advantages by assessing the organization's resources, capabilities, and core competencies. They highlight the interaction between resources and the specific strategies of firms as being crucial in the formation of a sustainable competitive advantage (Black & Boal, 1994). Furthermore, Barney (1991) built a classification of strategic resources to describe the presence of a sustainable advantage, focusing on the internal characteristics of firms rather than the competitive context in which they exist. Barney (1991) built the model on the assumption that strategic resources are heterogeneously distributed and that firms obtain competitive advantages by implementing strategies that exploit their internal strengths while responding to environmental opportunities. Firm resources are defined as assets, capabilities, organizational processes, or knowledge controlled by the firm, and their classification is done in three categories. The first is physical capital resources such as technology, plants, and equipment (Williamson, 1975). The second is human capital resources such as training or experience (Becker, 1964). Finally, the third is organizational capital resources as in routines, controlling, reporting, and similar systems (Tomer, 1987).

Within the resource-based view, to achieve a sustainable competitive advantage firms must implement a value-creating strategy that is not simultaneously being implemented by competitors (Barney, 1991). This framework requires firms to have heterogeneous resources since, for first mover advantage (Lieberman & Montgomery, 1988) and barriers to entry/exit (McGee & Thomas, 1986) to exist, there must be the possibility for firms to be clearly differentiated and to have a share of immobile resources. This last requirement further promotes the idea that the location advantages of clusters have a crucial impact on firms.

Finally, for a strategic resource to be considered capable of creating a sustainable competitive advantage it needs to fulfill four criteria (Barney, 1991). The necessary attributes are, first, being valuable by either exploiting opportunities or eliminating threats in the environment. The second is being rare and relatively unique among competitors, an example of that is managerial talent (Hambrick, 1987). The third is being imperfectly imitable (Lippman & Rumelt, 1982), and finally, the fourth is being without substitutes, even as strategic equivalents. Moreover, other papers have explored the topic of strategic resources, further expanding the theory around it. Strategic resources characterize the performance firms can achieve and the competitive advantages they can generate. Amit and Schoemaker (1993) expect firms to differ in the resources and capabilities they control. This asymmetry will then determine if such unique characteristics will be able to generate economic rent. Amit and Schoemaker (1993) further expand the list of requirements from Barney (1991) by adding the concepts of appropriability, durability, and sustainability. This section highlighted how the resource-based view is defined, from its origin to its relevance for firms and more specifically for clusters. In fact, the specific set of resources available to cluster members, is expected to enhance the reactivity of firms to a positive demand shock, by enhancing their innovative capabilities and their productivity. The following section will help link the RBV directly to clusters and emphasize the relevance of its application to them.

2.3.2. Resource-Based View Applications to the Concept of Clusters

The resource-based view has proven to be promising in interpreting the concept of clusters and, more specifically, in understanding the advantages they create for their members. The first interesting application of the RBV to clusters is the qualitative study that Wilk and Fensterseifer (2003) did on a Brazilian wine cluster, for which they strategically analyzed the resources available to the members through the lens of Barney (1991). They found several resources that met the requirements that Barney (1991) highlighted. Two main examples of those strategic factors were; first, the adaptability developed by the members that showed the path dependence and long-term investments in technical schools and research institutes. The second example was the tourist attraction and the topographical knowledge that were the result of both locational specificities and targeted investments, showing characteristics of immobility and inimitability. The second interesting application of the RBV in the cluster's context is the study by Hervás-Oliver and Albors-Garrigós (2007). RBV previously correlated resources and performance at the firm level and the same association was expected between the cluster's unique set of resources and capabilities and its performance (Hervás-Oliver & Albors-Garrigós, 2007). The authors justified their predictions with the idea that territories contain higher-order capabilities (Foss, 1996) available to firms located in specific areas, which contribute to explaining a firm's internal resources (Lawson, 1999). But the resources available in a specific location only generate a static advantage, which can interact with specific resources of firms to become dynamic and generate competitive advantage (Hervás-Oliver & Albors-Garrigós, 2007). For example, the presence of R&D centers does not automatically generate an advantage, but as Inkpen and Tsang (2005) found, firms require a strengthening of their relationships to the cluster network in order for effective knowledge transfer to occur. Linkages can be internal, if they occur just within cluster-located members, or external, between the cluster and outside agents (Hervás-Oliver & Albors-Garrigós, 2007). The paper's main conclusion outlined the fact that a cluster's unique set of resources and capabilities are relevant and influence the cluster's performance and reactivity to demand shocks. This also shows the relevance of the RBV to clusters and how this theory can predict increased performances across cluster members when compared to other more isolated firms. This also shows that the mere geographic proximity of firms from related sectors and other entities such as universities and research centers is not sufficient to generate the advantages related to clusters, but it is the relationships developed between the different parties that enhance local capabilities (McEvily & Zaheer, 1999). The access to highly specialized assets, human capital and knowledge is expected to enhance the ability of firms within a cluster to react to demand shocks, especially when compared to isolated firms who do not have access to those immobile resources. The successive section will highlight how the Tenerrdis cluster fits within the framework described here.

3. How the Tenerrdis Cluster Fits Within the Theoretical Framework

The Tenerrdis cluster is located in the French region of Auvergne-Rhone-Alpes and specializes in the green technology and energy sector with the goal of developing sustainable sources of energy and efficient materials. It specializes in the following areas: solar power, biomass, hydrogen, hydroelectricity, smart grid, energy efficiency in buildings, district heating and cooling, wind power, smart cities, and energy transition (Tenerrdis, n.d.).

Hill and Brennan (2000) leveraged Porter's (2000) theory to elaborate a methodology to identify clusters. They defined a competitive industrial cluster as a geographic concentration of firms from the same industry that either have tight buy-sell relationships with other industries in the region, use common technologies, or share a specialized labor pool (Hill & Brennan, 2000). The cluster of interest is located in a single region, concentrated around the cities of Lyon and Grenoble, fulfilling the geographic requirement of this definition.

The labor pool from which the companies pull their workers is fed by several universities and schools that offer programs relevant to the sectors in which the cluster is active. On the official website of the cluster organization, it is possible to find all the active collaborations. Among the collaborations, ECAM Lyon is a highly recognized university that offers programs in management of renewable energies; from the same city, EMLyon is a top engineering university with strong links with the cluster. ENTPE, Grenoble INP, and Ecole de Management are also part of the cooperation network, offering degrees highly related to public renewable infrastructure and energy (Tenerrdis, n.d.). A high concentration of universities can, as Anselin et al. (1997) showed, enhance innovative activity and, in turn, improve performance. Additionally, the organization that manages the cluster is responsible for multiple innovative projects with the goal of developing common technologies and improving the overall productivity of the members (Tenerrdis, n.d.).

As Porter (2000) and Spencer et al. (2010) mentioned, the involvement and cooperation of research institutions and local governments is crucial within the cluster's framework. Tenerrdis is an innovative pole that manages and promotes common projects among its members. Additionally, several research centers directly collaborate with the cluster, among them the CNRS, a public research center, Armines and the Institute Fayol, both linked to universities in Saint-Etienne and doing research in renewable energies. Notable mentions are the Cetiat Institute which provides training and calibration of scientific equipment, the CSTP, that researches building efficiency, or the CEA Institute that focuses its research on future sources of energy (Tenerrdis, n.d.).

To further emphasize the collaborative aspect of the cluster, the theory developed by Das and Teng (2000) is leveraged. Their view of clusters as a form of collaboration is particularly relevant considering the cluster of interest. Das and Teng (2000) argue that collaboration between firms is crucial for the development of expertise in critical areas of functioning where the requisite level of knowledge lacks and cannot be cheaply and quickly developed (Madhok, 1997). Das and Teng (2000) argue that collective strengths are the amounts of relevant, valuable resources possessed by the alliance. The collaboration and complementarity (Deeds & Hill, 1996; Harrigan, 1985) between members of the clusters enables a pooling of resources that enhances the performance of all parties and, indirectly, their reactivity to positive demand shocks. In the Tenerrdis cluster, such collaboration is displayed by the presence of several common projects that leverage the expertise of different members (Tenerrdis, n.d.).

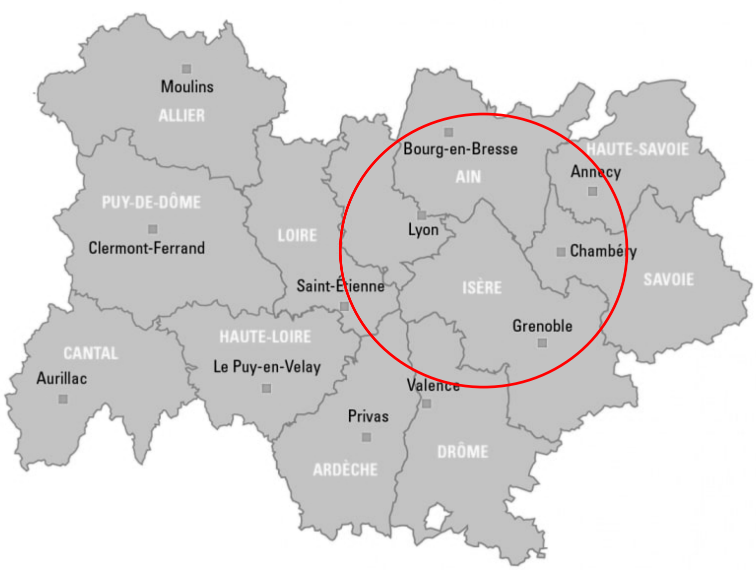


Figure 3.1 Map of the Auvergne-Rhone-Alpes region and the area of concentration of the cluster.

4. Law Change for the Energetic Transition

Porter (2000) presents crucial insights on how governments can impact the growth and overall performance of the economy, and indirectly of clusters, by describing four main roles endorsed by national authorities. The first role is to maintain macroeconomic and political stability and the second is to improve general micro-economic capacity through better quality and efficiency of general-purpose inputs to businesses. The third is to establish the overall microeconomic rules and incentives governing competition that will encourage productivity growth, while the fourth is to develop and implement a long-term economic program that mobilizes government, companies, and institutions (Porter, 2000). The following sections analyze the law change operated by the French government and evaluate its impact on the firms from the sectors of interest. It will also serve to highlight the impact that governments can have on companies.

4.1. The Law and its Goals

The stated goal of the law 'Loi n° 2015-992 du 17 août 2015 relative à la transition énergétique pour la croissance verte' or 'law for the energetic transition and green growth', was to accelerate and structure the green energy transition in France. A set of goals and targets was defined by the government to ensure the compatibility of their future direction with the Paris Accords of 2015. The goals of the latter were to strengthen the fight against climate change through investments and economic efforts (UNFCCC, n.d.). The main objectives of this change to the national legislation were to promote the reduction of CO_2 emissions through the increased use of renewable energies, the development of new and more efficient materials for construction, and finally, the empowerment of local governments in their control over the development of green projects. Throughout the text of the law clear goals appear. A plan to gradually increase the cost of a ton of carbon emissions is set to slowly disincentivize high-pollution energy sources. Following this logic precise targets for the share of total energy produced by renewable energies are set, coupled with limitations on other specific energy sources. Thanks to this, companies that operate in the field of renewable energy, from the consulting sector for the conception of projects to the solar, wind, and gas energy production firms can experience an increase in demand. Another clear goal of this legislative change is the promotion of clean vehicles and means of transportation. This happens by promoting the private use of green vehicles, electric or hydrogen-powered, through the creation of bonuses for individuals acquiring these means of transportation. These bonuses will benefit the manufacturing sector by favoring production, as well as the energy sector. Additionally, it will also incentivize cities and local governments to develop projects for the transition of their transport infrastructures. Tax relief initiatives and special funds were created to boost the adoption of energetically efficient and environmentally friendly materials in buildings. This new legislation also provides guidelines to expand and develop the infrastructure supporting the use and production of green energy. Overall, this reform creates strong support for companies specializing in engineering and environmental consulting as well as for manufacturers of machinery and parts for electricity production and, finally, the energy companies themselves (LOI n° 2015-992, 2015). A more in-depth analysis of the law can be found in Appendix A.

4.2. The Green Growth Act

The legislation change was followed by several concrete projects as highlighted by the report from 2016 redacted by the French ministry of environment, energy, and the sea. This report presents the ambitions of France in its green energy transition, stipulating its goals and sector-specific projects. Some of the targets are to mitigate climate change while preparing for a post-oil era, finance the energy transition, and boost employment in target sectors (Ministry of Environment, Energy, and the Sea, 2016). The initiatives from the Green Growth Act were intended to further implement the objectives highlighted in the law from 2015. A strong emphasis was placed on the empowerment of regional governments, which came in the form of large new funds to support local projects. For example, a 400-million-euro investment fund that supports solar energy and geothermal projects was created (Ministry of Environment, Energy and the Sea, 2016). Overall, the Green Growth Act report highlights how the ramifications of the effects of the law on environmental transition from 2015 would heavily impact companies from 2016 onwards. The necessity for consulting and engineering services', the collaboration of energy companies benefiting from the tightening limitations on emissions, the innovation in renewable energies and, the involvement of the construction sector show that the regulation change has the potential to benefit a large variety of companies and industries. A more in-depth analysis of the different projects can be found in Appendix B.

5. Data and Methodology

This section discusses the methodology and data selection. It begins with a description of the database used, the metrics, and the transformations that the variables selected received. Then the statistical model chosen and its assumptions are described and discussed.

5.1. Data Selection and Variables

The database selected for this empirical study is Orbis by the Bureau van Dijk, as it provides detailed information for a large number of firms. The treatment group was composed of 31 companies from the Tenerrdis cluster in the Auvergne-Rhone-Alpes region of France. This group was formed by selecting firms from the member list of the cluster organization and observing which ones had available data on Orbis. The firms selected for the treatment group were mostly of medium to large size. The period of interest was centered around the ratification and application of Law No. 2015-992 for the energetic transition and green growth. Hence, the time frame chosen for this paper was from 2013 to 2018 with a three-year period before and after the legislative change to have enough accuracy to estimate the pre- and post-trend periods. The data collected was in the form of panel data, with six observations per company. It is important to note that the period did not go past 2018 to avoid any interference from COVID-19 and its impact on firms and the overall economy. The control group was built by selecting firms that could be affected by the legislative change in a similar way to the ones from the cluster while not being part of one themselves. To do so, the platform Crunchbase was used as it allows searching companies by sector and keywords. The selection of the control firms was done manually by investigating their location and verifying that they did not belong to any cluster organization. The firms in both the control and treatment groups were active in seven main sectors, namely consulting, construction, energy production, technology and energy services, manufacturing, gas storage and production, and finally electricity production and network management.

Two metrics were selected to estimate the impact of clusters on firm performance. The first is turnover, namely the total operating revenues of a company; this metric was selected as it captured the firm’s activity. The second metric chosen was assets; this helped estimate the growth of a company’s overall size as shown by Cooper et al. (2008) and allowed for a simple cross-company comparison. Firms in both control and treatment groups ranged from medium-sized to large companies, making a direct comparison between them inaccurate. To avoid such issues, the number of employees was collected from Orbis and, if needed, the financial reports of the companies. The nominal number of employees was used to arrive at two relative measures of success for the two dependent variables: turnover per employee and assets per employee. To focus on and evaluate the changes to the trend operated by the law, the logarithm of those two same variables was computed and used in the statistical models. Taking the variables relatively to the number of employees allows a comparison across firms while avoiding discrepancies due to their size differences. The choice of using the logarithm was justified by its facilitated interpretation and its ability to avoid issues of skewness. Additionally, the logarithmic transformation helps better deal with large data ranges and heterogeneity as in the dataset there is a large variety of sizes, business models and sectors.

The final dataset was composed of 62 units, with each having six observations representing the years from 2013 to 2018. The total was then of 372 observations and was collected from Orbis as of May 14, 2024.

5.2. Difference-in-Difference and Synthetic Controls

In an attempt to find the causal effects between membership to a cluster and the performance and growth of a firm following a positive demand shock generated by a law change, the difference-in-differences (DiD) analysis was the most promising. The robustness of this method is recognized as Card and Krueger (1994) highlight in their evaluation of the effect of a minimum wage change on employment. For the empirical study of this thesis, the presence of a law change in the renewable energy sector was used as a catalyst to evaluate how the membership of a company in a cluster affects its ability to respond to a positive demand shock. The structure of the DiD itself allowed it to evaluate the differential impact that the law had between the two groups. A similar application of DiD, with an attempt to compare two groups that differ in a specific characteristic while being impacted by a common shock, was operated by Richardson and Troost (2009). The two authors compared the effect of a banking crisis on two states that had different monetary policies and found significant results.

Angrist and Pischke (2009) presented two key assumptions for the DiD to work: the presence of a common shock and parallel trends. In 4.1 and 4.2 the content of both the law and the successive governmental plans were analyzed and evaluated for their use as a common shock while also highlighting how the different sectors in which the selected firms are present were uniformly impacted. By thoroughly examining the legislative content and the scope of governmental plans, the magnitude and significance of these regulatory changes were found to be sufficiently impactful to constitute a common shock. The common shock assumption ensures that the observed changes in the dependent variables are primarily driven by the legislative intervention rather than other idiosyncratic factors. The assumption of parallel trends is more complex, as it implies that in the absence of treatment, both treated and control groups would be following a similar trend. In our case this would predicate that firms from the cluster and non-members should have had similar trends in performance and growth in the absence of the law. To ensure the validity of our chosen DiD methodology, the synthetic control method (SCM) was used. Abadie et al. (2010) described synthetic controls as being a weighted combination of units that are selected through a data-driven method to resemble as much as possible the treatment unit. In this paper, each firm had a synthetic control unit built by a weighted combination of the 41 non-cluster firms. Two control groups were built, one for each hypothesis. The synthetic units were constructed by using the values of the two outcome variables in the years 2013, 2014 and 2015, to ensure similar pre-law trends. This way, the parallel trend assumption holds as firms shared the trend preceding the legislative change with their synthetic controls. Additionally, the use of the SCM helps ensure the fulfillment of the no anticipation assumption as the pre-trends of the control and treatment groups match, as it is possible to see in Figure 6.3.1. The DiD was then operated with two groups of 31 units, one being the treated firms and the other built from the 31 synthetic controls. The Haussmann test was done to evaluate which of a random and fixed effect model is best suited for this data (Appendices E and F). The results from the test guided the choice of a fixed-effect model. Additionally, since the data was composed of different companies with six observations each, a clustering of the data was deemed necessary. This clustering improved the reliability and validity of the results by avoiding the intra-cluster correlation that could arise. The variables of interest were the interaction terms between the post-law periods, namely 2016, 2017 and 2018, and the treatment indicator. It was then possible to emphasize the specific effect that the cluster had on the dependent variables, either turnover or assets per employee. The following is the DiD model used:

$$Y_{it} = \alpha + \beta_1 * Cluster_i + \beta_2 * Post\ Law + \beta_3\ Cluster * Post\ Law\ 2016_{it} + \beta_4\ Cluster * Post\ Law\ 2017_{it} + \beta_5\ Cluster * Post\ Law\ 2018_{it} + u_i + e_{it}$$

6. Results

6.1. Cluster's Effect on Turnover per Employee After a Demand Shock

The results from the DiD regression are presented in Table 6.1. For the first hypothesis the focus was on turnover per employee, with the findings displayed in column 1. In this DiD the dependent variable was the logarithm of the turnover per employee. The coefficient for post-law was 0.047 indicating that, independently of treatment, all units appeared to experience an increase of 4.7% in their turnover per employee. The coefficient being significant at the 5% level, it was possible to conclude that the law affected all firms positively. The interaction coefficients between cluster membership and the specific periods after the law were of major empirical interest. First, for 2016, the coefficient was equal to 0.033 and was highly insignificant, potentially hinting towards an impact from the law in the first year after its creation that was indiscernible between the treatment and control groups. For 2017 instead, the coefficient jumped to 0.108, with significance at the 5% level. This implies that in the second year after the law, firms within the cluster experienced an increase in turnover per employee that was 10.8% superior to the one for isolated firms. Similarly, for 2018, the coefficient was significant at the 5% level and equal to 0.176. In the year 2018, the treated group presented a growth, namely the effect of the law, 17.6% higher than non-treated firms. Given these results, Hypothesis 1 can be accepted, as the DiD analysis reveals a significant positive impact of the law on turnover per employee for the years 2017 and 2018 with a statistically significant difference between the treatment and control group. Additionally, another DiD regression was run to verify robustness, and the results were coherent with the ones found here (Appendix C).

Table 6.1.1 Results of the DiD regressions for ratios of turnover and assets per employee

	Log of turnover per employee (1)	Log of assets per employee (2)
Post law	0.047**	-0.167***
	(0.017)	(0.035)
Interaction Cluster and Post law for 2016	0.033 (0.043)	0.106* (0.06)
Interaction Cluster and Post law for 2017	0.108** (0.042)	0.376*** (0.086)
Interaction Cluster and Post law for 2018	0.176** (0.083)	0.329*** (0.087)
Constant	12.428***	12.61***
	(0.013)	(0.016)
Observations	372	372

Notes: standard deviations are in parentheses. The significance at the 1 percent level is represented by ***, significance at the 5 percent level is shown by **, and the significance level at the 10 percent level is indicated by *

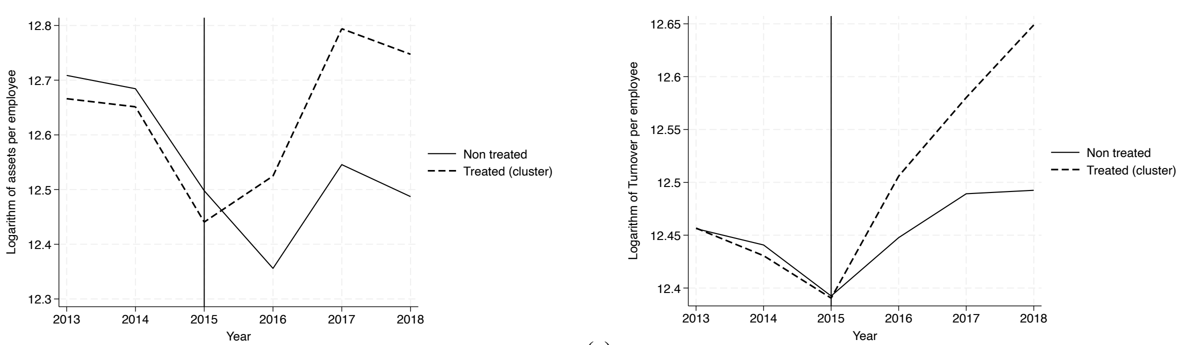
6.2. Cluster's Effect on Assets per Employee After a Demand Shock

Moving on now to the second hypothesis, where the focus shifted to the assets per employee. In Table 6.1, the results from the second DiD regression run are displayed in column 2. Here, the dependent variable is the logarithm of assets per employee. Contrary to the results for Hypothesis 1, here the coefficient of post-law was negative with a value of -0.167 and significant at the 5% level. Similar to the first DiD regression, three variables indicated the interaction effect between treatment and the specific years following the regulation changes. For 2016, the coefficient was significant only at the 10% level and was equal to 0.106. This lack of statistical significance was interpreted as a lack of clear difference in the law's effect between the treatment and control groups. For 2017, the coefficient obtained was equal to 0.376 and it was significant at the 1% level. This result implied that in this sample, firms in the cluster experienced an effect from the legislative change that was 37.6% higher than non-members. Finally, for 2018, the coefficient was 0.329 with significance at the 1% level. This highly significant result followed the one from the variable for 2017 and implied that the effect of the exogenous shock that cluster firms perceived was 32.9%

higher than the one for isolated firms. Given these results, Hypothesis 2 can be accepted, as the DiD analysis reveals a significant positive impact of the law on assets per employee for the years 2017 and 2018 with a statistically significant difference between the treatment and control groups. Similarly to what was done for Hypothesis 1, another DiD regression was run, and the results remained consistent with the ones here (Appendix D).

6.3. Graphical Results

In addition to the results presented in the tables, Figure 6.3.1 clearly show that firms with membership in the cluster have a distinct change in trend following the law reform in 2015. As opposed to that, non-members have a delayed response when considering the asset variable. For them, a change is only noticeable from 2016 and remains inferior to the treatment group. For the turnover variable the non-members seem to display a simply inferior effect, with a noticeably reduced positive trend.



(a) (b)

Notes: this figure presents the results of the DiD regression in a graphical form. For the turnover per employee (b), the results are those in column 1 of table 6.1. For the assets per employee (a), the results are those in column 2 of table 6.1. The vertical line at y=2015 represents the regulation change.

Figure 6.3.1: Graphical DiD results for the ratio of turnover per employee and assets per employee

7. Discussion and Conclusion

This section will focus on evaluating the results presented earlier through the lens of this paper's hypotheses and the theoretical framework previously built. Such analysis will explore the implications of the results, while also introducing certain limitations and future potential research. This thesis focuses on the idea that clusters generate advantages, both in terms of growth and performance, for their members when faced with a policy-induced positive demand shock.

7.1. Interpretation of the Results

This empirical study aimed to answer the question of whether industrial clusters generate performance and growth advantages for their members when facing a demand shock. To explore this question, the empirical study was centered around the Tenerrdis cluster in the French Auvergne-Rhone-Alpes region. After leveraging a sample of the firms from that industrial agglomeration and building a synthetic control group from a set of comparable companies, a difference-in-difference regression was run. The latter used Law No. 2015-992 as an exogenous event, and the results obtained showed a clear effect of membership in a cluster on both turnover per employee and assets per employee in the year following the law change. The synthetic control method was selected for its ability to ensure that the parallel trend assumption holds.

First, the focus is on the ratio of turnover per employee, which is used in the empirical study as a proxy for the performance of firms. The coefficients are, as mentioned earlier, significant only for 2017 and 2018. It implies that in those years, firms located within the cluster presented a clear performance advantage compared to non-members when faced with a demand shock. These results are in line with the first hypothesis and show that within a cluster, the availability of a specialized network of capacities, infrastructure, and knowledge is likely to enhance the ability of firms to react to positive demand shocks (Porter, 2000). For the second hypothesis, the focus shifts to the ratio of assets per employee, with this variable acting as a proxy for the growth of firms. The results show a similar picture to those for Hypothesis 1. This highlights a clear advantage for clusters in the years 2017 and 2018. A parallel can be drawn with the findings of Hervás-Oliver and Albors-Garrigós (2007). The two authors highlighted how, through the specialization and concentration of an industry in a geographic area, firms can find a performance advantage in locating within a cluster. Hervás-Oliver and Albors-Garrigós (2007) applied the RBV to clusters and found that the presence of networks of relationships between firms and suppliers or links to local institutions within them provides a competitive advantage to their members. Additionally, factors such as strong cluster governance or the presence of interconnected firms are important and give clusters competitive advantages (De Langen, 2002). Such characteristics are also present in the Tenerrdis cluster and make it unique, drawing a natural parallel between the results of this thesis and the literature.

The idea that clusters present an advantage reflects the arguments and findings that helped build the theoretical framework of this paper. Porter (2000) provided an intricate theory where specific capabilities, such as relationships between firms, public institutions and universities generate advantages in terms of competitivity and performance for firms within clusters. Such capabilities are found within Tenerrdis and provide support for the hypotheses and create coherence between the model and the empirical results. The RBV, when applied to clusters, argues that through specialization, path-dependency of investments and social or knowledge exchanges clusters should enhance the performance and efficiency of their members (Anselin et al., 1997; Inkpen & Tsang, 2005; Wilk & Fensterseifer, 2003). Overall, the findings could entail that the set of capabilities specific to clusters, such as strategic alliances (Das & Teng, 2000) or their strategic and organizational resources (Amit & Schoemaker, 1993; Barney, 1991) promote this enhanced reactivity to demand shocks. Porter (2000) also argued that proximity to customers is an advantage of clusters, as it enhances their understanding of demand and helps them predict changes in needs. The latter is reflected in the geographic concentration of the Tenerrdis cluster and help explain the empirical findings.

7.2. Limitations and Further Research

Although the results were significant and coherent within the literature, this study still presents some limitations and provides room for further research to either confirm or more accurately pinpoint the origin of clusters' advantages. The first notable limitations are the sample size and the selection criteria for firms. Indeed, the companies included in the treatment group were mostly of medium to large size due to the impossibility to obtain data for start-ups or small firms through Orbis. McCann and Folta (2011) showed that firms' benefits from a cluster can differ depending on their sector, the company's age, or even their knowledge stocks. Further research could then focus on a larger sample with a wider variety of firms. A second limitation could originate from the fact that France has a very peculiar energy sector. In fact, it presents a unique combination of energy sources since France is heavily reliant on its nuclear reactors (IEA, n.d.). This specificity can represent a limitation for the generalizability of the empirical study since other countries might react differently to a similar law depending on their dependance on fossil fuels (Appendix G). A final potential limitation comes from the difference-in-difference model itself. In fact, concerns about temporal autocorrelation could arise and could be further tested to exclude any influence on the results.

A natural follow-up study would be to consider a wider time frame. In this thesis, data availability restricted the possible range, but a richer database could allow for more accurate pre-trend modelling combined with a larger set of firms. The latter would provide more detailed results. Furthermore, exploring other indicators, such as profit, patenting, or R&D spendings, could provide a more accurate picture of the advantages or influence that the Tenerrdis cluster, or any other agglomeration of companies, has on the firms that form it. As Wolman and Hincapie (2015) argue, many papers observe and draw conclusions only on the effect of clusters themselves. What this implies is that although clusters are shown to influence their members, the specific mechanisms that generate this performance advantage remain relatively vague. Further critical research would entail an attempt to separate and associate different mechanisms and characteristics of clusters. This would allow a quantification of their effects and an identification of the channels of impact to better understand and advise on public policies. Similarly, Ketels and Memedovic (2008) brought forward the idea that a better understanding of the functioning of clusters can help develop industrial policies that target them. This requirement for economic policy related to cluster formations echoes Porter's (2000) description of the crucial role that governments can and should play in providing support and guidance. Further research is required to broaden the scope of the understanding of clusters, from the impact governments can have to their specific mechanisms.

7.3. Conclusion and Implications

The implications of the findings of this thesis are varied. In fact, they confirm the growing interest that the last two decades have brought to clusters. Even with the growing globalization of the economy, as Porter (2000) mentions, location seems to still play a crucial role. In this empirical context, the RBV appears to help correctly hypothesize and predict the effects of clusters. The empirical results of this thesis add on to the growing literature that focuses on the advantages that clusters can present for firms. The findings further expand this idea by focusing on the ability of firms to react to positive demand shocks. Overall, clusters are of crucial interest nowadays, providing policymakers, managers, or economists with a framework to be studied and better understood. The results obtained in this thesis hint toward a wide set of unexplored growth possibilities in the form of cluster formations. This thesis attempts to fill a gap in the literature, namely the scarcity of papers that focus on the ability of clusters to influence their members' performance and growth in the presence of a positive demand shock. Academically, the use of the synthetic control method provides an alternative way of studying clusters. In addition to that, the direction of this paper is relatively novel, possibly prompting other researchers to look deeper into the specificities of clusters that impact their flexibility and rapidity of reaction. For policymakers, the empirical insights of this paper can provide additional information to develop specific policies targeting clusters. It can also provide arguments to promote further research to identify mechanisms within the framework of clusters and leverage them to further boost economic growth (Ketels & Memedovic, 2008). Managers, on the other hand, can use the findings of this paper, coupled with previous insights informing them on location choices and their importance, to make decisions on the geographical positioning of their firm. The results of this thesis can be combined with insights from Stam (2007) on the location of new firms or Porter (2000) on the impact of location on clusters to further solidify future managerial decisions. This could generate a large social impact as it could help advise future entrepreneurs and help reduce the uncertainty around start-ups, especially in the initial stages or during period of positive demand shocks.

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Appendix

Appendix A: Law for the energetic transition and green growth

The stated goal of the law 'Loi n° 2015-992 du 17 août 2015 relative à la transition énergétique pour la croissance verte' or 'law for the energetic transition and green growth', was to accelerate and structure the green energy transition in France. Through a set of goals and targets, the government attempted to guide France in a future direction that was compatible with the Paris Accords of 2015. The goals of the latter were to strengthen the fight against climate change through investments and economic efforts (UNFCCC, n.d.). The main objectives of this change to the national legislation were to promote the reduction of CO2 emissions through the increased use of renewable energies, the development of new and more efficient materials for construction, and finally, the empowerment of local governments in their control over the development of green projects. The law is composed of 215 articles. This section will highlight the ones that are relevant to the sectors of activity of the companies present in the dataset built, namely the consulting, energy production, construction, manufacturing, and services sectors.

The first article of the law highlights the future goals of the state regarding its greenhouse gas emissions, proposing for example a reduction of 30% by 2030 compared to 1990 and dividing those emissions by four by 2050 (LOI n° 2015-992, 2015). Additionally, this article presents a plan to gradually increase the cost of a ton of carbon emissions, with the goal of reaching 56 euros in 2020 and 100 euros by 2030 compared to its cost of 14,50 euros in 2015. Finally, the target for share of total energy produced by renewable energies is of 23% in 2020 and 32% by 2030 while reducing to 50% the share of nuclear power before 2025 and by 30% the share of electricity produced with fossil fuels by 2030 (LOI n° 2015-992, 2015). Overall, this article clearly favors companies that operate in the field of renewable energy, from the consulting sector for the conception of projects to the solar, wind, and gas energy production firms.

The set of articles composed of numbers 36, 37, 40, 41, 46 and 48 puts emphasis on the promotion of clean vehicles and means of transportation. Those articles promote the private use of green vehicles, electric or hydrogen-powered, through the creation of bonuses for individuals acquiring those vehicles. These bonuses will benefit the manufacturing sector by favoring production, as well as the energy sector with companies such as Air Liquide that specialize in the production of hydrogen, or companies specializing in electric and gas storage or distribution. Another notable impact of these articles is that they incentivize cities and local governments to develop projects for the transition of their transport infrastructures, creating demand for companies offering environmental and engineering consulting to create plans and projects to facilitate such transitions. The last part is enforced by implementing a minimum of 50% of the renewed means of transport being ‘low emission’ for public institutions and a minimum of 20% for national companies (LOI n° 2015-992, 2015).

Articles 3 and 20, instead create clear advantages for both businesses and individuals to favor energetically efficient and environmentally friendly materials in their buildings, offering tax reliefs and a special fund to further boost the adoption of new construction techniques. The stated goal is to incentivize the renewal of at least 500,000 buildings per year, clearly providing a demand increase in the construction sector (LOI n° 2015-992, 2015).

Finally, additional articles relevant to this paper’s topic are 52, 119, 121, 182, 188 and 199. Across them, the new legislation provides guidelines to expand and develop the infrastructure supporting the use and production of green energy. The installation of green electricity production structures, liquid gas transportation, solar energy fields, and the development of infrastructure and storage of hydrogen gas are examples of that. Additionally, articles 188 and 199 empower local institutions by providing them with tools and funds to support local projects, with the goal of reaching at least 200 experiments by 2017(LOI n° 2015-992, 2015). This initiative creates strong support for companies specializing in engineering and environmental consulting as well as for manufacturers of machinery and parts for electricity production and, finally, the energy companies themselves (LOI n° 2015-992, 2015).

Appendix B: The Green Growth Act

The legislation change was followed by a succession of concrete projects highlighted in a report from 2016 redacted by the French ministry of environment, energy, and the sea. This report presents the ambitions of France in its green energy transition, stipulating its goals and sector-specific projects. Some of the targets are to mitigate climate change while preparing for a post-oil era, finance the energy transition, and boost employment in target sectors. The objectives for employment creation are upward of 100,000 jobs, 75,000 in the energy renovation sector with 30,000 of them in the renewable energy sector in the short term, and overall, more than 200,000 jobs by 2030 (Ministry of Environment, Energy and the Sea, 2016). The latter creates an outstanding opportunity for the sectors active in the energetic transition. Those sectors are in fact further assisted by investments expected to boost GDP by 0.8% in 2020 and by more than 1.5% by 2030 (Ministry of Environment, Energy, and the Sea, 2016).

The initiatives from the Green Growth Act were intended to further implement the objectives highlighted in the law from 2015. As mentioned in the previous part, the renewable energy share of total electricity production should be 23% by 2020. This target is also in line with the initiative of placing a ceiling on the amount of energy generated by nuclear power. This renewable energy focus is assisted by an energy transition tax credit of up to 8,000 euros, an interest-free eco-loan of 30,000 euros and, a 'constructability bonus' for buildings that respect strict energy consumption and efficiency standards. These initiatives and the 'Habiter mieux' program and its objective of renovating over 70,000 homes by 2016 have the goal of promoting the transition within the housing and construction sectors (Ministry of Environment, Energy and the Sea, 2016).

An important empowerment of regional governments comes in the form of large new funds to support local projects. For example, a 400-million-euro investment fund that supports solar energy and geothermal projects and companies was created (Ministry of Environment, Energy and the Sea, 2016). Another notable achievement was the support of over 350 photovoltaic installation projects. Overall, the Green Growth Act report highlights how the ramification of the effects of the law on environmental transition from 2015 will heavily impact companies from 2016 onwards. The necessity for consulting and engineering services', the collaboration of energy companies benefiting from the tightening limitations on emission, the innovation in renewable energies and, the involvement of the construction sector, show that the regulation change has the potential to benefit a large variety of companies and industries.

Appendix C: Difference in Difference Results for Hypothesis 1

	Log of turnover per employee
Post law	0.047**
	(0.017)
Interaction Cluster and Post law	0.106**
	(0.053)
Constant	12.428***
	(0.013)
Observations	372

Notes: standard deviations are in parentheses. The significance at the 1 percent level is represented by ***, significance at the 5 percent level is shown by **, and the significance level at the 10 percent level is indicated by *

Appendix D: Difference in Difference Results for Hypothesis 2

	Log of assets per employee
Post law	-0.167***
	(0.035)
Interaction Cluster and Post law	0.27***
	(0.064)
Constant	12.61***
	(0.016)
Observations	372

Notes: standard deviations are in parentheses. The significance at the 1 percent level is represented by ***, significance at the 5 percent level is shown by **, and the significance level at the 10 percent level is indicated by *

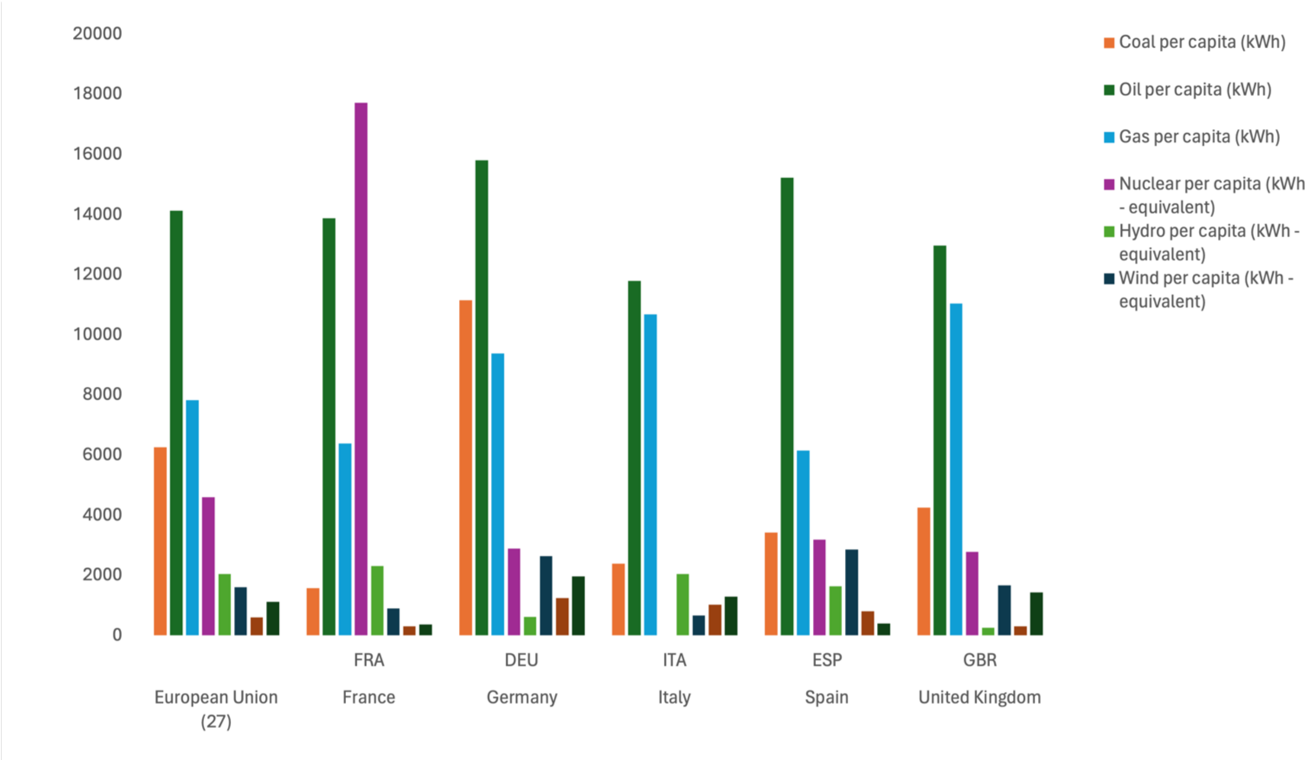
Appendix E: Results of Hausman test for hypothesis 1

Variable	Fixed effects (FE)	Random effects (RE)	Difference (FE - RE)	Std. Error of Difference
Post law	0.0466729	0.0467094	-0.0000365	0.0020562
Interaction Cluster and Post law	0.1061886	0.1061156	0.000073	0.0037173

Appendix F: Results of the Hausman test for hypothesis 2

Variable	Fixed effects (FE)	Random effects (RE)	Difference (FE - RE)	Std. Error of Difference
Post law	-0.1674508	-0.1669894	-0.0004613	0.0031299
Interaction Cluster and Post law	0.2701777	0.2692551	0.0009227	0.0057106

Appendix G: Energy mix of several European countries in 2015



Notes: Data was obtained from Ourworldindata.org and their article on energy mixes.

Appendix H: Synthetic control weights for hypothesis 1 (1/3)

Company id	1	2	3	4	5	6	7	8	9	10
32	0.022	0.021	0.004	0	0.005	0.012	0.035	0.018	0.011	0.001
33	0.02	0.017	0.006	0.002	0.007	0.017	0.014	0.019	0.016	0.002
34	0.152	0.018	0.143	0.426	0.077	0.008	0.116	0.013	0.009	0.233
35	0.016	0.01	0.018	0.008	0.018	0.019	0.012	0.01	0.008	0.006
36	0.07	0.258	0.002	0	0.002	0.013	0.014	0.186	0.027	0
37	0.02	0.02	0.005	0.001	0.006	0.018	0.015	0.022	0.017	0.001
38	0.016	0.01	0.043	0.225	0.05	0.014	0.014	0.009	0.007	0.468
39	0.021	0.017	0.006	0.002	0.009	0.012	0.019	0.016	0.012	0.002
40	0.021	0.016	0.006	0.003	0.01	0.013	0.016	0.016	0.013	0.003
41	0.024	0.022	0.004	0.001	0.006	0.013	0.016	0.022	0.017	0.001
42	0.017	0.013	0.01	0.004	0.012	0.016	0.017	0.012	0.01	0.003
43	0.017	0.015	0.007	0.002	0.007	0.021	0.022	0.015	0.011	0.001
44	0.02	0.015	0.007	0.003	0.01	0.014	0.015	0.016	0.014	0.003
45	0.021	0.017	0.006	0.002	0.009	0.013	0.019	0.015	0.012	0.002
46	0.02	0.012	0.013	0.006	0	0.021	0.01	0.012	0.037	0.001
47	0.022	0.021	0.005	0.001	0.006	0.016	0.014	0.024	0.02	0.001
48	0.019	0.014	0.009	0.004	0.012	0.015	0.015	0.014	0.012	0.003
49	0.021	0.02	0.005	0.002	0.006	0.015	0.015	0.021	0.017	0.001
50	0.024	0.022	0.004	0.001	0.006	0.013	0.017	0.021	0.015	0.001
51	0.02	0.018	0.006	0.002	0.007	0.018	0.014	0.021	0.018	0.001
52	0.018	0.014	0.009	0.003	0.01	0.016	0.018	0.014	0.011	0.002
53	0.017	0.011	0.018	0.009	0.02	0.015	0.014	0.011	0.009	0.008
54	0.02	0.018	0.006	0.002	0.007	0.02	0.012	0.022	0.021	0.001
55	0.018	0.013	0.011	0.005	0.015	0.013	0.021	0.012	0.01	0.004
56	0.011	0.005	0.298	0.243	0.281	0.174	0.118	0.005	0.005	0.053
57	0.019	0.013	0.01	0.004	0.014	0.014	0.017	0.013	0.011	0.004
58	0.018	0.013	0.011	0.004	0.013	0.016	0.015	0.013	0.011	0.004
59	0.035	0.094	0.243	0.006	0.259	0.014	0.01	0.115	0.329	0.159
60	0.014	0.04	0.002	0	0.002	0.173	0.159	0.05	0.013	0
61	0.017	0.012	0.011	0.005	0.012	0.019	0.012	0.014	0.013	0.003
62	0.022	0.017	0.005	0.002	0.01	0.013	0.015	0.017	0.015	0.002
63	0.026	0.026	0.003	0.001	0.004	0.014	0.014	0.03	0.022	0.001
64	0.024	0.019	0.003	0	0.009	0.01	0.022	0.016	0.012	0.003
65	0.02	0.016	0.006	0.002	0.009	0.015	0.015	0.017	0.015	0.002
66	0.023	0.022	0.004	0.001	0.006	0.013	0.018	0.021	0.015	0.001
67	0.02	0.019	0.005	0.002	0.006	0.017	0.014	0.021	0.017	0.001
68	0.019	0.014	0.009	0.004	0.011	0.015	0.015	0.014	0.013	0.003
69	0.015	0.011	0.013	0.005	0.013	0.022	0.013	0.012	0.01	0.003
70	0.02	0.014	0.009	0.004	0.014	0.012	0.021	0.012	0.01	0.004
71	0.022	0.02	0.005	0.002	0.005	0.082	0.011	0.059	0.127	0.001
72	0.019	0.014	0.01	0.004	0.013	0.014	0.017	0.013	0.011	0.004

Appendix H: Synthetic control weights for hypothesis 1 (2/3)

Company id	11	12	13	14	15	16	17	18	19	20	21
32	0.021	0.022	0	0.003	0	0	0.011	0	0.011	0.018	0.009
33	0.024	0.023	0	0.003	0	0	0.015	0	0.019	0.019	0.014
34	0.019	0.021	0	0.002	0	0.532	0.141	0.069	0.011	0.064	0.01
35	0.026	0.02	0	0.001	0	0	0.027	0	0.027	0.017	0.024
36	0.02	0.051	1	0.778	0	0.244	0.009	0	0.008	0.073	0.005
37	0.024	0.025	0	0.004	0	0	0.012	0	0.017	0.019	0.012
38	0.024	0.019	0	0.001	0.665	0	0.051	0.715	0.025	0.018	0.023
39	0.022	0.022	0	0.003	0	0	0.016	0	0.016	0.021	0.013
40	0.022	0.022	0	0.003	0	0	0.018	0	0.017	0.022	0.014
41	0.022	0.025	0	0.004	0	0	0.013	0	0.014	0.025	0.011
42	0.024	0.02	0	0.002	0	0	0.018	0	0.021	0.017	0.018
43	0.025	0.021	0	0.002	0	0	0.013	0	0.02	0.015	0.015
44	0.023	0.022	0	0.002	0	0	0.018	0	0.019	0.021	0.016
45	0.022	0.022	0	0.003	0	0	0.015	0	0.016	0.02	0.013
46	0.028	0.027	0	0.003	0	0	0.028	0	0.028	0.024	0.032
47	0.023	0.026	0	0.004	0	0	0.013	0	0.017	0.022	0.013
48	0.023	0.022	0	0.002	0	0	0.02	0	0.02	0.02	0.017
49	0.023	0.024	0	0.004	0	0	0.014	0	0.017	0.021	0.013
50	0.021	0.025	0	0.004	0	0	0.013	0	0.013	0.024	0.01
51	0.024	0.025	0	0.004	0	0	0.014	0	0.019	0.02	0.014
52	0.024	0.021	0	0.002	0	0	0.016	0	0.02	0.017	0.017
53	0.024	0.02	0	0.001	0	0	0.03	0	0.024	0.018	0.022
54	0.025	0.026	0	0.004	0	0	0.015	0	0.021	0.021	0.016
55	0.023	0.02	0	0.002	0	0	0.02	0	0.019	0.018	0.017
56	0.04	0.016	0	0	0.234	0	0.057	0.216	0.186	0.012	0.286
57	0.023	0.021	0	0.002	0	0	0.02	0	0.02	0.019	0.017
58	0.024	0.021	0	0.002	0	0	0.02	0	0.022	0.018	0.019
59	0.024	0.037	0	0.105	0.101	0.223	0.136	0	0.024	0.112	0.121
60	0.026	0.027	0	0	0	0	0.007	0	0.013	0.011	0.007
61	0.026	0.022	0	0.002	0	0	0.022	0	0.025	0.019	0.021
62	0.022	0.023	0	0.003	0	0	0.018	0	0.017	0.025	0.014
63	0.022	0.03	0	0.007	0	0	0.012	0	0.014	0.029	0.01
64	0.021	0.022	0	0.003	0	0	0.015	0	0.012	0.026	0.011
65	0.023	0.023	0	0.003	0	0	0.017	0	0.018	0.021	0.015
66	0.022	0.024	0	0.004	0	0	0.012	0	0.013	0.022	0.01
67	0.024	0.024	0	0.003	0	0	0.014	0	0.018	0.02	0.013
68	0.024	0.022	0	0.002	0	0	0.019	0	0.021	0.019	0.017
69	0.027	0.02	0	0.001	0	0	0.02	0	0.026	0.016	0.022
70	0.022	0.02	0	0.002	0	0	0.019	0	0.018	0.019	0.016
71	0.051	0.054	0	0.018	0	0	0.013	0	0.093	0.019	0.017
72	0.023	0.021	0	0.002	0	0	0.02	0	0.02	0.019	0.017

Appendix H: Synthetic control weights for hypothesis 1 (3/3)

Company id	22	23	24	25	26	27	28	29	30	31
32	0.018	0.001	0.015	0.006	0.004	0.023	0.011	0.022	0.006	0.022
33	0.015	0.003	0.013	0.009	0.01	0.021	0.017	0.02	0.012	0.022
34	0.111	0.001	0.011	0.13	0.004	0.032	0.159	0.019	0.11	0.019
35	0.014	0.006	0.007	0.022	0.017	0.019	0.031	0.013	0.026	0.014
36	0.018	0.001	0.353	0.002	0.003	0.038	0.009	0.166	0.003	0.1
37	0.014	0.002	0.017	0.006	0.009	0.021	0.014	0.023	0.009	0.024
38	0.016	0.005	0.006	0.034	0.012	0.02	0.04	0.012	0.035	0.013
39	0.02	0.002	0.012	0.01	0.007	0.023	0.016	0.019	0.012	0.02
40	0.021	0.002	0.011	0.012	0.008	0.023	0.019	0.019	0.014	0.02
41	0.019	0.002	0.017	0.006	0.006	0.025	0.014	0.025	0.008	0.025
42	0.015	0.004	0.009	0.014	0.011	0.02	0.021	0.015	0.017	0.016
43	0.012	0.003	0.012	0.008	0.01	0.018	0.015	0.016	0.011	0.018
44	0.019	0.003	0.011	0.012	0.009	0.022	0.019	0.018	0.015	0.02
45	0.019	0.002	0.012	0.01	0.007	0.023	0.016	0.019	0.012	0.019
46	0.015	0.52	0.012	0.019	0.102	0.02	0.039	0.017	0.023	0.035
47	0.016	0.002	0.017	0.007	0.008	0.023	0.015	0.024	0.009	0.026
48	0.017	0.003	0.01	0.014	0.01	0.021	0.021	0.017	0.017	0.018
49	0.017	0.002	0.015	0.007	0.008	0.023	0.015	0.023	0.01	0.024
50	0.02	0.002	0.016	0.006	0.005	0.026	0.013	0.024	0.008	0.024
51	0.015	0.003	0.015	0.008	0.01	0.022	0.016	0.022	0.011	0.024
52	0.014	0.003	0.01	0.011	0.01	0.02	0.019	0.016	0.014	0.017
53	0.016	0.004	0.007	0.023	0.013	0.02	0.03	0.013	0.026	0.015
54	0.015	0.003	0.015	0.009	0.013	0.021	0.018	0.022	0.012	0.025
55	0.018	0.003	0.009	0.016	0.009	0.021	0.022	0.015	0.018	0.016
56	0.006	0.35	0.003	0.168	0.291	0.016	0.084	0.006	0.301	0.008
57	0.018	0.003	0.009	0.015	0.009	0.021	0.022	0.016	0.018	0.017
58	0.016	0.004	0.009	0.015	0.011	0.021	0.023	0.015	0.019	0.017
59	0.241	0	0.132	0.268	0.225	0.109	0.036	0.086	0.061	0.067
60	0.01	0.001	0.031	0.002	0.019	0.016	0.008	0.041	0.003	0.046
61	0.015	0.005	0.009	0.017	0.016	0.02	0.025	0.016	0.021	0.018
62	0.022	0.002	0.012	0.011	0.007	0.024	0.018	0.02	0.014	0.021
63	0.018	0.002	0.023	0.005	0.006	0.027	0.013	0.03	0.007	0.032
64	0.028	0.002	0.013	0.009	0.005	0.027	0.014	0.021	0.009	0.021
65	0.018	0.003	0.012	0.01	0.009	0.022	0.018	0.019	0.013	0.021
66	0.018	0.002	0.016	0.006	0.005	0.024	0.013	0.024	0.008	0.024
67	0.015	0.002	0.015	0.007	0.009	0.022	0.015	0.022	0.01	0.023
68	0.017	0.003	0.01	0.013	0.011	0.021	0.021	0.017	0.016	0.018
69	0.012	0.006	0.008	0.016	0.018	0.019	0.024	0.013	0.02	0.015
70	0.02	0.003	0.01	0.015	0.008	0.022	0.021	0.016	0.017	0.017
71	0.013	0.029	0.043	0.007	0.038	0.02	0.015	0.026	0.01	0.044
72	0.018	0.003	0.009	0.015	0.009	0.021	0.021	0.016	0.018	0.017

Appendix I: Synthetic control weights for hypothesis 2 (1/3)

Company id	1	2	3	4	5	6	7	8	9	10
32	0.007	0.021	0.002	0.018	0	0	0.595	0.017	0.018	0.306
33	0.009	0.018	0.004	0.023	0	0.184	0	0.021	0.021	0.261
34	0.006	0.025	0.001	0.016	0	0	0.149	0.015	0.018	0
35	0.521	0.019	0.198	0.022	0	0.659	0.001	0.035	0.126	0
36	0.01	0.026	0.002	0.024	0	0	0.003	0.018	0.022	0
37	0.01	0.024	0.002	0.022	0	0	0.003	0.018	0.021	0
38	0.011	0.032	0.001	0.027	0	0	0.004	0.016	0.027	0
39	0.01	0.025	0.002	0.026	0	0	0.003	0.018	0.023	0
40	0.006	0.021	0.003	0.023	0	0	0.001	0.022	0.015	0
41	0.009	0.027	0.002	0.021	0	0	0.004	0.017	0.022	0
42	0.004	0.019	0.025	0.022	0.004	0	0.001	0.04	0.014	0
43	0.009	0.026	0.002	0.053	0	0	0.007	0.016	0.022	0
44	0.009	0.023	0.003	0.024	0	0	0.002	0.022	0.018	0
45	0.008	0.024	0.003	0.021	0	0	0.002	0.021	0.017	0
46	0	0.017	0.001	0.074	0.002	0	0.001	0.027	0.017	0
47	0.008	0.023	0.002	0.023	0	0	0.002	0.019	0.019	0
48	0.004	0.018	0.009	0.023	0.001	0	0.001	0.029	0.013	0
49	0.009	0.029	0.001	0.022	0	0	0.006	0.016	0.025	0
50	0.006	0.022	0.003	0.022	0	0	0.002	0.02	0.015	0
51	0.011	0.021	0.004	0.022	0	0	0.001	0.022	0.021	0
52	0.005	0.02	0.032	0.022	0.003	0	0.001	0.043	0.017	0
53	0.003	0.019	0.342	0.023	0.496	0	0.001	0.044	0.011	0
54	0.01	0.024	0.005	0.023	0.001	0	0.001	0.028	0.019	0
55	0.004	0.017	0.004	0.022	0.001	0	0	0.023	0.013	0
56	0.005	0.024	0.002	0.031	0	0	0.002	0.02	0.015	0
57	0.005	0.019	0.003	0.022	0	0	0.001	0.022	0.014	0
58	0.004	0.02	0.295	0.023	0.462	0	0.001	0.072	0.014	0
59	0.006	0.022	0.003	0.031	0	0	0.002	0.022	0.015	0
60	0.019	0.08	0.001	0.013	0	0	0.047	0.013	0.106	0
61	0.009	0.023	0.004	0.022	0.001	0	0.002	0.024	0.018	0
62	0.005	0.021	0.003	0.023	0	0	0.001	0.022	0.013	0
63	0.009	0.025	0.002	0.022	0	0	0.003	0.018	0.021	0
64	0.006	0.024	0.002	0.018	0	0	0.003	0.018	0.017	0
65	0.009	0.026	0.002	0.022	0	0	0.004	0.017	0.022	0
66	0.007	0.021	0.003	0.023	0	0	0.002	0.022	0.016	0
67	0.007	0.021	0.005	0.022	0.001	0	0.001	0.027	0.017	0
68	0.134	0.035	0.01	0.023	0.02	0	0.001	0.055	0.04	0
69	0.009	0.022	0.004	0.023	0.001	0	0.001	0.024	0.019	0
70	0.005	0.022	0.004	0.02	0.001	0	0.001	0.025	0.013	0
71	0.071	0.036	0.001	0.022	0	0.157	0.137	0.013	0.072	0.433
72	0.005	0.019	0.003	0.022	0	0	0	0.02	0.014	0

Appendix I: Synthetic control weights for hypothesis 2 (2/3)

Company id	11	12	13	14	15	16	17	18	19	20	21
32	0.007	0.001	0.467	0.002	0	0.1	0	0	0.02	0.005	0.015
33	0.012	0.001	0.238	0.002	0	0	0	0.174	0.134	0.005	0.018
34	0.006	0.373	0	0.442	0	0.011	0	0	0.016	0.007	0.014
35	0.205	0.001	0	0.002	0	0	0	0.531	0.138	0.005	0.164
36	0.007	0.004	0	0.005	0	0	0	0	0.017	0.008	0.018
37	0.008	0.003	0	0.004	0	0	0	0	0.019	0.008	0.018
38	0.006	0.076	0	0.007	0	0	0	0	0.015	0.01	0.019
39	0.008	0.003	0	0.004	0	0	0	0	0.018	0.008	0.019
40	0.012	0.002	0	0.002	0	0	0	0	0.019	0.008	0.017
41	0.007	0.005	0	0.004	0	0	0	0	0.017	0.008	0.017
42	0.045	0.001	0	0.001	0	0	0	0	0.018	0.009	0.015
43	0.006	0.003	0	0.003	0	0	0	0	0.017	0.006	0.016
44	0.011	0.002	0	0.003	0	0	0	0	0.019	0.01	0.02
45	0.01	0.002	0	0.003	0	0	0	0	0.017	0.013	0.019
46	0.032	0.001	0	0.001	0.048	0	0	0	0.042	0.005	0.014
47	0.009	0.003	0	0.003	0	0	0	0	0.018	0.008	0.018
48	0.025	0.001	0	0.001	0	0	0	0	0.019	0.008	0.015
49	0.006	0.006	0	0.005	0	0	0	0	0.016	0.007	0.017
50	0.01	0.002	0	0.002	0	0	0	0	0.017	0.01	0.016
51	0.012	0.002	0	0.002	0	0	0	0	0.023	0.007	0.021
52	0.042	0.001	0	0.001	0	0	0	0	0.02	0.007	0.015
53	0.228	0.001	0	0.001	0.952	0	0.586	0	0.017	0.005	0.013
54	0.016	0.002	0	0.002	0	0	0	0	0.019	0.015	0.025
55	0.015	0.001	0	0.001	0	0	0	0	0.022	0.006	0.014
56	0.009	0.069	0	0.003	0	0	0.195	0	0.015	0.033	0.015
57	0.011	0.001	0	0.002	0	0	0	0	0.019	0.008	0.015
58	0.067	0.001	0	0.001	0	0	0	0	0.017	0.011	0.013
59	0.011	0.002	0	0.002	0	0	0	0	0.018	0.011	0.017
60	0.003	0.405	0	0.215	0	0	0	0	0.014	0.006	0.019
61	0.013	0.002	0	0.003	0	0	0	0	0.019	0.011	0.021
62	0.011	0.002	0	0.002	0	0	0	0	0.017	0.012	0.015
63	0.007	0.004	0	0.004	0	0	0	0	0.018	0.008	0.018
64	0.007	0.004	0	0.003	0	0	0	0	0.017	0.009	0.015
65	0.007	0.004	0	0.004	0	0	0	0	0.017	0.008	0.018
66	0.011	0.002	0	0.002	0	0	0	0	0.019	0.008	0.018
67	0.017	0.001	0	0.002	0	0	0	0	0.02	0.009	0.019
68	0.04	0.001	0	0.002	0	0	0	0	0.019	0.23	0.166
69	0.013	0.002	0	0.002	0	0	0	0	0.02	0.008	0.021
70	0.014	0.002	0	0.002	0	0	0	0	0.016	0.429	0.015
71	0.004	0.001	0.294	0.242	0	0	0	0.296	0.019	0.004	0.021
72	0.01	0.001	0	0.002	0	0.889	0.218	0	0.019	0.007	0.014

Appendix I: Synthetic control weights for hypothesis 2 (3/3)

Company id	22	23	24	25	26	27	28	29	30	31
32	0.017	0	0.009	0.002	0	0.016	0	0.022	0.005	0.012
33	0.027	0	0.003	0.004	0	0.017	0	0.029	0.187	0.015
34	0.013	0	0.264	0.001	0	0.016	0.044	0.018	0.002	0.011
35	0.032	0	0.002	0.164	0	0.019	0	0.026	0.004	0.02
36	0.013	0	0.009	0.002	0	0.017	0	0.017	0.002	0.011
37	0.014	0	0.007	0.002	0	0.017	0	0.019	0.002	0.012
38	0.01	0	0.015	0.001	0	0.016	0	0.015	0.001	0.009
39	0.013	0	0.008	0.002	0	0.017	0	0.018	0.002	0.011
40	0.02	0	0.004	0.003	0	0.021	0	0.023	0.003	0.017
41	0.012	0	0.012	0.002	0	0.016	0	0.017	0.002	0.01
42	0.04	0	0.002	0.025	0	0.031	0	0.031	0.005	0.038
43	0.012	0	0.015	0.002	0	0.015	0	0.017	0.002	0.01
44	0.017	0	0.005	0.003	0	0.021	0	0.021	0.002	0.015
45	0.016	0	0.006	0.003	0	0.021	0	0.02	0.002	0.015
46	0.097	0	0.002	0.037	0	0.019	0	0.084	0.055	0.046
47	0.015	0	0.007	0.002	0	0.019	0	0.02	0.002	0.013
48	0.04	0	0.002	0.01	0	0.027	0	0.035	0.005	0.035
49	0.011	0	0.016	0.001	0	0.015	0	0.016	0.001	0.009
50	0.017	0	0.006	0.003	0	0.021	0	0.022	0.003	0.017
51	0.019	0	0.004	0.004	0	0.019	0	0.022	0.003	0.014
52	0.032	0	0.002	0.026	0	0.026	0	0.027	0.004	0.027
53	0.108	0.839	0.002	0.585	1	0.117	0	0.039	0.02	0.28
54	0.017	0	0.004	0.004	0	0.024	0	0.021	0.002	0.016
55	0.081	0	0.003	0.005	0	0.021	0	0.061	0.642	0.024
56	0.015	0.047	0.038	0.002	0	0.025	0	0.02	0.002	0.022
57	0.024	0	0.004	0.003	0	0.022	0	0.027	0.004	0.02
58	0.039	0	0.002	0.058	0	0.034	0	0.029	0.005	0.04
59	0.018	0	0.005	0.003	0	0.022	0	0.022	0.002	0.017
60	0.007	0	0.472	0.001	0	0.012	0	0.012	0.001	0.005
61	0.017	0	0.004	0.003	0	0.022	0	0.021	0.002	0.015
62	0.021	0	0.005	0.003	0	0.023	0	0.024	0.003	0.023
63	0.013	0	0.009	0.002	0	0.017	0	0.018	0.002	0.011
64	0.014	0	0.012	0.002	0	0.018	0	0.019	0.002	0.013
65	0.013	0	0.01	0.002	0	0.017	0	0.017	0.002	0.011
66	0.019	0	0.004	0.003	0	0.021	0	0.023	0.003	0.016
67	0.022	0	0.003	0.005	0	0.023	0	0.024	0.003	0.018
68	0.016	0	0.003	0.006	0	0.026	0	0.019	0.001	0.014
69	0.019	0	0.004	0.004	0	0.021	0	0.022	0.002	0.015
70	0.02	0	0.005	0.004	0	0.096	0	0.023	0.002	0.05
71	0.008	0	0.006	0.001	0	0.012	0	0.013	0.001	0.006
72	0.024	0.114	0.005	0.003	0	0.021	0.956	0.027	0.005	0.019